INTERNATIONAL STANDARD ISO 3746

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Acoustics — Determination of sound power levels of noise sources — Survey method

Acoustique — Détermination des niveaux de puissance acoustique émis par les sources de bruit — Méthode de contrôle

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (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 set up 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 3746 was developed by Technical Committee ISO/TC 43, *Acoustics*, and was circulated to the member bodies in June 1976.

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

Australia	Israel	Romania
Belgium	Italy	South Africa, Rep. of
Brazil	Korea, Rep. of	Spain
Canada	Mexico	Sweden
Denmark	Netherlands	Switzerland
Finland	New Zealand	Turkey
France	Norway	United Kingdom
Hungary	Philippines	USA
India	Poland	USSR

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Czechoslovakia
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0.1 RELATED INTERNATIONAL STANDARDS

This International Standard is one of a series specifying various methods for determining the sound power levels of machines and equipment. These basic documents specify only the acoustical requirements for measurements appropriate for different test environments as shown in table 1.

When applying these basic documents, it is necessary to decide which one is most appropriate for the conditions and purposes of the test. The operating and mounting conditions of the machine or equipment to be tested must be in accordance with the general principles stated in the basic documents.

Guidelines for making these decisions are provided in ISO 3740. *If no sound test code is specified for a particular machine,* the mounting and operating conditions shall be fully described in the test report.

TABLE 1 — **International Standards specifying various methods for determining the sound power levels of machines and equipment**

<table>
<tr><th>International Standard No.*</th><th>Classification of method</th><th>Test environment</th><th>Volume of source</th><th>Character of noise</th><th>Sound power levels obtainable</th><th>Optional information available</th></tr>
<tr><td>3741</td><td rowspan="2">Precision</td><td rowspan="2">Reverberation room meeting specified requirements</td><td rowspan="3">Preferably less than 1 % of test room volume</td><td>Steady, broad-band</td><td rowspan="2">In one-third octave or octave bands</td><td rowspan="2">A-weighted sound power level</td></tr>
<tr><td>3742</td><td>Steady, discrete-frequency or narrow-band</td></tr>
<tr><td>3743</td><td>Engineering</td><td>Special reverberation test room</td><td>Steady, broad-band, narrow-band, or discrete-frequency</td><td>A-weighted and in octave bands</td><td>Other weighted sound power levels</td></tr>
<tr><td>3744</td><td>Engineering</td><td>Outdoors or in large room</td><td>Greatest dimension less than 15 m</td><td>Any</td><td rowspan="2">A-weighted and in one-third octave or octave bands</td><td rowspan="2">Directivity information and sound pressure levels as a function of time; other weighted sound power levels</td></tr>
<tr><td>3745</td><td>Precision</td><td>Anechoic or semi-anechoic room</td><td>Preferably less than 0,5 % of test room volume</td><td>Any</td></tr>
<tr><td>3746</td><td>Survey</td><td>No special test environment</td><td>No restrictions : limited only by available test environment</td><td>Steady, broad-band, narrow-band, or discrete-frequency</td><td>A-weighted</td><td>Sound pressure levels as a function of time; other weighted sound power levels</td></tr>
</table>

* See clause 2.

0.2 SYNOPSIS OF ISO 3746

Applicability

Test environment

Installation (indoors or outdoors) meeting prescribed requirements.

Type of source

Device, machine, component, subassembly.

Size of noise source

No restrictions.

Character of noise radiated by the source

Steady; broad-band, discrete-frequency or narrow-band.

Accuracy

Survey (standard deviation for determining A-weighted sound power levels is about 5 dB for discrete tone sources and 4 dB for sources which radiate steady, broad-band noise).

Quantities to be measured

Weighted sound pressure levels at prescribed microphone positions.

Quantities to be determined

Weighted sound power level : A-weighting is required; other weightings are optional.

0.3 INTRODUCTION

This International Standard specifies a survey method for determining the weighted sound power level of a device or machine. The sound power level of the source is calculated from the measured values of the weighted sound pressure levels at prescribed microphone positions. The method specified in this International Standard is particularly useful for rating the sound output of a source that produces steady noise (as defined in ISO 2204) and cannot be moved from its location to a special test environment.

