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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Mechanical vibration of certain rotating electrical machinery with shaft heights between 80 and 400 mm — Measurement and evaluation of the vibration severity

Vibrations mécaniques de certaines machines électriques tournantes, de hauteur d'axe comprise entre 80 *et* 400 mm — *Mesurage et évaluation de l'intensité vibratoire*

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2373 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock,* in collaboration with IEC/TC 2, *Rotating machinery.*

This second edition cancels and replaces the first edition (ISO 2373 : 1974), sub-clause 7.1 of which has been technically revised.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Mechanical vibration of certain rotating electrical machinery with shaft heights between 80 and 400 mm — Measurement and evaluation of the vibration severity

0 Introduction

Vibrations in rotating electrical machinery are caused by

— unbalance in the rotating masses;

— slight deformations in the frame or bed of the machine caused by certain magnetic attraction between the stator and rotor;

— the rolling bearings;

— aerodynamic loads and some secondary effects, such as instability of the shaft in the bearings, passive resistance, asymmetric expansion, etc.

In spite of the accurate balancing that can be obtained with dynamic balancing machines, residual unbalance generally proves to be the main cause of once-per-revolution vibrations found in a machine.

The measurement of vibration is closely linked to the mounting of the machine and it is usually desirable to carry out vibration measurements under actual installation and operating conditions. However, in order to estimate the quality as far as balance and vibrations of rotating electrical machines are concerned, it is necessary to take measurements on the machine alone under properly determined test conditions which permit reproducible tests to be carried out and provide comparable measurements.

The annex is given for guidance only and does not form an integral part of this International Standard.

1 Scope

This International Standard specifies the test and measurement conditions, and provides guidance on the limits for the level of vibration severity, to enable the quality of a machine to be estimated as far as vibration is concerned.

2 Field of application

This International Standard applies to three-phase a.c.-machines and to d.c.-machines with shaft heights between 80 and 400 mm.

It does not apply to motor convertors, single-phase machines or three-phase machines operated on single-phase systems.

3 Reference

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

4 Measurement quantity

The criterion adopted for vibration severity is the r.m.s.-value of the vibration-velocity in millimetres per second. The greatest value, determined at the stipulated measuring points (see 7.3), characterizes the vibration severity of the machine.

NOTE — Recommended maximum limits of vibration severity are given in the annex for guidance.

5 Measuring equipment[1)]

The equipment to be used shall have an electrical instrument with a true r.m.s. rectification characteristic, permitting reading of the r.m.s.-value of vibration velocity. The instrument-system shall have a frequency range from 10 to 1 000 Hz with an overall frequency characteristic conforming to figure 1 and a measuring accuracy of at least ± 10 % of the indicated value.

The transverse sensitivity of the vibration pick-up shall be less than 10 % of the sensitivity in the normal measuring direction.

NOTE — There are certain instruments, operating mainly on mechanical principles,

— for measuring the vibration displacement,

— for measuring the vibration acceleration,

which also enable the vibration severity of the machine to be estimated. However, correspondence between vibration displacement, acceleration and velocity can only be precisely determined in the case of sinusoidal vibration.

In order to eliminate differences in estimation and to permit effective and sufficiently accurate comparison of measurement, the only instruments to be used should be those conforming to the specifications given in this clause.

1) See ISO 2954.

6 Machine mounting

In order to ensure reproducible tests and comparable measurements, the machine shall be installed in a state of "free suspension". This condition is achieved by suspending the machine on a spring or by mounting on an elastic support (springs, rubber, etc.).

The natural oscillation frequency of the suspension system and motor, in the six possible degrees of freedom, shall be lower than a quarter of the frequency corresponding to the slowest rotational speed of the machine being tested.

The effective mass of the elastic support shall not be greater than 1/10 of that of the motor so as to reduce the influence of the mass and the moments of inertia of these parts on the vibration level.

7 Conditions of measurement

7.1 Key

If a keyway is used, it shall be filled during rotor balancing with a contoured half-key profiled to conform with the parting line between the fitment and shaft.

NOTE — A full length rectangular key of half-height or a half-length key of full height, which should be centred axially in the keyway, are acceptable as practical alternatives provided that their unbalanced variance from the specified contoured key remains insignificant.

