

Acceptance code for gear units —

Part 1: Test code for airborne sound

ICS 17.140.20; 21.200

National foreword

This British Standard reproduces verbatim ISO 8579-1:2002 and implements it as the UK national standard. It supersedes BS 7676-1:1993 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/5, Gears, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Acceptance code for gear units —
Part 1:
Test code for airborne sound

Code de réception des engrenages sous carter —

Partie 1: Code d'essai pour la détermination du bruit aérien



Reference number
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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.

The main task of technical committees is to prepare International Standards. 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 part of ISO 8579 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8579-1 was prepared by Technical Committee ISO/TC 60, *Gears*.

This second edition cancels and replaces the first edition (ISO 8579-1:1993), which has been technically revised.

ISO 8579 consists of the following parts, under the general title *Acceptance code for gear units*:

- *Part 1: Test code for airborne sound*
- *Part 2: Determination of mechanical vibrations of gear units during acceptance testing*

Annexes A, B and C of this part of ISO 8579 are for information only.

Introduction

The sound emitted by a gear unit or gearmotor can be radiated by the casing of the gear unit, the driving system (e.g. motor, coupling, another gear unit), and the connected structures included in the gear-drive system.

On-site and on the shop test stand, the perceived sound can be significantly increased by reverberation effects or by the radiation of extraneous sources.

Depending on the type of gear unit or gearmotor, as well as on the requirement of the purchaser, it may be necessary for the manufacturer or supplier to know

- a) the sound emitted by the gear unit, excluding the sound from the driver/motor, driven system and transmission elements,
- b) the sound emitted by the gearmotor, including the motor and the transmission elements,
- c) the sound emitted by subsystems or auxiliaries, for example, the lubrication system, and
- d) the sound emitted by each of those elements in respect of a given requirement, or in view of an efficient sound-proofing of the installation.

This part of ISO 8759 describes methods for the determination of the sound emitted by a gear unit alone, a gearmotor or a gear-drive system. Sound emission is expressed in terms of the sound power level of the transmission system and the emission sound pressure level at the relevant work station (see 6.2).

Annex A provides examples of practical microphone positions on the measurement plane for different gear types and sizes. Annex B gives typical sound-pressure and sound power levels for different gear types and sizes. Annex C, developed for ISO 8579-1:1993, provides information on the determination of airborne sound power levels emitted by gear units, using a combination of the two methods given in clause 5.

Acceptance code for gear units —

Part 1: Test code for airborne sound

1 Scope

This part of ISO 8579 specifies the instructions and standardized conditions necessary for the determination of the airborne sound emission of gear units and gearmotors. It also specifies the allowed measurement methods, together with the operating and mounting conditions used for the test.

The emission characteristics include emission sound pressure levels at specified positions and the sound power level. The determination of these quantities is necessary for

- a) manufacturers of gear units or gearmotors, in order that they may be able to declare the emitted sound,
- b) for comparing the sound emitted by gear units and gearmotors under service operation, and
- c) for the purpose of noise control at the design stage.

This part of ISO 8579 has the aim of ensuring, with its use, the reproducibility of the determination of the airborne sound emission characteristics within specified limits determined by the grade of accuracy of the basic measurement method used. The sound measurement methods allowed by this part of ISO 8579 are engineering methods (grade 2) and survey methods (grade 3).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8579. 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 8579 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 3743-1:1994, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, movable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms*

ISO 3744:1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane*

ISO 3745:—¹⁾, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and semi-anechoic rooms*

ISO 3746:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

1) To be published. (Revision of ISO 3745:1977)

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO/TR 7849:1987, *Acoustics — Estimation of airborne noise emitted by machinery using vibration measurement*

ISO 9614-1:1993, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

ISO 9614-2:1996, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*

ISO 11203:1995, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level*

3 Terms and definitions

For the purposes of this part of ISO 8579, the terms and definitions given in ISO 3743-1, ISO 3744, ISO 3745, ISO 3746, ISO 4871, ISO 9614-1, ISO 9614-2 and ISO 11203 apply.

4 Gear configuration and acoustic environment

4.1 Gear configuration

This part of ISO 8579 is concerned with industrial gear units and gearmotors with gearing of the cylindrical, bevel and worm types.

There are three gear configurations to be considered:

- a) gear unit, independent of driving or driven systems;
- b) gearmotor, with motor integral to the gear unit;
- c) gear-drive system, where the motor or driving equipment is installed on a common baseplate with other required auxiliary equipment.

The purchaser and manufacturer shall agree on whether sound is to be measured on the system or on the gear unit alone.

Safety guards, such as cardan and coupling guards, and insulation hoods, where applicable, shall be present during the sound emission determination.

4.2 Acoustic environments

This part of ISO 8579 allows for three possible acoustic environments for each configuration. In each case, the gear configuration may be installed

- on-site (see 7.2.4),
- on the shop test stand (see 7.2.3), or
- in a specific facility intended for acoustic measurements (see 7.2.2).

5 Sound power level determination

5.1 General

Unless otherwise specified, the determination shall be an A-weighted sound power, with the testing being conducted in the manufacturer's test facility using the method chosen by the manufacturer.

5.2 Methods

In determining the method to be used, the grade of accuracy of the measurement must be considered. Each ISO standard method gives specific uncertainty limits for the grades, with grade 2 being more precise than grade 3. A typical example, taken from ISO 9614-2:1996, is given in Table 1.

Table 1 — Uncertainty in the determination of sound power levels

Octave band centre frequencies	One-third octave band centre frequencies	Standard deviations	
		Engineering (grade 2) dB	Survey (grade 3) dB
Hz	Hz		
63 to 125	50 to 160	3	—
250	200 to 315	2	—
500 to 4 000	400 to 5 000	1,5	—
—	6 300	2,5	—
A-weighted ^a	—	1,5 ^b	4

NOTE The stated uncertainty of the A-weighted estimate does not apply if the total A-weighted power in the one-third-octave bands outside the range 400 Hz to 5 000 Hz exceeds the total within this range; individual uncertainties then apply.

^a 63 Hz to 4 kHz or 50 Hz to 6,3 kHz.

^b The true value of the A-weighted sound power level is expected with a certainty of 95 % to be in the range of ± 3 dB about the measured value.

The preferred methods for determining the sound power level are the following grade 2 accuracy methods:

- ISO 3743-1;
- ISO 3744;
- ISO 9614-1 or ISO 9614-2.

If it has been shown that grade 2 cannot be attained, then one of the following grade 3 methods may be used:

- ISO 3746;
- ISO 9614-1 or ISO 9614-2.

If none of the above methods are practicable, the method of ISO/TR 7849 may be used.

For selection of a basic standard for the determination of the sound power level of an industrial gear unit or gearmotor, use Table 2 or Table 3.

The differences between Tables 2 and 3 reflect the relative ease of performing measurements for gear units as opposed to gearmotors. Table 2 addresses gear units and gear-drive systems, which are an assembly of components and thus present a more challenging measurement procedure. Table 3 represents the relatively more

easily achieved measurements for a “close-coupled” gearmotor configuration where the sound of the gear unit is not separated from the sound of the motor. The term “gearmotor” may also include other close-coupled arrangements where the sound cannot be separated. This would include close-coupled gears and generators and close-coupled hydraulic motors.

NOTE **Comments on recommended International Standards**

ISO 3743-1 is based upon a hard-walled room and low background noise. This International Standard gives specifications for sound pressure measurement in octave bands in order to enable the sound power level to be calculated.

ISO 3744 is based upon a non-reverberant environment and low background noise. This International Standard specifies a method for calculating the sound power level from the measured A-weighted sound pressure level or the sound pressure level in octave or one-third octave bands.

ISO 3745 is based upon a special anechoic or semi-anechoic test room. This International Standard gives specifications for A-weighted sound pressure level measurement in order to enable the sound power level to be calculated.

ISO 3746 is less demanding. It gives specifications for the A-weighted sound pressure level only and provides an A-weighted sound power level with grade 3 accuracy.

ISO 9614 can be used in all environments, including, to a large extent, reverberation and extraneous sound sources. It gives specifications to sound intensity and sound pressure measurements. Depending on the level of the reverberation and extraneous sound, it provides the sound power level either as an A-weighted, overall level or in octave bands. For grade 3 measurements only, the overall A-weighted sound power level is available.

ISO 9614-1 requires measurements of sound intensity and, simultaneously, of sound pressure (at discrete points). In this case, the number of points is generally higher than the number of points used for the standards based on sound pressure measurements.

ISO 9614-2 requires measurement of sound intensity and, simultaneously, of sound pressure by scanning. This could be made on a partial or global surface, depending on the configuration of the machine. The method generally reduces the measurement time.

ISO/TR 7849 is an ISO Technical Report which is used only when the other methods are impracticable. This method is based upon measurement of vibration velocity of the relevant parts of the gear unit or gearmotor. It provides an estimation of the A-weighted sound power level or sound power level in octave, or one-third octave, bands.

5.3 Reference box, measurement surface, microphone positions and intensity probe considerations

5.3.1 General

When either ISO 3744, ISO 3746, ISO 9614-1 or ISO 9614-2 is used, 5.3.2 to 5.3.4 are applicable.

5.3.2 Reference box

The reference box is a hypothetical surface, generally the smallest simple volume (parallelepiped or box) containing the gear unit or gearmotor to be measured, but excluding auxiliaries, transmission elements and the driver for the gear unit. The reference box for a gear-drive system would just include the structure supplied by the gear-drive manufacturer. The box encloses the source and terminates on the reflecting plane (hard ground or water). Examples of reference boxes are shown in Figures 1, 2 and 3.

NOTE Small components of the source, which do not contribute to the sound radiation, can lie outside the reference box.

Table 2 — Standard selection for sound power level determination of gear units and gear-drive systems

Acoustic environment	Grade of accuracy	Standard for sound power level determination		
		Gear unit or gear drive system input power level, kW		
		$\geq 0,1$ to ≤ 10	> 10 to ≤ 300	> 300
Specific facility ^{a, b, c}	2	ISO 3744 ^d ISO 3743-1 ^e ISO 9614	ISO 9614 ISO 3744 ^d	ISO 9614
Shop test stand ^a	2	ISO 9614 ^b		impracticable
	3	ISO 9614 ISO 3746 ^f		ISO 9614
On-site	2	ISO 9614 ^{f, b}		impracticable
	3	ISO 9614 ^f ISO 3746 ^{f, g}	ISO 9614 ^f ISO/TR 7849 ^h	
NOTE 1 The standard written in bold letters is the preferred standard, to be used wherever practicable.				
NOTE 2 For each measurement situation, the standard selection order of preference is indicated by the order of listing.				
NOTE 3 ISO 9614 refers to either ISO 9614-1 or ISO 9614-2.				
^a The power available for test may not be sufficient to represent on-site conditions. ^b The size of the gear unit may prevent proper measurement. ^c ISO 3745 could be used for grade 2 accuracy in a specific facility. ^d Normally requires an anechoic environment above a reflective plane. ^e Normally requires a reverberant room. ^f The background noise may be too erratic for proper measurement. ^g There may not be sufficient access between units for measurement. ^h The time to make all the necessary measurements may be too extensive.				

Table 3 — Standard selection for sound power level determination of gearmotors

Acoustic environment	Grade of accuracy	Standard for sound power level determination	
		Gearmotor rated power level, kW	
		$\geq 0,1$ to ≤ 300	> 300
Specific facility ^{a, b, c}	2	ISO 3744 ^d ISO 9614	ISO 9614 ISO 3744 ^d
	3	ISO 3746 ^e	ISO 9614 ^b
Shop test stand ^a	2	ISO 3744 ^d ISO 9614	ISO 9614 ^b
	3	ISO 3746 ^e	ISO 9614 ^b
On-site ^b	2	ISO 9614 ISO 3744 ^f	ISO 9614
	3	ISO 3746 ^f ISO 9614	ISO 9614 ISO 3746 ^f

NOTE 1 The standard written in **bold** letters is the preferred standard, to be used wherever practicable.

NOTE 2 For each measurement situation, the standard selection order of preference is indicated by the order of listing.

NOTE 3 ISO 9614 refers to either ISO 9614-1 or ISO 9614-2.

^a The power available for test may not be sufficient to represent on-site conditions.

^b The size of the gear unit may prevent proper measurement.

^c ISO 3745 could be used for grade 2 accuracy in a specific facility.

^d Normally requires an anechoic environment above a reflective plane.

^e Normally requires a reverberant room.

^f The background noise may be too erratic for proper measurement.

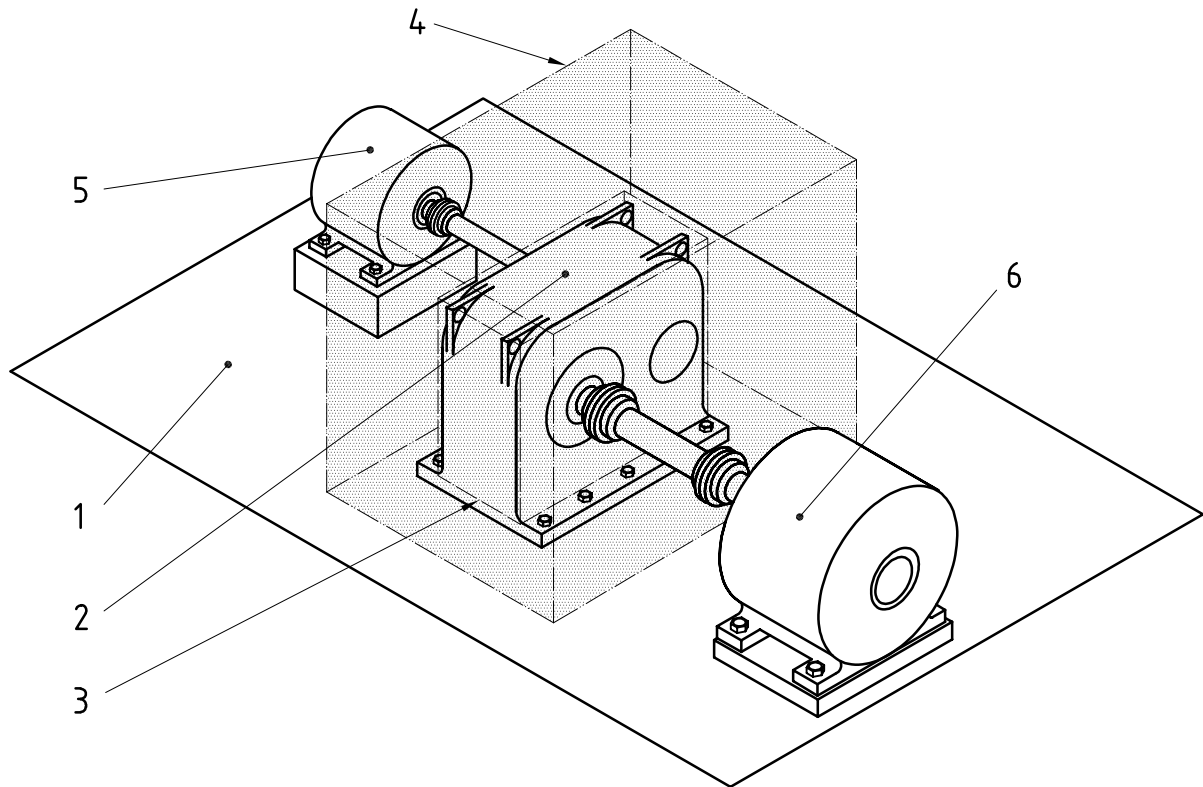
5.3.3 Measurement surface

The measurement surface is a surface generally enveloping the reference box at a given distance.

The distance between the measurement surface and the reference box is called the measurement distance. It depends on the basic method used:

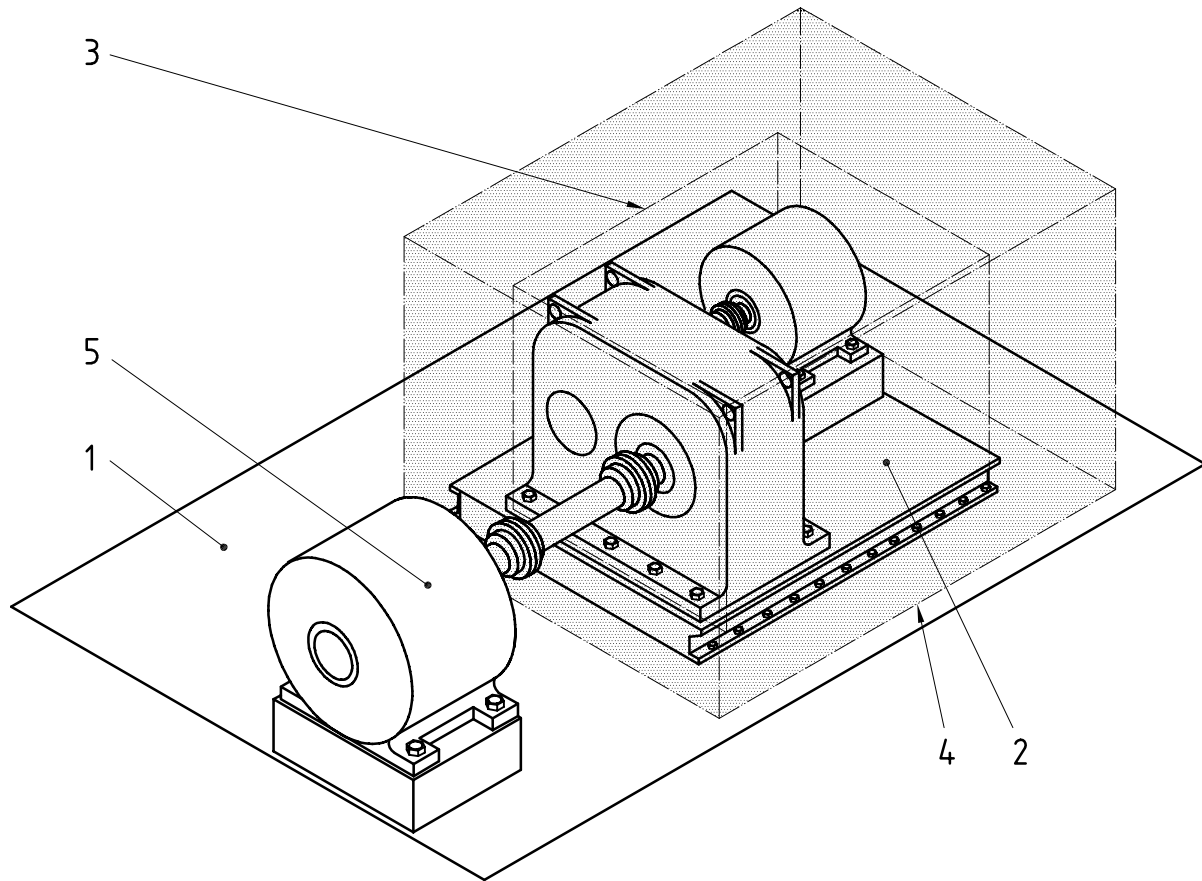
- for ISO 3744, based on a sound pressure level measurement, the distance, d , shall be 1 m;
- for ISO 9614, based on a sound intensity measurement, the distance, d , shall be
 - for ISO 9614-1, $d \geq 0,5$ m, and
 - for ISO 9614-2, $d \geq 0,2$ m.

For typical measurement surfaces, see Figures 1 to 3. Measurement surfaces terminate at reflecting planes, which lie at or within the measurement distance.

