

INTERNATIONAL STANDARD

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

Part 1: General guidelines

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

Partie 1: Directives générales



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 10816-1 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*.

This first edition of ISO 10816-1 cancels and replaces ISO 2372:1974 and ISO 3945:1985, which have been technically revised.

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 15000 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*

Annexes A, B, C, D, E and F of this part of ISO 10816 are for information only.

Introduction

This part of ISO 10816 is a basic document which establishes general guidelines for the measurement and evaluation of mechanical vibration of machinery, as measured on the non-rotating (and, where applicable, non-reciprocating) parts of complete machines, such as bearing housings. Recommendations for measurements and evaluation criteria pertaining to specific machine types are provided in additional parts of ISO 10816.

For many machines, measurements made on non-rotating parts are sufficient to characterize adequately their running conditions with respect to trouble-free operation. However, there are some machines, such as those containing flexible rotors, for which measurements on non-rotating parts may not be totally adequate. In such cases, it may be necessary to monitor the machine using measurements on both the rotating and non-rotating parts, or on the rotating parts alone. For such machines, the guidelines presented in this part of ISO 10816 are complemented by those given for shaft vibration in ISO 7919-1. If the procedures of both standards are applicable, the one which is more restrictive generally applies.

Vibration measurements can be used for a number of purposes including routine operational monitoring, acceptance tests and diagnostic and analytical investigations. This part of ISO 10816 is designed to provide guidelines for operational monitoring and acceptance tests only.

Three primary measurement parameters (displacement, velocity and acceleration) are defined and their limitations given. Adherence to the guidelines presented should, in most cases, ensure satisfactory service performance.

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

Part 1: General guidelines

1 Scope

This part of ISO 10816 establishes general conditions and procedures for the measurement and evaluation of vibration using measurements made on non-rotating and, where applicable, non-reciprocating parts of complete machines. The general evaluation criteria, which are presented in terms of both vibration magnitude and change of vibration, relate to both operational monitoring and acceptance testing. They have been provided primarily with regard to securing reliable, safe, long-term operation of the machine, while minimizing adverse effects on associated equipment. Guidelines are also presented for setting operational limits.

The evaluation criteria relate only to the vibration produced by the machine itself and not to vibration transmitted to it from outside.

This part of ISO 10816 does not include any consideration of torsional vibration.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 10816. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and

ISO maintain registers of currently valid International Standards.

ISO 7919-1:—¹⁾, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 1: General guidelines*.

3 Measurements

This clause describes the measurements, procedures and operating conditions recommended for assessing machine vibration. The guidelines given will permit the evaluation of vibration in accordance with the general criteria and principles given in clause 5.

3.1 Measurement parameters

3.1.1 Frequency range

The measurement of vibration shall be broad band, so that the frequency spectrum of the machine is adequately covered.

The frequency range will depend on the type of machine being considered (e.g. the frequency range necessary to assess the integrity of rolling element bearings should include frequencies higher than those on machines with fluid-film bearings only).

Guidelines for instrumentation frequency ranges for specific machine classes will be given in the appropriate parts of ISO 10816.

1) To be published. (Revision of ISO 7919-1:1986)

NOTE 1 In the past, vibration severity was often related to broad-band vibration velocity [mm/s (r.m.s.)] in the range 10 Hz to 1 000 Hz. However, different frequency ranges and measurement quantities may apply for different machine types.

3.1.2 Measurement quantity

For the purposes of this part of ISO 10816, the following can be used:

- a) vibration displacement, measured in micrometres;
- b) vibration velocity, measured in millimetres per second;
- c) vibration acceleration, measured in metres per square second.

The use, application and limitations of these quantities are discussed further in clause 5.

Generally, there is no simple relationship between broad-band acceleration, velocity and displacement; nor is there between-peak (0-p), peak to peak (p-p), root mean square (r.m.s.) and average values of vibration. The reasons for this are briefly discussed in annex A, which also defines some precise relationships between the above quantities when the harmonic content of the vibration waveform is known.

In order to avoid confusion and to ensure correct interpretation, it is important at all times to identify clearly the measurement units [e.g. μm (p-p), mm/s (r.m.s.)].

3.1.3 Vibration magnitude

The result of measurements made with an instrument which complies with the requirements of clause 4 is called the vibration magnitude at a specific measuring position and direction.

It is common practice, based on experience, when evaluating broad-band vibration of rotating machinery to consider the r.m.s. value of vibration velocity, since this can be related to the vibration energy. However, other quantities such as displacement or acceleration and peak values instead of r.m.s. values may be preferred. In this case, alternative criteria are required which are not necessarily simply related to criteria based on r.m.s. values.

3.1.4 Vibration severity

Normally measurements are made at various measuring positions and in two or three measuring di-

rections, leading to a set of different vibration magnitude values. The maximum broad-band magnitude value measured under agreed machine support and operating conditions is defined as the vibration severity.

For most machine types, one value of vibration severity will characterize the vibratory state of that machine. However, for some machines this approach may be inadequate and the vibration severity should then be assessed independently for measurement positions at a number of locations.

