
**Acoustics — Determination of sound power
levels of noise sources using sound
pressure — Comparison method *in situ***

*Acoustique — Détermination des niveaux de puissance acoustique émis
par les sources de bruit à partir de la pression acoustique — Méthode de
comparaison in situ*



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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 3747 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

This second edition cancels and replaces the first edition (ISO 3747:1987), which has been technically revised.

Annex A forms a normative part of this International Standard. Annex B is for information only.

Introduction

This International Standard is one of the ISO 3740 series which, together with ISO 9614, specifies various methods for determining sound power levels of machines, equipment and sub-assemblies thereof. When selecting one of the methods of the 3740 series, it is necessary to decide which one is most appropriate for the conditions and purposes of the test. General guidelines to assist in the selection are provided in ISO 3740. Insofar as the operating and mounting conditions of the machine or equipment under test are concerned, only general principles are given in the ISO 3740 series. Reference should be made to the test code for a specific type of machine or equipment, if available, for specifications on mounting and operating conditions.

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Acoustics — Determination of sound power levels of noise sources using sound pressure — Comparison method *in situ*

1 Scope

1.1 This International Standard specifies a method for determining the sound power levels of sound sources *in situ*, especially if non-movable. A comparison method is used and all measurements are carried out in octave bands. The measurement uncertainty depends on the test environment. The measurement uncertainty is evaluated by comparing with an indicator describing the spatial sound distribution. The accuracy will either be that of an engineering method or a survey method.

The sound power level of the source under test is calculated from the measured values of the sound pressure levels produced at specified measurement points by the source and by a reference sound source, respectively. The sound power level is calculated using the calibrated values of the reference sound source and the differences between the values obtained with the source under test and those of the reference sound source. All calculations are carried out in octave bands, from which the A-weighted sound power level is determined.

NOTE For noise sources which can be moved, other relevant standards in the ISO 3740 series may be used.

1.2 This International Standard is applicable to all kinds of test environments which are to be found outside a laboratory environment, provided that the background noise level is sufficiently low and the sound pressure level at the microphone positions depends mainly on reflections from the room surfaces.

NOTE ISO 3744 or ISO 9614 may provide alternative methods.

1.3 This International Standard is primarily applicable to sources which radiate broad-band noise. It may, however, also be used for sources which radiate narrow-band noise or discrete tones, although the measurement uncertainty might then become larger than stated herein.

NOTE For noise sources emitting stationary noise, ISO 9614 may be used as an alternative.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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.

ISO 6926, *Acoustics — Requirements for the performance and calibration of reference sound sources used for the determination of sound power levels*.

ISO 7574-1, *Acoustics — Statistical methods for determining and verifying stated noise emission values of machinery and equipment — Part 1: General considerations and definitions*.

IEC 60942, *Electroacoustics — Sound calibrators*.

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave band filters*.

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*.¹⁾

3 Terms and definitions

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

3.1 reference sound source RSS

stable and steady source emitting constant broad-band noise with an adequate sound power level, in conformance with and calibrated according to ISO 6926

3.2 calibration position

position, well-defined relative to reflecting surfaces, in which the reference sound source has been calibrated

3.3 reference box

hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source and terminates on the reflecting plane(s)

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

3.5 measurement distance

d_m
closest distance from the reference box to a microphone position

3.6 background noise

noise from all sources other than the source under test

NOTE Background noise may include contributions from airborne sound, structure-borne vibration, and electrical noise in instrumentation.

3.7 frequency range of interest

for general purposes, the frequency range of interest includes the octave bands with midband frequencies from 125 Hz to 8 000 Hz

NOTE 1 For special purposes, it is permissible to extend or reduce the frequency range of interest at either end, provided that the test environment, reference sound source and instrument accuracy are satisfactory for use over the extended or reduced frequency range. For sources which radiate predominantly high (or low) frequency sound, it is permissible to extend or reduce the frequency range of interest in order to optimize the test procedures.

NOTE 2 For determination of A-weighted sound power levels (or other frequency-weighted levels), frequency components within the range which do not contribute to the A-weighted sound power level may be disregarded.

