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ISO 2151

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Acoustics — Noise test code for compressors and vacuum pumps — Engineering method (Grade 2)

Acoustique — Code d'essai acoustique pour les compresseurs et les pompes à vide — Méthode d'expertise (classe de précision 2)

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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 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2151 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*, Subcommittee SC 6, *Air compressors*.

This second edition cancels and replaces the first edition (ISO 2151:1972), which has been technically revised.

Introduction

The noise test code presented by this International Standard describes methods for determining and presenting the acoustical characteristics of compressors and vacuum pumps, i.e. the total noise level from the compressor or vacuum pump expressed as sound power level, or the emission sound pressure level at the work station or other specified positions.

Based on current industry practice, this noise test code requires the compressor or vacuum pump under test to be run under conditions representing the noisiest operation in typical usage — full-load for compressors and off-load for vacuum pumps.

It needs to be noted that operators' exposure to noise depends upon the characteristics of individual applications and environmental factors beyond the control of the manufacturers of compressors and vacuum pumps.

This International Standard does not give requirements for octave band analysis, however, where there is an interest this can be undertaken.

Acoustics — Noise test code for compressors and vacuum pumps — Engineering method (Grade 2)

1 Scope

This International Standard specifies methods for the measurement, determination and declaration of the noise emission from portable and stationary compressors and vacuum pumps. It prescribes the mounting, loading and working conditions under which measurements are to be made, and includes measurement or determination of the noise emission expressed as

— the sound power level under specified load conditions,

— the emission sound pressure level at the work station under specified load conditions.

It is applicable to

— compressors for various types of gases,

— oil-lubricated air compressors,

— oil-flooded air compressors,

— water injected air compressors,

— oil-free air compressors,

— compressors for handling hazardous gases (gas compressors),

— compressors for handling oxygen,

— compressors for handling acetylene,

— high-pressure compressors [over 4 Mpa (40 bar)],

— compressors for application at low inlet temperatures, i.e. below 0 °C,

— large compressors (over 1 000 kW input power),

— portable and skid-mounted air compressors, and

— rotary positive displacement blowers and centrifugal blowers and exhausters in applications $\leqslant$ 0,2 MPa ($\leqslant$ 2 bar).

It is not applicable to

— compressors for gases other than acetylene having a maximum allowable working pressure of less than 0,5 bar/0,05 MPa,

— refrigerant compressors used in refrigerating systems or heat pumps,

— hand-held portable compressors.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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 11201:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane*

ISO 11202:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Survey method in situ*

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*

IEC 61672-1:2002, *Electroacoustics — Sound level meters — Specifications*

3 Terms and definitions

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

3.1
compressor
machine which compresses air, gases or vapours to a pressure higher than the inlet pressure

NOTE A compressor comprises the bare compressor itself, the prime mover and any component or device supplied with the compressor.

3.2
vacuum pump
device for creating, improving and/or maintaining vacuum

NOTE A vacuum pump comprises the bare pump, the prime mover and any component or device supplied with the vacuum pump.

3.3
emission
airborne sound radiated by a well-defined noise source (e.g. the machine under test) under specified operating and mounting conditions

NOTE 1 Adapted from ISO 11203:1995.

NOTE 2 Noise emission values can be incorporated in a product label and/or published in a product specification. The basic noise emission descriptors are the sound power level of the product itself and the emission sound pressure levels at the work station and at other specified positions in the vicinity of the product (if any).

3.4
emission sound pressure
p
sound pressure, expressed in pascals, at a specified position near a noise source, when the source is in operation under specified operating and mounting conditions on a reflecting plane surface, corrected for background noise and reflections from room surfaces other than the plane over which the machine under test is placed

NOTE Adapted from ISO 11203:1995.

3.5
emission sound pressure level
L_p
ten times the logarithm to the base 10 of the ratio of the square of the emission sound pressure to the square of the reference sound pressure, expressed in decibels, and measured with a particular time weighting and a particular frequency weighting selected from those defined in IEC 61672-1:2002

EXAMPLE A-weighted emission sound pressure level, $L_{p\mathrm{A}}$.

NOTE 1 The reference sound pressure is 20 µPa.

NOTE 2 $L_{p\mathrm{A}}$ levels are established as $L_{p\mathrm{A}eqT}$ time-averaged sound pressure levels measured with an integrating-averaging sound level meter meeting the requirements of IEC 61672-1:2002. $L_{p\mathrm{A}eqT}$ is usually abbreviated to $L_{p\mathrm{A}}$. For further details of $L_{p\mathrm{A}eqT}$ see ISO 3744:1994, 3.2.1.

NOTE 3 Adapted from ISO 11203:1995.

3.6
sound power
W
rate per unit time, expressed in watts, at which airborne sound energy is radiated by a source

[ISO 3744:1994]

3.7
sound power level
L_W
ten times the logarithm to the base 10 of the ratio of the sound power radiated by the source under test to the reference sound power, expressed in decibels

NOTE 1 The frequency weighting or the width of the frequency band must be indicated. For example, A-weighted sound power level $L_{W\mathrm{A}}$.

NOTE 2 The reference sound power is 1 pW (1 pW $= 10^{-12}$ W).

NOTE 3 Adapted from ISO 3744:1994.

3.8
sound intensity
product of the sound pressure at a point and the associated particle velocity

NOTE 1 It is a vectorial quantity.

NOTE 2 See ISO 9614-1 and ISO 9614-2 for further guidance on sound intensity.

3.9
partial sound power
P_i
time-averaged rate of flow of sound energy through an element (segment) of a measurement surface, given by

$$P_i = \vec{I}_i \times \vec{S}_i = I_{\mathrm{n}i} \times S_i$$

where

$I_{\mathrm{n}i}$ is the signed magnitude of the normal sound intensity component measured at position i on the measurement surface;

S_i is the area of the segment of surface associated with point i.