**Key**

- 1 Test floor
- 2 Gear unit
- 3 Reference box
- 4 Measurement surface
- 5 Motor
- 6 Load

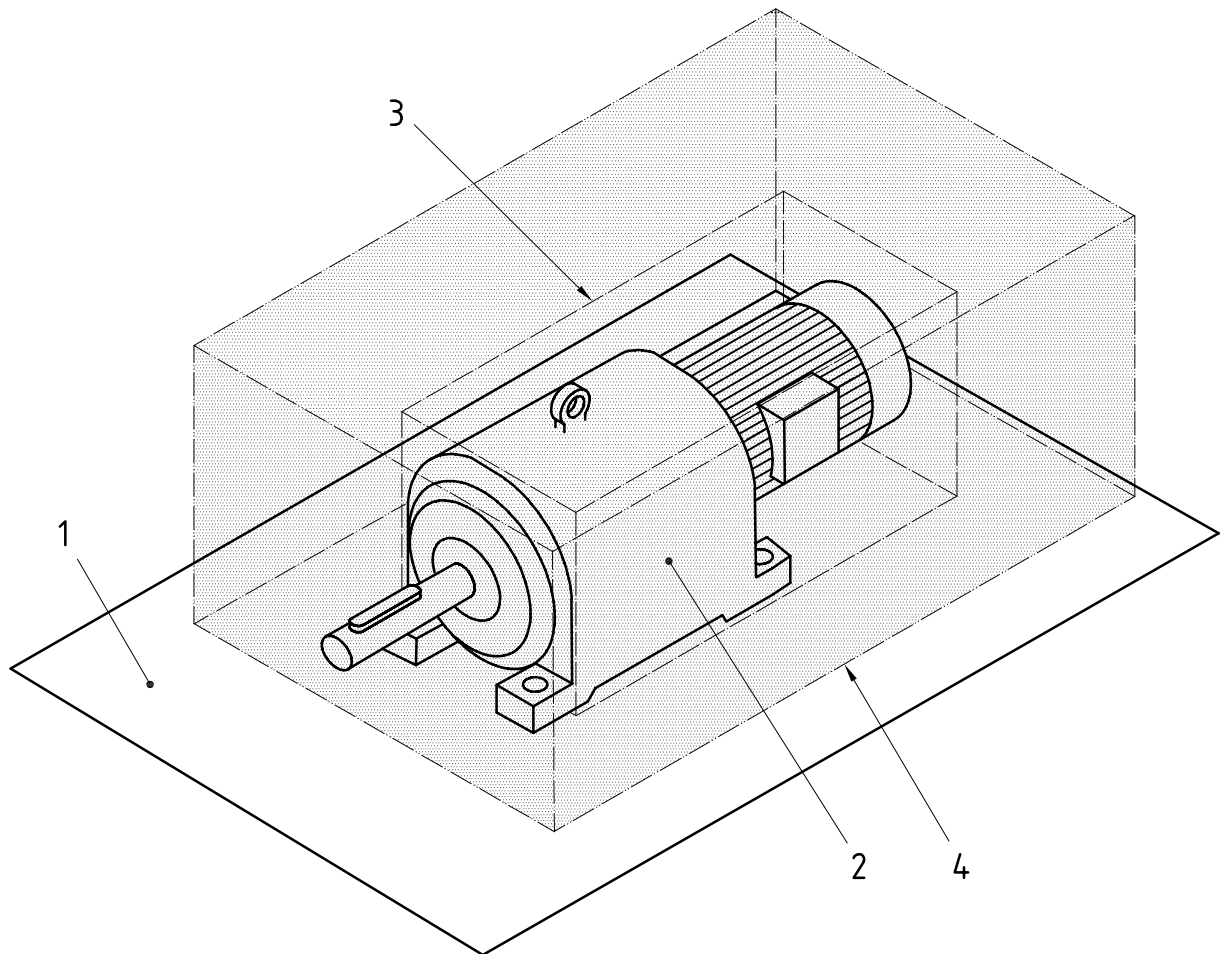
Figure 1 — Reference box and measurement surface for gear unit



Key

- 1 Test floor
- 2 Gear unit
- 3 Reference box
- 4 Measurement surface
- 5 Load

Figure 2 — Reference box and measurement surface for gear-drive system



Key

- 1 Test floor
- 2 Gear unit
- 3 Reference box
- 4 Measurement surface

Figure 3 — Reference box and measurement surface for gearmotor

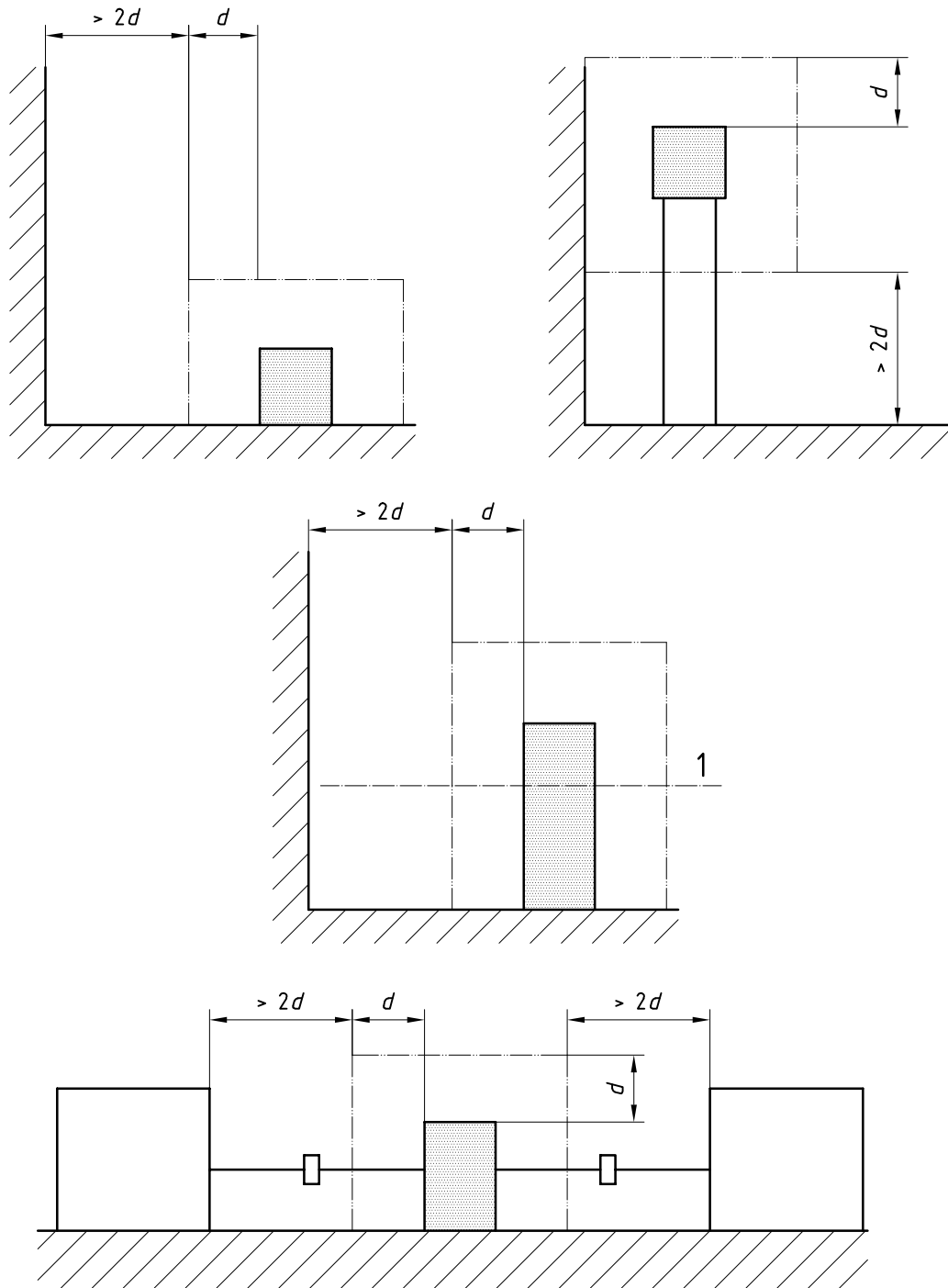
5.3.4 Position of microphones and intensity probes

The positions of the microphones and intensity probes on the measurement surface shall be those specified by the measurement standard used.

Typical microphone positions for sound pressure measurements are shown in Figures 4 to 11. The locations for intensity probes and the distance, d , may be different for intensity measurements.

Caution should be taken in selecting the proper positions of the microphones and intensity probes. They shall be chosen with care and should be appropriate for the arrangement of the machinery and location of walls or sound reflecting surfaces. Otherwise, the determined sound power may not accurately represent that radiated from the gear configuration only.

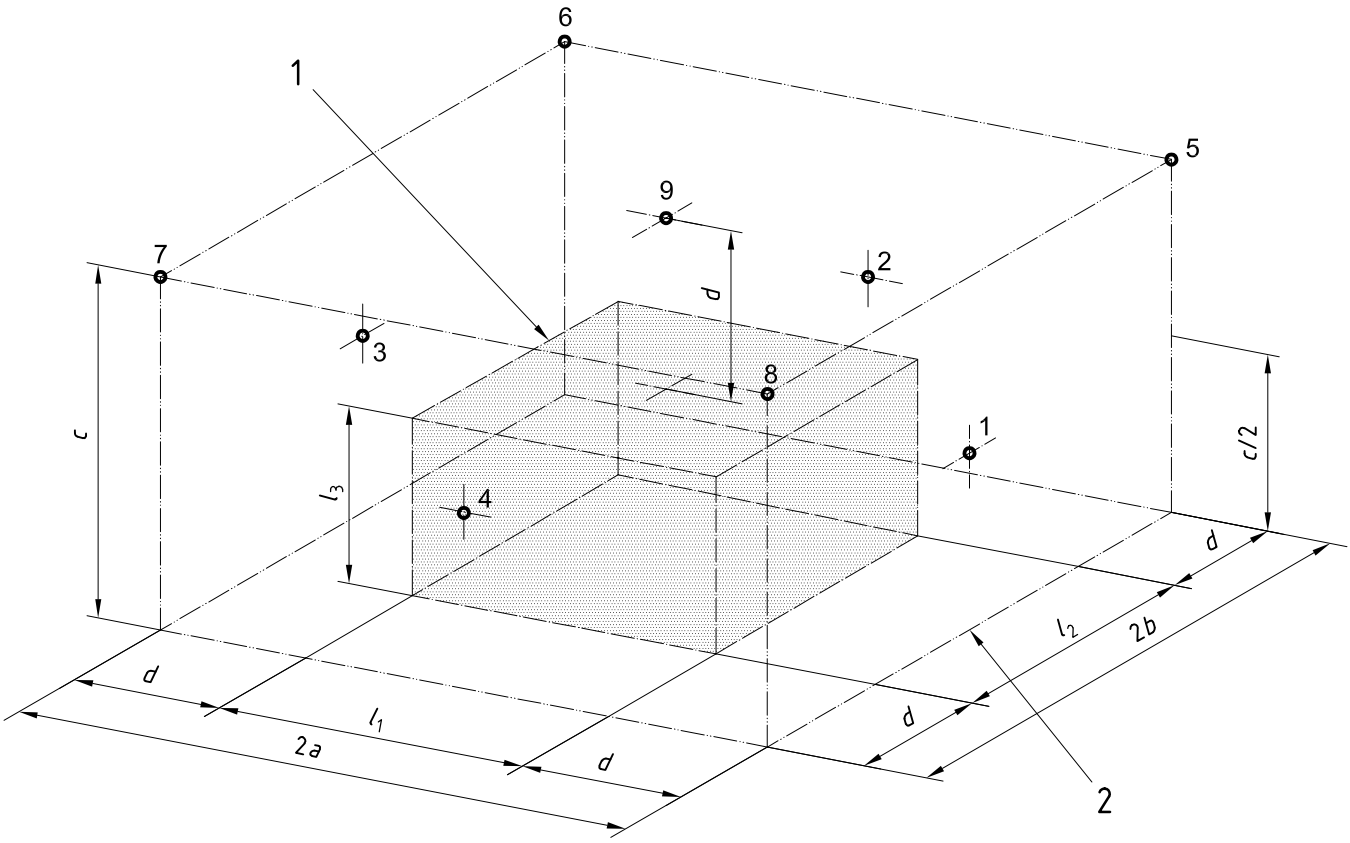
Additional examples of practical microphone positions for various types and sizes of gear are given in annex A.



Key

- 1 Flooring grill

Figure 4 — Examples of machinery mounted on floor or by a wall

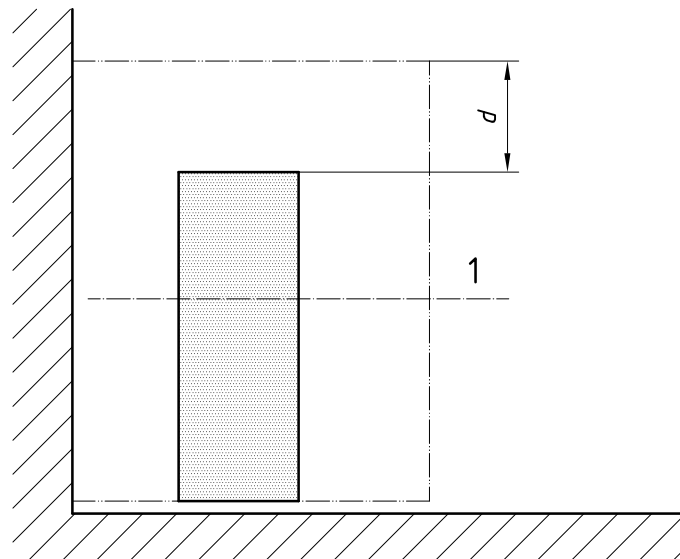
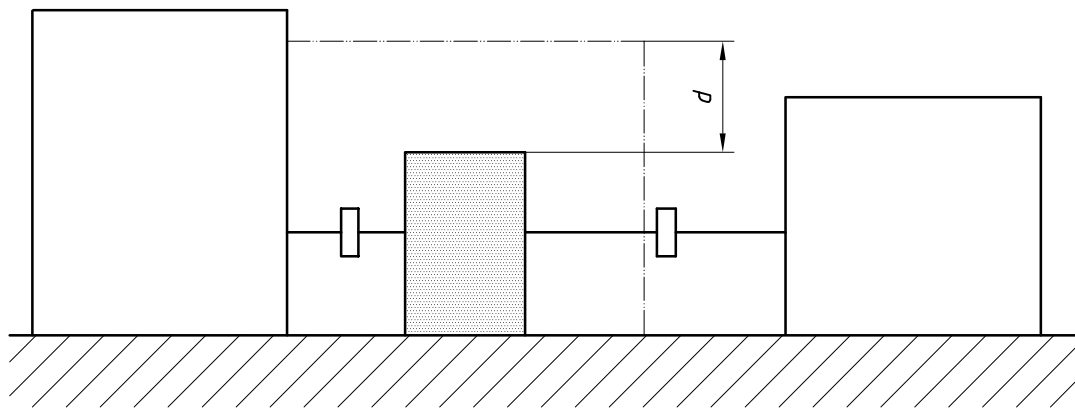
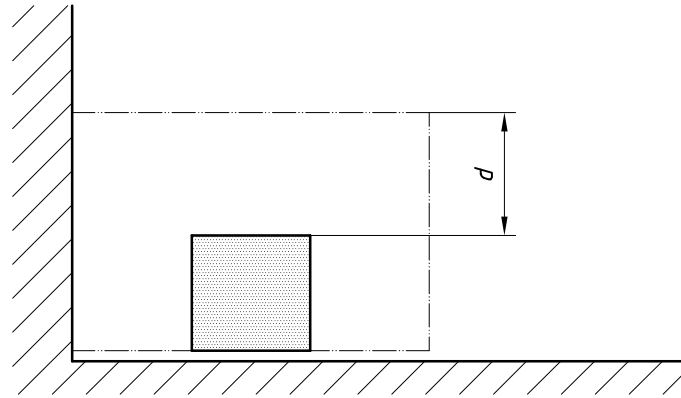


Key

- 1 Reference box
- 2 Measurement surface

Figure 5 — Measurement points arrangement for Figure 4

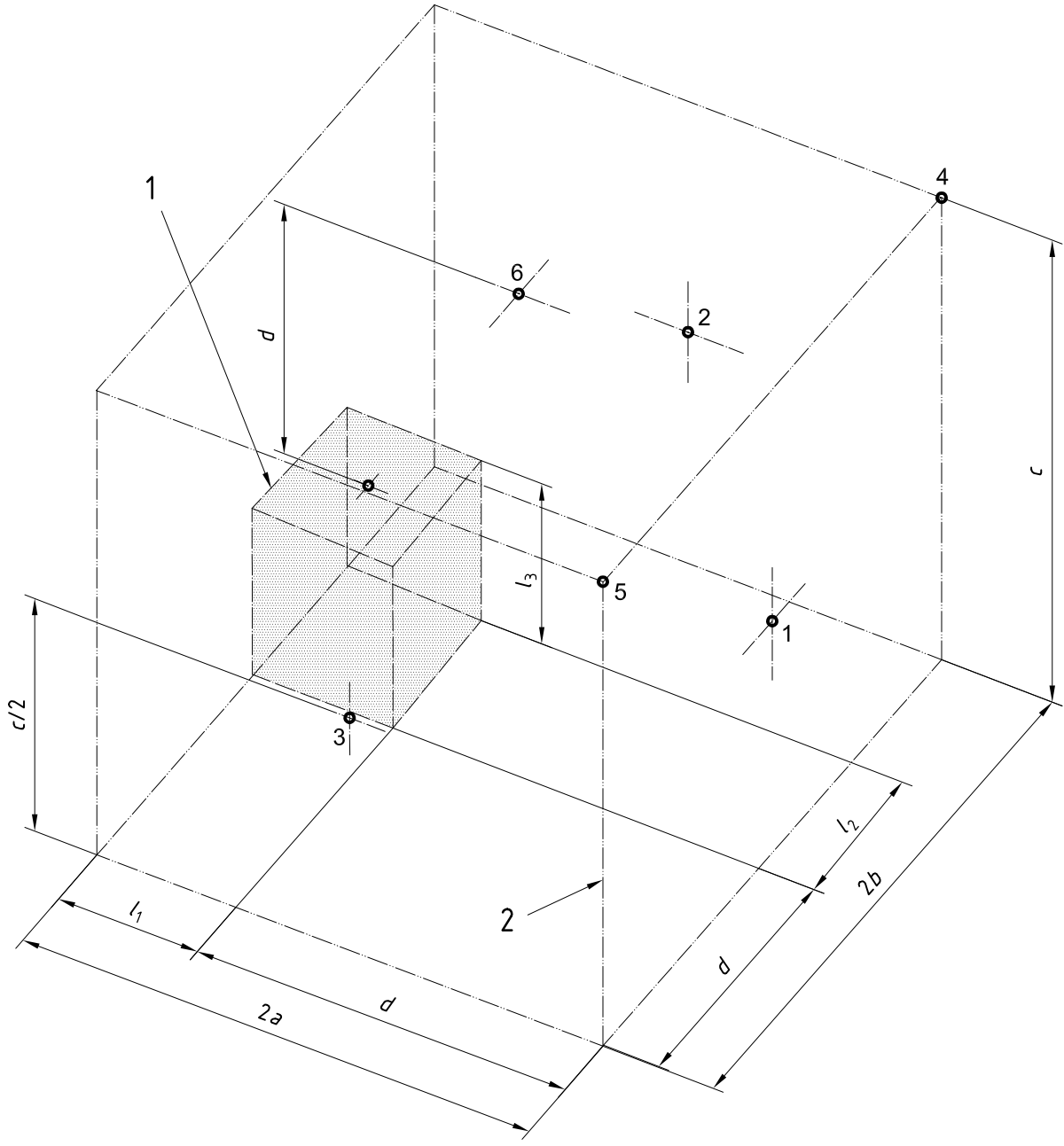
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Key