The method requires measurement of the A-weighted sound pressure level at four or more microphone positions located on a hypothetical measurement surface which envelops the source. One of two alternative measurement surfaces may be selected, either a hemisphere or a rectangular parallelepiped. The hemispherical surface is best suited for measurement of the noise emitted by small sources as well as that emitted by larger sources which are approximately cubical in shape. The rectangular parallelepiped is best suited for long or tall sound sources as well as for those situations in which measurements must be carried out close to the source. This may occur when use of the hemispherical surface leads to microphone positions that are not sufficiently far away from reflecting surfaces, when measured levels with the source in operation are close to the background noise levels, or when other unfavorable environmental conditions are present. In general, the hemispherical surface is preferred when the measuring distance is large compared to the dimensions of the source and the rectangular parallelepiped is preferred for close-in measurements.

The method specified in this International Standard yields physical data that may be useful for

a) comparing machines which are similar in size and kind:

b) rating apparatus in terms of its overall weighted sound power output.

This method should not be used when it is feasible to use a more precise method, for example, when a laboratory semi-anechoic room is available for the measurements.

The method specified in this International Standard requires that the background noise be lower than the noise produced by the source.

The annex gives a procedure for qualifying the acoustic environment for the purposes of measurements made according to the requirements of this International Standard. If the test environment does not meet the requirements of the annex, the method specified in this International Standard shall not be used for determining the sound power level of a source.

The method specified in this International Standard permits the determination of the A-weighted sound power level of a noise source. If additional information is required, for example, the sound power levels in frequency bands, ISO 3744 should be used.

This International Standard, together with the others in this series (see table 1), supersedes ISO/R 495.

1 SCOPE AND FIELD OF APPLICATION

1.1 General

This International Standard specifies a survey method for measuring the weighted sound pressure levels at prescribed microphone positions around a noise source. The A-weighted sound power level of the source is calculated from the measured values. This method may be applied *in situ* to sources which cannot be moved to a special test environment and to which the methods specified in ISO 3741, ISO 3742, ISO 3743, ISO 3744 and ISO 3745 cannot be applied or should not be applied because they require too much effort.

1.2 Field of application

1.2.1 *Types of noise*

This International Standard applies to sources which radiate broad-band noise, narrow-band noise, discrete tones and combinations thereof. The procedures specified in this International Standard are primarily applicable to sources that radiate steady noise. These procedures may also be applied to sources that radiate non-steady noise as defined in ISO 2204, with the exception of an isolated burst of sound energy or a burst train with a repetition rate less than 5 per second.

1.2.2 *Size of source*

The method specified in this International Standard does not restrict the volume of the noise source. However, if the measurements are made indoors, the volume of the test room must be sufficiently larger than the volume of the source to permit the microphones to be located as specified in clause 7.

1.3 Measurement uncertainty

Measurements made in conformity with this International Standard tend to result in standard deviations which are equal to or less than those given in table 2.

TABLE 2 — **Uncertainty in determining A-weighted sound power level by the survey method**

Application	Standard deviation dB
For a source which produces sounds that contain prominent discrete tones	5
For a source which produces sounds that are uniformly distributed in frequency over the frequency range of interest	4

NOTES

1 If the method specified in this International Standard is used to compare the sound power levels of similar machines that are omnidirectional and radiate broad-band noise, the uncertainty in this comparison tends to result in a standard deviation which is equal to less than 3 dB, provided that the measurements are performed in the same environment.

2 The standard deviations given in this table reflect the cumulative effects of all causes of measurement uncertainty, excluding variations in the sound power level from machine to machine or from test to test which may be caused, for example, by changes in the mounting or operating conditions of the source. The reproducibility and repeatability of the test results may be considerably better (i.e., smaller standard deviations) than the uncertainties given in table 2 would indicate.

2 REFERENCES

ISO 266, *Preferred frequencies for acoustical measurements.*

ISO/R 354, *Measurement of absorption coefficients in a reverberation room.*

ISO 2204, *Acoustics — Guide to the measurement of airborne acoustical noise and evaluation of its effects on man.*

ISO 3740, *Acoustics — Determination of sound power level of noise sources — Guidelines for the use of basic International 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 3743, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for special reverberation test rooms.*

ISO 3744, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for free-field conditions over a reflecting plane.*[1)]

ISO 3745, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-anechoic rooms.*

IEC Publication 179, *Precision sound level meters.*

IEC Publication 179A, First supplement to Publication 179, *Additional characteristics for the measurement of impulsive sounds.*

IEC Publication 225, *Octave, half-octave and third-octave band filters intended for the analysis of sound and vibrations.*

3 DEFINITIONS

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

3.1 sound pressure level, L_p, in decibels : Twenty times the logarithm to the base 10 of the ratio of the sound pressure to the reference sound pressure. The weighting network used shall be indicated : for example, A-weighted sound pressure level, L_{pA}. The reference sound pressure is 20 µPa.