3.10
background noise correction
K_1
correction term to account for the influence of background noise on the surface sound pressure level, expressed in decibels

NOTE 1 K_1 is frequency dependent.

NOTE 2 The correction in the case of A-weighting is denoted $K_{1\mathrm{A}}$.

NOTE 3 Adapted from ISO 3744:1994.

3.11
environmental correction
K_2
correction term to account for the influence of reflected or absorbed sound on the surface sound pressure level, expressed in decibels

NOTE 1 K_2 is frequency dependent.

NOTE 2 The correction in the case of A-weighting is denoted $K_{2\mathrm{A}}$.

NOTE 3 Adapted from ISO 3744:1994.

3.12
reference box
hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source and terminates on the reflecting plane

[ISO 3744:1994]

3.13
measurement surface
hypothetical surface of area S, enveloping the source, on which the measurements are made

NOTE The measurement surface terminates on the reflecting plane.

3.14
measurement distance
distance, d, from the reference box to the parallelepiped measurement surface, or radius, r, of the hemispherical measurement surface

NOTE Adapted from ISO 3744:1994.

3.15
noise emission declaration
information on the noise emitted by the machine given by the manufacturer or supplier in technical documents or other literature concerning noise emission values

3.16
uncertainty
K
value of the total uncertainty associated with a measured noise emission value and the production, expressed in decibels

[ISO 4871:1996]

NOTE See also 4.2.

3.17
declared dual-number noise emission value
L, K
noise emission value, L, and its associated uncertainty, K, given in the noise emission declaration

NOTE 1 The symbols used are

— A-weighted sound power level, L_{WAd}, with uncertainty, K_{WAd}, and

— A-weighted emission sound pressure level, L_{pAd}, with uncertainty, K_{pAd}.

NOTE 2 Adapted from ISO 4871:1996.

3.18
work station
position in the vicinity of the compressor or vacuum pump under test, intended for the operator

NOTE 1 For the purposes of this International Standard, this is the surface enveloping the machine on test at a distance of 1 m from the reference box (see 3.12).

NOTE 2 Adapted from ISO 11203:1995.

3.19
A-weighted emission sound pressure level at the work station
L_{pWSA}
energy average of the A-weighted emission sound pressure levels at the work station

4 Sound power level determination

4.1 General

The sound power level shall be determined according to either of the basic standards ISO 3744 or ISO 9614-1 or ISO 9614-2, yielding Grade 2 level of accuracy.

The sound power level shall be given as A-weighted sound power level in decibels referenced to 1 pW (dB re 1 pW).

NOTE 1 Octave band information may also be obtained.

Consider the following when choosing which International Standard to use.

ISO 3744 assumes a non-reverberant environment and low background noise. It specifies a method to calculate sound power level from sound pressure levels measured on a surface enveloping the compressor or vacuum pump.

ISO 9614-1 or ISO 9614-2 can be used in most environments including semi-reverberant and/or when extraneous noise sources exist. It specifies methods for determining the sound power level from sound intensity levels measured on a surface enveloping the compressor or vacuum pump. Depending on the level of reverberation and extraneous noise, it can provide A-weighted sound power level data with Grade 2 or 3 accuracy.

NOTE 2 Further information on sound power is given in ISO 3740.

4.2 Uncertainty

The uncertainty of the determination of the sound power level comprises the measurement uncertainty of reproducibility (which includes repeatability) conditions and the uncertainty of production. For definitions of these components of the uncertainty, see ISO 4871.

In the basic standards ISO 3744, ISO 9614-1 and ISO 9614-2, measurement uncertainty is expressed in terms of the standard deviation of reproducibility. These standards provide a maximum value of the standard deviation of reproducibility. A manufacturer can use this value if he has no evidence, from his own experience with noise emission determination, that a different value applies to a particular machine or machine family.

Determination of production uncertainty is the responsibility of the product manufacturer. A method of determination is specified in ISO 4871:1996. Production uncertainty is expressed in terms of a standard deviation of production.

ISO 4871 indicates how the standard deviation of reproducibility and the standard deviation of production combine to provide uncertainty K.

Experience with the manufacture of compressors and vacuum pumps shows that uncertainty K for these machines and for A-weighted levels is typically $+$ 3 dB for measurements according to engineering Grade 2. If a manufacturer can prove that his uncertainty statistically differs from 3 dB, he may use his own value of K.

4.3 Test arrangement

4.3.1 General

Vacuum pumps are used in a wide range of applications covering the complete vacuum spectrum. Designs of vacuum pumps are available for pumping any combination of gases and vapours. For many applications, two or more pumps are combined together and are supplied as a unit. These pumping units shall be tested as a single unit.

4.3.2 Measurement according to ISO 3744:1994

When ISO 3744:1994 is applied, the measurement surface shall be either a parallelepiped or a hemisphere. The reference box and the measurement surfaces are shown in Annex C and Annex D. The reference box should only include parts of the machine that are acoustically relevant; connecting pipes shall be excluded.

Annex C and Annex D show microphone positions for both surfaces and identify typical arrays of 9 microphones for a parallelepiped and 10 for a hemisphere. The actual number of microphone positions and their location depends on the size of the machine under test and the nature of its sound field. Guidance on this is given in ISO 3744:1994, 7.2 and 7.4 for the hemisphere and 7.3 and 7.4 for the parallelepiped.

For examples of typical reference boxes, see Annex E.

When using a parallelepiped array the preferred distance between the reference box and the measurement surface is 1 m. For further guidance see ISO 3744:1994, 7.3.

4.3.3 Measurement in accordance with ISO 9614-1:1993 and ISO 9614-2:1996

When ISO 9614-1 is applied, the reference box and measurement surface shall be chosen in accordance with ISO 9614-1:1993, Clause 7.

When ISO 9614-2 is applied, the reference box and measurement surface to be scanned shall be chosen in accordance with ISO 9614-2:1996, Clause 7.