- 1 Flooring grill

Figure 6 — Examples of machinery mounted on floor and near a wall



Key

- 1 Reference box
- 2 Measurement surface

Figure 7 — Measurement points arrangement for Figure 6

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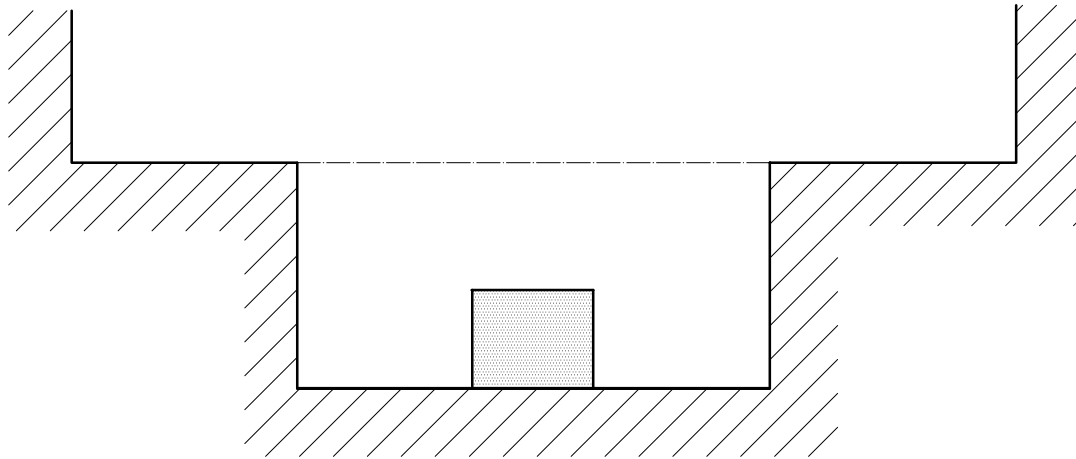
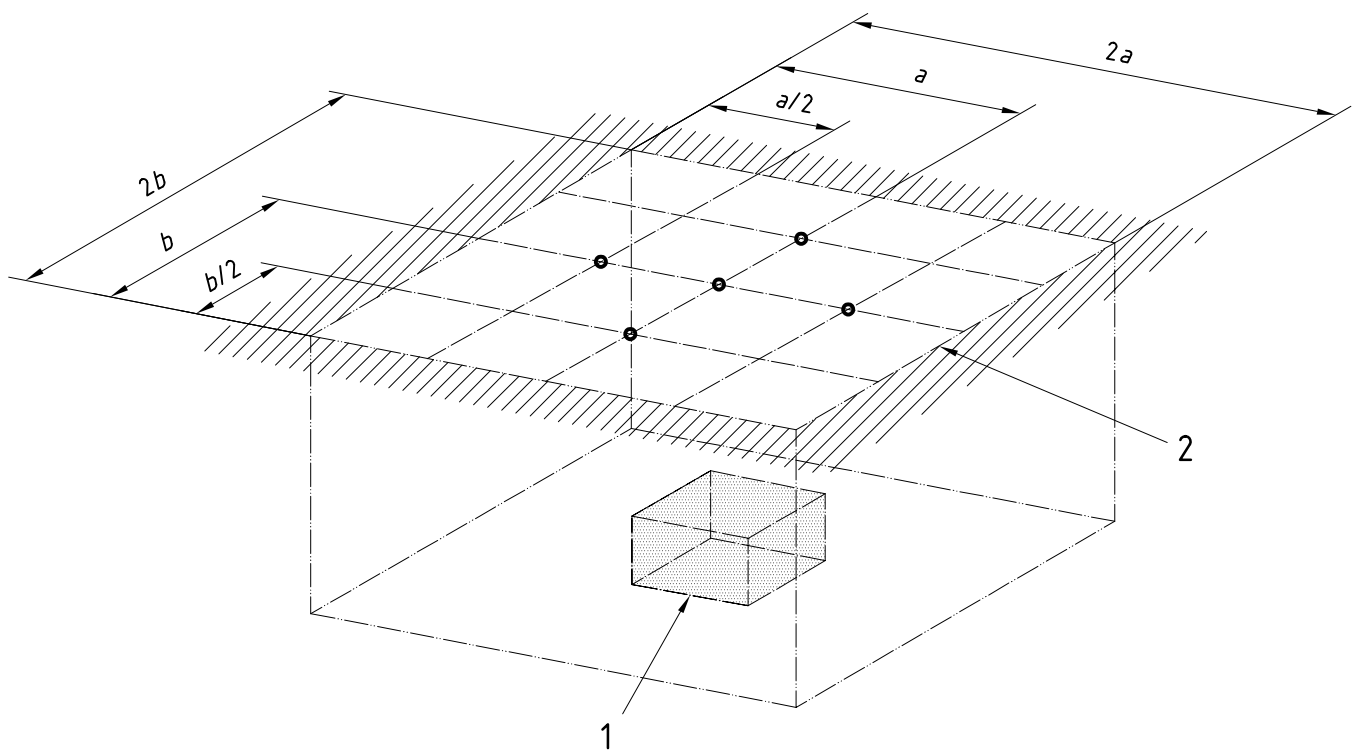


Figure 8 — Example of machinery mounted in a pit with hard, sound-reflecting walls



Key

- 1 Reference box
- 2 Measurement surface

Figure 9 — Measurement points arrangement for Figure 8

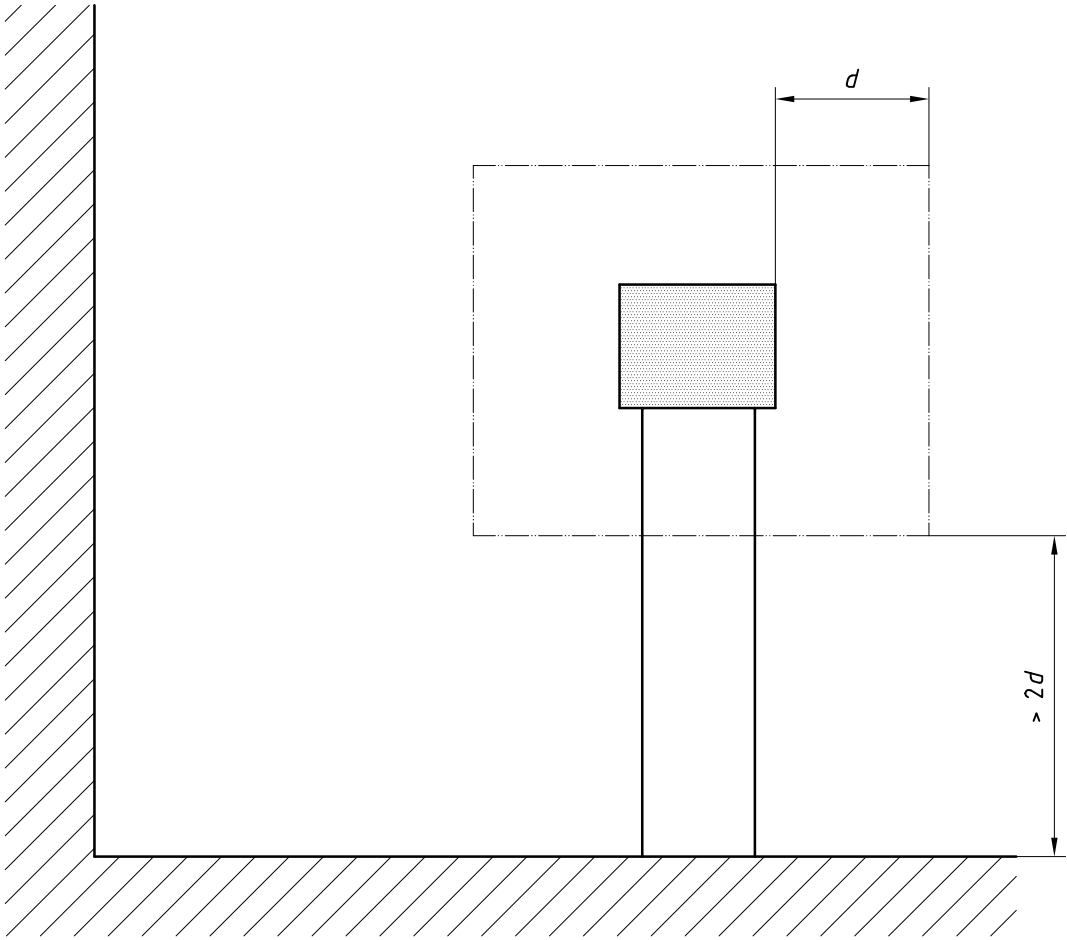
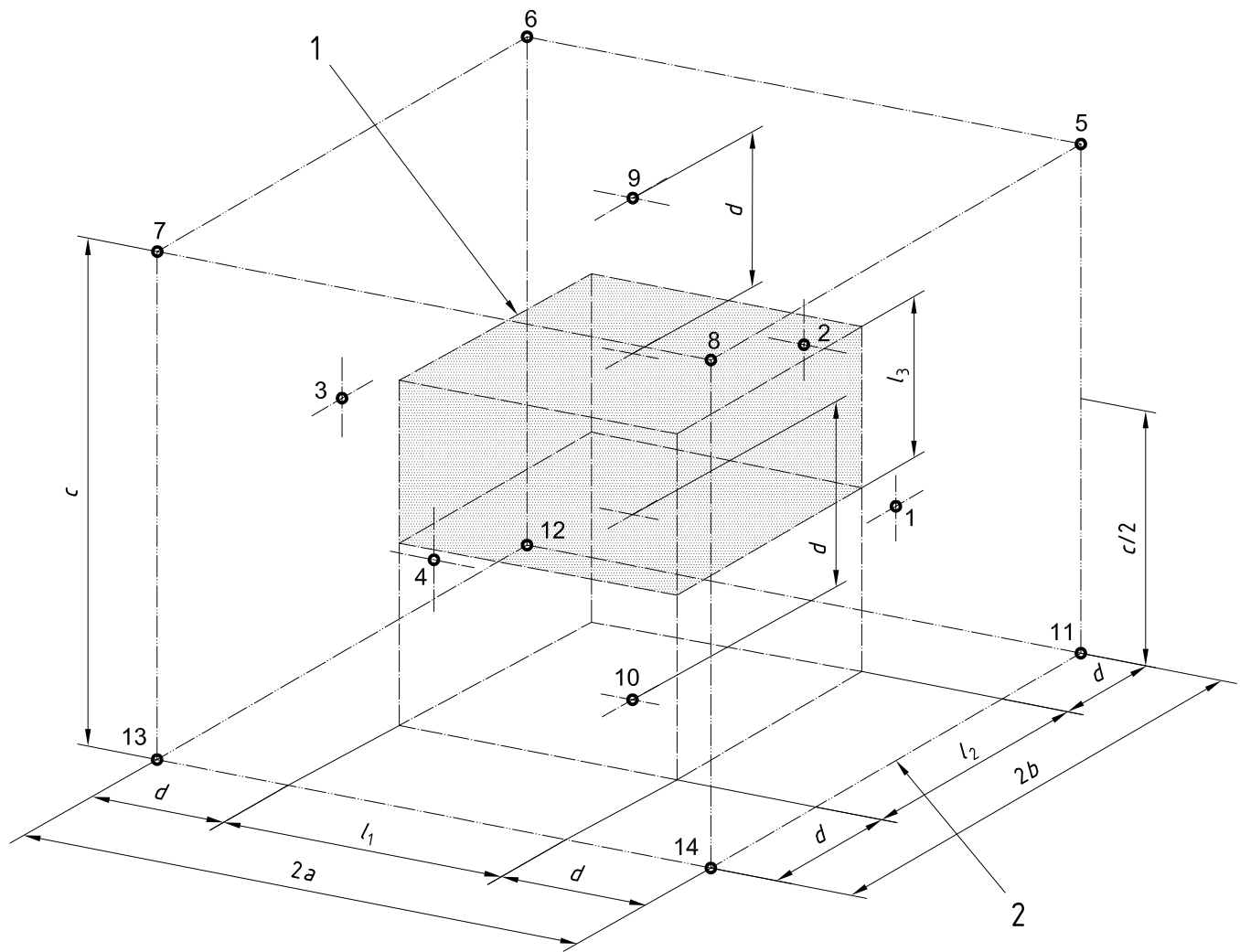


Figure 10 — Example of machinery mounted at considerable distance from sound-reflecting surface



Key

- 1 Reference box
- 2 Measurement surface

Figure 11 — Measurement points arrangement for Figure 10

5.4 Measurement uncertainty

The measurement uncertainty shall be in accordance with the relevant standard and the corresponding grade used.

NOTE Measurements may be distorted under difficult conditions (by vibrations, electrical and magnetic fields, wind or gas streams, abnormal temperatures etc.).

6 Determination of emission sound pressure level

6.1 Basic standard to be used

The A-weighted sound pressure level at the work station (see 6.2) shall be determined using ISO 11203:1985 [method using a value calculated from Q ($Q = Q_2$)] that prescribes a derivation of the A-weighted sound pressure

level from the A-weighted sound power level. It represents the average A-weighted sound pressure level over the measurement surface enveloping the gear configuration defined in 5.3.3.

6.2 Work station

Since gear units/motors have no identifiable work stations, the work station is defined conventionally as being at a point a distance of 1 m from the reference box defined in 5.3.2.

7 Installation and mounting conditions

7.1 Grade of accuracy

The grade of accuracy is dependent upon the installation and mounting conditions. For a required grade of accuracy, sound intensity measurements are much less demanding than for a sound pressure measurement, since the sound intensity method strongly eliminates the effect of extraneous sources.

7.2 Acoustic environment

7.2.1 General

Installation and mounting conditions for the gear configurations are dependent upon the acoustic environment.

7.2.2 Specific facility intended for acoustic measurements

The test facility is an area specifically intended for acoustic measurement. The test facility shall fulfil the following minimum requirements:

- use of low-sound driving and braking devices;
- avoidance of standing waves effects;
- insulation of structure-borne sound between the gear configuration and supporting structure;
- avoidance of mechanical resonance;
- in the case of gear units, insulation by acoustical barrier or enclosure of the transmission elements, braking devices and drive/motor.

A facility may be qualified as specifically designed for sound measurement if it yields grade 2 measurements.

7.2.3 Shop test stand

Acoustic feedback from loading in the case of gear units and braking devices outside the inlet/outlet flanges and the connected auxiliary systems shall not influence the measurement of the sound emission of the gear unit/motor. Low-sound braking devices should preferably be used.

Consideration should be given to

- acoustic lagging of connected systems,
- operating at a minimum of other sound sources,
- temporary screening of the driver/motor in the case of gear units, transmission elements and braking devices, and
- temporary application of absorbing material on reflecting surfaces.

7.2.4 On-site

Wherever possible, the following actions to improve the acoustic environment shall be taken:

- operating at a minimum of other sound sources;
- temporary screening of the driver/motor in the case of gear units, transmission elements and braking devices;
- temporary application of absorbing material on reflecting surfaces.

8 Operating conditions during sound measurements

8.1 General

Unless otherwise agreed by the purchaser and the manufacturer/supplier, the conditions of 8.2 to 8.4 shall apply.

If the normal operating conditions cannot be met during the tests due to power limitations or other reasons, the reduced conditions should be agreed upon between the manufacturer and the purchaser.

8.2 Test conditions during sound measurement

The test conditions are the following:

- the gear configuration shall be tested in its intended direction of rotation or, if reversible, in both directions;
- the measurements shall be conducted using the operating lubrication system and the lubricant viscosity equivalent to the operating viscosity;
- the measurements shall be conducted when the gear configuration is operating within its design temperature range.

8.3 Operating speed

The gear configuration shall be tested at its intended operating speed.

A gear configuration intended for service over a range of operating speeds shall be tested at speeds which span the operating range, unless otherwise agreed upon between manufacturer and purchaser.

8.4 Operating load

The measurement shall be made while the gear configuration is at nominal or at an agreed upon load. This operating point can be defined as one of the following:

- rated conditions (= guaranteed conditions) when specified for the gear configuration;
- contractual conditions (other than rated conditions);
- nominal conditions at the point of best efficiency.

NOTE If the agreed condition is at low load (idling), care needs to be taken if a rattle exists that is difficult to interpret.

9 Information to be recorded

The information to be recorded includes all the information required by the sound measurement standards used for the test.

10 Information to be reported

The information to be included in the test report is at least the information the manufacturer requires to prepare a sound test declaration or that the user requires to verify the declared values.

As a minimum, the following information shall be included:

- a) full identification of the gear configuration (see 4.1);
- b) technical characteristics of the gear configuration;
- c) reference to this part of ISO 8579 and to the basic sound emission standard used, chosen from among those allowed by this part of ISO 8579; if the power of the gear configuration is such that this sound test code recommends use of a grade 2 standard, but a grade 3 standard is used instead, the reasons why it has not been possible to use a grade 2 standard shall be stated;
- d) a statement to the effect that all requirements of this sound test code, and of the basic standard used, have been fulfilled;
- e) descriptions and operational conditions, including a dimensional sketch of the test room, the arrangement of the gear unit, the position of measurement points, the distance of measurement points from the gear unit surfaces, and data from measurement points (see clause 7);
- f) a list of the measurement equipment used, by make, type and calibration status;
- g) the sound emission values obtained; A-weighted sound pressure or power levels and, when appropriate, frequency-band sound power levels.

11 Declaration and verification of sound emission values

The declaration of the sound emission values is the sole responsibility of the manufacturer. It shall be made in such a fashion that the values can be verified according to ISO 4871.

The declaration of both the A-weighted sound power level and A-weighted sound pressure level, at the relevant work station as defined in 6.2, is recommended. The sound declaration shall mention explicitly the fact that the sound emission values have been obtained according to this sound test standard and indicate the basic standard used for the determination of the sound power level. If such a statement could not be justified, the sound declaration shall indicate clearly the deviation from this sound test standard or from the basic standards used, or both.

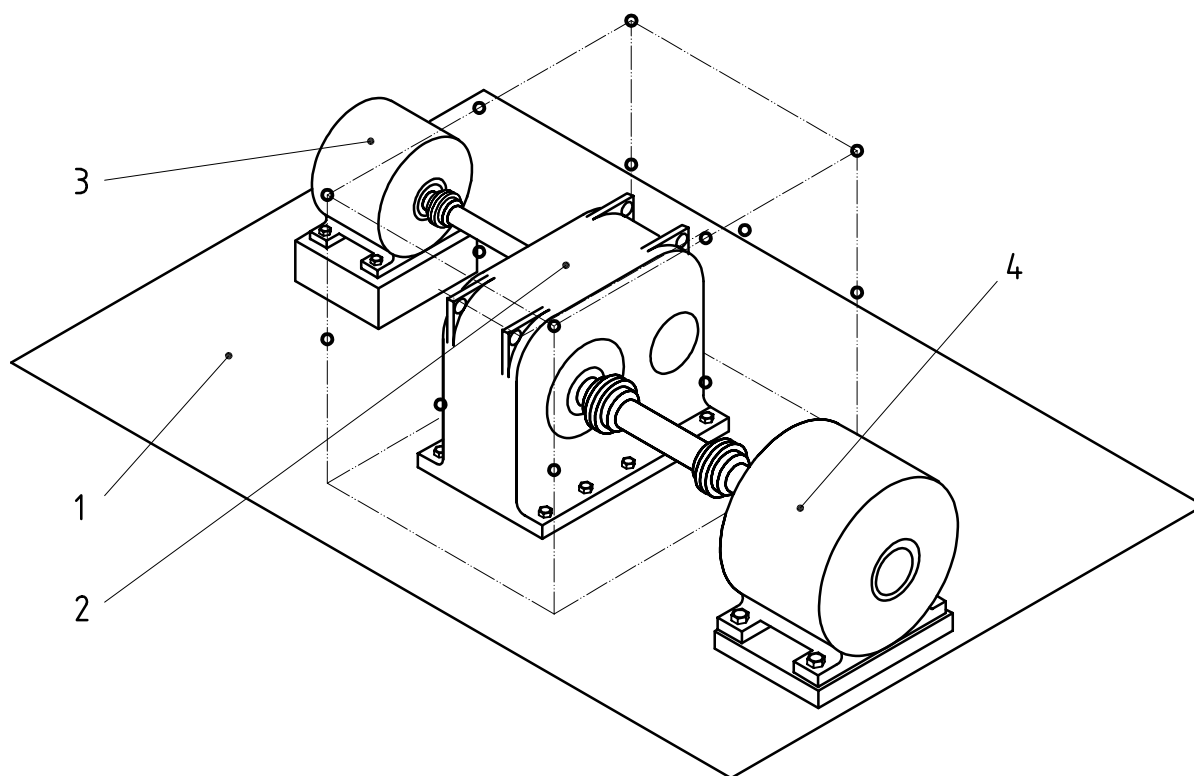
Use of the method for declaration given in annex A of ISO 4871:1996 is recommended.

If performed, verification shall be conducted using the same mounting and operating conditions as those used for the initial determination of the sound emission values. It shall be made on a single machine in accordance with 6.2 of ISO 4871:1996.

Additional sound emission quantities, including sound power levels in octave bands and measured values of the sound emission quantities declared, may also be given in the sound declaration. In this case, care shall be taken to avoid confusion between these additional sound emission data and the declared sound emission values.