3.2 A-weighted surface sound pressure level, $\overline{L_{pA}}$, in decibels : The A-weighted sound pressure level averaged over the measurement surface as required in clause 8.

3.3 sound power level, L_W, in decibels : Ten times the logarithm to the base 10 of the ratio of a given sound power to the reference sound power. The weighting network used shall be indicated : for example, A-weighted sound power level, L_{WA}. The reference sound power is 1 pW (= 10^{-12} W).

1) At present at the stage of draft.

3.4 measurement surface : A hypothetical surface of area *S* enveloping the source on which the microphone positions are located.

3.5 reference surface : A hypothetical surface which is the smallest rectangular parallelepiped (i.e., rectangular box) that just encloses the source and terminates on the reflecting plane.

3.6 measurement distance : The distance between the reference surface and the measurement surface.

3.7 background noise : The A-weighted sound pressure level at each microphone position with the source inoperative.

4 ACOUSTIC ENVIRONMENT

4.1 Criteria for adequacy of the test environment

Ideally, the test environment should be free from reflecting objects other than a reflecting plane so that the source radiates into a free field over a reflecting plane. Test environments that are suitable for measurements according to this International Standard include a flat outdoor area and a room which meets the qualification requirements of the annex. If indoors, the test environment shall be adequately isolated from extraneous noise (see 4.2). The annex specifies a procedure for determining whether or not a test environment is adequate for measurements made according to this International Standard.

4.2 Criterion for background noise

At the microphone positions, the A-weighted sound pressure level due to the background noise shall be at least 3 dB below the A-weighted sound pressure level with the source operating.

NOTE — Background noise levels which are less than 3 dB below the sound level of the source to be measured are too high for the purposes of this International Standard. Under such circumstances, it is not possible to determine the A-weighted sound power level of the source whithin the accuracy limits prescribed in 1.3. However, the result determined with higher background noise levels may be useful as an indication of the upper limit of the sound power level of the source.

4.3 Wind

If measurements are to be made outdoors, the wind speed shall be less than 6 m/s. A windscreen should be used for wind speeds above 1 m/s to ensure that the level of the background noise is at least 3 dB below the level with the source operating.

5 INSTRUMENTATION

5.1 General

A sound level meter that meets the requirements of IEC Publication 179 shall be used with the "slow" meter characteristic.

NOTES

1 The "fast" meter characteristic may be used to check that interfering events are not influencing the measurements.

2 To check the impulsive character of a noise, the "impulse" meter characteristic according to IEC Publication 179A may be used, and the difference between "slow" and "impulse" level may be stated in the test report.

To minimize the influence of the observer on the measurements, a cable should preferably be used between the microphone and the sound level meter. The observer shall not stand between the microphone and the source whose sound power level is being determined.

5.2 Calibration

At least before each series of measurements, an acoustical calibrator with an accuracy of ± 0,5 dB shall be applied to the microphone for calibration of the entire measuring system, including cable, if used, at one or more frequencies. One calibration frequency shall be in the range 250 to 1 000 Hz. The calibrator shall be checked annually to verify that its output has not changed.

6 INSTALLATION AND OPERATION OF SOURCE

6.1 General

The source to be tested shall be installed and mounted with respect to the reflecting plane in one or more positions that are representative of normal use.

6.2 Auxiliary equipment

Care shall be taken to ensure that any auxiliary equipment does not radiate significant amounts of sound energy in the test environment in conformity with 4.2. If practicable, all auxiliary equipment necessary for the operation of the device under test shall be located outside of, or acoustically isolated from, the test environment.

6.3 Operation of source during tests

During the acoustical measurements, the source shall be operated in a specified manner typical of normal use. The following operational conditions may be appropriate :

a) device under specified load and operating conditions;

b) device under full load [if different from a)];

c) device under no load (idling);

d) device under operating condition corresponding to maximum sound generation representative of normal use;

e) device with simulated load operating under carefully defined conditions.

7 MEASUREMENT OF WEIGHTED SOUND PRESSURE LEVELS

7.1 Measurement surface

The microphone positions lie on the measurement surface, a hypothetical surface of area *S* enveloping the source. One of two alternative measurement surfaces may be used :

a) a hemispherical surface of radius *r*, or

b) a rectangular parallelepiped whose sides are parallel to those of a reference surface (in this case, the measurement distance, *d*, is the minimum distance between the measurement surface and the reference surface).

For measurements on a series of similar sources (for example, concrete mixers, air compressors), the use of the same shape of measurement surface and orientation of microphone array is recommended. The specific test code for the particular source under test should be consulted for detailed information. The selection of the reference surface, the size and shape of the measurement surface as well as the measurement distance, *d*, or the radius of the hemisphere, *r*, shall be described in the test report.

