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Hydraulic fluid power — Test code for the determination of sound power levels using sound intensity techniques: Engineering method —

Part 1: **Pumps**

Transmissions hydrauliques — Code d'essai pour la détermination des niveaux de puissance acoustique à l'aide des techniques d'intensimétrie: Méthode d'expertise —

Partie 1: Pompes

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 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 16902-1 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 8, *Product testing*.

ISO 16902 consists of the following parts, under the general title *Hydraulic fluid power — Test code for the determination of sound power levels using sound intensity techniques: Engineering method*:

— *Part 1: Pumps*

— *Part 2: Motors*[1)]

1) In preparation.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure in a closed circuit. Pumps are components that convert rotary mechanical power into fluid power. During the process of converting mechanical power into fluid power, airborne noise, fluid-borne noise and structure-borne noise are radiated from the pump.

The airborne noise level of a hydraulic fluid power pump is an important consideration in component selection. ISO 4412-1 [1] describes a method of taking noise level measurements but requires a very specialized and costly test environment. The procedures described in this part of ISO 16902 do not require specialized and expensive test conditions but can be expected to achieve “engineering” or “survey” levels of accuracy. The results should be sufficiently accurate so that comparisons can be made between pumps. It should be noted that sound power is physically a function of the test environment, and may in some cases differ from the sound power of the same source determined under other conditions.

Hydraulic fluid power — Test code for the determination of sound power levels of pumps using sound intensity techniques: Engineering method —

Part 1: **Pumps**

1 Scope

This part of ISO 16902 establishes a test code based on ISO 9614-1 and ISO 9614-2 for determining the sound power levels of a hydraulic fluid power pump under controlled conditions of installation and operation. The sound power level will include sound power radiated by any piping within the measurement surface. This part of ISO 16902 is suitable for providing a basis for comparing the airborne noise levels of any type of pump that is normally used to convert rotary mechanical power to hydraulic fluid power, incorporating valves, solenoids, drive gears, couplings or any other auxiliary device normally fitted in service.

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 3448, *Industrial liquid lubricants — ISO viscosity classification*

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 5598, *Fluid power systems and components — Vocabulary*

ISO 6743-4, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems)*

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 9614-3, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 3: Precision method for measurement by scanning*

IEC 61043, *Electroacoustics — Instruments for the measurement of sound intensity — Measurements with pairs of pressure sensing microphones*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and the following apply.

3.1
pumping frequency
frequency determined as follows:

$$\frac{n \times z}{60}$$

where

n is the pump shaft speed in revolutions per minute;

z is the number of pumping chambers per revolution.

4 Sound power level determination

The sound power level shall be determined in accordance with ISO 9614-1, ISO 9614-2 or ISO 9614-3.

In the above standards the quantity to be measured is sound intensity level in one octave and one-third octave frequency bands, while the quantity to be determined is sound power level in one octave and one-third octave frequency bands.

Because noise generated by pumps is dominated by the harmonics of pumping frequency, measurements of narrow band frequency are useful and are permitted in this part of ISO 16902.

5 Installation and mounting conditions

5.1 General

If two or more pumps are coupled together, they may be treated as a single pump. The operating conditions for each pump should be stated in the report.

5.2 Pump mounting

It is desirable that the pump mounting be constructed so that the noise radiated from the mounting is as low as possible. This shall be done by passive means (e.g. using a high damping material).

5.3 Drive coupling

The drive coupling shall conform to the pump manufacturer's recommendations.

5.4 Hydraulic circuit

5.4.1 The circuit shall include all oil filters, oil coolers, reservoirs and restrictor valves as required to conform to the pump hydraulic operating conditions.

5.4.2 The test fluid, temperature and contamination level shall conform to the pump manufacturer's recommendations.

5.4.3 Inlet and discharge lines shall be installed with diameters applicable to the pump manufacturer's recommendations. Care shall be exercised when assembling inlet lines in order to prevent air leaking into the circuit.

5.4.4 The inlet pressure sensor shall be mounted at the same height as the pump inlet or shall be calibrated for any height difference.

5.4.5 The load valve should be located so that it has negligible influence on the noise level of the pump.

5.4.6 A stable load valve shall be used.

NOTE Unstable load valves in the discharge line can generate and transmit noise through the fluid and piping, that can emerge as airborne noise at the pump.