Annex A
(informative)

Examples of microphone positions on the measurement surface for different gear types and sizes

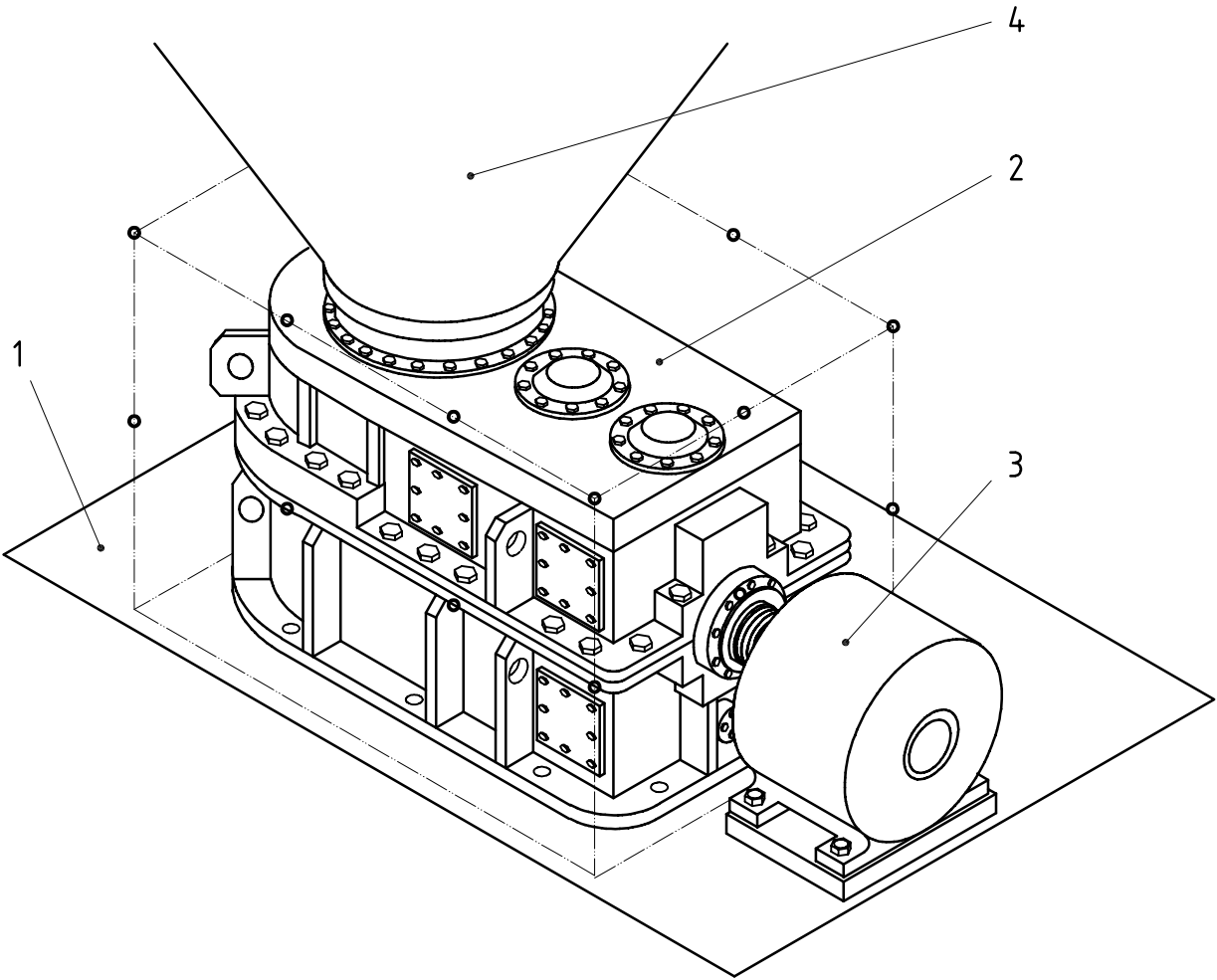


Key

- 1 Test floor
- 2 Gear unit
- 3 Motor
- 4 Load

● Microphone position

Figure A.1 — Single reduction gear unit

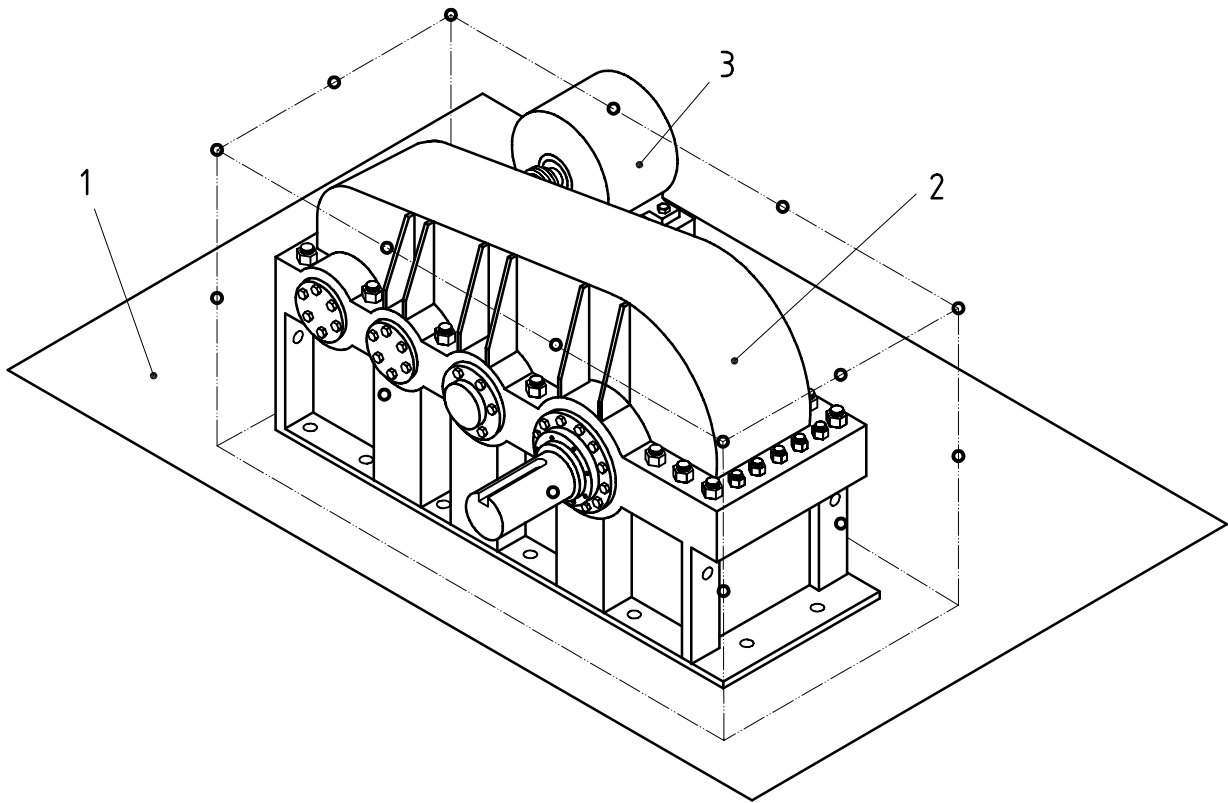


Key

- 1 Test floor
- 2 Gear unit
- 3 Motor
- 4 Load

● Microphone position

Figure A.2 — Triple reduction, bevel helical mill drive

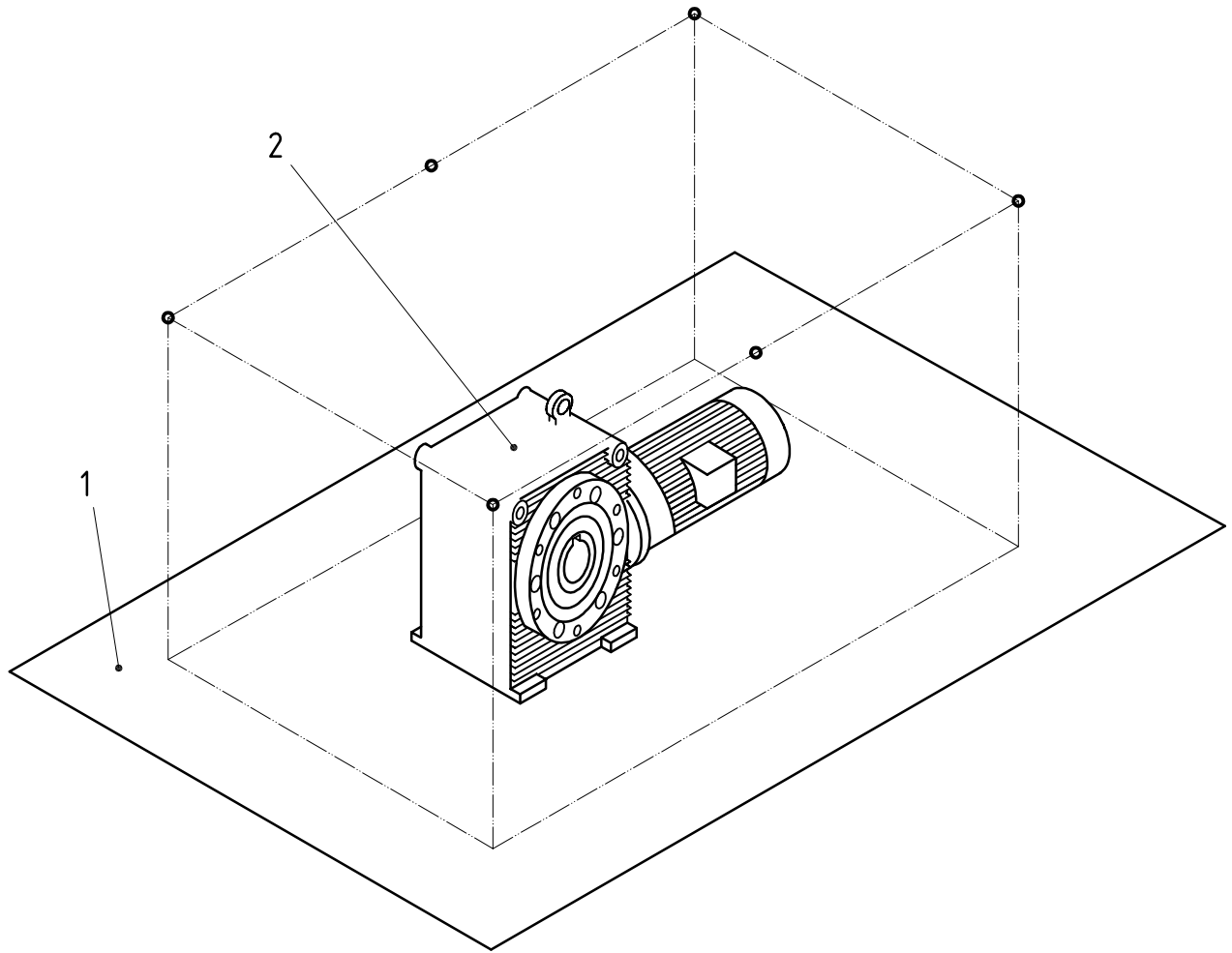


Key

- 1 Test floor
- 2 Gear unit
- 3 Motor

● Microphone position

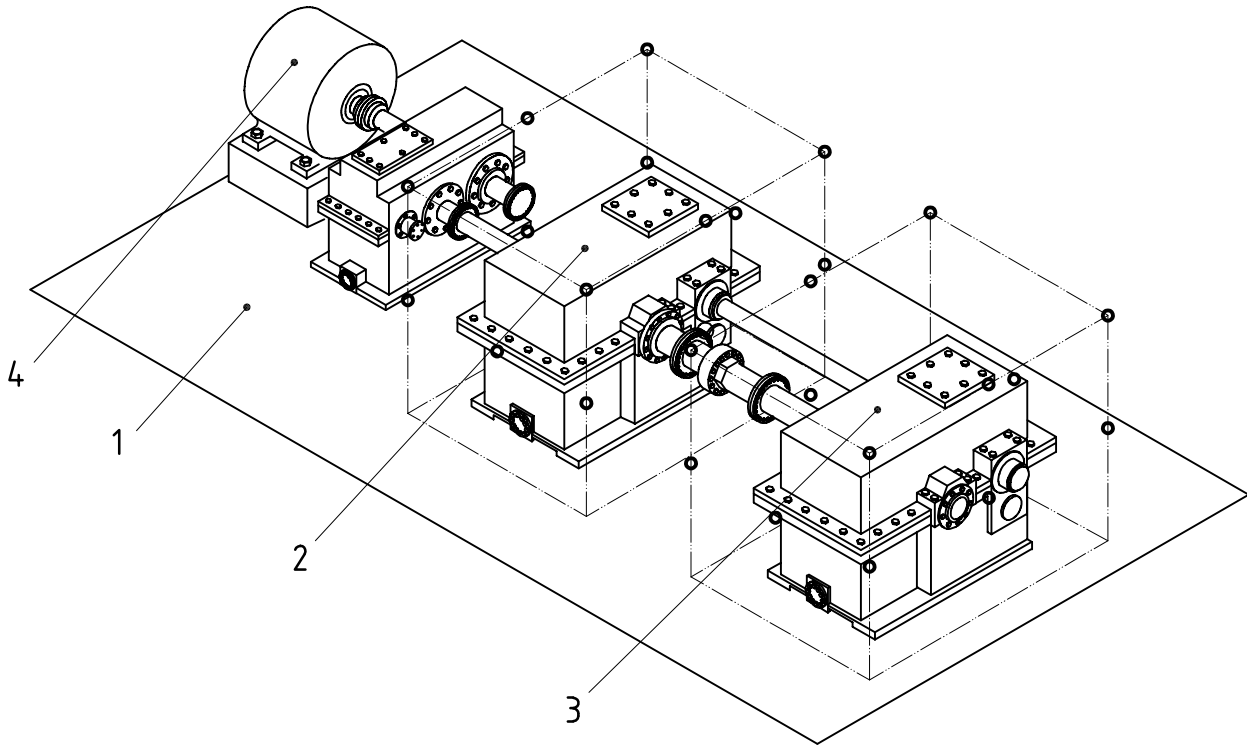
Figure A.3 — Triple reduction, parallel shaft drive

**Key**

- 1 Test floor
- 2 Gearmotor

● Microphone position

Figure A.4 — Helical worm shaft-mounted drive

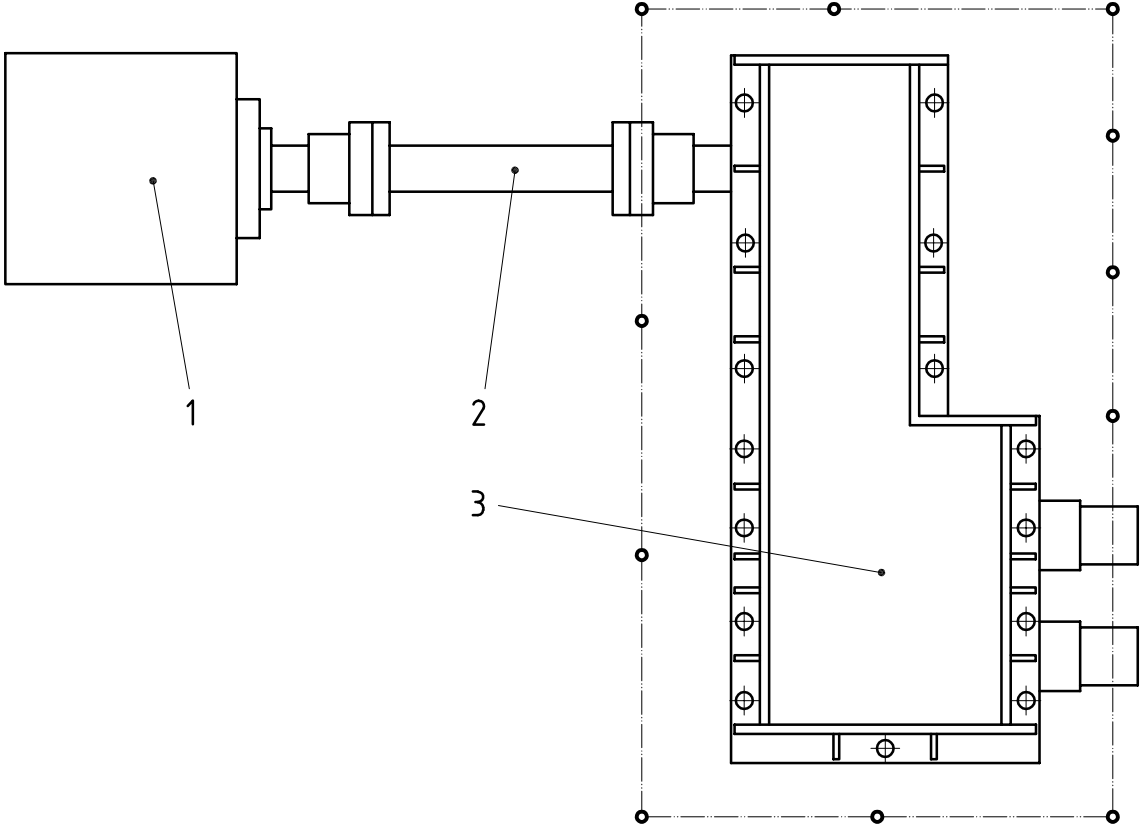


Key

- 1 Test floor
- 2 Gear unit 1
- 3 Gear unit 2
- 4 Motor

○ Microphone position

Figure A.5 — High-speed “back to back” shop test

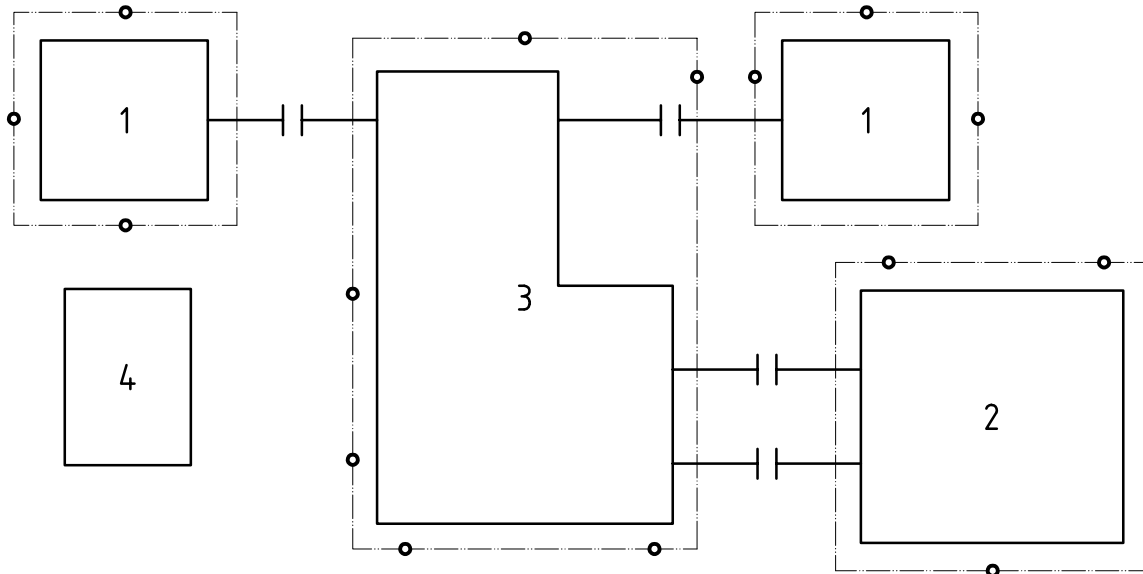


Position of microphone in measuring cross-section

Key

- 1 Motor
- 2 Coupling
- 3 Gear unit (for rubber mixer)
- Microphone position

Figure A.6 — Practical shop measurement set-up



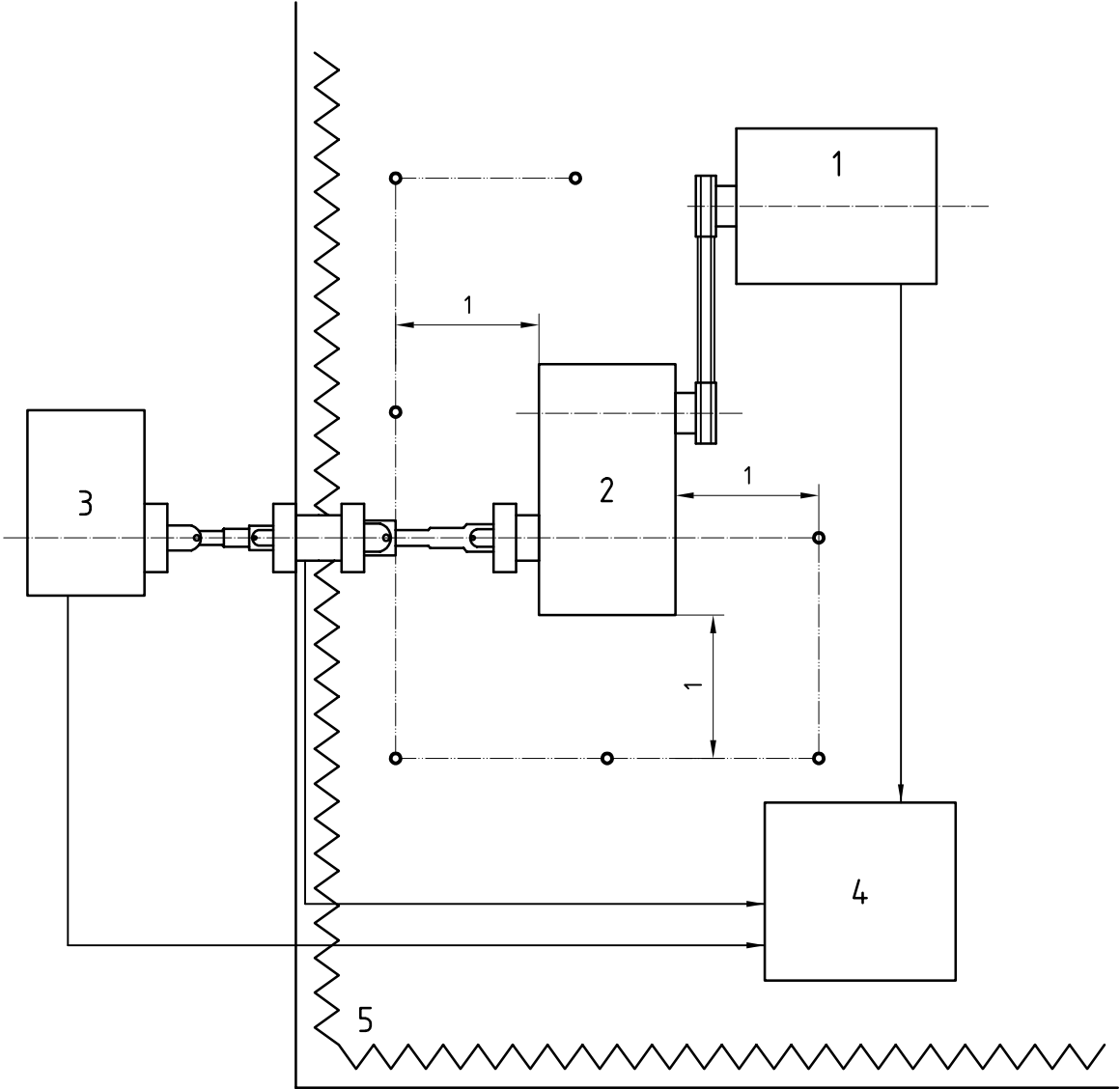
Intensity probe envelope in sound measuring cross-section for each component of interest