1) To be published. (Revision of IEC 60651 and IEC 60804)

3.8

comparison method

method in which the sound power level is calculated by comparing the measured sound pressure levels produced by the source under test in an environment with the sound pressure levels produced in the same environment by a reference sound source of known sound power output

3.9

excess of sound pressure level at a given distance

ΔL_f

difference, in decibels, for a reference sound source with a reference calibration, at a given distance, between the spatial sound distribution curve of the room and the spatial sound distribution curve for a free field (6 dB per distance doubling) according to annex A

NOTE This term and its definition differ from that of ISO 14257 which relates to an *average* difference over a given distance range.

4 Test methodology

4.1 General

The test method is a comparison method, that is the sound power output of the source under test is compared with that of a reference sound source with known sound power level. In order to obtain a good comparison, at least the following condition must be fulfilled:

- the test environment is sufficiently reverberant to cause the directivity of the source under test to have only an insignificant influence on the measured sound pressure levels.

The better the above condition is fulfilled, the lower the measurement uncertainty will be. To make an objective evaluation of the measurement conditions, it is necessary to determine one indicator, ΔL_f , for the test environment. Further information about this indicator is given in annex A.

4.2 Accuracy

ΔL_f will be influenced by the selection of the reference sound source and the microphone positions. Thus it may, in some cases, be possible to improve the measurement accuracy from that of a survey method to that of an engineering method by changing these positions; see annex A.

5 Measurement uncertainty

A single value of the sound power level of a sound source determined according to the procedures of this International Standard is likely to differ from the true value by an amount within the measurement uncertainty. The uncertainty in determinations of the sound power level arises from several factors which affect the results, some associated with environmental conditions in the test environment and others with experimental techniques and the directional characteristics of the sound source under test.

If a particular source were to be transported to each of a number of different test environments and if, in each environment, the sound power level of that source were to be determined in accordance with the provisions of this International Standard, the results would show a scatter. The standard deviations of the measured octave band values could be calculated (examples are given in ISO 7574-4:1985, annex B) and would vary. These standard deviations would, with few exceptions, not exceed those listed in Table 1 for the A-weighted sound power level. The standard deviation will depend on the indicator ΔL_f . If this indicator is not evaluated, the default standard deviation of reproducibility, s_R , is 4,0 dB.

Table 1 — Estimated upper values of the standard deviation of reproducibility, s_R , of A-weighted sound power levels of sound sources determined according to this International Standard

Indicator values	Upper values of standard deviation of reproducibility for the A-weighted sound power level	Grade of accuracy
$\Delta L_{fA} \geq 7 \text{ dB}^a$	1,5 dB	Grade 2
$\Delta L_{fA} < 7 \text{ dB}$ or not determined	4,0 dB	Grade 3
^a To be met by all microphone positions.		

NOTE 1 The standard deviations given in Table 1 might become larger for sources that radiate narrow-band noise, discrete tones and combinations of these. In these cases the engineering grade of accuracy might not be achieved.

The values given in Table 1 are standard deviations of reproducibility, s_R , as defined in ISO 7574-1. The values of Table 1 take into account the cumulative effects of measurement uncertainty in applying the procedures of this International Standard, but exclude variations in the sound power output caused by changes in operating conditions (e.g. rotational speed, line voltage) or mounting conditions.

The measurement uncertainty depends on the standard deviation of reproducibility tabulated in Table 1, the systematic errors discussed below, and the degree of confidence that is desired. As examples, excluding the systematic errors, there is a 90 % confidence that the expected value of the sound power level of a source lies within the range $\pm 1,645s_R$ of the measured value and a 95 % confidence that it lies within the range $\pm 1,96s_R$. For further examples, see ISO 7574-4.

NOTE 2 Where s_R exceeds 2 dB, the ranges of confidence intervals may not apply.

Normally the A-weighted sound power level is mainly influenced by the levels in the 250 Hz to 4 000 Hz octave bands. The A-weighted sound power level is determined with a standard deviation which varies with the indicator values as shown in Table 1. If frequencies lower than 500 Hz are very important for the A-weighted level, the standard deviation will become higher. If frequencies higher than 2 000 Hz are important the source may be highly directional. If, in such cases, there are strongly absorbing surfaces close to the machine under test (e.g. an absorbing ceiling), the measurement uncertainty may become greater.

NOTE 3 One reason, specific for this International Standard, for increased measurement uncertainty at low frequencies is that the reference sound source is not always used in calibrated positions. Thus calibration errors are introduced. These errors occur at low frequencies where the RSS is located at distances in relation to nearby reflecting surfaces which are different from the ones used during the calibration.