The calculation of partial sound power levels for each segment of the measurement surface and the total sound power level of the compressor or vacuum pump shall be made in accordance with Clause 8 of ISO 9614-1:1993 or ISO 9614-2:1996.

A typical segmentation of the measurement surface for an intensity scanning is given in Figure 1, which shows a sketch of a compressor package and an example of how its measurement surface can be divided into segments, the development of it and the designation of the respective sides and segments.

4.3.4 Procedure for compressors with major dimension $>$ 7 m

This standard assumes that sound power is always determined. However, for very large compressors with a major dimension $>$ 7 m, the concept of sound power ceases to be relevant and, in many cases, its precise determination will not be possible. On account of this a different approach, given as follows, shall be taken for such compressors.

A-weighted emission sound pressure levels for such compressors shall be established at positions along a path around the machine, at a distance of 1 m from it and at a height of 1,6 m above the floor or access platform. There shall be microphone positions at each end and side of the machine under test. The total number of positions depends on the size of the machine, however, in no case shall the microphone positions be more than 2 m apart. These measurements shall be made in accordance with ISO 11201:1995 (Grade 2), one of the standards for the determination of the emission sound pressure at specified positions around the machine.

If the environmental conditions do not allow the valid application of ISO 11201:1995, then ISO 11202:1995 (Grade 3) may be applied and this fact shall be recorded in the test report.

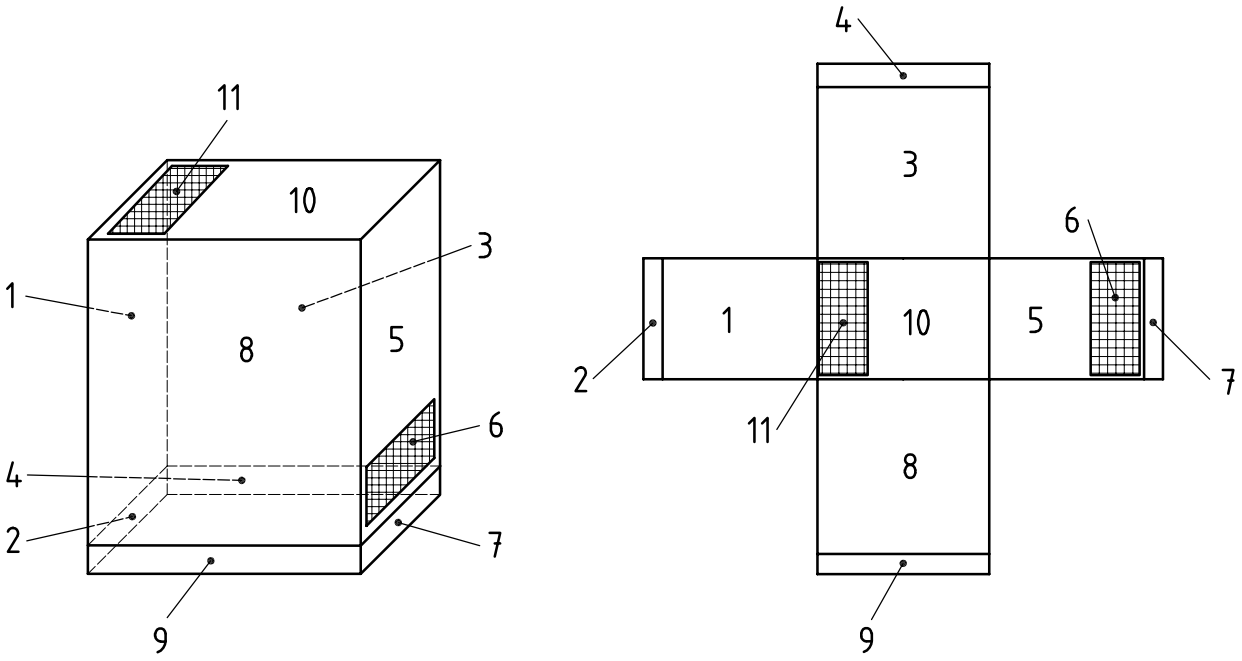
5 Emission sound pressure level determination at the work station

5.1 Work station

The determination of emission sound pressure level at the work station shall be carried out

— according to 5.2 when measurements have been made as identified in 4.3.2 and 4.3.3 (for further information see ISO 11203:1995), or

— according to 5.3 for compressors for which sound power is not to be determined (see 4.3.4).



a) Typical compressor or vacuum pump package (view from the left)

b) Measurement surface

Key

1 front panel
2 front base frame
3 right door
4 right base frame
5 back panel
6 back ventilation opening
7 back base frame
8 left door
9 left base frame
10 roof panel
11 roof ventilation opening

Figure 1 — Scanning method

5.2 Determination of L_{pWSA} from L_{WA}

For the purpose of this noise test code, the A-weighted emission sound pressure level at the work station is defined as the average of the A-weighted sound pressure levels at the work station, L_{pWSA}, over a surface of area S_{WS} enveloping the machine at a distance of 1 m from the reference box.

Calculate the A-weighted emission sound pressure level at the work station, L_{pWSA} according to the method specified in ISO 11203:1995, with the following equation:

$$L_{pWSA} = L_{WA} - Q_2$$

$$Q_2 = 10 \lg \left(\frac{S_{WS}}{S_0} \right) \text{ dB}$$

where

L_{pWSA} is the A-weighted emission sound pressure level at the work station, in decibels;

L_{WA} is the A-weighted sound power level, in decibels, as established by one of the methods identified in Clause 4;

S_0 $= 1\ m^2$;

S_{WS} is the area, in square metres, of the work station surface in accordance with 3.18.

5.3 Method for determination of L_{pWSA} when L_{WA} is not to be determined

For the purpose of this noise test code, the A-weighted emission sound pressure level at the work station is defined as the energy average value of the A-weighted emission sound pressure levels determined according to 4.3.4. This is the value to be declared.

Uncertainty K for the emission sound pressure level is that pertaining to the determination of the sound power level.