7.2 Vibration pick-up

Care shall be taken to ensure that the contact between the pick-up and the machine surface is as specified by the manufacturer of the pick-up and does not disturb the vibratory condition of the machine being tested. The most important point is to ensure that the pressure and mass of the pick-up have no significant influence on the vibratory state of the machine. In all cases, the total coupled mass of the pick-up assembly shall be less than 1/50 of the mass of the machine.

7.3 Measuring points

Measurements shall be made on the bearings, in the vicinity of the shaft, in three perpendicular directions, the machine operating only in the position it occupies under normal conditions (with the shaft horizontal or vertical) as indicated in figure 2.

7.4 Operating conditions

The motors shall be fed at rated voltage and nominal frequency (for alternating current) and vibration measurement shall be carried out at nominal speed. For machines with several speeds or variable speeds, the test shall be carried out at the various operational speeds.

In the absence of instructions to the contrary, measurement of the vibration severity shall be carried out under no load operation at the temperature reached by the motor after a sufficient period of no load operation.

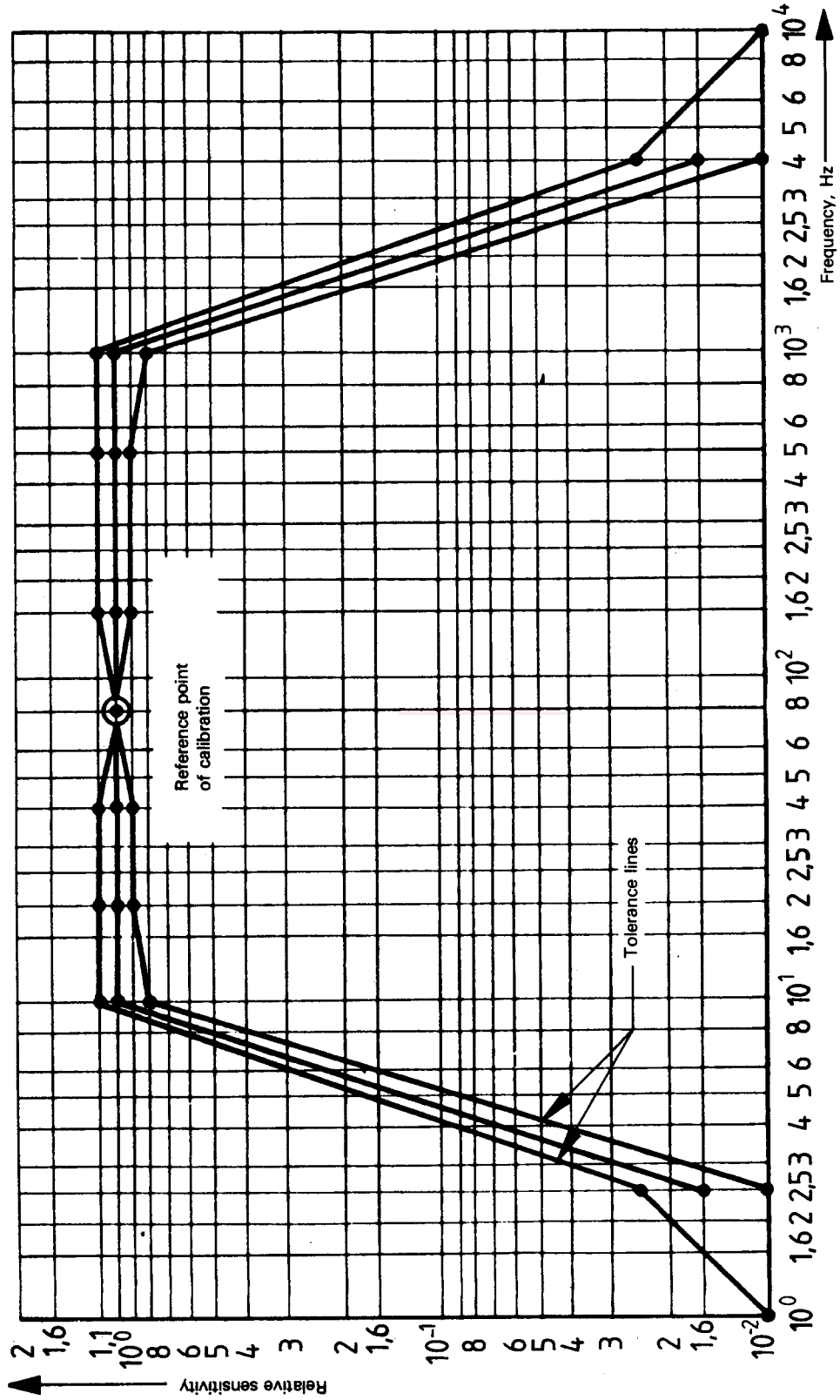

Figure 1 — Sensitivity-frequency characteristic for the vibration measuring system