6 Instrumentation

6.1 Instrumentation system

The instrumentation system, including the microphone and cable, shall meet the requirements for a class 1 instrument specified in IEC 61672-1. The calibrator shall meet the requirements for class 1 specified in IEC 60942.

For measurements in octave bands, the instrumentation system shall meet the requirements of IEC 61260.

6.2 Calibration

6.2.1 Measuring system

During each series of measurements, apply the sound calibrator to the microphone for checking the calibration of the entire measuring system at one or more frequencies over the frequency range of interest.

Verify the compliance of the calibrator with the requirements of IEC 60942 once a year and the compliance of the instrumentation system with the requirements of IEC 61672-1 at least every two years in a laboratory making traceable calibrations.

Record the date of the last check and confirmation of the compliance with the relevant IEC standard.

6.2.2 Reference sound source

The reference sound source shall be in conformance with and calibrated according to ISO 6926.

NOTE Normally this calibration is valid only for positions away from walls with the reference sound source either directly on the floor or on a stand at a specified elevation above the floor. If the RSS is used in other positions, unless it has been calibrated specifically in these positions, systematic errors may occur at low frequencies.

7 Operating conditions of the source under test

During the measurements use the operating conditions specified in the relevant test code, if one exists for the particular type of machinery or equipment under test. If there is no test code, operate the source, if possible, in a manner which is typical of normal use. In such cases, one or more of the following operating conditions shall be selected:

- device under specified load and operating conditions;
- device under full load (if different from above);
- device under no load (idling);
- device under operating condition corresponding to maximum sound generation representative of normal use;
- device with simulated load operating under carefully defined conditions;
- device under operating condition with characteristic work cycle.

The sound power level of the source may be determined for any desired set of operating conditions (i.e. loading, device speed, temperature, etc.). These test conditions shall be selected beforehand and shall be held constant during the test. The source shall be in the desired operating condition before any noise measurements are made.

If the noise emission depends on secondary operating parameters, such as the type of material being processed or the type of tool being used, as far as practicable, those parameters shall be selected that give rise to the smallest variations and that are typical of the operation. The noise test code for a specific family of machines shall specify the tool and the material for the test.

For special purposes it is appropriate to define one or more operating conditions in such a way that the noise emission of machines of the same family is highly reproducible and that the operating conditions which are most common and typical for the family of machines are covered. These operating conditions shall be defined in specific test codes.

If simulated operating conditions are used, they shall be chosen to give sound power levels representative of normal use of the source under test.

If appropriate, the results for several separate operating conditions, each lasting for defined periods of time, shall be combined by energy-averaging to yield the result for a composite overall operating procedure.

The operating conditions of the source during the acoustical measurements shall be fully described in the test report.

8 Preliminary survey

8.1 Background noise

With the source under test turned off, identify, first by listening or by using a sound level meter, possible zones with high background noise. With the source under test and the RSS turned on separately, make rough evaluations of noise levels in the zones where background noise is present and conclude whether these zones are allowed or not considering the background noise criteria of 10.3. For later use, select zones with no background noise problems.

8.2 Characterization of the source under test

Walk around the source under test and detect by listening whether, among the radiating parts of the source under test, one clearly dominates. If the answer is yes, consider the geometrical centre of it to be the acoustic centre of the source. If the answer is no, exclude all parts of the source under test not radiating noise and consider the geometrical centre of the remainder to be the acoustic centre of the source.

Measure the sound pressure at a distance of 1 m from the reference box and at a height, H , above the floor. Normally select $H = 1,5$ m. If the source under test radiates predominantly upwards, select a value of H high enough to ensure that the microphone positions are illuminated properly by the acoustic centre of the source. If the sound pressure level along this contour varies by no more than 4 dB, the source under test is considered to be omnidirectional. If it varies more than 4 dB, it is considered to be directional.

9 Positions of the reference sound source

9.1 One position

Normally one RSS position is enough. Position the reference sound source as close as possible to the acoustic centre of the source under test. Unless another position will simulate the radiation pattern of the source under test significantly better, position the RSS, whenever practical, on top of the source under test. If this is not possible, select a position along the sides of the source under test at a height and position best simulating the radiation pattern of the source under test. In these cases, avoid positions closer than 0,5 m to the lateral surfaces of the reference box unless the RSS has been calibrated in such positions. For an omnidirectional source make sure that the height makes it possible for the RSS to radiate sound in all directions.

