INTERNATIONAL STANDARD

ISO 10816-3

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Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts —

Part 3:
Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured *in situ*

Vibrations mécaniques — Évaluation des vibrations des machines par mesurages sur les parties non tournantes —

Partie 3: Machines industrielles de puissance nominale supérieure à 15 kW et de vitesse nominale entre 120 r/min et 15 000 r/min, lorsqu'elles sont mesurées in situ

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.

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.

International Standard ISO 10816-3 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

ISO 10816 consists of the following parts, under the general title *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts*:

— *Part 1: General guidelines*

— *Part 2: Large land-based steam turbine generator sets in excess of 50 MW*

— *Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured in situ*

— *Part 4: Gas turbine driven sets excluding aircraft derivatives*

— *Part 5: Machine sets in hydraulic power generating and pumping plants*

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— *Part 6: Reciprocating machines with power ratings above 100 kW*

Annex A forms an integral part of this part of ISO 10816. Annex B is for information only.

Introduction

ISO 10816-1 is the basic document which describes the general requirements for evaluating the vibration of various machine types when the vibration measurements are made on non-rotating parts. This part of ISO 10816 provides specific guidance for assessing the severity of vibration measured on bearings, bearing pedestals, or housings of industrial machines when measurements are made *in situ*.

Two criteria are provided for assessing the machine vibration. One criterion considers the magnitude of the observed vibration; the second considers changes in the magnitude. It must be recognized, however, that these criteria do not form the only basis for judging the severity of vibration. For some machine types, it is also common to judge the vibration based on measurements taken on the rotating shafts. Shaft vibration measurement requirements and criteria are addressed in separate documents, ISO 7919-1 and ISO 7919-3.

Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts —

Part 3:
Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured *in situ*

1 Scope

The vibration criteria provided in this part of ISO 10816 apply to machine sets with, for instance, steam turbine or electrical drives, having a power above 15 kW and operating speeds between 120 r/min and 15 000 r/min.

The machine sets covered by this part of ISO 10816 include:

— steam turbines with power up to 50 MW;

— steam turbine sets with power greater than 50 MW and speeds below 1 500 r/min or above 3 600 r/min (not included in ISO 10816-2);

— rotary compressors;

— industrial gas turbines with power up to 3 MW;

— pumps of centrifugal, mixed flow or axial flow type;

— generators, except when used in hydraulic power generating and pumping plants;

— electrical motors of any type;

— blowers or fans.

NOTE However, it should be noted that the vibration criteria presented in this part of ISO 10816 are generally only applicable to fans with power ratings greater than 300 kW or other fans with a reasonably rigid structure/frame which are not flexibly supported. As and when circumstances permit, recommendations for other types of fans, including those which are flexibly supported or with lightweight sheet metal construction, will be prepared. Until such time, classifications may be agreed between the manufacturer and customer, using results of previous operational experience; see also ISO 14694.

The following are excluded from this part of ISO 10816:

— land-based steam turbine generator sets with power greater than 50 MW and speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min, or 3 600 r/min (see ISO 10816-2);

— gas turbine machines with power greater than 3 MW (see ISO 10816-4);

— machine sets in hydraulic power generating and pumping plants (see ISO 10816-5);

— machines coupled to reciprocating machines (see ISO 10816-6);

— rotary positive displacement compressors (e.g. screw compressors);

— reciprocating compressors;

— reciprocating pumps;

— submerged motor-pumps;

— wind turbines.

The criteria of this part of ISO 10816 apply to *in situ* broad-band vibration measurements taken on the bearings, bearing pedestals, or housing of machines under steady-state operating conditions within the nominal operating speed range. They relate to both acceptance testing and operational monitoring. The evaluation criteria of this part of ISO 10816 are intended to apply to both continuous and non-continuous monitoring situations.

This part of ISO 10816 encompasses machines which may have gears or rolling element bearings, but does not address the diagnostic evaluation of the condition of those gears or bearings.

The criteria are applicable only for the vibration produced by the machine set itself and not for vibration which is transmitted to the machine set from external sources.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10816. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10816 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 496:1973, *Driving and driven machines — Shaft heights*

ISO 2954:1975, *Mechanical vibration of rotating and reciprocating machinery — Requirements for instruments for measuring vibration severity*

ISO 7919-3:1996, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 3: Coupled industrial machines*

ISO 10816-1:1995, *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 1: General guidelines*

3 Measurement procedures and operational conditions

The general procedures described in ISO 10816-1 shall be used, subject to the recommendations set out below.