6 Mounting, loading and operating conditions of compressor or vacuum pump during noise tests

6.1 General

The mounting, loading and operating conditions shall be the same regardless of which method is used for the determination of the sound power level.

The machine under test shall be new and typically equipped with accessories as provided by the manufacturer. The machine shall have been warmed up and shall be operating in a stable condition as for continuous operation. It shall be properly serviced and lubricated as specified by the manufacturer.

6.2 Mounting

Transfer of structure-borne noise from a compressor or a vacuum pump to its mounting or to other parts of the test room can influence the sound pressure level in the test room.

Measurements shall be made under conditions representative of typical field installation: resilient mounts, isolation pads, etc. shall be used only if these are representative of typical use.

Should the design of the compressor or vacuum pump be such that certain components, e.g. aftercoolers, are mounted away from the compressor or vacuum pump, endeavours shall be made to separate the noise generated from such parts when performing the noise test. Separation of the various noise sources could require special equipment for the attenuation of the noise from these sources during the measurement.

6.3 Loading and operating conditions

Operate compressors at full load conditions and vacuum pumps off-load.

The noise emission values of remotely mounted parts shall be measured in accordance with this standard and shall be reported separately in the test report.

During the test, the air or gas delivered by the compressor shall be piped clear of the test area.

Noise radiated from connecting pipes and regulating valves shall not be included; special arrangements could be required to reduce (by insulation/shielding) the noise radiated from these during the test period.

7 Test report

The test report shall contain the following information:

— reference to this noise test code and the basic standards used;

— identification of any deviations from full compliance with this standard during testing;

— description of the compressor or vacuum pump;

— loading conditions;

— operating conditions (those not stated in this noise test code, if any);

— acoustic environment;

— instrumentation;

— test arrangements;

— acoustical data;

— for large machines, reasons why Grade 2 accuracy may not have been fulfilled.

Examples of the format and content of the test reports are given in Annex A.

8 Declaration and verification of noise emission values

The noise declaration is the responsibility of the manufacturer. It shall be made in such a manner that the declared values can be verified according to the methods given in ISO 4871:1996.The noise declaration shall explicitly mention the fact that the noise emission values declared have been obtained according to the noise test code of this International Standard and indicate the basic standard that has been used. If this is not true, the noise declaration shall indicate precisely what the deviations are from this International Standard and/or from the basic International Standards.

If undertaken, a verification of noise emission values shall be conducted using the same test arrangement as was used to establish the declared values. Mounting, loading and operating conditions shall be the same for declaration and verification.

Declared values shall be rounded to the nearest decibel and given as dual-numbers, i.e.

— the A-weighted sound power level (L_{WAd}), and the uncertainty, K_{WAd}, and/or

— the A-weighted emission sound pressure level at the work station (L_{pWSAd}), and the uncertainty, K_{pAd}.

When the declared values are stated they shall be reported with equal prominence. An identical size and type of font shall be used to report both the sound power level and associated uncertainty and the emission sound pressure level and associated uncertainty (see 4.2).

A model form for declared noise emission values is given in Annex B.

Annex A
(informative)

Example test reports

A.1 Noise test based on ISO 3744

Report on noise emission measurement for compressors and vacuum pumps		
1. Description of compressor or vacuum pump		
Manufacturer:		
Model:	Serial No:	
Rated speed and capacity:		
Major dimensions:		
Type of prime mover:		
Auxiliaries:		
2. Operating conditions during test		
Speed: ..... r/min	Loading conditions:	
Working pressure: ..... bar/MPa	Compressor (full load):	
	Vacuum pump (off load):	
3. Test conditions		
Barometric pressure: ..... bar/MPa	Wind speed: ..... m/s	Ambient temp.: ..... °C
Reflecting plane composition and dimensions:		
Remarks: (including weather conditions)		
4. Instrumentation		
Microphone(s):	Serial No:	
Sound level meter:	Serial No:	
Calibrator:	Serial No:	
Other (e.g. wind screen, or recorder):		
Confirmation of system calibration:		
5. Test arrangement		
Sketch showing microphone locations, orientation, direction of exhaust, direction and distance to any large objects near the machine on test:		
6. Measurement array		
Area of measurement surface S_m = ... m^2		

7. Acoustical data

Background noise levels		Machine noise levels	
Microphone position	**Noise level** dB	**Microphone position**	**Noise level** dB
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
N		N	
Average background noise level $\overline{L''_{pA}}$		Average machine noise level $\overline{L'_{pA}}$	

All measurements on a measurement surface S_m = ... m^2

K_{1A} (background noise correction) determined according to ISO 3744:1994 using $\overline{L'_{pA}}$ and $\overline{L''_{pA}}$;

K_{2A} (environmental and, if relevant, windscreen correction) computed by one of the methods given in ISO 3744:1994, Annex A;

L_{pmsA} Surface sound pressure level = $\overline{L'_{pA}} - K_{1A} - K_{2A}$;

L_{WA} Sound power, is derived from = $L_{pmsA} + 10 \lg \left(\frac{S_m}{S_0} \right)$.

NOTE For further information on $\overline{L'_{pA}}$ and $\overline{L''_{pA}}$ see ISO 3744:1994, 8.1 and 8.3.