7.2 Reference surface

To facilitate the location of the microphone positions, a hypothetical reference surface is defined. This reference surface is the smallest possible rectangular parallelepiped, i.e., rectangular box, that just encloses the source and terminates on the reflecting plane. When defining the dimensions of the reference box, elements protruding from the source which are not significant radiators of sound energy should be disregarded. For safety reasons, the reference parallelepiped may be made sufficiently large to include dangerous operations, for example, trajectories of moving parts of an otherwise stationary machine.

7.3 Measurements on hemispherical measurement surface

7.3.1 *Microphone positions*

The microphone positions lie on the hypothetical hemispherical surface of radius *r* and area $S = 2\pi r^2$, enveloping the source and terminating on the reflecting plane. The microphone positions of the hemispherical array are shown in figure 1 and tabulated in table 3. The centre of the hemisphere is the vertical projection on the reflecting plane of the geometrical centre of the source. The radius of the hemisphere is at least twice the major source dimension, i.e., twice the largest dimension of the reference box (l_1, l_2, or l_3). The value of the radius of the hemisphere, in metres, shall be rounded to the next higher integer. Values of the radius equal to 1, 2, 4, 6, 8, 10, 12, 14 or 16 m are preferred.

No microphone position shall be less than 0,5 m from any reflecting object other than the required reflecting plane.

7.3.2 *Preliminary measurements*

The orientation of the machine (and reference box) relative to the microphone array shall be established after preliminary measurements are made of the noise levels produced by the machine. These measurements shall be made along a circular path with the microphone of a sound level meter at a height of 0,6 *r* and at a distance from the *z* axis of 0,8 *r* to locate the point on the path at which the A-weighted sound pressure level has the highest value. The orientation of the microphone array with respect to the reference box shall be selected so that one of the four microphone positions of the array coincides with this point.

NOTES

1 Figure 1 illustrates a coordinate system with the horizontal axes *x* and *y* in the ground plane parallel to the length and width of the reference box and with the vertical axis *z* passing through the geometric centre of the box. This orientation of the reference box with respect to the microphone array is a special case. In general, the l_1 and l_2 dimensions of the box will not be parallel to the *x* and *y* axes, respectively.

2 If the source radiates audible discrete-frequency component selection of a microphone array at a height 0,6 *r* above the ground plane may result in significant errors in the determination of L_{WA}. In this case, the microphone positions may be located on the hemispherical surface just above the ground plane. However, an array of microphones just above the ground plane may be used only if the ground plane is a hard, reflecting material such as concrete, sealed asphalt or the equivalent. For outdoor measurements just above the ground plane, the use of a windscreen is mandatory. A windscreen may also be used for indoor measurements to protect the microphone. The centre of the microphone shall not be more than 0,05 m above the ground plane. In this case, the levels measured at the four microphone positions just above the reflecting plane are used to calculate the surface sound pressure level (equation 1).

7.3.3 *Measurements on hemispherical array*

After appropriate orientation of the machine (and rectangular box) relative to the hemispherical microphone array, the A-weighted sound pressure levels are measured at each of the four microphone positions of the array. After corrections are applied for background noise (see 7.5), these data are used for the calculation of the surface sound pressure level and sound power level according to clause 8.

NOTE — For large machines, the reference surface may be defined to enclose only the principal source or sources of noise, thus reducing the radius of the hemispherical measurement surface. In this case, preliminary measurements on at least one machine of a given type should be carried out (in addition to those measurements required by 7.3.2) to demonstrate that the calculated value of the sound power level is the same as that determined using a larger hemispherical measurement surface.

7.4 Measurements on rectangular measurement surface

7.4.1 *Microphone positions*

The microphone positions lie on a hypothetical rectangular parallelepiped of area *S* enveloping the source whose sides are parallel to the sides of the reference surface (rectangular box) and spaced out a distance *d* (measurement distance) from the reference surface. The key measurement points are shown in figure 2. The measurement distance *d* between the reference box and each of the key measurement points is normally 1,0 m. It shall be not less than 0,15 m.

The height h of the microphone above the ground is such that it lies in the horizontal plane a height $(H + d)/2$ above the ground. The minimum height of the microphone above the reflecting plane shall be 0,15 m. For a source with a height $\geqslant$ 2,5 m, the microphone shall be successively positioned at the two heights $(H + d)/2$ and $(H + d)$ (see 7.4.3.3).