5.4.7 All fluid lines shall operate as in a working installation (i.e. not wrapped in sound insulating material). See ISO 9614-1:1993, 0.3, and ISO 9614-2:1996, 0.4.

6 Measurement surfaces

6.1 General

Alternative mounting arrangements are depicted in Figures 1 to 5.

Measurement surfaces should conform to the recommendations given in ISO 9614-1, ISO 9614-2 or ISO 9614-3.

6.2 Piping

To simplify the geometry of measurement surfaces, if possible do not pass piping through them. If reflecting planes are used, pass the piping through these.

If there is no alternative to passing the piping through the measurement surface, split the surface into segments with the split lines on the pipe centre line (see Figure 5).

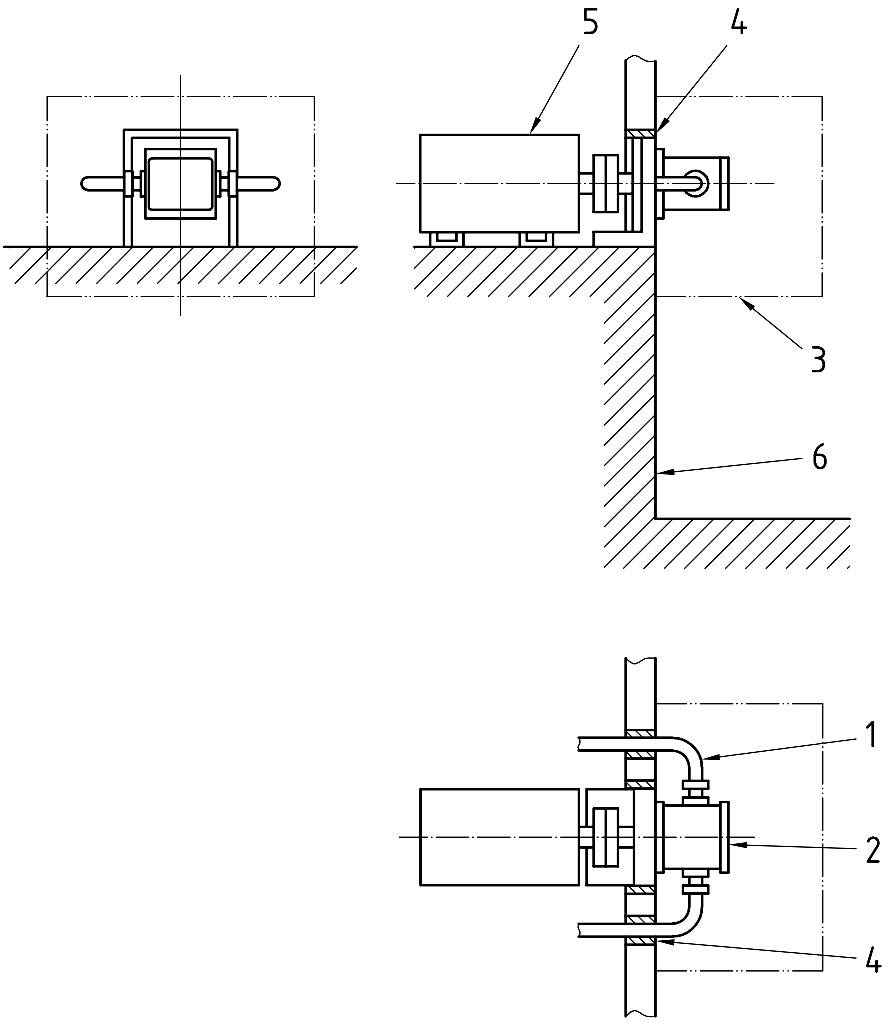
It is permissible to shield piping that is outside the measurement surface providing that this shielding does not account for more than 10 % of the area of the measurement surface.

6.3 Pump mounting

6.3.1 If a pump is flange-mounted, one of the measurement surfaces shall be aligned with the mounting face.

6.3.2 If the pump is flange-mounted to a bell housing or bracket where the noise radiated from the pump toward the drive motor cannot be measured at the mounting face, a reflecting plane coincident with the mounting face may be used.