A-weighted surface sound pressure level $L_{pmsA} = \overline{L'_{pA}} - K_{1A} - K_{2A}$	.....dB
A-weighted sound power level $L_{WA} = L_{pmsA} + 10 \lg \left(\frac{S_m}{S_0} \right)$ $S_0 = 1 m^2$	.....dB
$Q_2 = 10 \lg \left(\frac{S_{WS}}{S_0} \right)$ S_{WS} as defined in 5.2 $S_0 = 1 m^2$	.....dB
A-weighted sound pressure level at the work station, $L_{pWSA} = L_{WA} - Q_2$	.....dB

Reported by:	Date:	Approved by:	Date:

A.2 Noise test based on ISO 9614

Report on noise emission measurement for compressors and vacuum pumps		
1. Description of compressor or vacuum pump		
Manufacturer:		
Model:	Serial No:	
Rated Speed and capacity:		
Major dimensions:		
Type of prime mover:		
Auxiliaries:		
2. Operating conditions during test		
Speed: ..... r/min	Loading conditions:	
Working pressure: ..... bar/MPa	Compressor (full load):	
	Vacuum pump (off load):	
3. Test conditions		
Barometric pressure: ..... bar/MPa	Ambient temp.: ..... °C	Wind speed: ..... m/s
Description and sketch of test site:		
Remarks (including weather conditions)		
4. Instrumentation		
Intensity probe:	Serial No:	Date of calibration:
Microphones:	Serial No:	Date of calibration:
Probe configuration:		
Sound intensity analyser:	Serial No:	Date of calibration:
Calibration of the whole system	Date:	Place:
Description of each step in measurement procedure (use separate sheet if required):		
Description of mounting or support system of the intensity probe and if applicable the scanning system (Use separate sheet if required):		
5. Measurement details		
Quantitative description of the measurement surface positions and segments, respectively (a diagram may be presented):		
Description or sketch of measurement array or scanning pattern:		
Averaging time on each segment: ..... s		
Scanning speed: ..... m/s		

Emission sound power levels (at loading condition) according to ISO 9614				
6. Acoustical data				
Segment number	**Segment area** m^2	**A-weighted sound intensity level** dB	**A-weighted partial sound power** dB	**Non-complying field indicator**
1				
2				
3				
4				
5				
6				
N				
Noise emission data obtained according to ISO 9614				
A-weighted total sound power level, L_{WA}			..... dB	
Q_2 factor			..... dB	
A-weighted emission sound pressure level at the workstation, L_{pWSA}			..... dB	
Reported by:			Date:	
Approved by:			Date:	

A.3 Noise test based on ISO 11201 or ISO 11202

Report on noise measurement for compressors and vacuum pumps		
1. Description of compressor or vacuum pump		
Manufacturer:		
Model:	Serial No:	
Rated speed and capacity:		
Major dimensions:		
Type of prime mover:		
Auxiliaries:		
2. Operating conditions during test		
Speed: ..... r/min	Loading conditions:	
Working pressure: ..... bar/MPa	Compressor (full load):	
	Vacuum pump (off load):	
3. Test conditions		
Barometric pressure: ..... bar/MPa	Wind speed: ..... m/s	Ambient temp.: ..... °C
Reflecting plane composition and dimensions:		
Remarks (including weather conditions):		
4. Instrumentation		
Microphone(s):	Serial No:	
Sound level meter:	Serial No:	
Calibrator:	Serial No:	
Other (e.g. wind screen, or recorder):		
Confirmation of system calibration:		
5. Test arrangement		
Sketch showing microphone locations, orientation, direction of exhaust, direction and distance to large objects near machine under test:		

Test report for compressor or vacuum pump			
6. Acoustical data			
Background noise levels		**Machine noise levels**	
Microphone position	**Noise level** dB	**Microphone position**	**Noise level** dB
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
N		N	
Average background noise level $\overline{L''_{p\mathrm{A}}}$		Average machine noise level $\overline{L'_{p\mathrm{A}}}$	
All measurements on a path around the machine and 1 m distant from it and at a height of 1,6 m above the floor or access platform.			
$K_{1\mathrm{A}}$	(background noise correction) determined according to ISO 3744:1994 using $\overline{L'_{p\mathrm{A}}}$ and $\overline{L''_{p\mathrm{A}}}$;		
$K_{2\mathrm{A}}$	(environmental and, if relevant, windscreen correction) computed by one of the methods given in ISO 3744:1994, Annex A; $K_{2\mathrm{A}} =$ ..... dB;		
NOTE 1	$K_{2\mathrm{A}}$ shall not exceed 2 dB for valid application of ISO 11201:1995 (Grade 2).		
$L_{p\mathrm{WSA}}$	A-weighted sound pressure level $= \overline{L'_{p\mathrm{A}}} - K_{1\mathrm{A}}$;		
NOTE 2	A local environmental correction is applied when testing to ISO 11202:1995. For details of computation of this, see ISO 11202:1995, Annex A.		
A-weighted sound pressure level on measurement path $L_{p\mathrm{WSA}}$			.....dB
Reported by:	Date:	Approved by:	Date:

Annex B
(informative)