Key

- 1 Motor
 - 2 Mixer
 - 3 Gear unit
 - 4 Lubrication system
- Microphone position

Figure A.7 — Typical on-site measurement set-up for determining component levels

Dimensions in metres

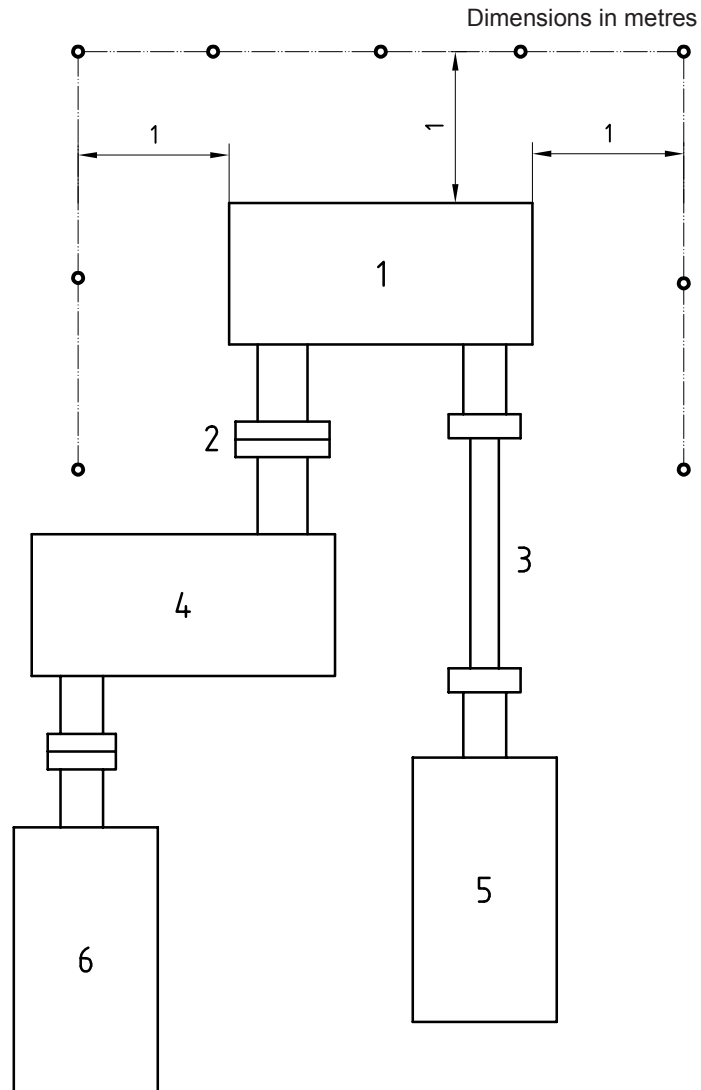


Key

- 1 Motor
- 2 Gear unit
- 3 Load
- 4 Speed torque control
- 5 Absorption wall

● Microphone position

Figure A.8 — Schematic of test cell set-up



Microphone position in sound measuring cross-section where speed-increasing gear is quiet

Key

- 1 Gear unit (test object)
 - 2 Gear tooth coupling
 - 3 Floating shaft
 - 4 Speed-increasing gear unit
 - 5 Drive motor
 - 6 Generator
- Microphone position

Figure A.9 — Schematic test layout of shop floor load test

Annex B (informative)

Typical sound levels for different gear types and sizes (sound power and sound pressure)

B.1 Purpose

The purpose of this annex is to present typical sound levels for enclosed gear configurations measured.

NOTE Sound power and sound pressure are different data. The results of each in decibels cannot be directly compared.

B.2 Typical sound pressure levels

B.2.1 General

The sources of generated sound in a gear-driven system are important. However, the levels generated and the methods of measurement become the points of major interest when determining whether a system will meet a specification. The gear industry has had years of experience measuring sound, both on the test stand and in field installations. This experience has indicated the sound pressure levels that can be expected on qualification spin or load tests. These sound pressure levels can be obtained from test results of identical or comparable units, or from empirical data extrapolated from similar equipment, or from both. The levels generally will not include driving- or driven-equipment sound and system influences. When a gear unit is actually installed, the prediction or estimation of its sound pressure level is difficult, since the gear unit will then be part of a total acoustic system that includes, in addition to the gear unit, the prime mover, driven equipment, gear unit mounting and surrounding acoustical environment. Some insights into this problem can be gained by examining the effect of certain system parameters, such as speed and load.

B.2.2 Typical maximum data

Typical maximum sound pressure levels for representative types of gear unit are shown in Figures B.1 to B.7, for information only. The typical maximum curves of Figures B.1 to B.3 were established based on the measured sound pressure levels of the gear units given by the points in the figures. The curves for gearmotors in Figure B.2 were obtained by adding estimated electric motor sound pressure levels to gear unit sound levels.

B.2.3 Speed effects

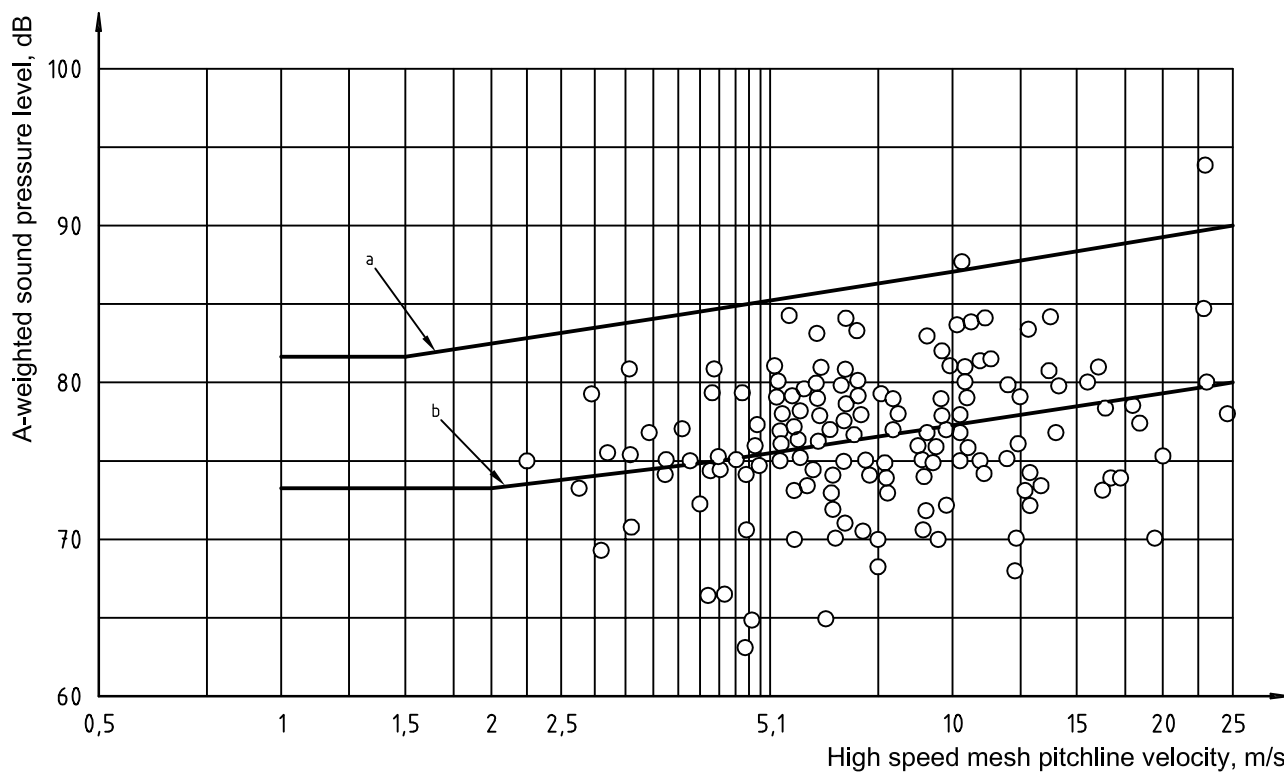
Typical data for the effect of speed (input revolutions per minute) on the gear unit sound pressure level is presented in Figure B.4.

B.2.4 Load effects

One of the most significant operating parameters affecting the level of gear unit sound is load. Much of the experimental literature to date indicates an increase in sound due to an increase in load (see Figure B.5). Some data has indicated as much as a 20 dB increase for spur gearing between a load and no-load (spin) test. However, empirical data collected throughout the gear industry indicates increased sound level does not always accompany increased loading. In some cases, even the reverse occurs, i.e. when the tooth geometry has been modified for loaded deflections and operating temperatures. Until these design loads and temperatures have been reached, the mesh action may be noisy. The average statistical difference in gear unit sound between no-load spin and full load (rated load/service factor) is an increase of approximately 4 dB(A) (see Figure B.6 — helical, herringbone, spiral bevel and worm gearing).

The maximum increase in sound between no load and full load observed was 12 dB(A). The data showed about two thirds of the units increased in sound with load. About one-fifth did not indicate a measured difference with load, and the remainder had reduced sound pressure levels with increased load.

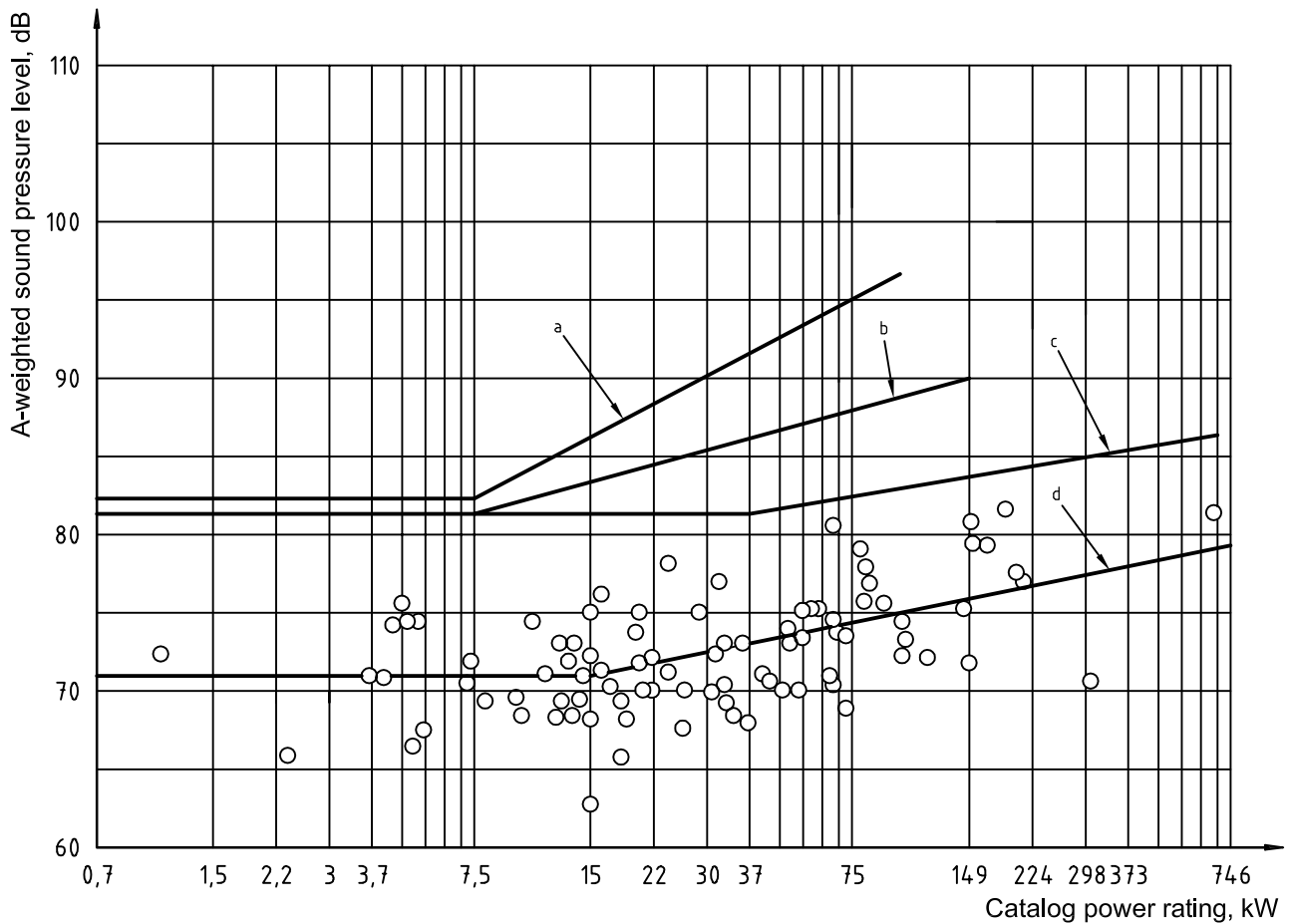
Therefore, for gears of this type, a majority showed an average increase of 4 dB(A). Only in similar gear-drive systems may this be used as a guideline for the expected difference between a shop spin test and field-installed load operation.



Enclosed helical and spiral bevel gear units — single-, double- and triple-reduction, without cooling fan

- a Typical maximum
- b Average

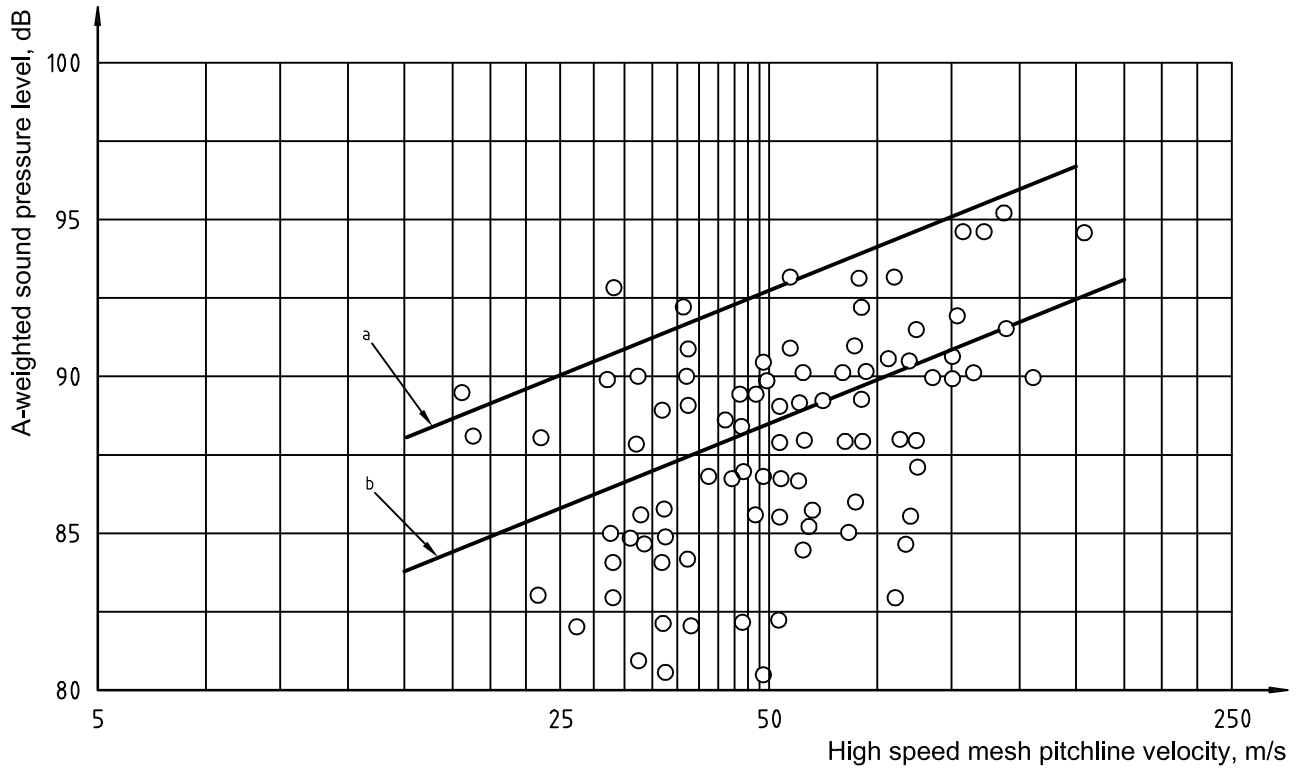
Figure B.1 — Typical maximum and average A-weighted sound pressure levels versus high-speed mesh pitch line velocity at no or light load



Gearmotors, in-line reducers and increasers — single, double and triple reduction, without cooling fan

- a Typical maximum: gearmotor (with totally enclosed fan-cooled motor, 1 800 r/min)
- b Typical maximum: gearmotor (with drip-proof motor, 1 800 r/min)
- c Typical maximum: in-line reducer and increaser (no motor)
- d Average: in-line reducer and increaser (no motor)