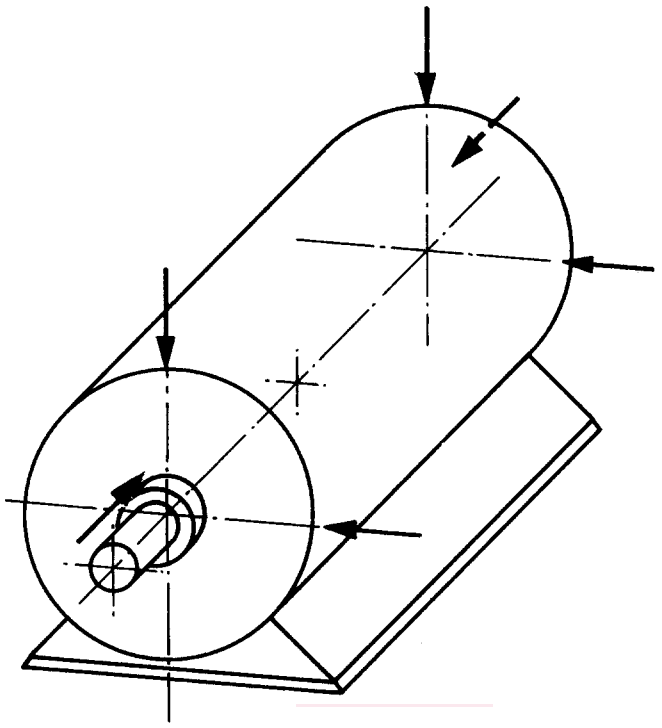

Figure 2 — Measuring points

Annex

Recommended maximum limits of vibration severity

(This annex does not form an integral part of the standard.)

The table gives the recommended limits of vibration severity, expressed in millimetres per second and inches per second, for the various standard shaft heights and for three quality grades, which are called "N" (normal), "R" (reduced) and "S" (special).

NOTES

1 Manufacturer and purchaser should take into account that measured values can have a deviation from the true values of ± 10 %.

2 Provided that no other agreements are reached, the recommended limits of quality grade "N" apply to normal electrical machines.

3 For machines requiring better quality grades than those given in the table, these grades should be related to grade "S" by dividing its limits by 1,6 or a multiple thereof. Because of their special nature, the arrangements to be made for installing machines of this quality grade should be the subject of prior agreement between manufacturer and user.

4 A machine which is well balanced in itself and of a quality conforming with the table, may exhibit large vibrations in normal service arising from various causes, such as unsuitable foundations, reaction of the driven machine, etc. Vibration may also be caused by driving elements with a natural oscillation frequency very close to that due to the small residual unbalance of the rotating mass of the machine. In such cases, checks should be carried out not only on the machine, but also on each element of the installation.

Table — Recommended limits of vibration severity

Quality grade	Speed n	Maximum r.m.s.-values* of the vibration velocity for the shaft height, H, in mm					
		$80 < H < 132$		$132 < H < 225$		$225 < H < 400$	
	r/min	mm/s	in/s	mm/s	in/s	mm/s	in/s
N (normal)	$600 < n < 3\,600$	1,8	0.071	2,8	0.110	4,5	0.177
R (reduced)	$600 < n < 1\,800$	0,71	0.028	1,12	0.044	1,8	0.071
	$1\,800 < n < 3\,600$	1,12	0.044	1,8	0.071	2,8	0.110
S (special)	$600 < n < 1\,800$	0,45	0.018	0,71	0.028	1,12	0.044
	$1\,800 < n < 3\,600$	0,71	0.028	1,12	0.044	1,8	0.071

* A single set of values, e.g. those applicable to the 132 to 225 mm shaft height, may be used if shown by experience to be required.