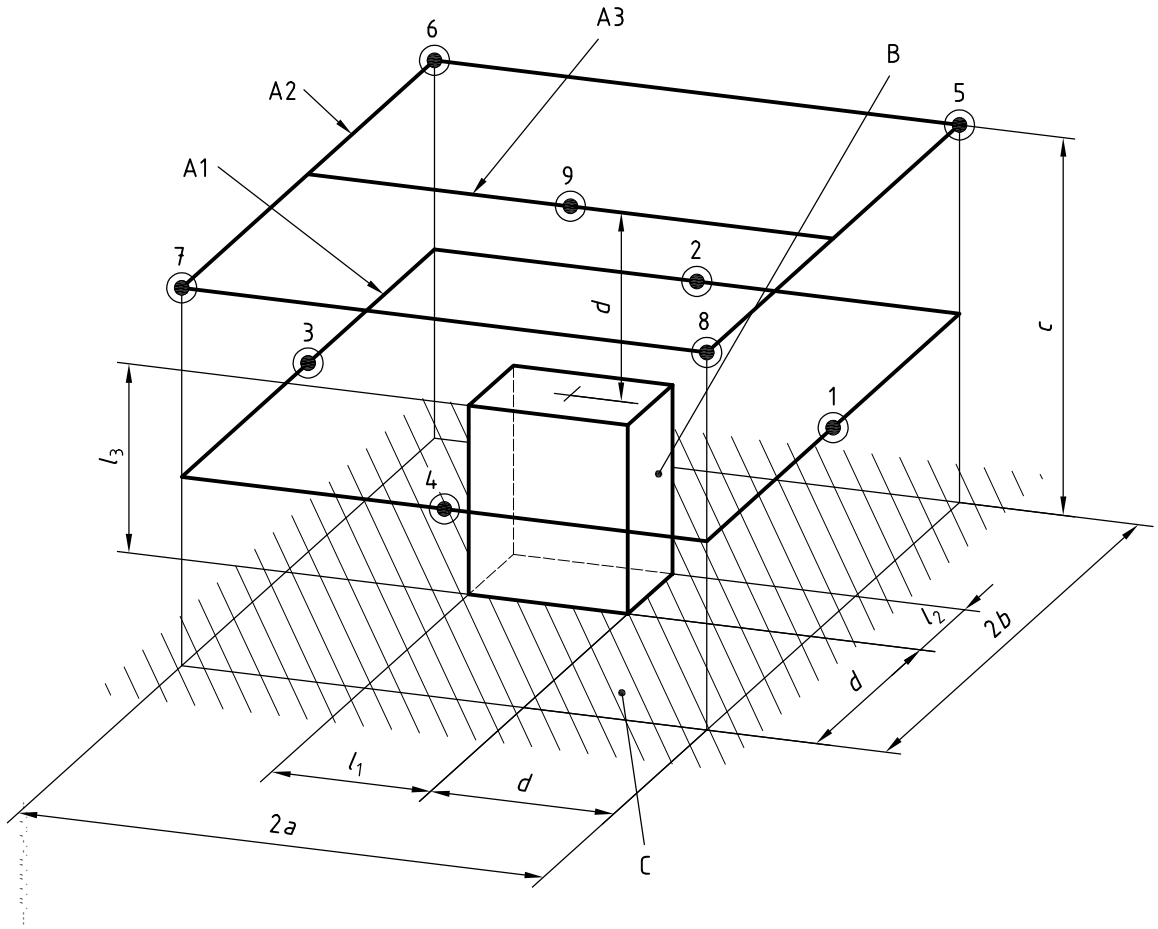
Model form for declared noise emission values

Declared dual-number noise emission values in accordance with ISO 2151	
Compressor or vacuum pump tested:	
Manufacturer:	
Model No:	
Serial No:	
Family or series:	
Rated speed:	..... r/min
Rated capacity:	
Major dimensions:	..... m
Type of prime mover:	
Product description:	
At operating conditions (state "on-load/off-load"):	
A-weighted sound power level, L_{WA}, (re 10^{-12} W):	..... dB
Uncertainty, K_{WA}:	..... dB
A-weighted emission sound pressure level at the work station, L_{pWSA} (re 20 µPa) at the work station:	..... dB
Uncertainty, K_{pA}:	..... dB
Values determined according to noise test code ISO 2151 and noise measurement standard ISO	
NOTE The sum of a measured noise emission value and its associated uncertainty represents the statistical upper boundary of the range of values that could occur for the type of machine/machine range assessed.	

Annex C
(normative)

Parallelepiped measurement surface

See Figure C.1.



Key

A1 measurement path 1
A2 measurement path 2
A3 measurement path 3
B reference box
C plane
⊙ microphone positions 1 to 9

Figure C.1 — Microphone positions (based on Figure C.2 of ISO 3744:1994)

Figure C.1 shows a rectangular parallelepiped whose sides are parallel to those of the reference box. The measurement distance, d, is the distance between the measurement surface and the reference box.

Measurements shall be made with the machine under test on a single reflecting plane. The measurement distance, d, shall be in accordance with ISO 3744:1994, 7.3, and should be 1 m.

The reference box is a hypothetical surface that is generally the smallest simple volume containing the machine under test excluding the connecting pipes. For examples, see Annex E.

When using a microphone array at 1 m from a compressor, care shall be taken to ensure that the turbulent air flow from cooling ducts does not prejudice readings. To avoid this it may be necessary to displace laterally one or more microphone positions; however such movement should be kept to a minimum.

If turbulent airflow causes a problem with the measurement array then it may be necessary to increase d or change to a hemispherical array in accordance with ISO 3744:1994.

The actual number of microphone positions depends on the size of the machine under test and the nature of its sound field. See ISO 3744:1994, 7.3 and 7.4, for guidance on the actual number of microphone positions necessary.

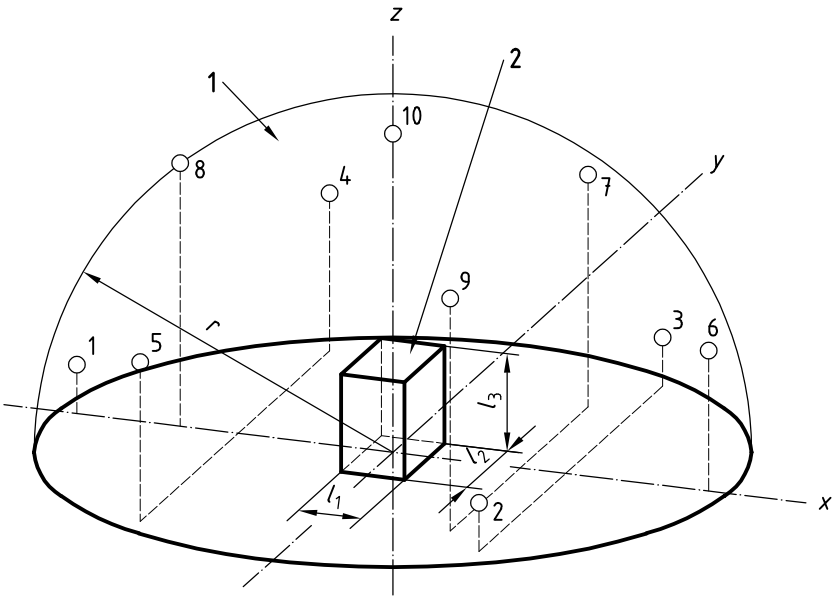
Annex D
(normative)

Hemispherical measurement surface

Measurements shall be made over a single reflecting plane; the microphone positions lie on the hypothetical hemispherical surface of area $S = 2\pi r^2$, enveloping the surface and terminating on the reflecting plane.