Two additional microphone positions are

a) directly above the centre of the parallelepiped at the measurement distance d;

b) on the horizontal path (shown as a dashed line in figure 2) at a location determined according to 7.4.2.

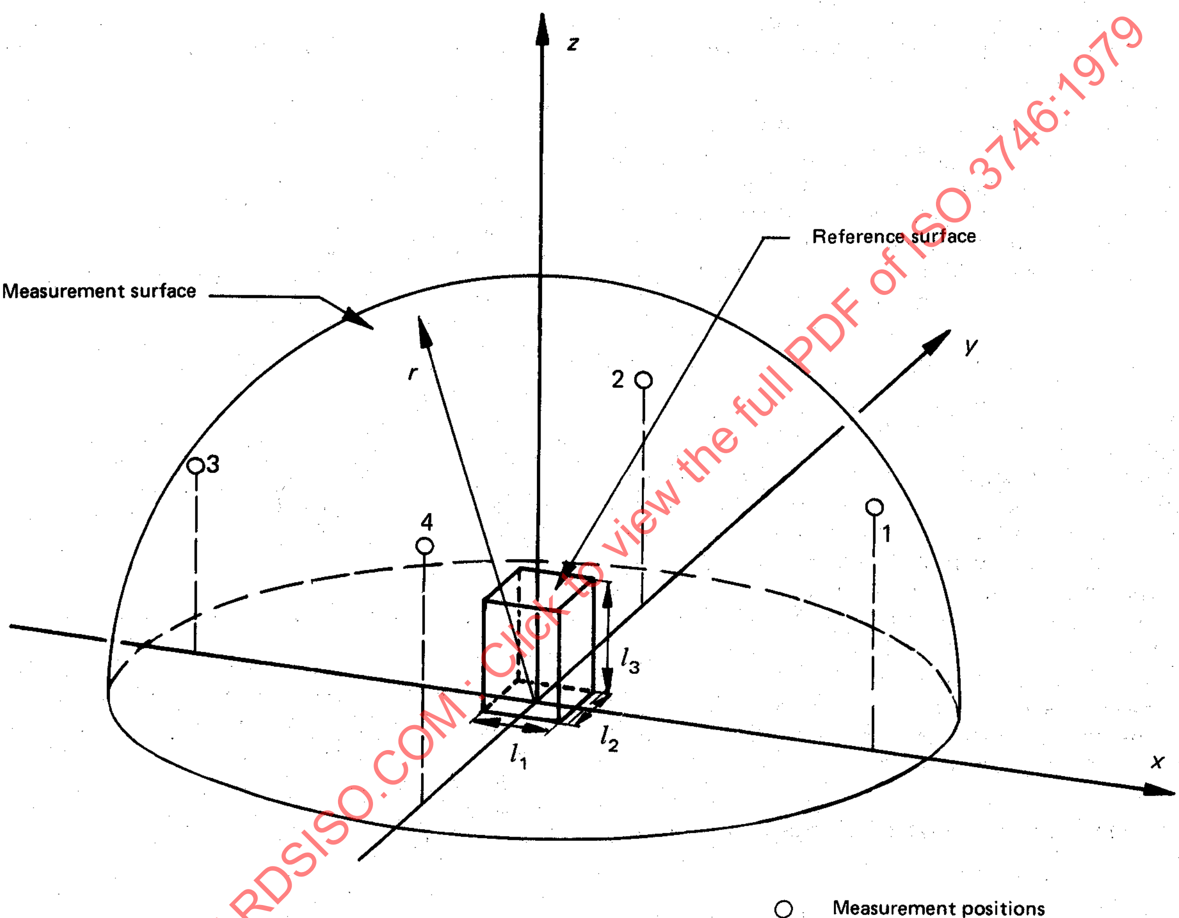

FIGURE 1 – **Microphone array on the hemisphere**

TABLE 3 – **Co-ordinates of microphone positions in terms of distances from centre of hemisphere along three mutually perpendicular axes (x, y, z)**

Microphone Number	Microphone at height $z = 0{,}6\,r$			Microphone just above reflecting plane		
	$\frac{x}{r}$	$\frac{y}{r}$	$\frac{z}{r}$	$\frac{x}{r}$	$\frac{y}{r}$	z
1	0,8	0,0	0,6	1,0	0,0	< 0,05 m
2	0,0	0,8	0,6	0,0	1,0	< 0,05 m
3	– 0,8	0,0	0,6	– 1,0	0,0	< 0,05 m
4	0,0	– 0,8	0,6	0,0	– 1,0	< 0,05 m