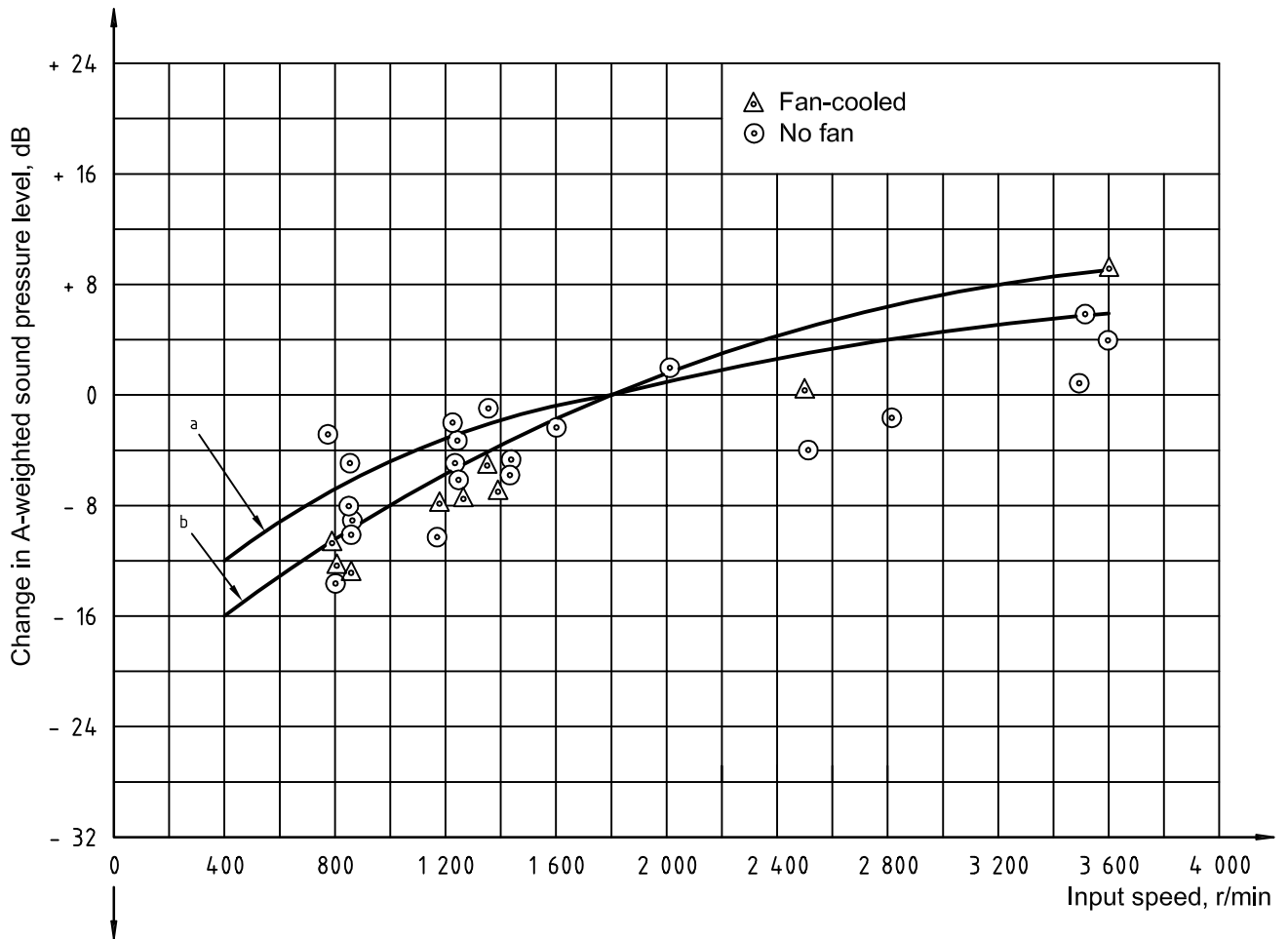
Figure B.2 — Typical maximum and average A-weighted sound pressure levels versus catalogue power ratings at no load or light load



High-speed helical and double helical single reduction gear units at full speed

- a Typical maximum
- b Average

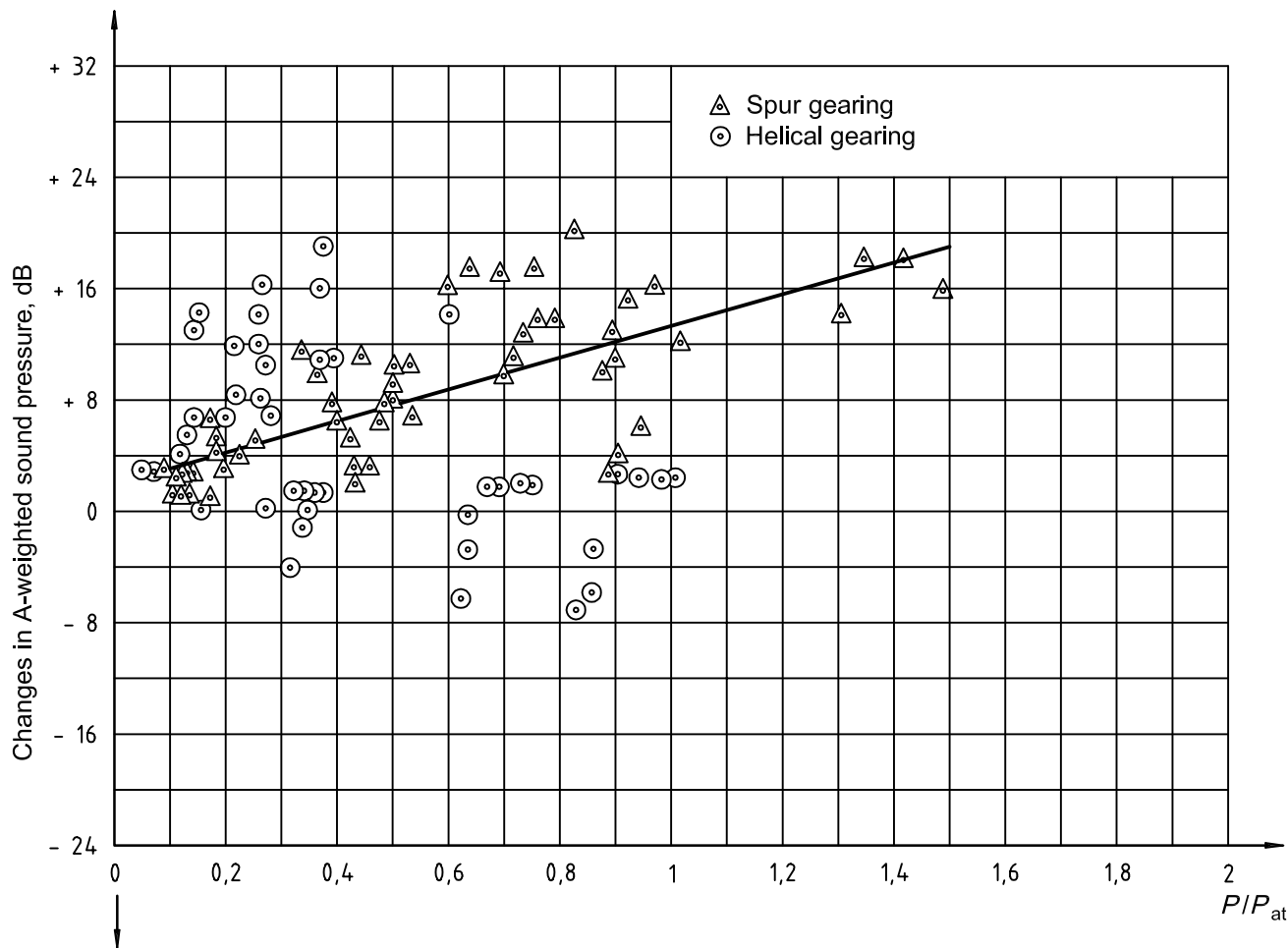
Figure B.3 — A-weighted sound pressure level versus pitchline velocity, taken 0,9 m from housing, at no or light load



Helical gear units
 $\Delta L_{pA} = L_{pA, n} - L_{pA, n = 1750 \text{ r/min}}$

- a Typical maximum
- b Average

Figure B.4 — Change in A-weighted sound pressure level (ΔL_{pA}) relative to that at 1 750 r/min versus input speed

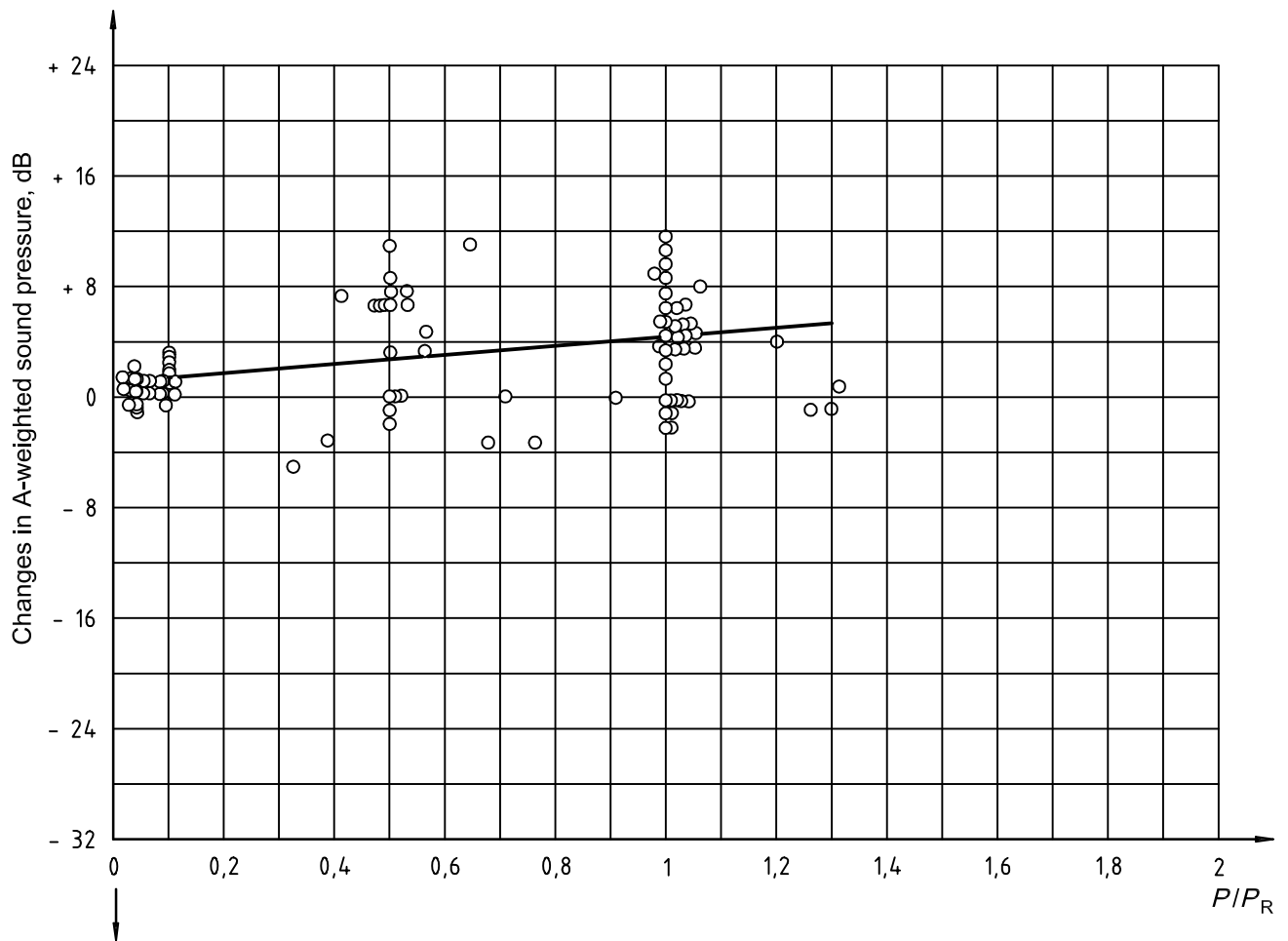


Published literature data

$$\Delta L_{pA} = L_{pA, n} - L_{pA, n=0}$$

- P Transmitted power, in kilowatts
- P_{at} AGMA strength rating, in kilowatts

Figure B.5 — Change in A-weighted sound pressure level relative to that at no load (ΔL_{pA}) versus P/P_{at}



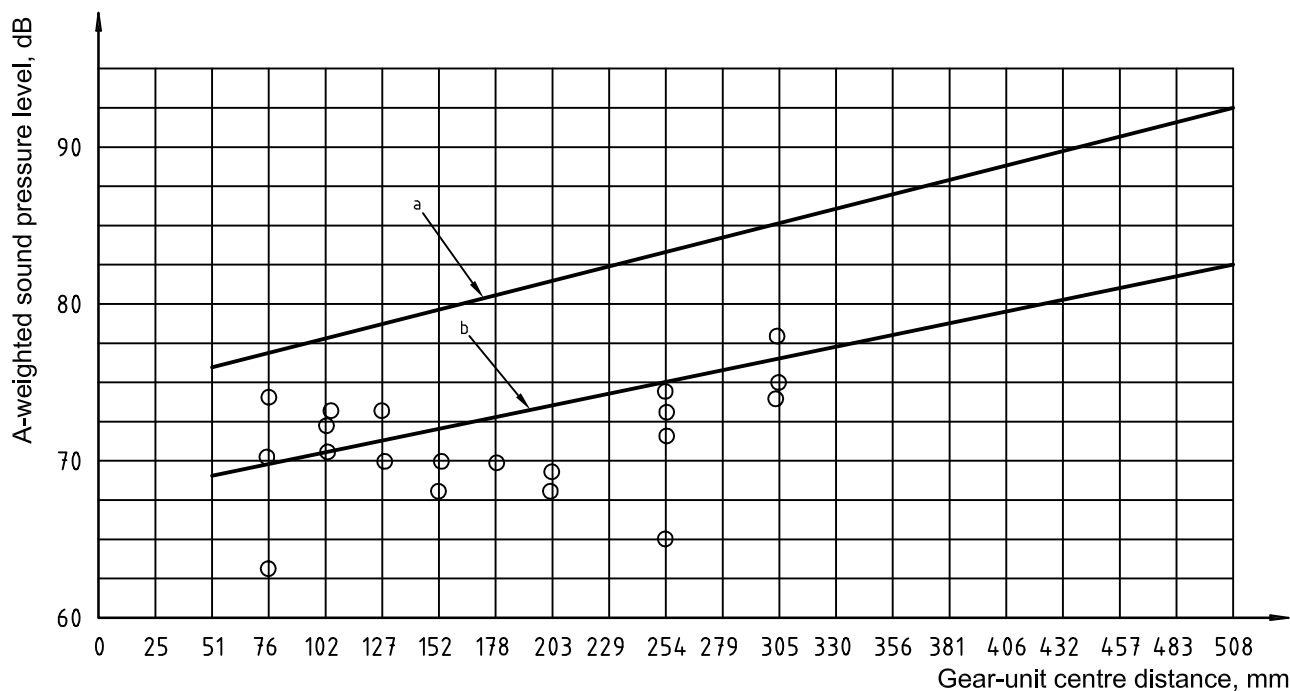
Manufacturer's data:
helical, herringbone, spiral bevel and worm gear units

$$\Delta L_{pA} = L_{PA, n} - L_{PA, n=0}$$

P Transmitted power, in kilowatts

P_R Catalogue rating, in kilowatts

Figure B.6 — Change in A-weighted sound pressure level relative to that at no load (ΔL_{pA}) versus P/P_R



Single-reduction worm reducers at a input speed of 1750 r/min, fan cooled

- a Typical maximum
- b Average

Figure B.7 — A-weighted sound pressure level versus centre distance, taken 1,5 m from housing, at no load or light load

B.3 Typical sound power levels

Sound power levels determined by acceptance testing from the operation of various gear configurations at varying levels of speed and load are shown in Figures B.8 to B.12.

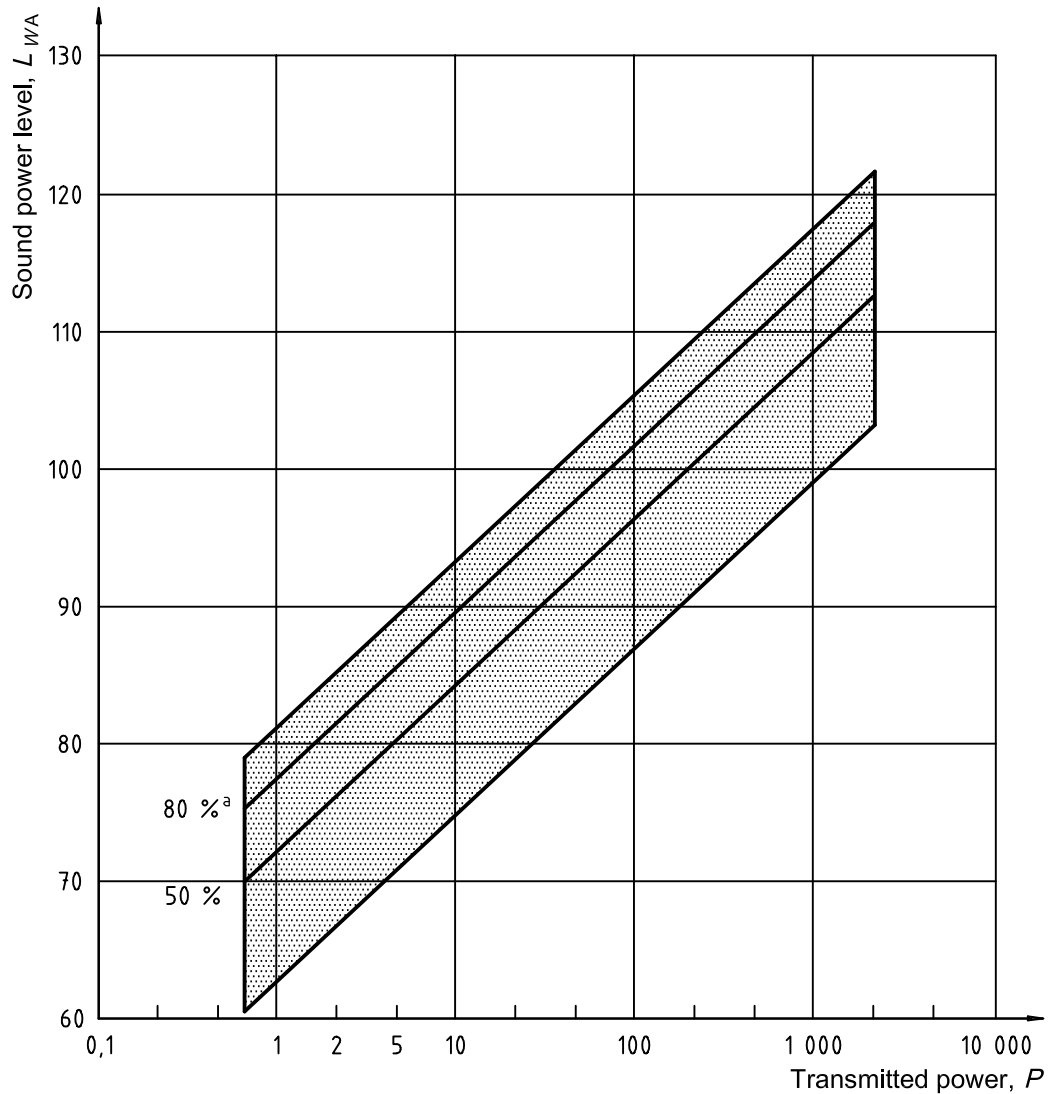
B.4 Typical installed sound levels

Typical sound pressure levels obtained during the operation of an installed single-reduction, parallel shaft gear unit (1 m from the gear unit), containing gearing manufactured to quality grade 4 or lower, in accordance with ISO 1328-1 and at various levels of transmitted power, are shown in Figure B.13.

B.5 Typical sound intensity data

Sound power testing of installed gear units (up to 5 MW) evaluated using vectorial acoustic intensity techniques are shown in Figure B.14. This technique enables the rejection of extraneous sound and reverberation effects.