The more reverberant the test site is, the less critical is the selection of the RSS position. The RSS can either be located in calibration positions or in other positions. If the latter, the measurement uncertainty will increase, in particular at low frequencies; see clause 4.

NOTE Further guidance is given in annex B.

9.2 More than one position

For sources under test which are large or which have two or more clearly distinguishable sound sources far apart, two or more RSS positions may be needed. The number of RSS positions shall depend on the ratio a/d_m , where a is the largest source dimension and d_m is the measurement distance, as follows.

- If $a/d_m > 1$ and if the source is omnidirectional, use several RSS positions along the sides of the source under test separated by a distance equal to d .
- If $a/d_m > 1$ and if the source has clearly definable radiation areas, use one RSS position for each area.
- If $a/d_m \leq 1$ and if the source is omnidirectional but it is impossible to use one RSS position on top of the machine, use four RSS positions along the sides.

10 Measurement procedure

10.1 Selection of microphone positions

10.1.1 General

As a first step, position the microphones in front of the sides of the source under test (ST) so as to achieve equal propagation conditions for all radiating areas; i.e. for a particular microphone position, either each area is in the field of vision or each area is screened. Avoid positions on which only a few parts of the source are radiating.

Use three or four microphone positions, subject to the restrictions given below, distributed as evenly as possible around the source under test. These positions and the microphone orientations shall be the same for measurements made on the RSS and the source under test respectively. Select, if possible, a measurement distance, d_m , large enough to make the microphone position be in an area where the test environment is qualified for the measurement uncertainty of an engineering method, that is $s_R \leq 1,5$ dB; see annex A.

A microphone position shall be no closer than 0,5 m to any boundary surface of the room. If the room is large enough, and if the source under test is located away from all boundary surfaces, the positions of the microphones shall be on all sides of the reference box. This means that four microphone positions shall be used in this case. Space the positions of the microphones at a distance of at least 2 m from each other. If the ceiling is high and sound absorbing, and frequencies higher than 2 000 Hz are important, select at least two microphone positions as high as possible and as close as possible to the source under test without violating other requirements.

10.1.2 Zoning

The objective of zoning is to assess the similarity between the radiation pattern in the horizontal plane of the source under test on one hand and of the RSS in the presence of the source under test on the other hand. Zoning is also used to assess RSS and microphone positions. Use zoning according to Table 2.

Table 2 — Zoning

Illuminated ^a		Relative distances, r , from the microphone	Effect on the sound power estimation	Notation of the zone
by ST	by RSS			
Yes	No	—	Strong overestimate	++
No	Yes	—	Strong underestimate	--
Yes	Yes	$r(ST) < r(RSS)$	Overestimate	+
Yes	Yes	$r(ST) > r(RSS)$	Underestimate	-
Yes	Yes	$r(ST) \approx r(RSS)$ (within 10 %)	Small under- or overestimate	+/-
No	No	—	Either strong over- or underestimate	++/- -
Unless the room is highly reverberant (no acoustical treatment of walls and/or ceiling, no large absorbing obstacles) no microphone positions shall be located in a ++/- - zone.				
^a Receiving unscreened sound radiated directly by the reference sound source (RSS) or source under test (ST).				

10.1.3 Selection of positions

Use zoning according to 10.1.2 and, complying with the general requirements of 10.1.1, select microphone positions as follows.

- a) The source under test is omnidirectional and the RSS is on top of it
 - In this case all zones are + or +/–. Select one microphone position on each free side of the source under test.
- b) All other cases
 - Try to find microphone positions in a +/– zone. If that is not possible, select one microphone position in a + zone, one in a +/– and one or two positions in – zones.

10.2 Measurements

Determine the time-averaged sound pressure level for each octave band of interest (usually 125 Hz to 8 000 Hz). When measuring on the reference sound source (RSS), use an integration time $T > 30$ s unless the spectrum of the source under test is broad-band and dominated by frequencies above 250 Hz, in which case $T = 10$ s may be used for measurements on the RSS. Often the source under test is less stable and thus requires a longer integration time. In that case the integration time shall include at least one typical period of operation of the source under test.

The following data shall be obtained.

