INTERNATIONAL STANDARD

ISO 20816-3

First edition
2022-10

Mechanical vibration — Measurement and evaluation of machine vibration —

Part 3: Industrial machinery with a power rating above 15 kW and operating speeds between 120 r/min and 30 000 r/min

Vibrations mécaniques — Mesurage et évaluation des vibrations de machines —
Partie 3: Machines industrielles avec une puissance nominale supérieure à 15 kW et une vitesse de fonctionnement comprise entre 120 r/min et 30 000 r/min

Reference number
ISO 20816-3:2022(E)

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Published in Switzerland

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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.

The procedures used to develop this document and those intended for its further maintenance are specified in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This first edition of ISO 20816-3 cancels and replaces ISO 7919-3:2009, ISO 7919-3:2009/Amd 1:2017, ISO 10816-3:2009 and ISO 10816-3:2009/Amd 1:2017, which have been merged and editorially revised. A list of all parts in the ISO 20816 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides specific guidance for assessing

a) the severity of vibration measured on bearings, bearing pedestals, or housings of industrial machines when measurements are made in-situ, and

b) the severity of radial shaft vibration on coupled industrial machines.

Evaluation criteria, based on previous experience, are given for use as guidelines for assessing the vibratory conditions of such machines. One criterion considers the magnitude of the observed broad-band vibration; the second considers the changes in the magnitude of the observed broad-band vibration. It should be recognized, however, that these criteria do not form the only basis for judging the severity of vibration.

Mechanical vibration — Measurement and evaluation of machine vibration —

Part 3: Industrial machinery with a power rating above 15 kW and operating speeds between 120 r/min and 30 000 r/min

1 Scope

This document specifies the general requirements for evaluating the vibration of various coupled industrial machine types with a power above 15 kW and operating speeds between 120 r/min and 30 000 r/min when measurements are made in-situ. Guidelines for applying evaluation criteria are provided for measurements taken on non-rotating and rotating parts under normal operating conditions. The guidelines are presented in terms of both steady running vibration values and in terms of changes to vibration magnitude, which can occur in these steady values. The numerical values presented are intended to serve as guidelines based on worldwide machine experience, but shall be applied with due regard to specific machine features which can cause these values to be inappropriate. In general, the condition of a machine is assessed by consideration of both the shaft vibration and the associated structural vibration, as well as specific frequency components, which do not always relate to the broadband severity values presented.

The machine types covered by this document include:

a) steam turbines and generators with outputs less than or equal to 40 MW (see Note 1 and Note 2);

b) steam turbines and generators with outputs greater than 40 MW which normally operate at speeds other than 1 500 r/min, 1 800 r/min, 3 000 r/min or 3 600 r/min (although generators seldom fall into this category) (see Note 1);

c) rotary compressors;

d) industrial gas turbines with outputs less than or equal to 3 MW (see Note 2);

e) turbofans;

f) electric motors of any type, if the coupling is flexible. When a motor is rigidly coupled to a machine type covered by any other part of ISO 20816, the motor may be assessed either against that other part or against ISO 20816-3;

g) rolls and mills;

h) conveyors;

i) variable speed couplings; and

j) blowers or fans (see Note 3).

NOTE 1 Land based steam turbines, gas turbines and generators of greater than 40 MW capacity, which run at 1 500 r/min, 1 800 r/min, 3 000 r/min or 3 600 r/min are covered by the requirements of ISO 20816-2. Generators in hydro-electric plants are covered by ISO 20816-5.

NOTE 2 Gas turbines of power greater than 3 MW are covered by ISO 20816-4.

NOTE 3 The vibration criteria presented in this document are generally only applicable to fans with power ratings greater than 300 kW or fans which are not flexibly supported. As and when circumstances permit, recommendations for other types of fans, including those of lightweight sheet-metal construction, will be prepared. Until these recommendations are available, classifications can be agreed between the manufacturer and the customer; using results of previous operational experience (see also ISO 14694).

Machinery including a geared stage can fall under the scope of this document. For performing acceptance tests of gearboxes please refer to ISO 20816-9.

The following types of industrial machine are not covered by this document:

k) land-based gas turbines, steam turbines and generators with power outputs greater than 40 MW and speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min or 3 600 r/min (see ISO 20816-2);

l) gas turbine sets with power outputs greater than 3 MW (see ISO 20816-4);

m) machine sets in hydraulic power generating and pumping plants (see ISO 20816-5);

n) reciprocating machines and machines solidly coupled to reciprocating machines (see ISO 10816-6);

o) rotordynamic pumps and any integrated or solidly coupled electric motors where the impeller is mounted directly on the motor shaft or is rigidly attached to it (see ISO 10816-7);

p) reciprocating compressor systems (see ISO 20816-8);

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

r) submerged motor-pumps; and

s) wind turbines (see ISO 10816-21).

The requirements of this document apply to in-situ broad-band vibration measurements taken on the shafts, bearings, bearing pedestals, or housings of machines under steady-state operating conditions within their nominal operating speed range. The requirements relate to both acceptance testing and operational monitoring. The evaluation criteria included in this document can be applied to both continuous and non-continuous monitoring situations.