3.1 Measurement equipment

The measurement equipment shall be capable of measuring broad-band r.m.s. vibration with flat response over a frequency range of at least 10 Hz to 1 000 Hz, in accordance with the requirements of ISO 2954. Depending on the vibration criteria, this may require measurements of displacement or velocity or combinations of these (see ISO 10816-1). However, for machines with speeds approaching or below 600 r/min, the lower limit of the flat response frequency range shall not be greater than 2 Hz.

NOTE If the measurement equipment is also to be used for diagnostic purposes, an upper frequency limit higher than 1 000 Hz may be necessary.

Care should be taken to ensure that the measuring system is not influenced by environmental factors such as:

— temperature variations;

— magnetic fields;

— sound fields;

— power source variations;

— transducer cable length;

— transducer orientation.

Particular attention should be given to ensure that the vibration transducers are correctly mounted and that such mountings do not degrade the accuracy of the measurements.

3.2 Measurement locations

Measurements will usually be taken on exposed parts of the machine that are normally accessible. Care shall be taken to ensure that measurements reasonably represent the vibration of the bearing housing and do not include any local resonances or amplification. The locations and directions of vibration measurements shall be such that they provide adequate sensitivity to the machine dynamic forces. Typically, this will require two orthogonal radial measurement locations on each bearing cap or pedestal, as shown in figures 1 and 2. The transducers may be placed at any angular position on the bearing housings or pedestals. Vertical and horizontal directions are usually preferred for horizontally mounted machines. For vertical or inclined machines, the location that gives the maximum vibration reading, usually in the direction of the elastic axis, shall be one of those used. In some cases it may be recommended to measure also in the axial direction (see 5.1.3). The specific locations and directions shall be recorded with the measurement.

A single transducer may be used on a bearing cap or pedestal in place of the more typical pair of orthogonal transducers if it is known to provide adequate information on the magnitude of the machine vibration. However, caution should be observed when evaluating vibration from a single transducer at a measurement plane since it may not be oriented to provide a reasonable approximation to the maximum value at that plane.

3.3 Continuous and non-continuous monitoring

It is common practice on large or critical machinery to have installed instrumentation for continuous on-line monitoring of vibration values at key measurement points. For many machines, mainly those of small size or power, continuous monitoring of the vibration parameters is not necessarily carried out. Changes in unbalance, bearing performance, alignment, etc. can be detected with sufficient reliability from periodic measurements with permanently installed or hand-held instruments. The use of computers for trend analysis and warning against malfunctions is also becoming more common.

3.4 Operational conditions

Measurements shall be carried out when the rotor and the main bearings have reached their normal steady-state operating temperatures and with the machine running under specified conditions; for example at rated speed, voltage, flow, pressure and load.

On machines with varying speeds or loads, measurements shall be made under all conditions at which the machine would be expected to operate for prolonged periods. The maximum measured value under these conditions shall be considered representative of vibration severity.

If the measured vibration is greater than the acceptance criteria allowed and excessive background vibration is suspected, measurements should be made with the machine shut down to determine the degree of external influence. If the vibration with the machine stationary exceeds 25 % of the value measured when the machine is running, corrective action may be necessary to reduce the effect of background vibration.

NOTE In some cases the effect of background vibration may be nullified by spectrum analysis or by eliminating the offending external source.