- a) Sound pressure levels for each microphone position $i = 1, \dots, n$ during the specified operation (see clause 7) of the source under test: $L'_{pi(ST)}$.
- b) Sound pressure levels for each microphone position $i = 1, \dots, n$ for the background noise: $L'_{pi(B)}$.
- c) Sound pressure levels produced by the RSS for each microphone position $i = 1, \dots, n$: $L'_{pi(RSS)}$.

10.3 Correction for background noise

For each octave band, correct the measured sound pressure levels L'_{pi} for the background noise if $L'_{pi(B)}$ is 6 dB to 15 dB below these levels. The corrected value is given by

$$L_{pi} = 10 \lg \left(10^{L'_{pi}/10} - 10^{L'_{pi(B)}/10} \right) \text{ dB} \quad (1)$$

If $\Delta L = L'_{pi} - L'_{pi(B)} > 15$ dB, no correction is made. If $\Delta L \geq 6$ dB, the measurement is valid according to this International Standard. Even if the measurement is invalid for a single frequency band, it can still be valid for the A-weighted value, provided that ΔL_A is greater than 6 dB, where ΔL_A is the difference between the values of L'_{pAi} and $L'_{pAi(B)}$.

If the 6 dB criterion is not satisfied, the accuracy of the result(s) is reduced and grade 2 cannot be achieved. Grade 3 is attained if $3 \text{ dB} \leq \Delta L < 6 \text{ dB}$. The maximum correction to be applied to these measurements is 1,3 dB. The results may, however, be reported and may be useful for determining an upper boundary to the sound power level of the source under test. If such data are reported, it shall clearly be stated in the text of the report, as well as in graphs and tables of results, that the background noise requirements of this International Standard have not been fulfilled.

10.4 Evaluation of the measurement uncertainty

If $\Delta L_f \geq 7$ dB, the measurement uncertainty is that of an engineering method. In all other cases try to improve ΔL_f ; see annex A. The measurement uncertainty in terms of standard deviations of reproducibility is then given by Table 1. The indicator requirements shall be complied with by each RSS position.

11 Calculation of sound power levels

11.1 One RSS position

For each octave band, calculate the sound power level, L_W , by using the following equation:

$$L_W = L_{W(RSS)} + 10 \lg \left[\frac{1}{n} \sum_{i=1}^n 10^{0,1 \Delta L_{pi}} \right] \text{ dB} \quad (2)$$

where, for each octave band

n is the number of microphone positions;

$L_{W(RSS)}$ is the sound power level of the RSS derived from its calibration;

$$\Delta L_{pi} = L_{pi}(\text{ST}) - L_{pi}(\text{RSS})$$

$L_{pi}(\text{ST})$ is the sound pressure level of the source under test in microphone position i , corrected for background noise;

$L_{pi}(\text{RSS})$ is the sound pressure level of the reference source in microphone position i , corrected for background noise.

11.2 Several RSS positions

When m RSS positions ($j = 1$ to m) are used, calculate, for each octave band, the sound power level, L_W , by using the following equation:

$$L_W = 10 \lg \left[\frac{1}{mn} \sum_{j=1}^m \sum_{i=1}^n 10^{0,1(L_{Wj(RSS)} + \Delta L_{pij})} \right] \text{ dB} \quad (3)$$

where

$L_{Wj(RSS)}$ is the sound power level of the RSS;

$$\Delta L_{pij} = L_{pi}(\text{ST}) - L_{pij}(\text{RSS})$$

n is the number of microphone positions.

11.3 A-weighted sound power level

Calculate the A-weighted value according to the following equation:

$$L_{WA} = 10 \lg \left(\sum_k 10^{0,1(L_{Wk} + A_k)} \right) \text{ dB} \quad (4)$$

where

L_{Wk} is the octave-band sound power level, in decibels, in octave band k ;

A_k is the A-weighting constant of the mid-frequency of octave band k .

The A-weighting constants are given in Table 3.