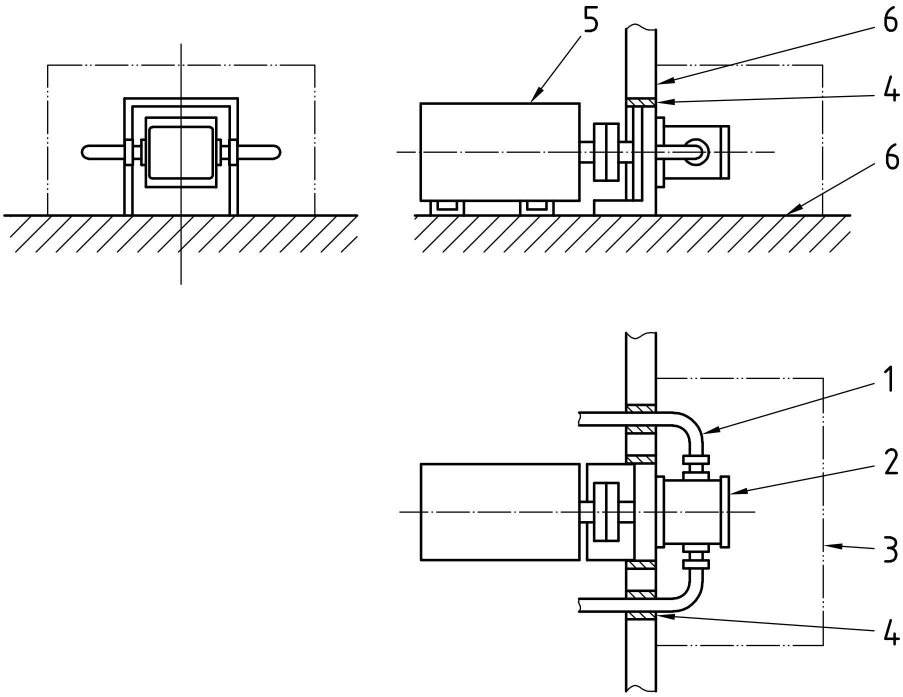
6.3.3 If a pump is foot mounted, the floor may be used as a reflecting plane.



Key

1 piping
2 pump under test
3 measurement surface
4 soft rubber seal
5 prime mover
6 reflecting plane

Figure 1 — Reflecting plane at pump mounting face with rigid support for prime mover and with pipes passing through reflecting plane



Key

1 piping
2 pump under test
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4 soft rubber seal
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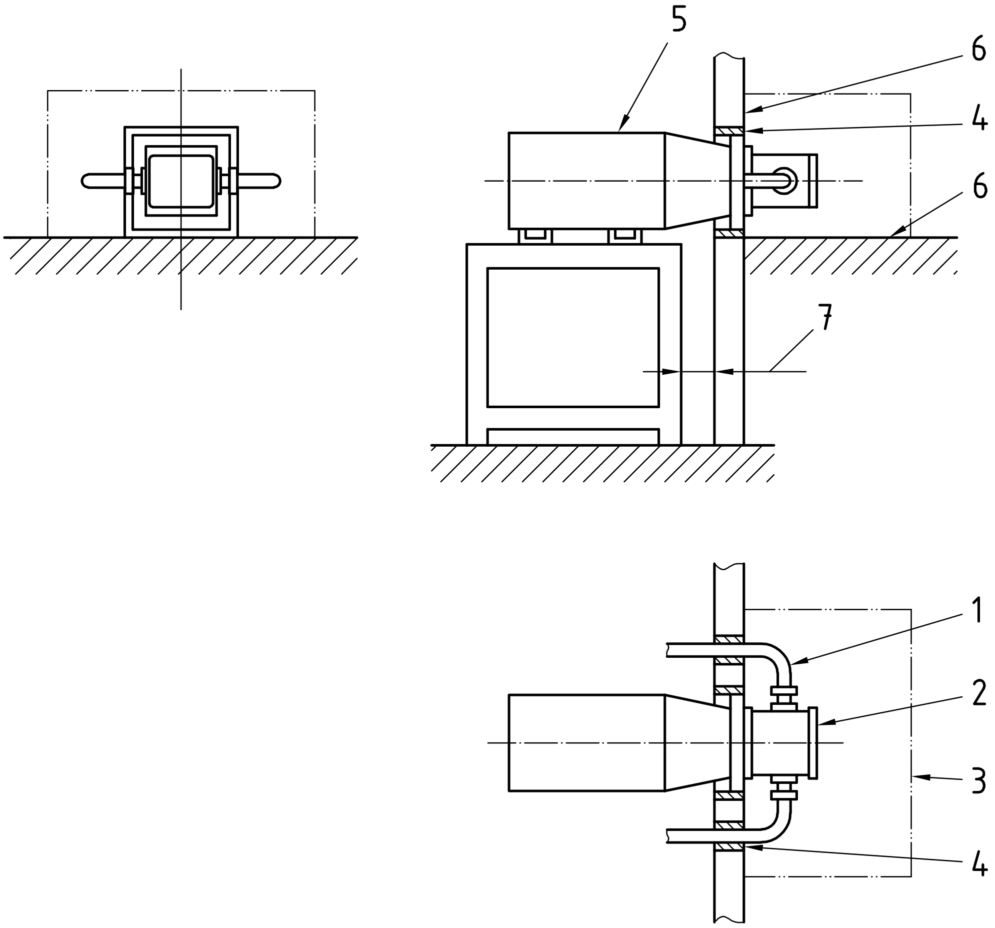
6 reflecting plane