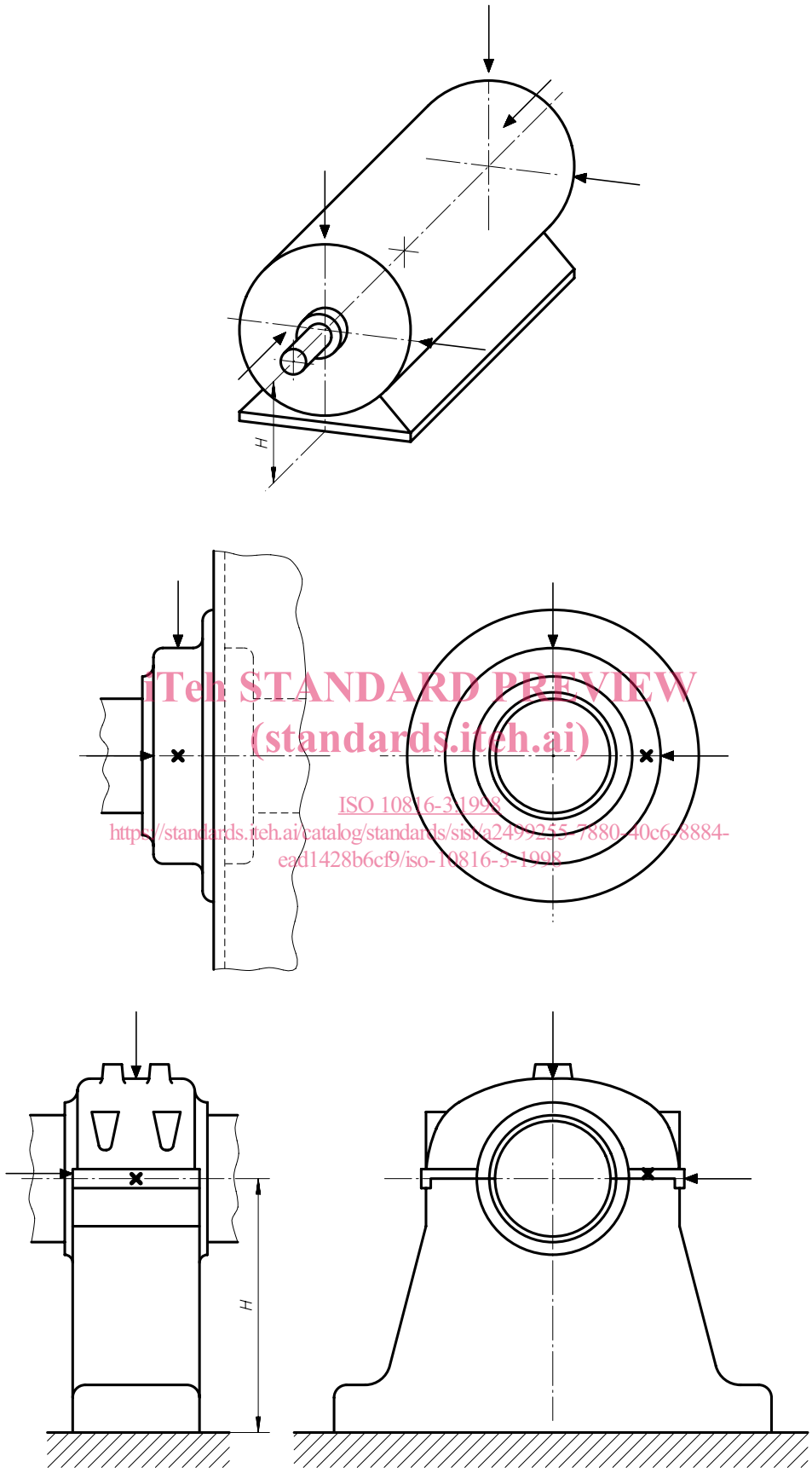

Figure 1 — Measuring points

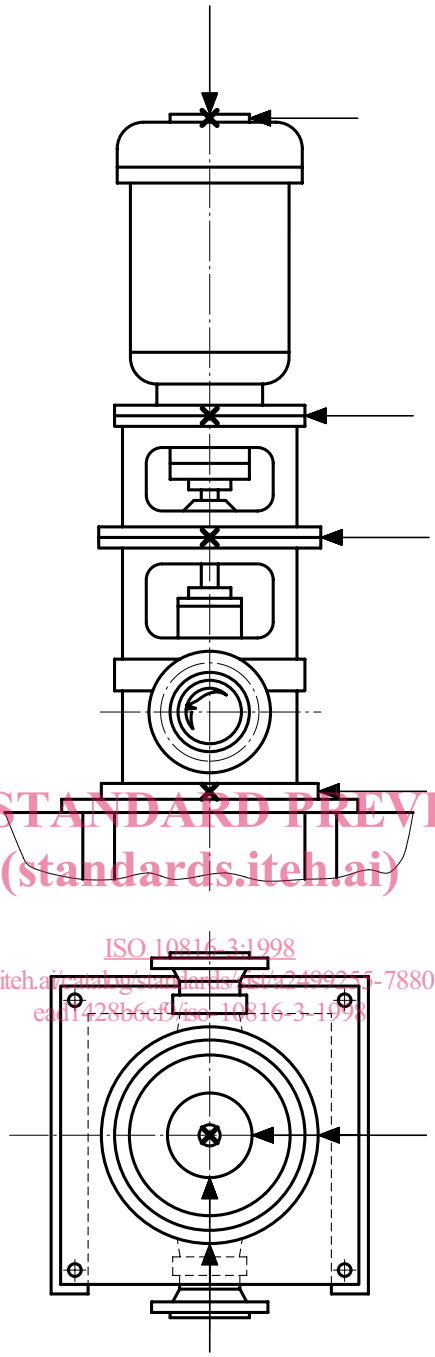

Figure 2 — Measuring points for vertical machine sets

4 Machine classification

In this part of ISO 10816, the vibration severity will be classified according to the following parameters:

– machine type;

– rated power or shaft height;

– support system flexibility.