3.2 Measuring positions

Measurements should be taken on the bearings, bearing support housing, or other structural parts which significantly respond to the dynamic forces and characterize the overall vibration of the machine. Typical measurement locations are shown in figures 1 to 5.

To define the vibrational behaviour at each measuring position, it is necessary to take measurements in three mutually perpendicular directions. The full complement of measurements represented in figures 1 to 5 is generally only required for acceptance testing. The requirement for operational monitoring is usually met by performing one or both measurements in the radial direction (i.e. normally in the horizontal-transverse and/or vertical directions). These can be supplemented by a measurement of axial vibration. The latter is normally of prime significance at thrust bearing locations where direct axial dynamic forces are transmitted.

Detailed recommendations for specific machine types are provided in the additional parts of ISO 10816.

3.3 Machine support structure for acceptance testing

3.3.1 *In situ* tests

When acceptance tests are carried out *in situ*, the support structure shall be that supplied for the machine. In this case it is important to ensure that all the major components of the machine and structure are installed when testing is carried out.

It should be noted that valid comparisons of vibration for machines of the same type but on different foundations or sub-foundations can only be made if the foundations concerned have similar dynamic characteristics.

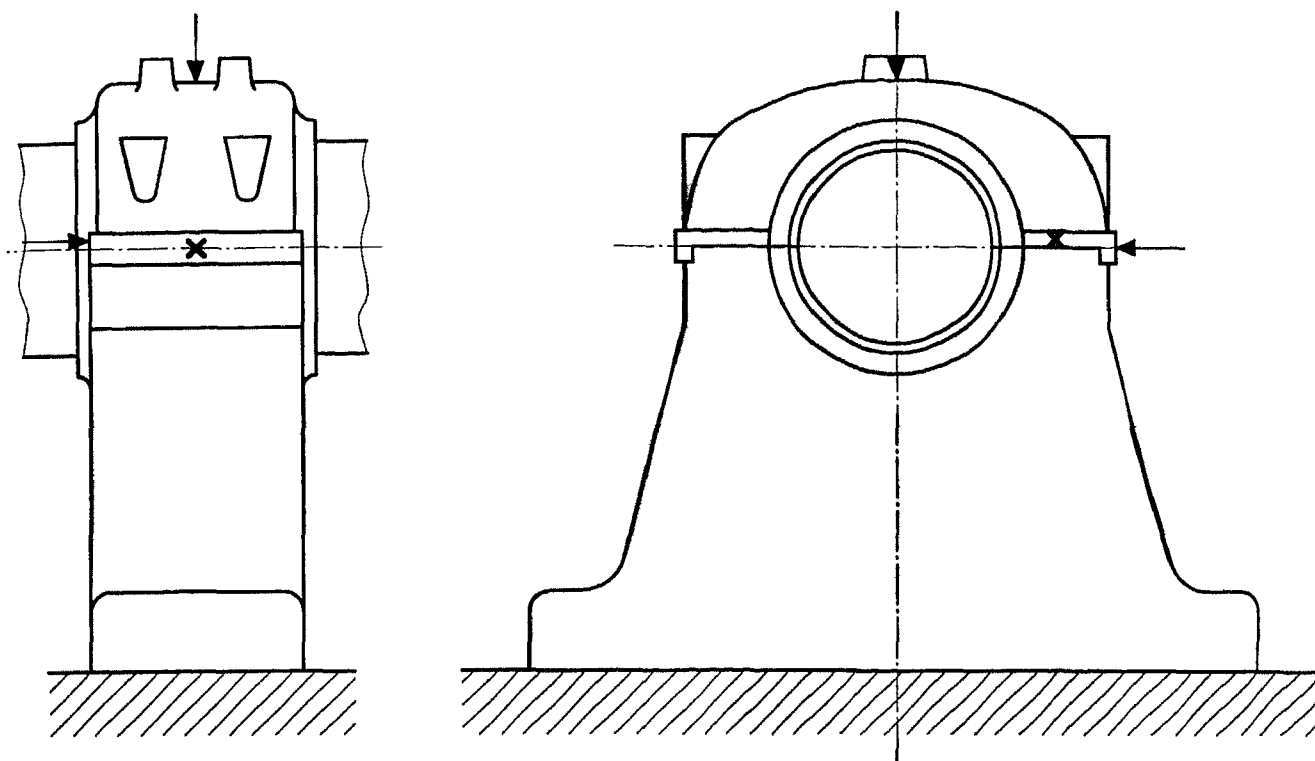


Figure 1 — Measuring points for pedestal bearings

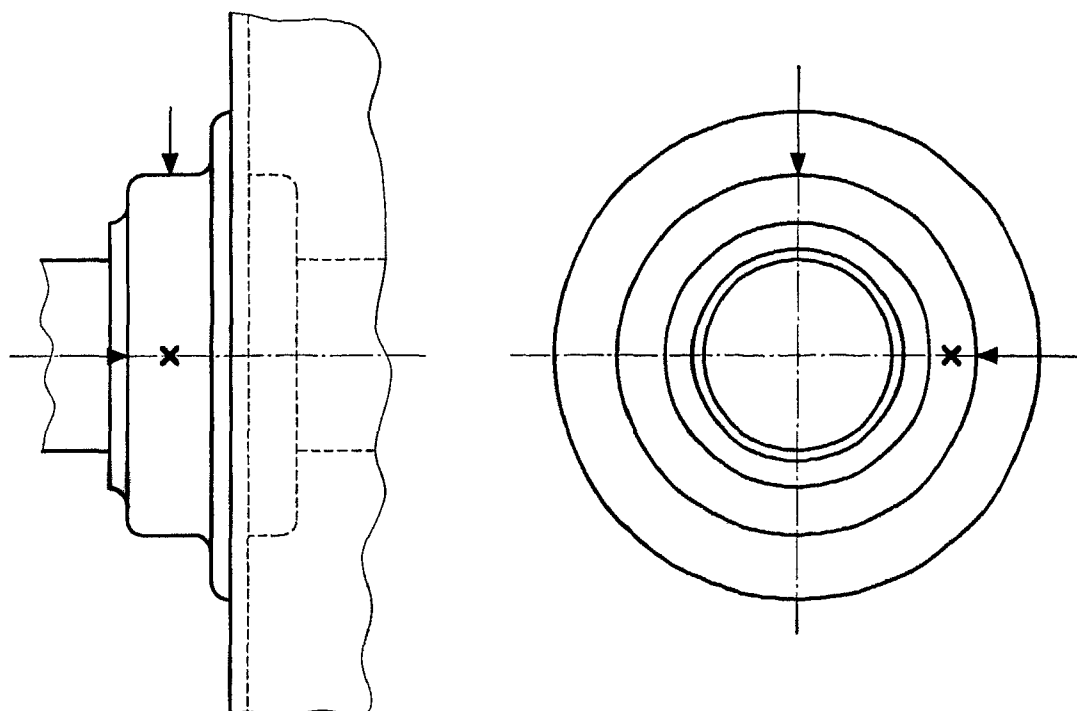


Figure 2 — Measuring points for housing-type bearings

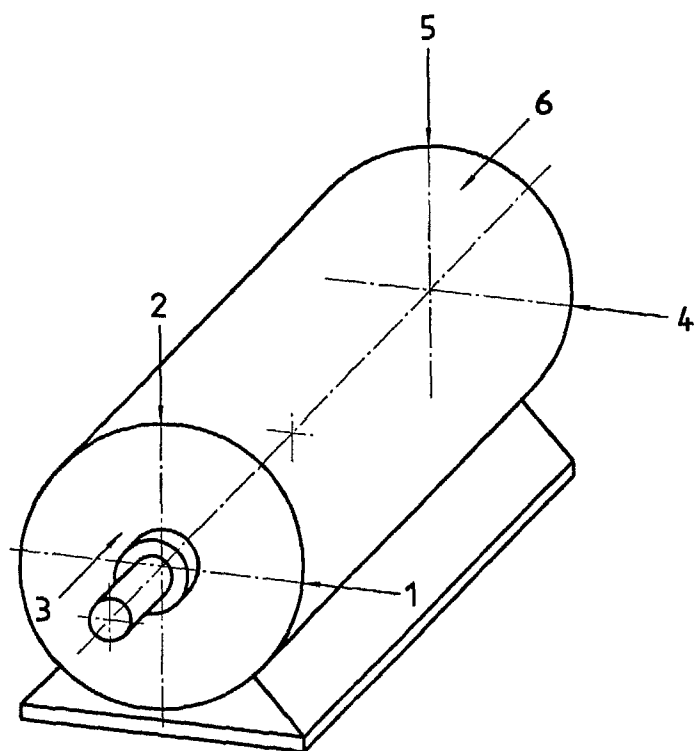


Figure 3 — Measuring points for small electrical machines

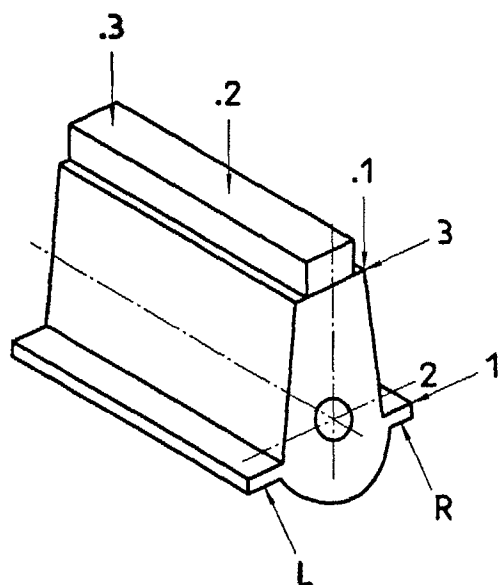


Figure 4 — Measuring points for reciprocating engines