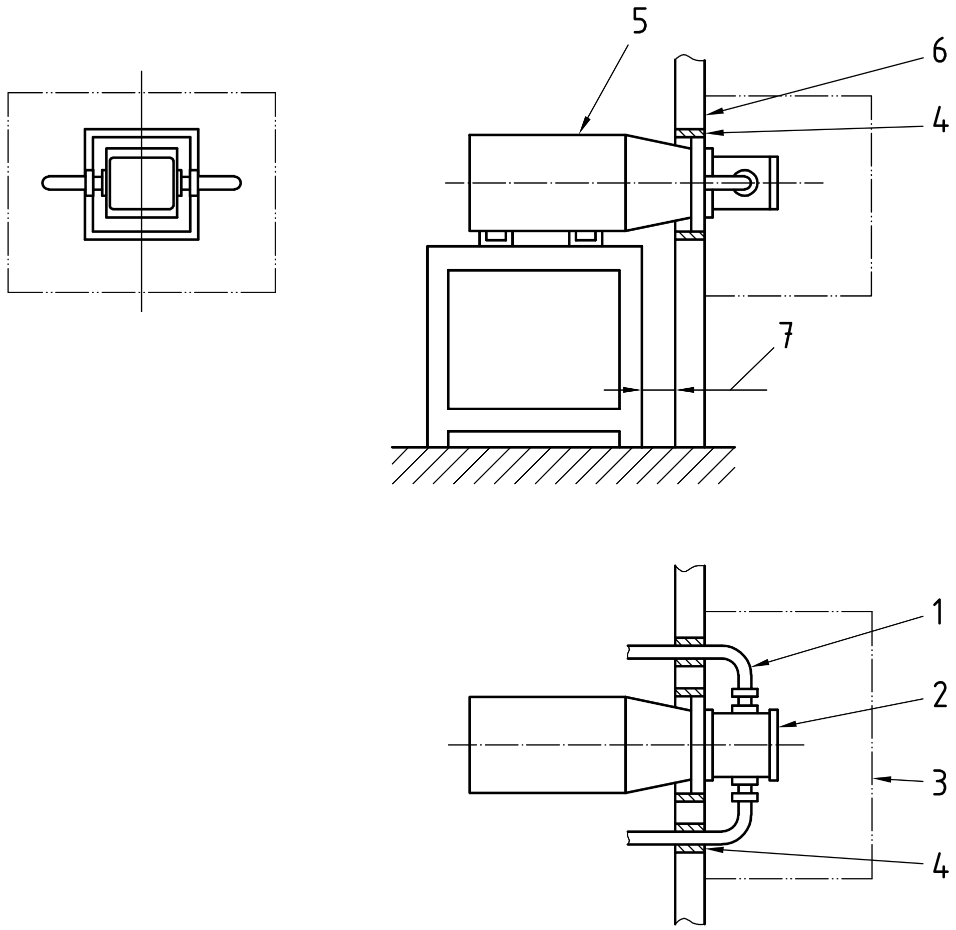
Figure 2 — Reflecting plane at pump mounting face and underneath, having rigid support for prime mover and with pipes passing through reflecting plane