Table 3 — A-weighting constants

Frequency Hz	A_k dB
125	−16,1
250	−8,6
500	−3,2
1 000	0
2 000	1,2
4 000	1,0
8 000	−1,1

12 Information to be recorded

Record the following information, when applicable, for measurements that are made according to the requirements of this International Standard.

a) Sound source under test

- description of the sound source under test (including its dimensions);
- operating conditions (according to measurement test code, if any);
- mounting conditions (according to measurement test code, if any).

b) Reference sound source

- state the conformance with ISO 6926;
- state the calibration values of the sound power level $L_{W(RSS)}$.

c) Acoustic environment

- description of test environment;
- treatment of walls, ceiling and floor;
- a sketch showing the location of the source and room contents.

d) Instrumentation

- equipment used for the measurements, including name, type, serial number and manufacturer;

- date and place of calibration of the sound calibrator and other acoustical instrumentation;
- name, type, serial number and manufacturer of reference sound source used in the measurements.

e) Acoustical data

- locations of the positions of microphones (a sketch may be included, if necessary) and the source under test;
- locations of the reference source positions;
- sound pressure levels at all positions of microphones for the sound source under test and for the RSS, A-weighted and, if required, in octave bands;
- calculated sound power level, in decibels; A-weighted and in octave bands rounded to the nearest decibel (reference: 1 pW);
- ΔL_f and the measurement uncertainty as given by Table 1;
- date when the measurements were performed;
- information on background noise, if any (see 10.3).

13 Information to be reported

The report shall state whether or not the reported sound power levels have been obtained in full conformity with the requirements of this International Standard. The report shall state the sound power level, A-weighted and, optionally, in octave bands given in decibels (reference: 1 pW) and the measurement uncertainty given by the ΔL_f indicator.

Report the items listed in clause 12.

In addition, the test report shall include the following information:

- a) name and address of the testing institution;
- b) identification number of the test report;
- c) name and address of the organization or the person who ordered the test.

Annex A (normative)

Evaluation of ΔL_f and of the measurement uncertainty

A.1 Determination of the measurement uncertainty

See Figure A.1.

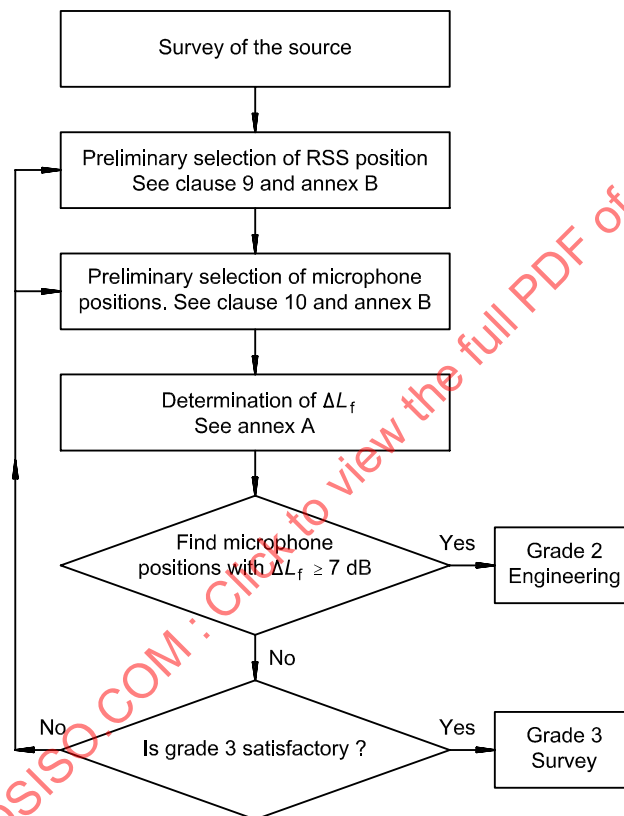


Figure A.1 — Flow chart

A.2 Determination of ΔL_f

For a suitable position of the reference sound source in the vicinity of the machine under test measure the sound pressure level L_{pr} due to the reference sound source along a measuring path without screening obstacles and varying the distance r . Determine the excess of sound pressure level:

$$\Delta L_f = L_{pr} - L_{W(RSS)} + 11\text{dB} + 20 \lg \left(\frac{r}{r_0} \right) \text{dB} \quad (\text{A.1})$$

where

- $L_{W(RSS)}$ is the sound power level of the reference sound source;
- L_{pr} is the sound pressure level at a distance r (in metres) from the RSS;
- r is the distance between the RSS and the microphone ($r_0 = 1$ m).

