

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

Part 1: General guidelines

ICS 17.160

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National foreword

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The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by **A1** **A1**.

The UK participation in its preparation was entrusted by Technical Committee GME/21, Mechanical vibration, shock and condition monitoring, to Subcommittee GME/21/5, Vibration of machines.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Measurements	1
4 Instrumentation	6
5 Evaluation criteria	6
Annex A (informative) Vibratory waveform relationships	11
Annex B (informative) Informative guidelines for setting zone boundary limits	13
Annex C (informative) General guidelines for specification of criteria	14
Annex D (informative) Vector analysis of change in vibration	14
Annex E (informative) Specialist measurement and analysis techniques for detection of problems in rolling-element bearings	17
Bibliography	19
Figure 1 — Measuring points for pedestal bearings	3
Figure 2 — Measuring points for housing-type bearings	3
Figure 3 — Measuring points for small electrical machines	4
Figure 4 — Measuring points for reciprocating engines	4
Figure 5 — Measuring points for vertical machine sets	5
Figure 6 — General form of vibration velocity acceptance criteria	8
Figure A.1 — Relationship between acceleration, velocity and displacement for single-frequency harmonic components	12
Figure D.1 — Comparison of vector change and change in magnitude for a discrete frequency component	16
Table B.1 — Typical zone boundary limits	13
List of references	Inside back cover

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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.

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

[A1] 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 7919-1, *Mechanical vibration of non-reciprocating machines — Measurements on rotating shafts and evaluation criteria — Part 1: General guidelines* **[A1]**

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.

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;

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

- 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 directions, 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 Figure 1 to Figure 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 Figure 1 to Figure 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.

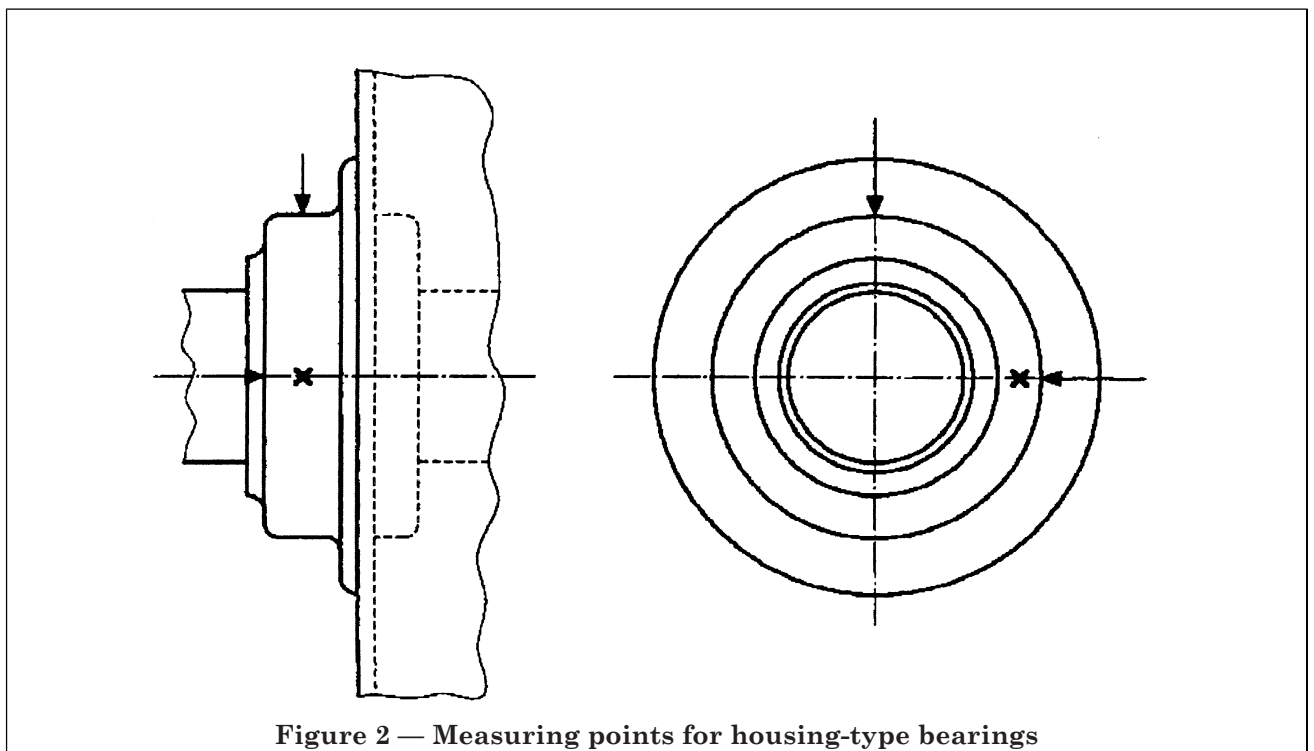
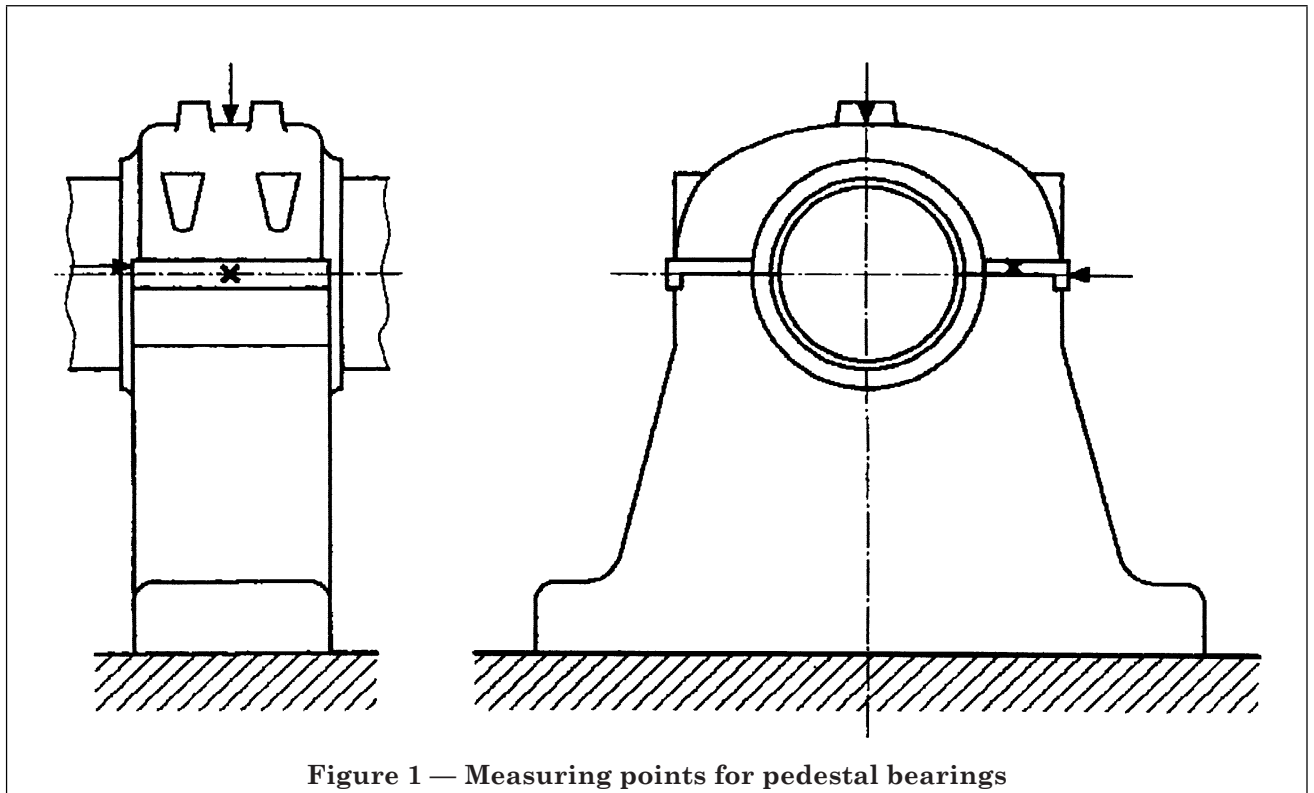
Detailed recommendations for specific machine types are provided in the additional parts of ISO 10816.