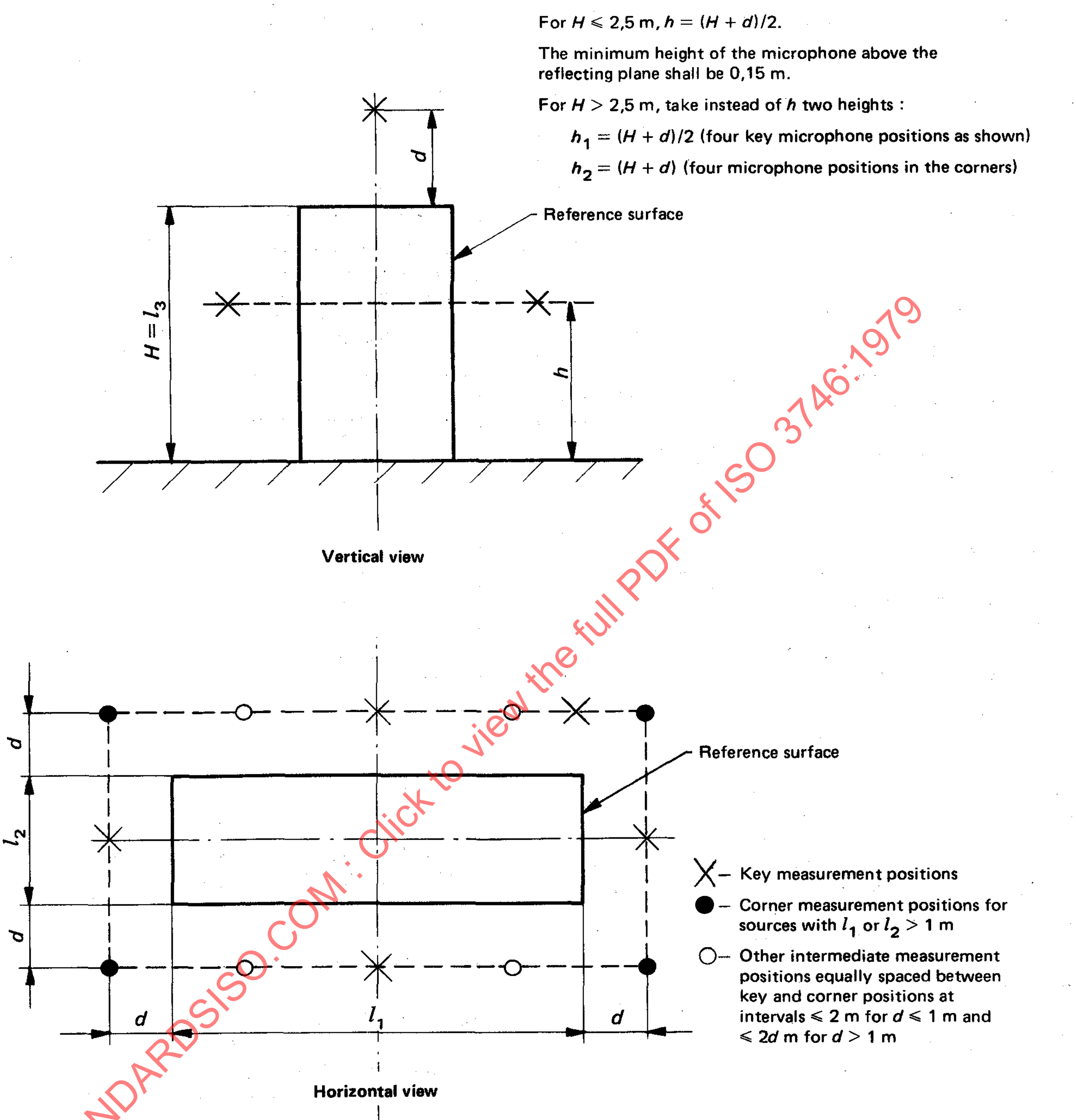

FIGURE 2 — **Location of measurement positions on the parallelepiped**

7.4.2 *Preliminary measurements*

The orientation of the machine (and reference box) relative to the microphone array on the rectangular measurement surface is fixed. Preliminary measurements shall be made with the microphone of a sound level meter moving on the horizontal, rectangular path (shown as a dashed line in figure 2) to locate the point at which the A-weighted sound pressure level has the highest value. This point shall be selected as one of the additional microphone positions defined in 7.4.1.

NOTE — The overhead position may be deleted, for example for safety reasons, provided it can be shown by preliminary measurements that the exclusion of the overhead position does not significantly affect the calculated value of the sound power level of the source.