NOTE When the sound pressure levels are A-weighted, the notation is ΔL_{fA} . If the frequency spectrum of the RSS is similar to that of the source under test (ST), the sound decay curve is related to A-weighted levels. Otherwise it is measured in frequency bands and the A-weighted levels of the decay curve are calculated for the spectrum of the ST. If the spectra of the ST and the RSS differ, but the spectrum of the ST is typically broad-band with a maximum between 500 Hz and 1 000 Hz when A-weighted, the decay curve of the 1 000 Hz octave band can be used.

The sound propagation curve $\Delta L_f(r)$ shall be used to determine the necessary distance d between the microphones and the reference box with $\Delta L_f \geq 7$ dB. If the sound propagation curve cannot be determined according to the described method, use the defining equation (A.1) to determine ΔL_f at the microphone position selected.

If $\Delta L_f(r) \geq 7$ dB cannot be met for any microphone position, the test environment does not in general satisfy the requirements for an engineering method according to this International Standard for any source under test.

Annex B (informative)

Recommendations for the location of the reference sound source and the microphones, if only one RSS position is used

B.1 General

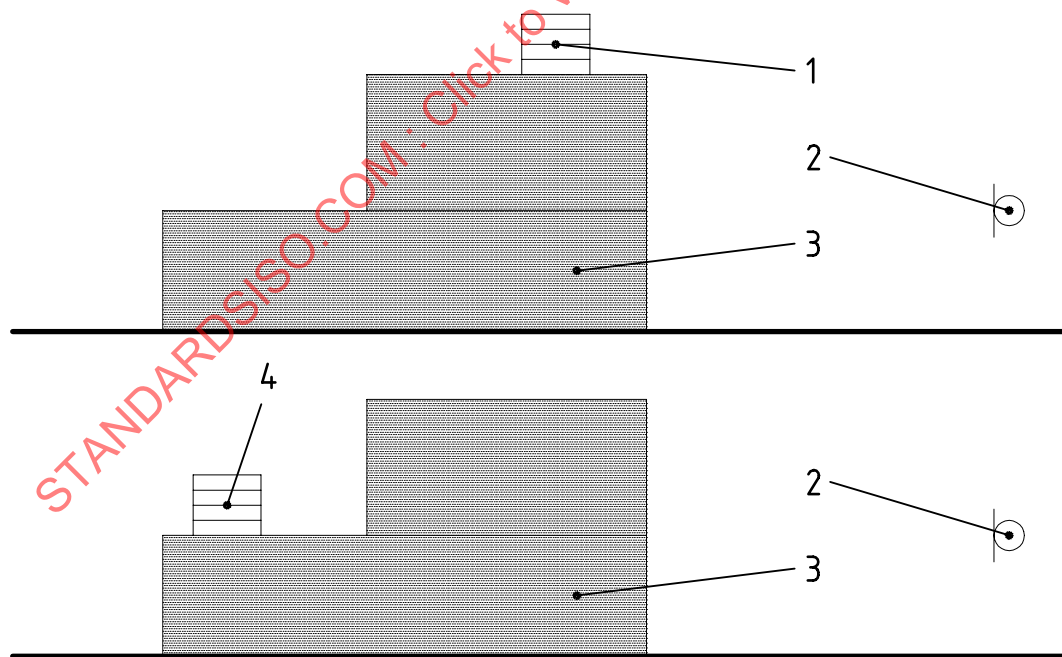
Favourable positions of the reference sound source (RSS) and the microphones relative to the source under test depend on the type of radiation pattern of the source under test. Whether the source under test radiates fairly omnidirectionally or predominantly in one or more horizontal directions can be determined by moving a sound level meter along a path going around the source under test at 1,2 m above the floor and 1 m from the external surfaces of the source under test. If the variation of the measured sound pressure levels is smaller than 4 dB, the source under test can be considered, for the purposes of this annex, as having a fairly omnidirectional radiation.

If the variation of the measured sound pressure levels is higher than or equal to 4 dB, for the purposes of this annex, horizontal direction(s) where the source under test radiates sound preferentially can be identified.

B.2 Recommendation 1

It is recommended to locate the reference sound source in such a position that its radiation pattern, in the presence of the source under test, is similar to that of the source under test.

For a source under test that radiates sound fairly omnidirectionally in space, reference sound source positions above the source under test are particularly favorable, see Figure B.1.



Key

- 1 Favourable RSS position
- 2 Microphone
- 3 Omnidirectional machine
- 4 Unfavourable RSS position

Figure B.1 — RSS positions when the source under test is fairly omnidirectional