Key

1 piping
2 pump under test
3 measurement surface
4 soft rubber seal
5 prime mover
6 reflecting plane
7 reflecting plane isolated from support frame

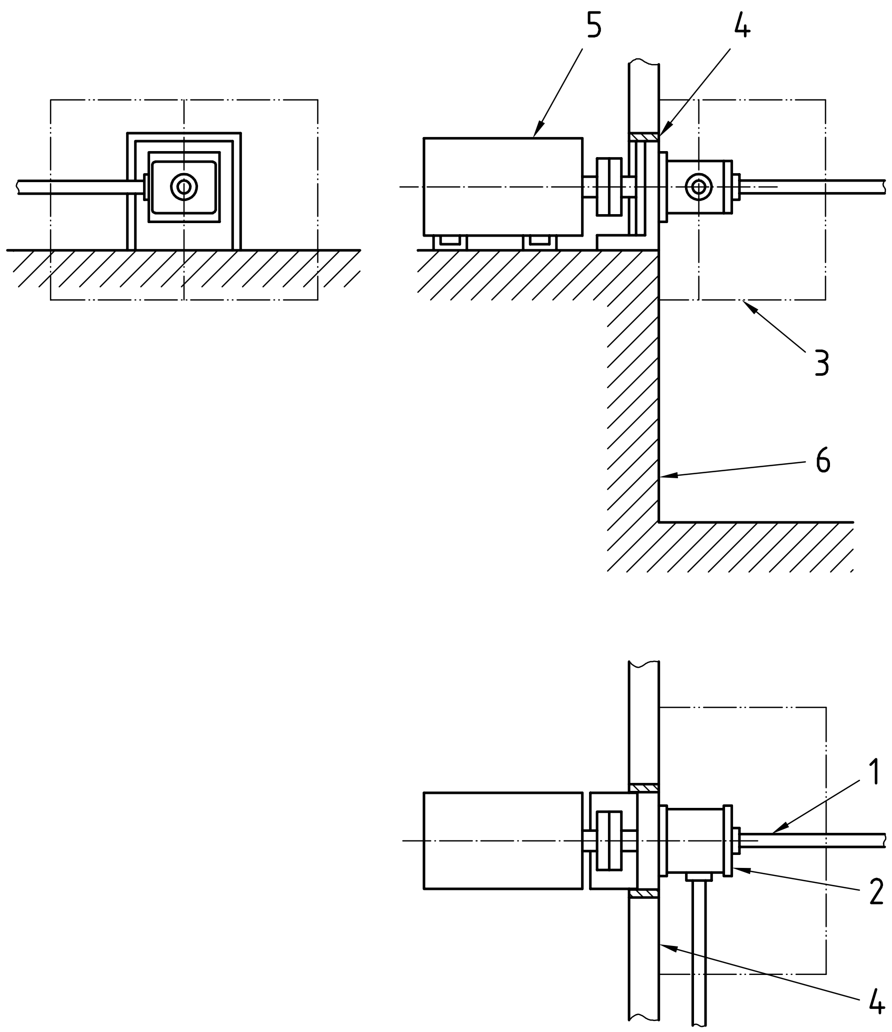
Figure 3 — Reflecting plane at pump mounting face and underneath, having non-rigid support for prime mover and with pipes passing through reflecting plane



Key

1 piping
2 pump under test
3 measurement surface
4 soft rubber seal
5 prime mover
6 reflecting plane
7 reflecting plane isolated from the support frame

Figure 4 — Reflecting plane at pump mounting face and non-rigid support for prime mover and with pipes passing through reflecting plane



Key

1 piping
2 pump under test
3 measurement surface
4 soft rubber seal
5 prime mover
6 reflecting plane

Figure 5 — Example of dividing measurement surfaces if pipes pass through them

6.4 Reflecting plane

6.4.1 For guidance on the size of reflecting planes see ISO 3744:1994, Annex A.

6.4.2 Large reflective surfaces (e.g. tanks, test cell walls and floors) should be at least 2 m away from the measurement surface unless used on the measurement surface as a reflecting plane.

Field indicators conforming to ISO 9614-1 and ISO 9614-2 determine if reduced accuracy has been caused by reflective surfaces that are too close to the measurement surface. These surfaces shall be lagged or, if possible, moved if increased accuracy is required.