Logarithmic regression
 $L_{WA} = 77,1 + 12,3 \times \log P$
 (80 % line)
 Variance $r^2 = 0,83$
 Stated probability 90 %

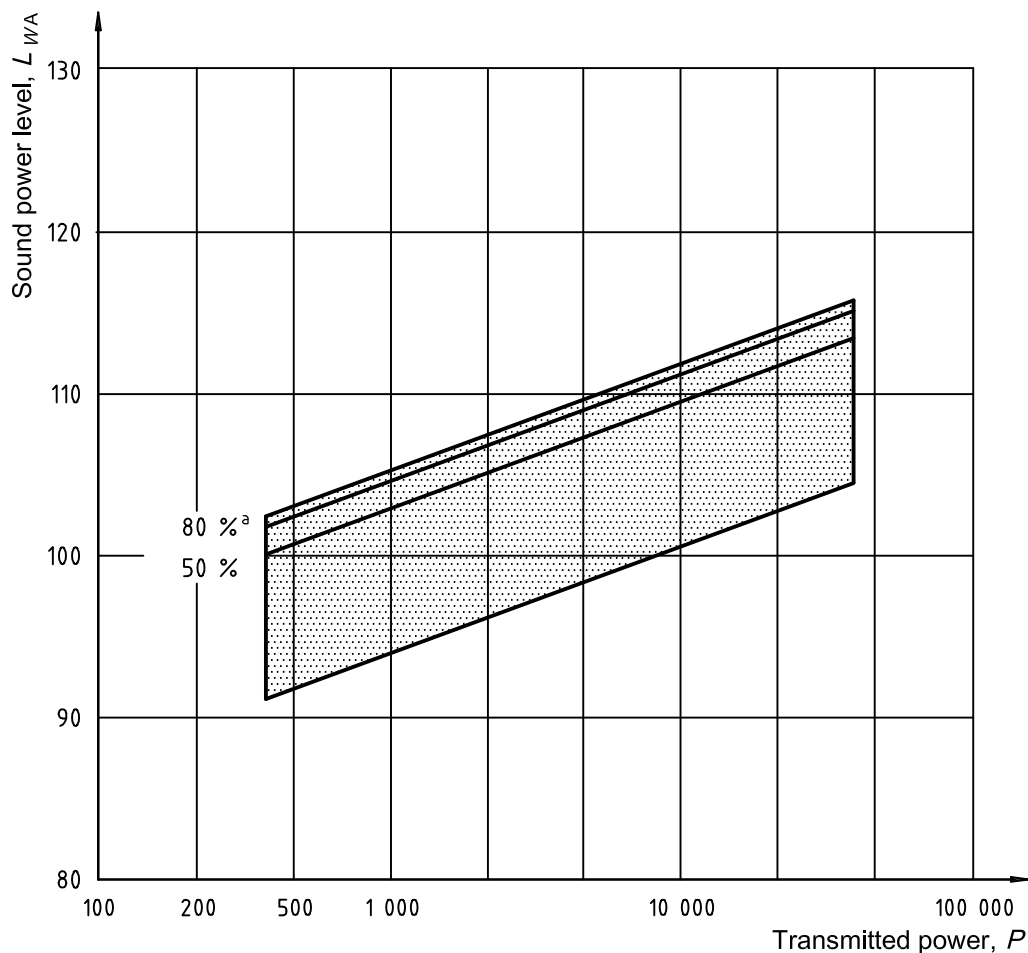


a Regression line

Type: external cylindrical drives with the following predominant (> 80 %) characteristic properties.	
Housing:	Cast
Bearings:	Roller bearings
Lubrication:	Splash lubrication
Mountings:	Rigid on steel and/or concrete
Power	0,7 kW to 2 400 kW
Input speed (= max. r/min)	1 000 r/min to 5 000 r/min (majority 1 500 r/min)
Pitchline velocity	1 m/s to 20 m/s
Output torque	100 N·m to 200 000 N·m
Number of stages	1 to 3
Information on gear teeth	Highest speed stage helical gearing ($\beta = 10^\circ$ to 30°) hardened, finish cut. DIN 3960 quality 5 to quality 8.

Figure B.8 — Sound power values for cylindrical gears (industrial drives)

Logarithmic regression
 $L_{WA} = 85,6 + 6,4 \times \log P$
 (80 % line)
 Variance $r^2 = 0,48$
 Stated probability 90 %

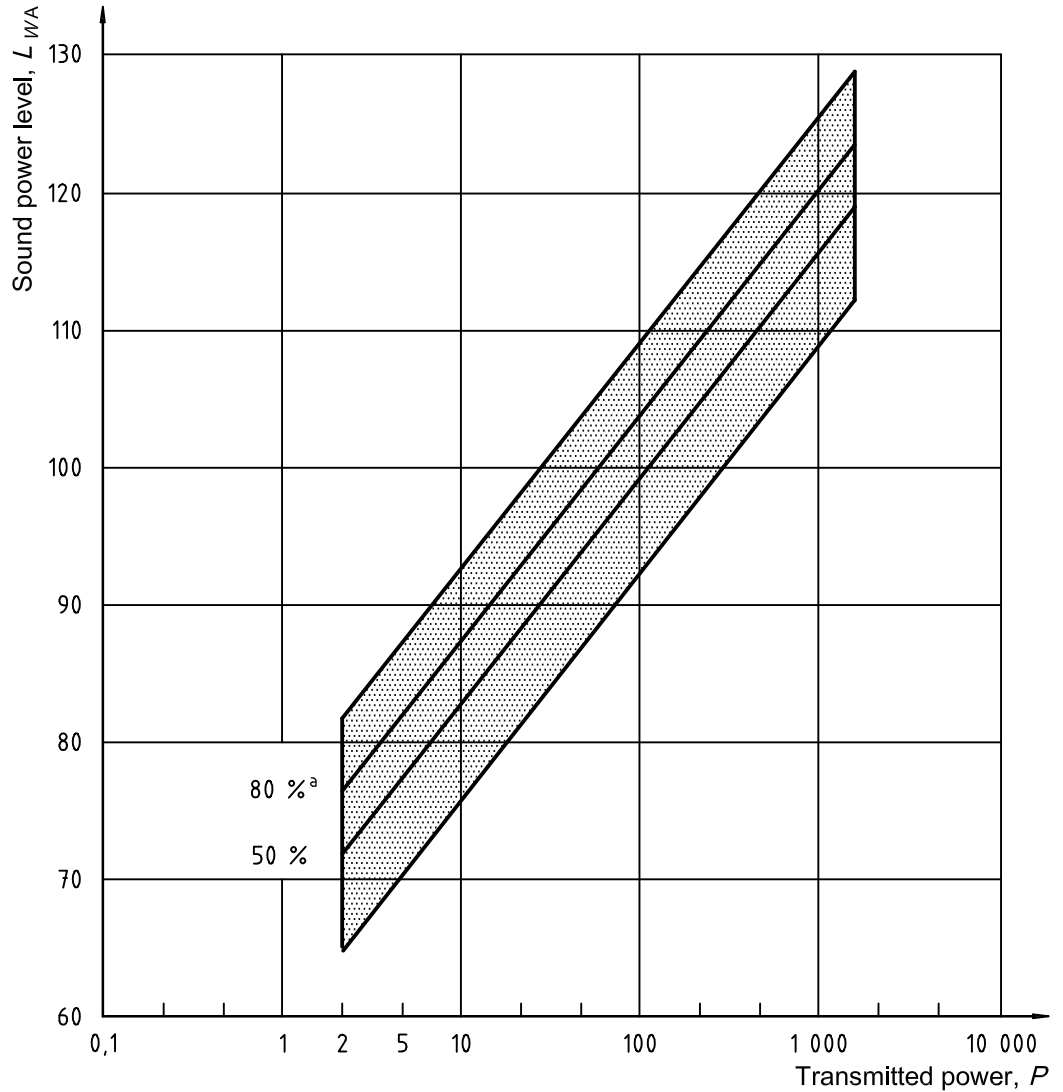


a Regression line

Type: external cylindrical drives with the following predominant (> 80 %) characteristic properties.	
Housing:	Cast
Bearings:	Sleeve
Lubrication:	Pressure system with oil injection
Mountings:	Rigid on steel or concrete
Power	380 kW to 42 000 kW
Input speed (= max. r/min)	1 000 r/min to 12 700 r/min
Pitchline velocity	> 35 m/s
Output torque	3 600 N·m to 460 200 N·m
Number of stages	1 to 2
Information on gear teeth	Majority double helical ($\beta = 20^\circ$ to 30°) hardened, finish cut. DIN 3960 quality 3 to quality 5.

Figure B.9 — Sound power values for cylindrical gears (geared turbine drives)

Logarithmic regression
 $L_{WA} = 77,1 + 15,9 \times \log P$
 (80 % line)
 Variance $r^2 = 0,88$
 Stated probability 90 %

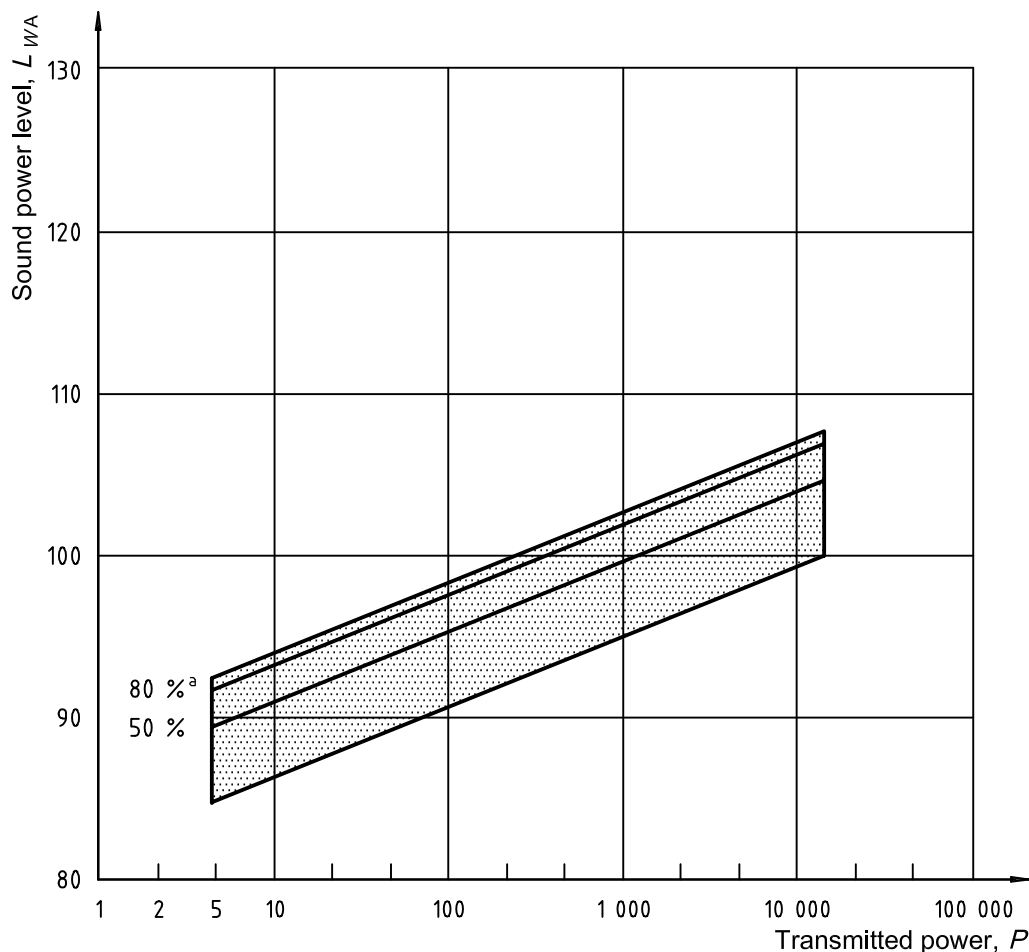


a Regression line

Type: bevel and bevel/cylindrical drives with the following predominant (> 80 %) characteristic properties.	
Housing:	Cast and welded construction
Bearings:	Roller bearings, bevel pinion tapered bore bearing
Lubrication:	Splash lubrication
Mountings:	Rigid on steel structure
Power	2 kW to 1 800 kW
Input speed (= max. r/min)	970 r/min to 3 000 r/min
Pitchline velocity	2 m/s to 24 m/s
Output torque	3 600 N·m to 190 000 N·m
Number of stages	1 to 3
Information on gear teeth	Bevel gear stage (mostly fastest stage) case-hardened and lapped; spiral bevel, no axis offset; fabrication and tooth measurement capabilities not as well developed as for cylindrical gears.

Figure B.10 — Sound power values for bevel and bevel/cylindrical gear drives

Logarithmic regression
 $L_{WA} = 87,7 + 4,4 \times \log P$
 (80 % line)
 Variance $r^2 = 0,78$
 Stated probability 90 %

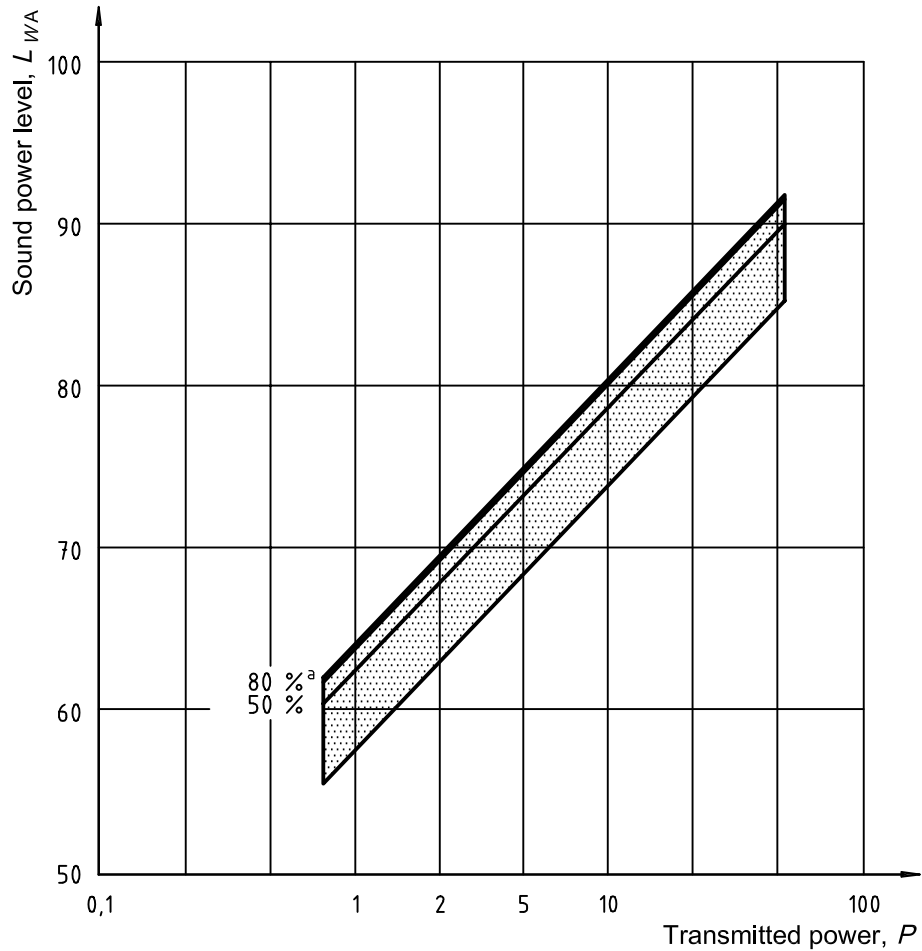


a Regression line

Type: planetary drives with the following predominant (> 80 %) characteristic properties.	
Housing:	Cast
Bearings:	Low-speed: roller bearings. High-speed: sleeve
Lubrication:	Injection
Mountings:	Rigid on steel and/or concrete
Power	6 kW to 12 500 kW
Input speed (= max. r/min)	350 r/min to 16 500 r/min
Output torque	1 000 N·m to 330 000 N·m
Number of stages	1 to 2
Information on gear teeth	Spur gearing
Low-speed:	Helical gearing ($\beta = 25^\circ$ to 30°)
High-speed:	Internal gear heat-treated, sun gear and planet gears hardened. The tooth quality increases with speed input.

Figure B.11 — Sound power values for planetary drives

Logarithmic regression
 $L_{WA} = 65,0 + 15,9 \times \log P$
 (80 % line)
 Variance $r^2 = 0,95$
 Stated probability 90 %



a Regression line

Type: Wormgear drives with the following predominant (> 80%) characteristic properties.	
Housing:	Strongly ribbed case housings (heat-dissipating)
Bearings:	Roller bearings
Lubrication:	Splash lubrication
Mountings:	Rigid on steel plates
Power	0,7 kW to 56 kW
Input speed (= max. r/min)	1 360 r/min to 1 480 r/min
Output torque	67 N·m to 3 800 N·m
Number of stages	1, simple wormgear drive
Worm starts	1 to 6 1 to 3
Information on gear teeth	Worm case-hardened and ground; wormgear of tin-bronze.

Figure B.12 — Sound power values for wormgear drives

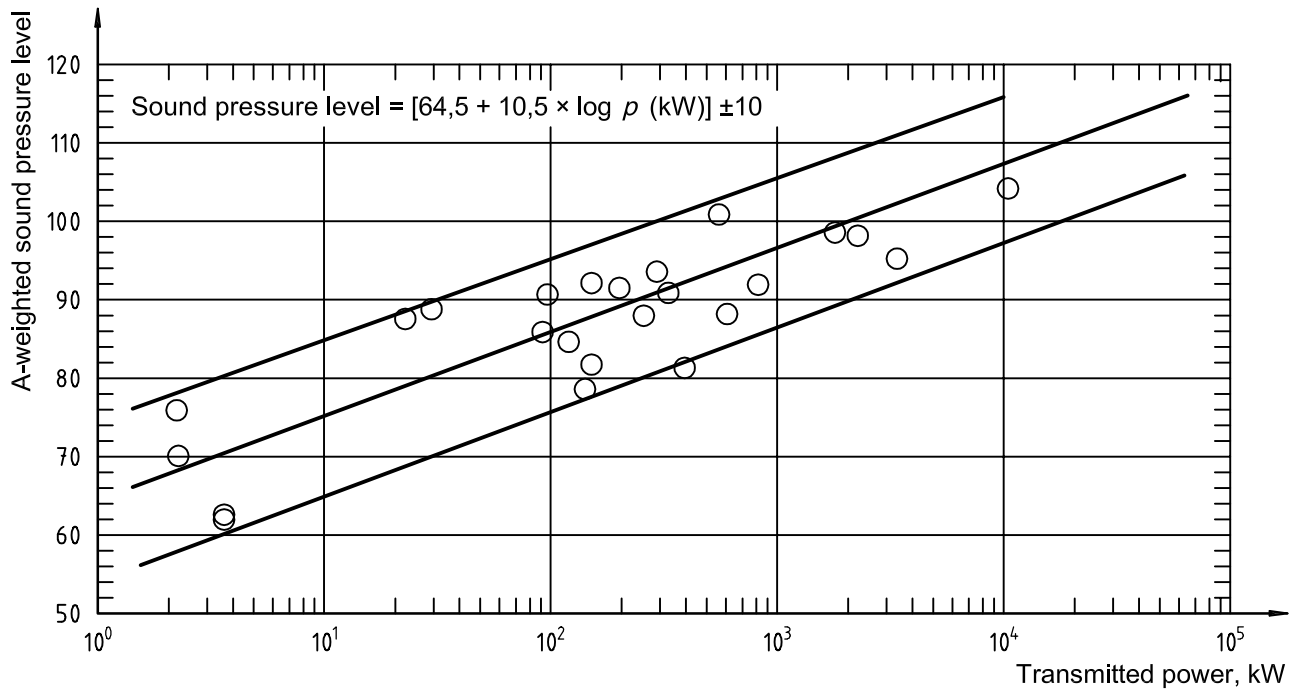


Figure B.13 — Typical A-weighted sound pressure level

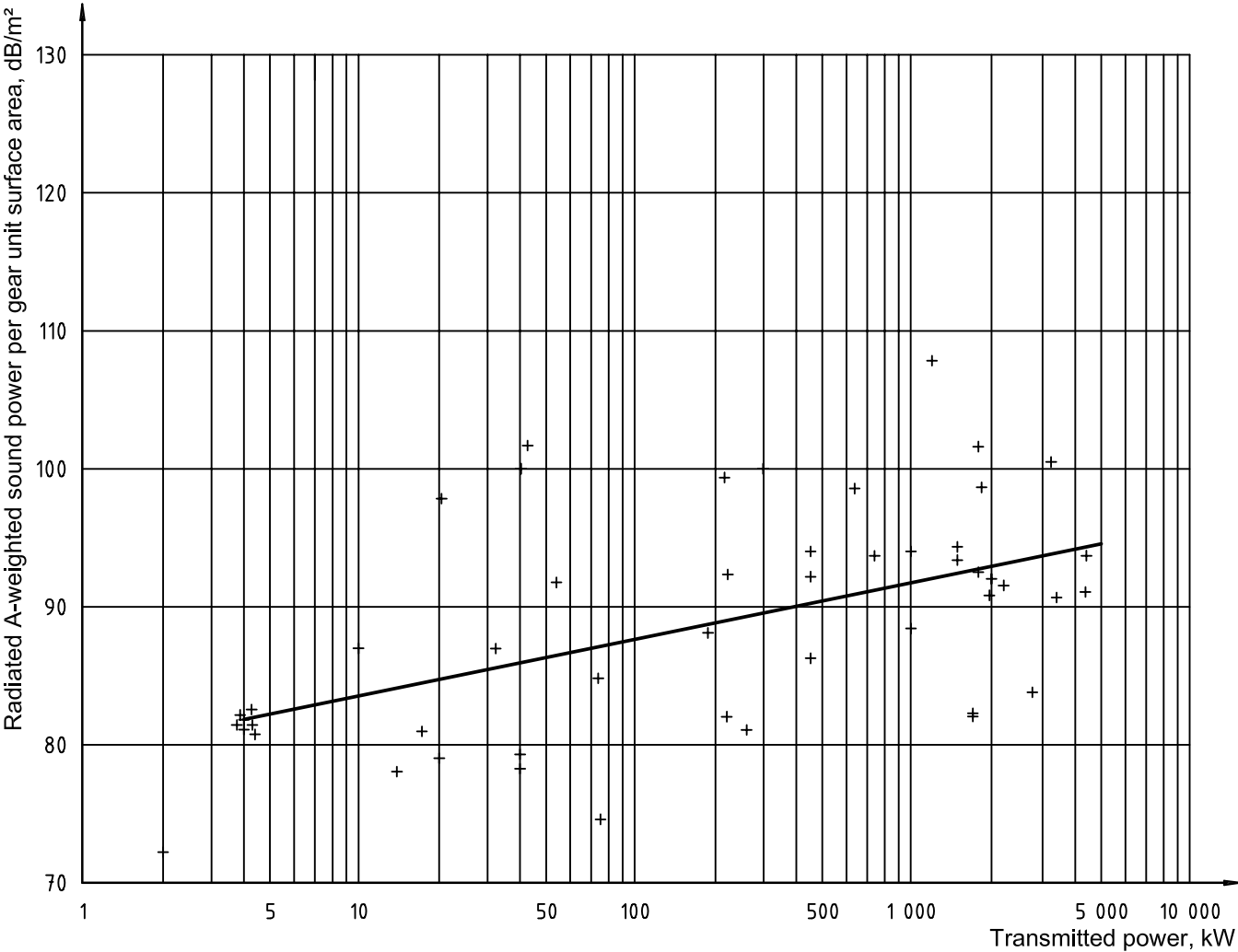


Figure B.14 — Range of sound power emitted per square metre

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Annex C (informative)

Information for the determination of airborne sound power levels using the methods of ISO 3744:1981 and ISO 3746:1979

C.1 Purpose

This annex gives historical information for determining sound emitted from a gear configuration, developed for the first edition of ISO 8579-1 and based on ISO 3744:1981[2] and ISO 3746:1979[3] for measurements over a reflective plate.