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.



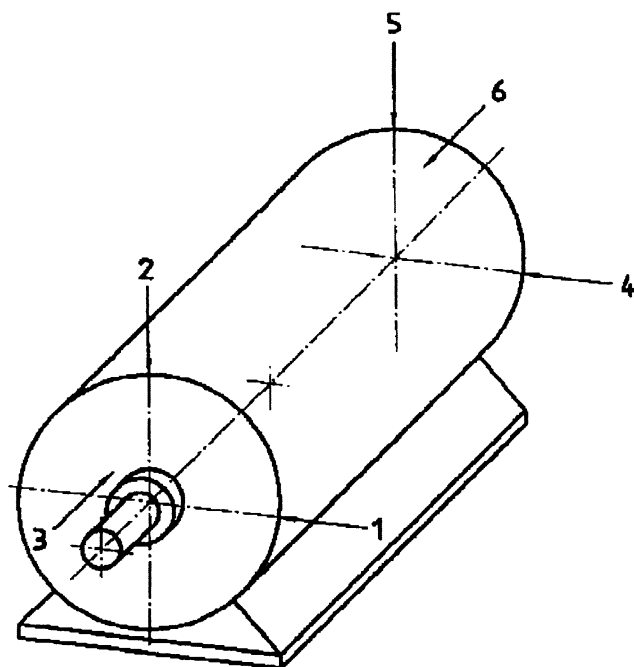


Figure 3 — Measuring points for small electrical machines

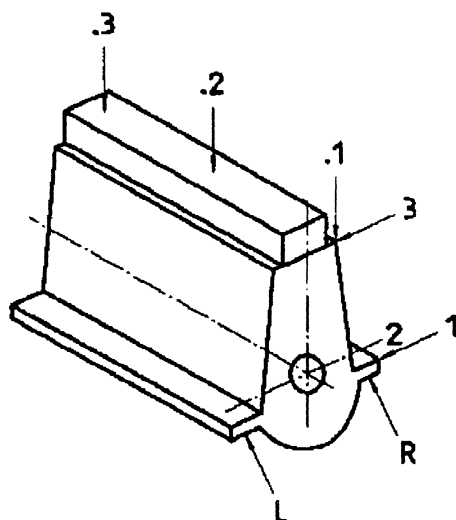


Figure 4 — Measuring points for reciprocating engines