6.4.3 Reflecting planes should be uncoupled from the pump, prime mover and associated piping with air gaps filled with soft rubber. The reflecting planes should be sufficiently rigid not to generate noise. Materials such as concrete or brick are suitable.

6.5 Drive motor and drive couplings

The drive motor and drive couplings should be outside the measurement surface.

7 Operating conditions

7.1 Determine the sound power level of the pump for any desired set of operating conditions taking into account the manufacturer's recommendations.

7.2 The test conditions in 7.1 shall be maintained throughout the test within the limits given in Table 1.

Table 1 — Permisiable variations of mean indicated values of controlled parameters

Test parameter	Allowable variation
Flow	± 2 %
Pressure	± 2 %
Speed	± 2 %
Temperature	± 2 °C

7.3 The pump shall be tested in the “as-delivered” condition with any ancillary pumps and valves operating normally during the test, so as to include their noise contributions to the airborne noise of the pump.

8 Measurement uncertainty

Measurement uncertainty shall be determined by the field indicators detailed in ISO 9614-1, ISO 9614-2 or ISO 9614-3.

NOTE Precision accuracy measurements may not be achievable with the methods described in this part of ISO 16902. Engineering or survey grades should be possible. ISO 9614-3 gives provisions for precision grade measurements.

9 Information to be recorded

9.1 General

The following information shall be recorded:

a) the name and address of the pump manufacturer and, if applicable, the user;

b) reference number(s) for identification of the pump;

c) the name and address of persons or the organization responsible for the test on the pump;

d) the date and place of the test.

9.2 Pump under test

9.2.1 Description of pump

The following information shall be recorded:

a) the type of pump (e.g. gear or piston), including ancillary equipment;

b) the type of displacement (fixed or variable);

c) the pump overall linear dimensions (with sketch if required);

d) the pump maximum displacement;

e) the type of displacement controller and setting if applicable.

9.2.2 Acoustic environment for test

The following information shall be recorded:

a) a dimensioned sketch of the measurement area showing its position relative to the pump and the position of any reflecting planes;

b) the position of the pump relative to walls, ceilings, screens, other machines etc., that do not form part of the measurement surface.

9.2.3 Mounting and installation conditions of the pump

The following information shall be recorded:

a) a description of the pump mounting conditions;

b) a description of pipework included in the measurement area, a full description of the pipe type (e.g. hose or steel) and fittings using dimensioned sketches for clarity;

c) a description of the hydraulic circuit;

d) the nature and a description of other machines used that could influence sound measurements.

9.2.4 Instrumentation

The following information shall be recorded:

a) details of the equipment used to monitor pump operating conditions, including type, manufacturer and serial number;

b) details of equipment used for acoustic measurement, including name, type, serial number and manufacturer;

c) the bandwidth of the frequency analyser;

d) the overall frequency response of the instrumentation system and the date and method of calibration or compliance of measuring system to IEC 61043;

e) the method of calibration of microphones and the date and place of calibration.

9.2.5 Pump operating conditions

The following information shall be recorded :

a) a full description of the fluid, including classification in accordance with ISO 6743-4;

b) the fluid viscosity classification in accordance with ISO 3448, in square millimetres per second (mm^2/s) or in centistokes (cSt);

c) the pump shaft speed, in revolutions per minute (rpm);

d) inlet pressure, in pascals (Pa);

e) outlet pressure, in megapascals (MPa);

f) pump delivery flow, in litres per minute (l/min);

g) temperature of the fluid at the pump inlet, in degrees centigrade (°C).

9.2.6 Acoustic data

Include all data specified in ISO 9614-1, ISO 9614-2 and ISO 9614-3.

10 Test report

In addition to the pump operating conditions of 9.2.5, the following information shall be recorded:

a) the overall "A" weighted sound power level and octave, one-third octave or narrow band frequency spectra, as produced by the frequency analyser, over the frequency band of interest;

b) a statement that the sound power levels have been obtained in accordance with the procedures described in this part of ISO 16902;

c) a statement of the grade of accuracy achieved.

NOTE This information should also be used in any published literature such as catalogues and sales literature.

Bibliography

[1] ISO 4412-1:1991, *Hydraulic fluid power — Test code for determination of airborne noise levels — Part 1: Pumps*

ICS 17.140.20; 23.100.10

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