7.4.3 *Number of microphone positions*

7.4.3.1 SMALL SOUND SOURCES

The minimum number of microphone positions is six; that is, the four key measurement positions, plus the overhead position and the position on the horizontal, rectangular path where the highest A-weighted sound pressure level is observed.

7.4.3.2 LARGE SOUND SOURCES

When the source is large and preliminary measurements at the five key measurement positions of figure 2 shown that the range of sound pressure levels (i.e., the difference in decibels between the highest and lowest values) exceeds 5 dB, additional microphone positions are required as follows.

For large sources (i.e., sources with one horizontal dimension which exceeds 1,0 m), four additional microphone positions at the corners of the horizontal path as shown in figure 2 shall be used. For very large sources (i.e., sources with one horizontal dimension which exceeds 5,0 m), intermediate microphone positions in addition to those prescribed for large sources shall be used as shown in figure 2.

7.4.3.3 TALL SOUND SOURCES

For tall sources (i.e., sources whose vertical dimension exceeds 2,5 m), measurements at two heights $(H + d)/2$ and $(H + d)$ are required. The positions on the horizontal, rectangular paths at which the preliminary measurements indicate that the highest values of the A-weighted sound pressure level are observed shall be included as required positions in the microphone array. The minimum number of microphone positions at each of the two heights is five; therefore, the minimum number of microphone positions for the tall sound source is eleven : five positions at each of the two heights, plus the overhead position.

7.4.4 *Measurements on rectangular array*

Following selection of the appropriate microphone locations on the rectangular array, the A-weighted sound pressure levels are measured at each of the specified positions. After corrections are applied for background noise (see 7.5), these data are used for the calculation of the surface sound pressure level and sound power level according to clause 8.

NOTE — For large, irregularly shaped machines, the reference surface may be composed of several separate reference boxes placed in juxtaposition so that they just enclose the different parts of the machine. The construction of the reference surface and of the measurement surface and the distribution of the microphone positions should be clearly described in the measurement code for the particular class of machines.

7.5 Corrections for background noise

The sound pressure levels recorded at each of the microphone positions shall be corrected for the influence of background noise according to table 4.

TABLE 4 — **Correction for background noise**

Difference between sound pressure level measured with sound source operating and background sound pressure level alone	Correction to be subtracted from sound pressure level measured with sound source operating to obtain sound pressure level due to sound source alone
dB	dB
3	3
4	2
5	2
6	1
7	1
8	1
9	0,5
10	0,5
> 10	0,0

8 CALCULATION OF SURFACE SOUND PRESSURE LEVEL AND SOUND POWER LEVEL

8.1 Calculation of surface sound pressure level

An A-weighted surface sound pressure level, $\overline{L_{pA}}$, shall be calculated from the measured values of the A-weighted sound pressure level, L_{pAi} (after corrections are applied according to 7.5, if necessary), by using the equation

$$\overline{L_{pA}} = 10 \log_{10} \left[\frac{1}{N} \sum_{i=1}^{N} 10^{0,1 L_{pAi}} \right] \qquad \dots (1)$$

where

$\overline{L_{pA}}$ is the A-weighted surface sound pressure level, in decibels. Reference : 20 μPa;

L_{pAi} is the A-weighted sound pressure level at the ith measurement position, in decibels. Reference : 20 μPa;

N is the total number of measurement positions.

NOTE — When the range of values of L_{pAi} does not exceed 5 dB, a simple arithmetical average may be used. This average will not differ by more than 0,7 dB from the value calculated using equation (1).

8.2 Calculation of sound power level

The A-weighted sound power level of the source, L_{WA} shall be calculated from the equation

$$L_{WA} = (\overline{L_{pA}} - K) + 10 \log_{10} \frac{S}{S_0} \quad \ldots (2)$$

where

S is the area of the measurement surface, in square metres. Reference : $S_0 = 1 \text{ m}^2$;

K is the environmental correction to account for the influence of reflected sound, in decibels.

NOTE — The environmental correction K typically ranges from 0 dB (for measurements outdoors) to more than 10 dB for measurements indoors in highly reverberant rooms. For the purposes of this International Standard, the maximum allowable value of the environmental correction K is 7 dB. The procedures given in the annex are used to calculate the value of the environmental correction K.

For the hemispherical measurement surface

$$S = 2\pi r^2$$

For the rectangular parallelepiped measurement surface

$$S = 4\,(ab + bc + ca)$$

where

$$a = \frac{l_1}{2} + d;$$

$$b = \frac{l_2}{2} + d;$$

$$c = l_3 + d;$$

l_1, l_2, l_3 are the dimensions of the rectangular reference parallelepiped;

d is the measuring distance, normally 1,0 m.