Figure D.1 shows the locations of the 10 key microphone positions, each associated with equal areas on the surface of the hemisphere radius r. Table D.1 gives their co-ordinates.

The actual number of microphone positions depends on the size of the machine under test and the nature of the sound field. See ISO 3744:1994, 7.2 and 7.4 for the number of microphone positions necessary.



Key

1 measurement surface
2 reference box
○ microphone positions 1 to 10

Figure D.1 — Microphone positions (As in Annex B, Figure B.1 of ISO 3744:1994)

Table D.1 — Co-ordinates of key microphone positions (1 to 10)

Microphone position	$\frac{x}{r}$	$\frac{y}{r}$	$\frac{z}{r}$
1	–0,99	0	0,15
2	0,50	–0,86	0,15
3	0,50	0,86	0,15
4	–0,45	0,77	0,45
5	–0,45	–0,77	0,45
6	0,89	0	0,45
7	–0,33	0,57	0,75
8	–0,66	0	0,75
9	0,33	–0,57	0,75
10	0	0	1,0

Annex E
(informative)

Examples of reference box for different machines

See Figures E.1 to E.5.

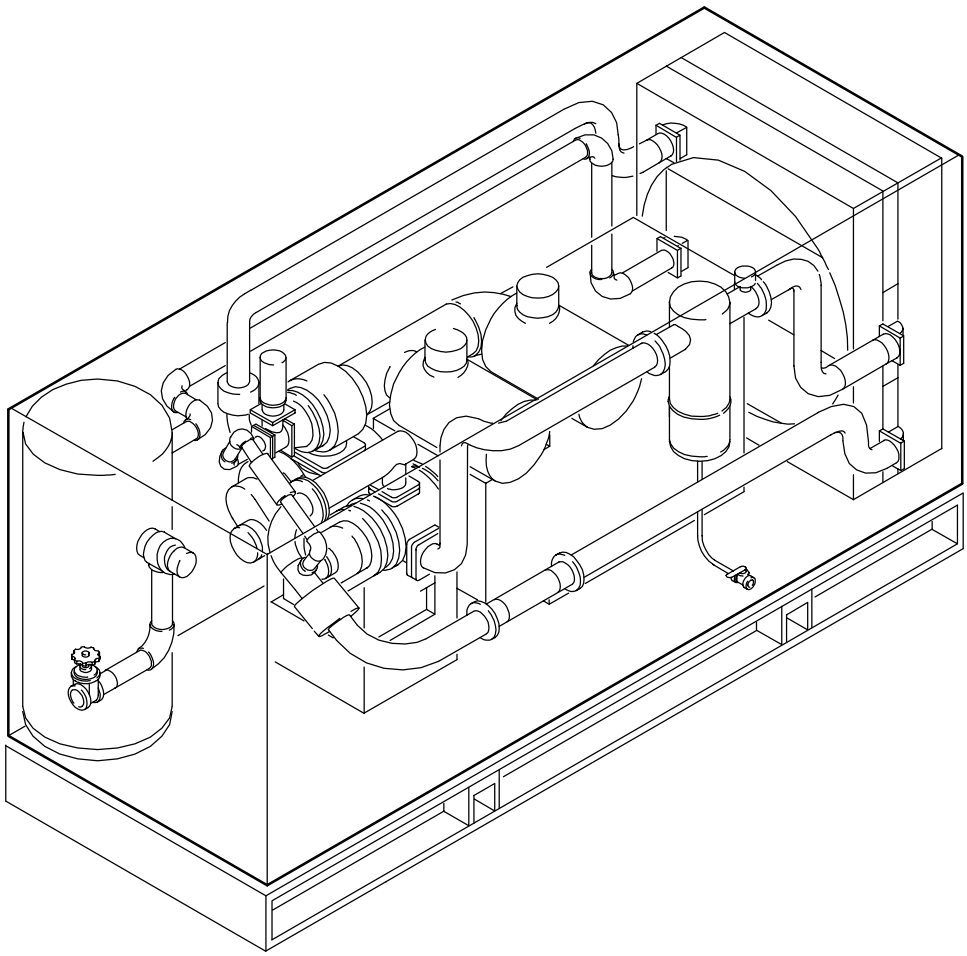


Figure E.1 — Conventional boxed packaged compressor

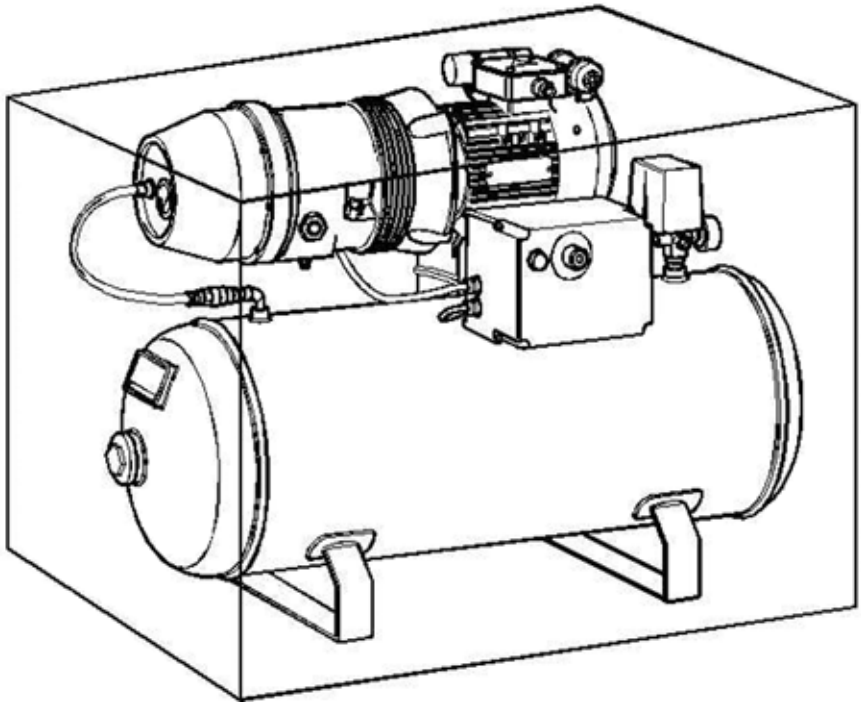


Figure E.2 — Receiver-mounted compressor unit

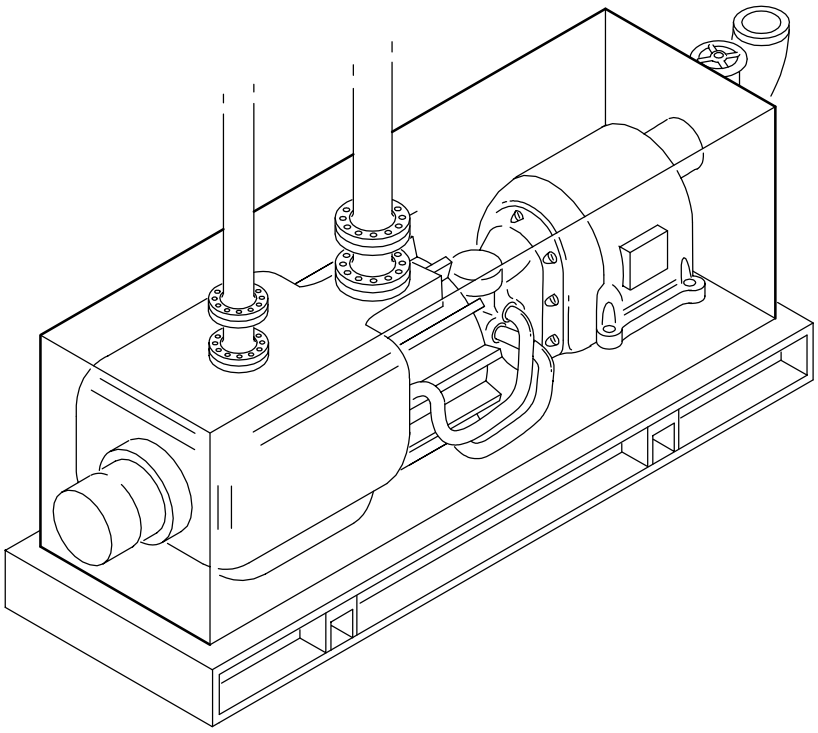


Figure E.3 — Rotary positive displacement compressor with reference box

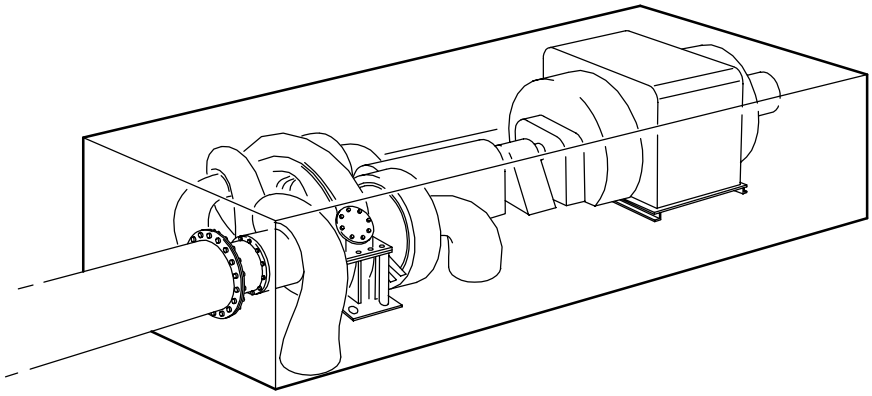
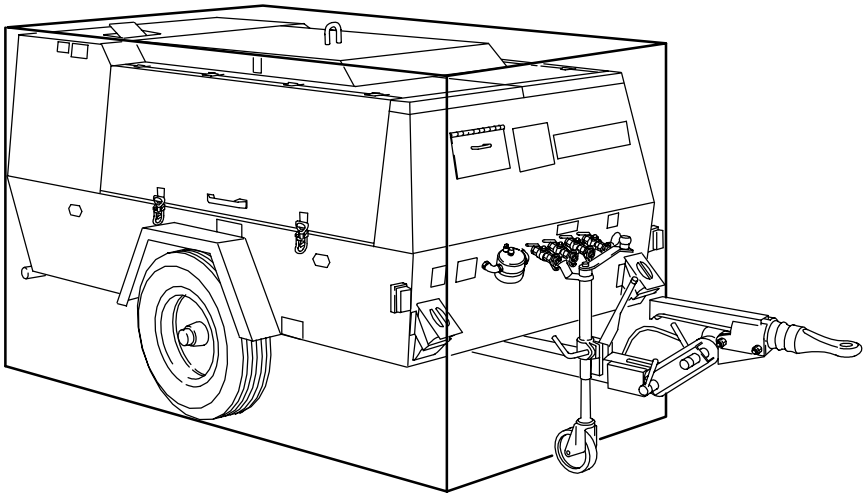


Figure E.4 — Integral gear centrifugal compressor with reference box



The draw bar shall not be enclosed in the reference box

Figure E.5 — Portable compressor

Bibliography

[1] ISO 1217, *Displacement compressors — Acceptance Test*

[2] ISO 3740, *Acoustics — Determination of sound power levels of noise sources — Guidelines for the use of basic standards*

[3] ISO 5388, *Stationary air compressors — Safety rules and code of practice*

[4] ISO 5389, *Turbo Compressors — Performance test code*

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