The requirements of this document cover machines which can have gears or rolling element bearings, but do not address the diagnostic evaluation of the condition of those gears or bearings.

The requirements in this document are applicable only for the vibration produced by the machine set itself and not for vibration that is transmitted to the machine set from external sources.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

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

ISO 10817-1, *Rotating shaft vibration measuring systems — Part 1: Relative and absolute sensing of radial vibration*

ISO 20816-1, *Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041 apply. It provides a range of vocabulary and definitions specific to mechanical vibration, shock and condition monitoring used in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Measurement procedures

4.1 General

The measurement procedures to be followed and the instrumentation which shall be used are specified in ISO 20816-1, subject to the recommendations given in this clause.

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

a) temperature variations;

b) magnetic fields, including magnetisation of the shaft;

c) sound fields;

d) power source variations;

e) transducer cable length (some designs of shaft vibration probe require matched cable lengths);

f) transducer cable faults;

g) transducer orientation.

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

4.2 Measurement location

It is common practice to measure vibration on non-rotating parts, or rotating parts (shaft relative vibration), or both. Unless stated otherwise, this document refers to shaft relative vibration when referring to displacement measurements taken on rotating parts. On rotating parts, measurement methods using non-contacting transducers are most commonly used and are preferred. The transducers are usually mounted as an orthogonal pair so that an orbit can be visualised. In some machines it is not possible to access the shaft directly adjacent to the bearing. Ensure that measurements reasonably represent the shaft vibration at the bearing and do not include any amplification due to local resonances of the supporting bracket, or due to a non-homogeneous shaft surface. See ISO 10817-1 for further details of instrumentation for radial vibration measurement on rotating parts.

Measurements taken on non-rotating parts shall be taken on the bearings, bearing support housing or other structural parts which significantly respond to the dynamic forces transmitted from the rotating elements at the bearing locations and characterize the overall vibration of the machine. In some machines it is not possible to access the bearing housings directly. In such cases, 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. Thin or otherwise flexible surfaces, such as fan covers or cowlings, should be avoided. It can be necessary to confirm the repeatability and validity of such measurement locations (e.g. by taking measurements at several locations and comparing the results).

The chosen locations and directions of vibration measurements shall be such, that they provide adequate sensitivity to the machine dynamic forces. Typically, this requires two orthogonal radial measurement locations on each bearing cap or pedestal. The transducers may be placed at any angular position on the bearing housings or pedestals. Vertical and transverse directions are usually preferred for horizontally mounted machines. For vertical or inclined machines, the location that gives the maximum vibration reading shall be one of those used. In some cases, it is also recommended to measure in the axial direction (see 6.2.1). The specific measurement locations and directions used shall be recorded along with the measurement result.

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 severity of the machine vibration. However, caution shall be exercised when evaluating vibration from a single transducer at a measurement plane, since it may not provide a reasonable approximation to the maximum value at that plane.

Figures showing recommended measurement positions for both shaft vibration and housing vibration can be found in ISO 20816-1, which are reproduced in Figure 1 to Figure 6 for convenience.