9 INFORMATION TO BE RECORDED

The following information, when applicable, shall be compiled and recorded for measurements that are made according to the requirements of this International Standard.

9.1 Sound source under test

a) Description of the sound source under test (including its dimensions).

b) Operating conditions.

c) Mounting conditions.

9.2 Acoustic environment

a) Description of test environment; if indoors, describe physical treatment of walls, ceiling and floor, include a sketch showing location of source and room contents; if outdoors, include a sketch showing location of source with respect to surrounding terrain, including physical description of test environment. The nature of the reflecting (ground) plane shall be recorded.

b) Acoustical qualification of test environment according to the annex.

9.3 Instrumentation

a) Equipment used for the measurements, including name, type, serial number and manufacturer.

b) Method used to calibrate the instrumentation system.

c) The date and place of calibration of the acoustical calibrator.

9.4 Acoustical data

a) The locations of the microphone positions (a sketch may be included if necessary) and the measurement distance.

b) The area S of the measurement surface.

c) The A-weighted sound pressure levels at all microphone positions.

d) The A-weighted sound pressure levels of the background noise for each measuring point and the corresponding correction, if any.

e) The environmental correction K calculated according to the annex.

f) The A-weighted surface sound pressure level, with reference to 20 µPa, $\overline{L_{pA}}$, in decibels.

g) The calculated A-weighted sound power level, with reference to 1 pW (= 10^{-12} W), in decibels. The value shall be rounded to the nearest whole decibel.

h) Remarks on subjective impression of noise (audible discrete tones, impulsive character, spectral content, temporal characteristic, etc.).

j) The date when the measurements were performed.

10 INFORMATION TO BE REPORTED

The report shall contain the statement that the A-weighted sound power level has been obtained in full conformity with the procedures of this International Standard. The report shall state that the A-weighted sound power level, re 1 pW (= 10^{-12} W), is expressed in decibels.

Only those data (see clause 9) need be reported which are required by the ultimate user of the information.

ANNEX

TEST ENVIRONMENT QUALIFICATION PROCEDURE

A.1 GENERAL

An environment providing an approximately free field over a reflecting plane shall be used for measurements made according to this International Standard. The environment may be provided by a suitable test area outdoors or by an ordinary room if the requirements given in this annex are satisfied.

Reflecting objects shall be removed to the maximum extent possible from the vicinity of the machine under test with the exception of the reflecting plane. A test room shall ideally provide a hypothetical measurement surface which lies

a) inside a sound field essentially undisturbed by reflections from nearby objects and the room boundaries, and

b) outside the near field of the sound source under test for the purposes of this International Standard.

For the purposes of this survey method at frequencies above 100 Hz, the measurement surface is considered to lie outside the near field if the measurement distance from the source under test is equal to or greater than 0,25 m.

For outdoor measurements, the prescribed conditions of clause A.2 shall be satisfied. For indoor measurements, one of the alternative qualification procedures of clause A.3 shall be followed. Otherwise, the measurements will not be in conformity with the requirements of this International Standard.

A.2 ENVIRONMENTAL CONDITIONS

A.2.1 Types of reflecting planes

For outdoor measurements, the reflecting plane may be undisturbed earth or an artificial surface of concrete or sealed asphalt. For indoor measurements, the reflecting plane is usually the floor of the room.

NOTE — When the reflecting surface is not a ground plane or the floor of the test room, care shall be taken to ensure that the reflecting surface does not radiate any appreciable sound energy due to vibrations.

A.2.1.1 *Shape and size*

The reflecting surface shall be larger than the projection of the measurement surface on it.

A.2.1.2 *Acoustic absorption coefficient*

The acoustic absorption coefficient of the reflecting plane should preferably be less than 0,1 over the frequency range of interest. This requirement is usually fulfilled when outdoor measurements are made over concrete, sealed asphalt, sand or stone surfaces. For reflecting planes with higher acoustic absorption coefficients, for example, grass- or snow-covered ground, the measurement distance shall be not greater than 1 m. For indoor measurements, wooden and tile floors are permitted.

A.2.2 Reflecting objects

No reflecting objects that are not part of the source under test shall be located inside the measurement surface.

A.2.3 Precautions for outdoor measurements

It should be realized that adverse meteorological conditions (for example, temperature gradients, wind gradients, precipitation and humidity) may all affect the measurements. Extreme meteorological conditions should be avoided during the measurements.

In all cases, the precautions of the manufacturer as stated in the instruction manuals for the instruments shall be observed.