Because of the characteristic tolerances of instruments, disturbances during measurement and uncertainties inherent to the procedures given in this annex, the measurement uncertainty for the sound power determination is ± 2 dB.

NOTE If the distribution is normal and the standard deviation, s , is equal to 1 dB, then, in 70 % of all cases, uncertainties will be less than ± 1 dB and, in 95 % of all cases, uncertainties will be less than ± 2 dB.

C.2 Instrumentation and test conditions

For the purposes of this annex only, instrumentation and test conditions may be the same as those given in ISO 8579-1:1993.

C.3 Measurement surfaces, distances, and position and number of measurement points

C.3.1 Position and number of measurement points

C.3.1.1 General

The measuring points may be arranged in one of the ways given in C.3.1.2 to C.3.1.4.

C.3.1.2 Complete measurement point arrangement

The measuring points should be chosen with regard to the size of the reference box and the arrangements shown in Figures 5, 7, 9 and 11. The number of measurement points should be increased if the horizontal distance between adjacent points exceeds 2 m or if the difference in decibels between the highest and lowest values of sound pressure level is greater than the number of measurement points. Care should be taken that the measurement points are evenly spaced. The measurement points should be arranged so that the microphone is not placed in air currents from exhaust openings or rotating parts.

C.3.1.3 Simplified measurement point arrangement

The basic arrangements of measuring points shown in Figures 5, 7, 9 and 11, or even more simple arrangements, may be sufficient, if it has been established by test measurements of the gear unit type that the sound field is sufficiently even to the extent that the sound level determined from the measured values will be greater than or equal to that which would be determined by a full complement of measured values.

C.3.1.4 Single-point measurement for acceptance testing

Owing to the cost of sound power testing, a standard production test for a gear unit may be conducted using a single-point sound pressure measurement. This single-point sound pressure measurement may be used only when

- a single point cannot be used to obtain a true sound power level,
- the test area and unit type are qualified by prior sound power determination in accordance with C.3.1.2, and
- the point of sound pressure measurement is selected as the surface measuring point of least perturbation established by the sound power determination.

The single-point sound pressure method should only be used when agreed upon between manufacturer and purchaser.

C.4 Test room

Gear unit sound may be measured in accordance with this annex if the influence of room acoustic reaction (reverberation) on the sound field near the measurement points is not more than 3 dB. This requirement is met if environmental correction factor K_2 is less than or equal to 3 dB (see C.6.1.4), this value of K_2 being acceptable for gear unit measurements and also being an intermediate value between those of ISO 3744 and ISO 3746.

When the distance from the measurement surface to the nearest flat surface, including room walls and other machines, is at least twice the measurement distance, it can be assumed that the test room is suitable if the interior volume of the room is nearly numerically greater than or equal to the area of the measurement surface in square metres multiplied by 100. If the test room does not meet these volumetric requirements, room suitability may be determined as follows.

Place a small broadband sound source at the position to be occupied by the geometric centre of the gear unit under test. Using this sound source, determine the average sound pressure levels at two sets of measurement points. These two sets of measurement points are

- a) the pre-selected measurement points, and
- b) the corresponding points half or twice the distance from the source (provided that the points are not in the nearfield).

The room is suitable if the difference between the means of each measurement set is at least 5 dB. Measurements are then corrected in accordance with C.6.1.4.

If environmental correction factor K_2 is greater than 3 dB, then measurements cannot be corrected in accordance with C.6.1.4 because incremental pressures included in the measured levels are excessive. In such cases, recalibration with smaller measurement distances can be tried, free-hanging absorbers or additional sound absorption material can be installed, or a more suitable room chosen.

C.5 Procedure for obtaining sound pressure level data

C.5.1 General

Before carrying out measurements, review the conditions set out in the appropriate standard to establish any corrections that could be necessary.

C.5.2 Obtaining A-weighted sound pressure levels

At each measurement point, the sound level L_{pAS} on the sound-level meter should be observed using the frequency-weighting characteristic, A, and the time average. From the observed levels, the time-averaged level, L_{pASm} , should be recorded. The measurement time for this mean level should be chosen such that the sound level recorded is representative of normal operating conditions.

C.5.3 Obtaining sound pressure level spectra

Sound pressure level spectra should in general be determined without weighting in frequency bands. Measurements at each measurement point, in each octave band frequency range, will be sufficient and are recommended unless pure tones are present, in which case third-octave, narrow-band spectra or Fourier transform analysis may be necessary.

C.5.4 Background noise

C.5.4.1 When the gear configuration is at a standstill, background noise levels should be measured at each measurement point and recorded as described in C.5.2 and C.5.3. These levels should preferably be low enough not to influence measurements of gear sound. This is assured if A-weighted background noise levels are lower than levels observed during the tests by 10 dB or more in each band. If this is not the case, the measures specified in C.5.4.2 to C.5.4.5 might help to reduce background noise.

C.5.4.2 As many of the background sound sources as possible should be moved out of the test area, or as far away as safety (because of extended shafts) and the area will allow.

C.5.4.3 Background noise sources can, if practicable, be acoustically screened. Possible reflection of gear sound from screens should be considered.

C.5.4.4 Subject to agreement, operating conditions might be altered to avoid, for example, structural resonance in the test area.

C.5.4.5 If the above measures do not sufficiently reduce background noise, a correction in accordance with C.6.1.3 should be made when background levels are between 3 dB and 9 dB below the levels observed in accordance with C.5.2 and C.5.3.

C.5.5 Calculation of S and L_S

The measurement surface area, S , in square metres, is given by

- $S = 4 (ab + ac + bc)$ (see Figure 5 of this part of ISO 8579),
- $S = 2 (2ab + 2ac + bc)$ (see Figure 7 of this part of ISO 8579),
- $S = 4 ab$ (see Figure 9 of this part of ISO 8579), and
- $S = 4 (2ab + ac + bc)$ (see Figure 11 of this part of ISO 8579).

The measurement surface quantity, L_S , in decibels, is given by:

$$L_S = 10 \lg_{10} \left(\frac{S}{S_0} \right)$$

where S_0 is the reference surface area ($= 1 \text{ m}^2$).

Table C.1 gives L_S for various values of S .

Only an approximate value of the measurement surface area need be determined, since an error of -20% to $+25\%$ will result in a measurement surface value change of only 1 dB.

Table C.1 — Measurement surface quantity L_S relative to $S_0 = 1 \text{ m}^2$

Measurement surface			
Area S m^2	Quantity L_S dB	Area S m^2	Quantity L_S dB
0,63	-2	25	+ 14
0,8	-1	32	+ 15
1	0	40	+ 16
1,25	+ 1	50	+ 17
1,6	+ 2	63	+ 18
2	+ 3	80	+ 19
2,5	+ 4	100	+ 20
3,2	+ 5	125	+ 21
4	+ 6	160	+ 22
5	+ 7	200	+ 23
6,3	+ 8	250	+ 24
8	+ 9	320	+ 25
10	+ 10	400	+ 26
12,5	+ 11	500	+ 27
16	+ 12	630	+ 28
20	+ 13		

C.6 Determination of A-weighted sound power level

C.6.1 Determination of the mean surface sound pressure level, \bar{L}_{pAm}

C.6.1.1 General

The mean surface sound pressure level \bar{L}_{pAm} should be determined in accordance with C.6.1.2 to C.6.1.4 from values of sound pressure measured at the measurement surface.

C.6.1.2 Time-averaged values

Values obtained in accordance with C.5.2 and C.5.3 are time-averaged values.

C.6.1.3 Corrections for background noise

If background noise needs to be taken into account, it is recommended that correction values K_1 be taken from Table C.2 at each of the measurement points i , which depend on the difference in decibels between measurements, in accordance with C.5.2 and C.5.3 and background noise measurements.

If the difference is less than 3 dB at any point, the sound pressure level so corrected is not accurate.

The mean surface sound pressure level at 1 m is defined as the sound pressure level at a typical work station. If measurements have not been taken at 1 m distance, this level has to be calculated from the existing measured values.

Table C.2 — Correction values K_1 for background noise

Difference between the values obtained in accordance with C.5.2 and C.5.4	Correction value K_1 subtracted from values obtained in accordance with C.5.2
3 dB	3 dB
4 dB to 5 dB	2 dB
6 dB to 9 dB	1 dB

C.6.1.4 Mean surface sound pressure level, \bar{L}_{pAm}

The mean surface sound pressure level, \bar{L}_{pAm} , should be calculated from all the time-averaged values determined at all measurement points, and corrected, if necessary, in accordance with C.6.1.3.

The mean of each individual sound pressure level should be determined on the energy basis. \bar{L}_{pAm} is then given by

$$\bar{L}_{pAm} = 10 \lg_{10} \frac{1}{n} \sum_{i=1}^n 10^{(L_{pASmi} - K_{1i})/10}$$

C.6.2 Determination of the environmental correction factor, K_2

C.6.2.1 General

The effect of acoustic reaction in the test area on the surface sound pressure levels determined in accordance with C.6.1.4 is dependent mainly on the absorption characteristics of the test room and on the quotient of its volume, V , divided by the measurement surface, S .

The correction factor, K_2 , can be determined using the methods of ISO 3744:1981, ISO 3746:1979, Table C.3 of this annex, or a reference sound source.

The reference sound source should be capable of radiating broadband sound covering the frequency range of interest without significant directivity or pure tone content.

Constancy of level may be deemed adequate if the sound pressure level measured in the slow response mode at a fixed position does not vary by more than 0,5 dB in 1 h.

The nearfield zone of the reference sound source should be known over the entire frequency range of interest.

NOTE In general, smaller sound sources have less extensive nearfield zones. Small fans driven at high variable and controlled rotational speeds are especially suitable (e.g. the motor and fan assembly of a vacuum cleaner).

Table C.3 — Environmental correction factor, K_2 , determined by type of test room and quotient of V/S

Room furnishings and fittings		K_2 for usual machine and testing room, dependent on the measurement surface, dB															
		Quotient room volume by measurement surface ^a , V/S															
		25	32	40	50	63	80	100	125	160	200	250	320	400	500	630	800
A	Room with strongly reflecting walls (e.g. tiles, flat concrete or plaster)							$K_2 = 3$		$K_2 = 2$			$K_2 = 1$				$K_2 = 0$
B	Room without features given under A and C						$K_2 = 3$		$K_2 = 2$			$K_2 = 1$					$K_2 = 0$
C	Room with weakly reflecting surface with some sound-absorbing areas				$K_2 = 3$		$K_2 = 2$			$K_2 = 1$							$K_2 = 0$
NOTE This table helps estimate K_2 without frequent recourse to sound source measurements (see clause C.8). The qualification test by direct measurement is, however, essential in cases where application of this table raises some doubts or gives correction values greater than 3 dB (shaded zones).																	
^a The measurement surface area, S , in square metres, the room characteristics and the volume, V , in cubic metres, are known.																	

C.6.2.2 Determination of K_2 and measurements

The reference sound source should be installed in the test room at the position to be occupied by the geometric centre of the gear unit whose sound is to be measured. For all measurement points chosen for measuring gear unit sound, the sound power level, L_{W1} , and octave band power levels for all frequency bands of interest should be determined in accordance with clause C.6.

The determination of sound power level, L_{W1} , of the reference sound source should be repeated for another set of measurement points nearer to the source but remaining outside the nearfield zone. It is recommended that for this purpose the original measurement distance be at least halved. The result of the second determination of sound power level should be designated L_{W2} .

The correction value, K_2 , for unfiltered or band sound power levels, is then calculated from the difference in sound power determinations:

$$K_2 = L_{W1} - L_{W2}$$

C.6.2.3 Calculation of the corrected mean sound pressure level, \bar{L}_{pAf}

If necessary, the correction factor, K_2 , should be used to calculate the corrected mean sound pressure level, \bar{L}_{pAf} , as follows:

$$\bar{L}_{pAf} = \bar{L}_{pAm} - K_2$$

C.6.3 Calculation of the A-weighted sound power level, L_{WA}

The A-weighted sound power level is usually approximated as the sum of the corrected mean pressure level, \bar{L}_{pAf} , and the measurement surface quantity, L_S , in accordance with C.5.5:

$$L_{WA} = \bar{L}_{pAf} + L_S$$

C.7 Test report

C.7.1 General

The test report should include the information in clause 10 and C.7.2 of this part of ISO 8579.

C.7.2 Test measurements and results

The A-weighted measurements and results should include

- the A-weighted sound pressure level, L_{pASm} (C.5.2), at each measurement point,
- the background noise level and correction factors, K_1 , at each measurement point (C.6.1.3),
- the mean value of surface sound pressure level, \bar{L}_{pAm} , calculated from L_{pASm} and K_1 at each point (C.6.1.4),
- the applied environmental correction factor, K_2 (C.6.2.2),
- the measurement surface quantity, L_S , corresponding to the measurement surface area, S , adopted (C.5.5),
- the sound power level, L_{WA} (C.6.3),
- the sound pressure level at the typical work station according to C.6.1.4, determined or calculated at 1 m, and
- any requested measurements at a further chosen point or points that have been made, reported precisely.

C.8 Procedures for calculating A-weighted sound pressure or power levels from octave or one-third octave band spectra

C.8.1 Calculate the mean A-weighted sound pressure level, \bar{L}_A , in decibels, from

$$\bar{L}_A = 10 \lg_{10} \sum_{j=1}^{j_{\max}} 10^{0,1(\bar{L}_{\text{Oct}j} + C_j)}$$

where C_j is the relative A-weighted correction, in decibels, in the j octave or one-third octave band (see C.8.2 or C.8.3).

NOTE The same formula can be used to obtain the sound power level, substituting L_{WA} for \bar{L}_A and $L_{W\text{Oct}}$ for \bar{L}_{Oct} .

C.8.2 For calculations with one-third octave band data ($j_{\max} = 21$), values for C_j are given in Table C.4.

C.8.3 For calculations with octave band data ($j_{\max} = 7$), values for C_j are given in Table C.5.

Table C.4 — Relative A-weighted correction, C_j , for one-third octave band data

j	One-third octave band centre frequency	C_j
	Hz	dB
1	100	-19,1
2	125	-16,1
3	160	-13,4
4	200	-10,9
5	250	-8,6
6	315	-6,6
7	400	-4,8
8	500	-3,2
9	630	-1,9
10	800	-0,8
11	1 000	0,0
12	1 250	0,6
13	1 600	1,0
14	2 000	1,2
15	2 500	1,3
16	3 150	1,2
17	4 000	1,0
18	5 000	0,5
19	6 300	-0,1
20	8 000	-1,1
21	10 000	-2,5

Table C.5 — Relative A-weighted correction, C_j , for octave-band data

j	Octave band centre frequency	C_j
	Hz	dB
1	125	-16,1
2	250	-8,6
3	500	-3,2
4	1 000	0,0
5	2 000	1,2
6	4 000	1,0
7	8 000	-1,1

C.9 Flow chart of method

Figure C.1 shows an example flow chart of the method.

Sound power determination using measurements of sound pressure

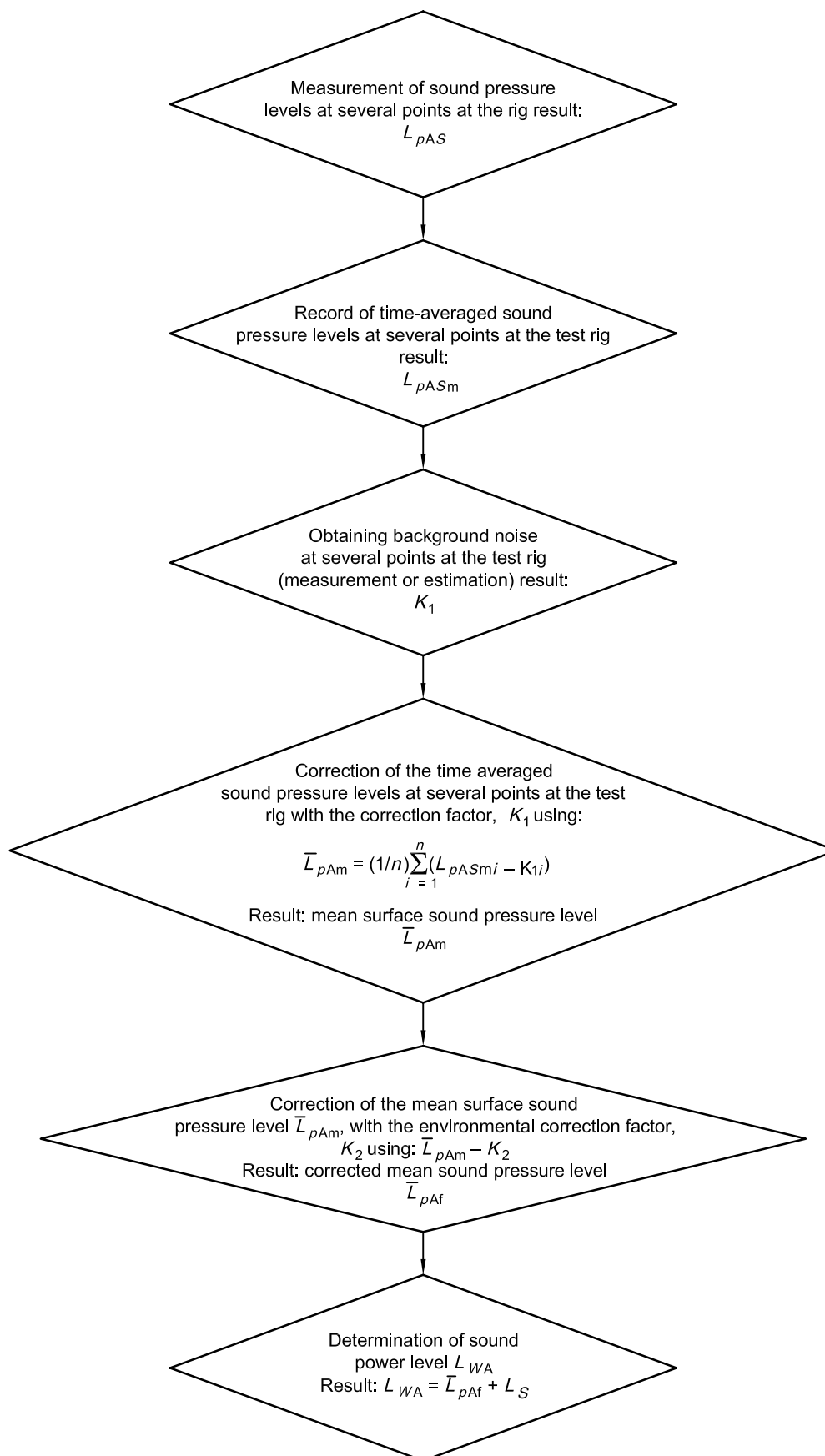


Figure C.1 — Flow chart of method

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