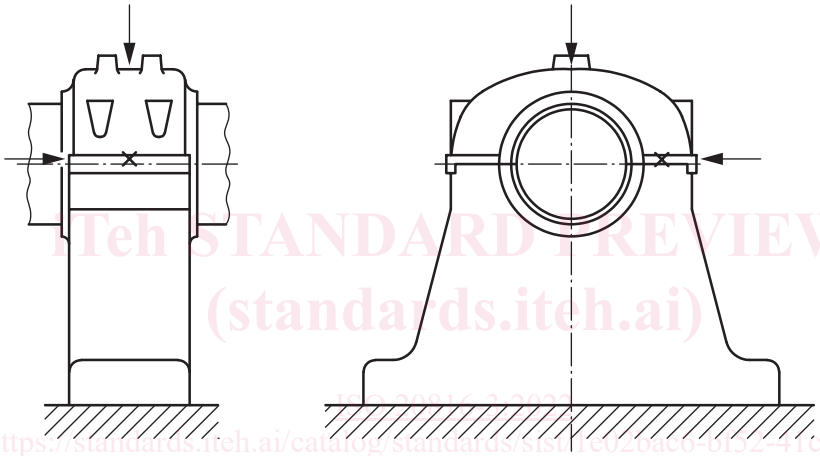


Figure 1 — Measuring points for pedestal bearings

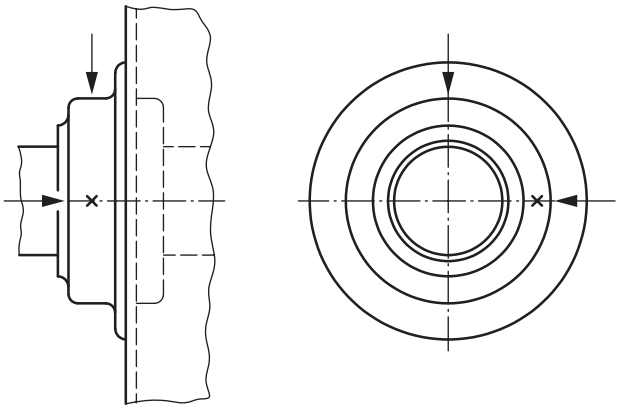


Figure 2 — Measuring points for housing-type bearings

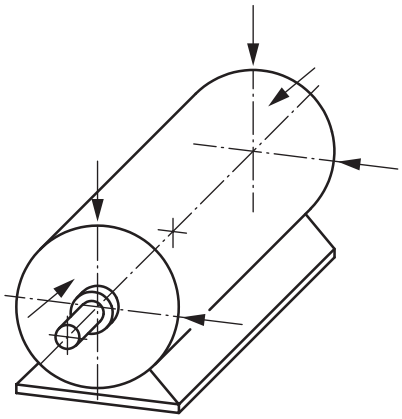


Figure 3 — Measuring points for small electrical machines

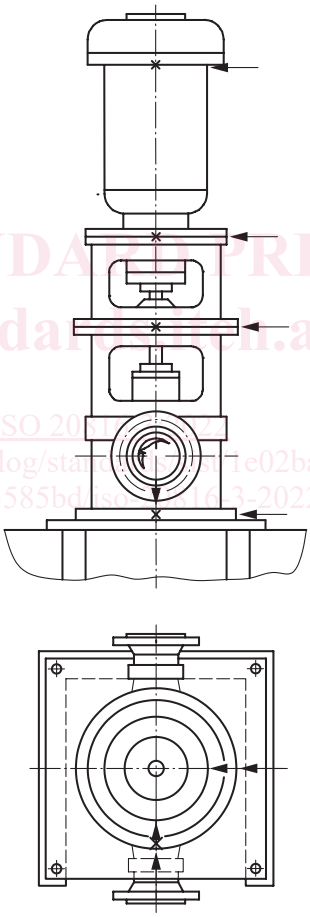
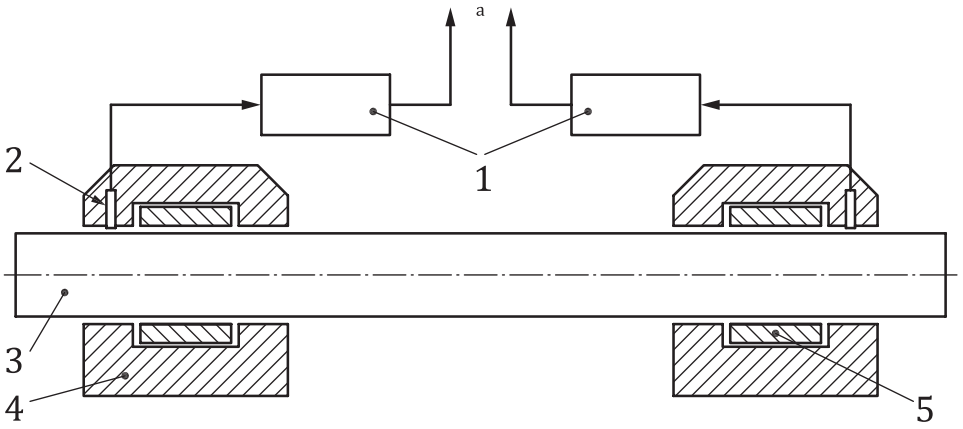


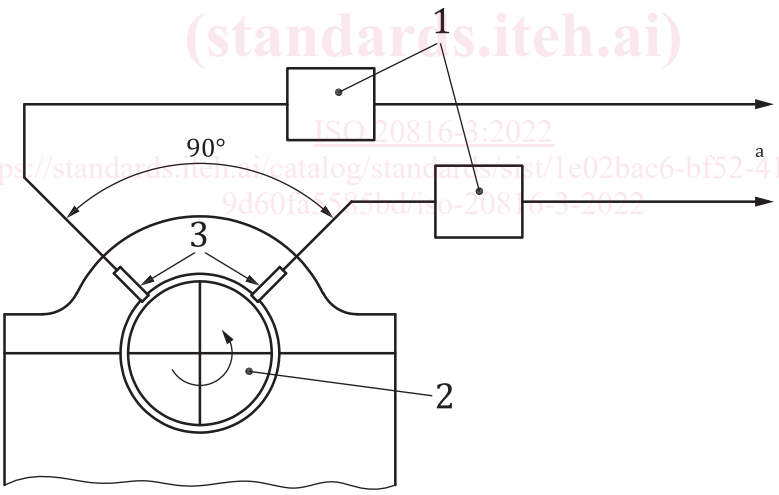
Figure 4 — Measuring points for vertical machine sets



Key

1 signal conditioning units
2 non-contacting transducers
3 shaft
4 bearing housings
5 bearings
a To signal processing.

Figure 5 — Measuring points for measurements on rotating shafts



Key

1 signal conditioning units
2 shaft
3 non-contacting transducers
a To signal processing.

Figure 6 — Mounting of non-contacting probes for the measurement of shaft relative vibration

4.3 Measurement equipment

For monitoring purposes, the equipment used shall be capable of measuring broad-band root-mean-square (r.m.s.) vibration with flat response over a frequency range of at least 10 Hz to 1 000 Hz. 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.