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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

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

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FOREWORD

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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.

International Standard ISO 2373 was drawn up by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, and circulated to the Member Bodies in June 1971.

It has been approved by the Member Bodies of the following countries :

Austria	Ireland	South Africa, Rep. of
Belgium	Japan	Sweden
Egypt, Arab Rep. of	Netherlands	Switzerland
France	New Zealand	U.S.A.
Germany	Poland	U.S.S.R.

The Member Body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

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

1 SCOPE

This International Standard specifies the test and measurement conditions and provides guidance on the limits for the level of vibration severity which enables 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*.¹⁾

4 MEASUREMENT QUANTITY

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

5 MEASURING EQUIPMENT²⁾

The equipment to be used shall have an electrical instrument with a true rms rectification characteristic, permitting reading of the rms-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 $\pm 10\%$ of the indicated value.

1) At present at the stage of draft.

2) See ISO 2954.

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.

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

6 MACHINE MOUNTING

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 under test.

The effective mass of the elastic support shall not be greater than 1/10 of that of the motor, 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

The end of the shaft shall have a full key of normal shape and length, unless otherwise specified. The key shall be the same as that used for balancing the rotor in all cases.

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 under test. 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 neighbourhood of the shaft, in three perpendicular directions, the machine operating only in the position it occupies under normal conditions (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.

ANNEX

RECOMMENDED MAXIMUM LIMITS OF VIBRATION SEVERITY

(For guidance purposes only)

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 shall take into account that measured values can have a deviation from the true values of $\pm 10\%$.

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

3 For machines requiring better quality grades than given in the table, these grades shall be related to grade "S" by dividing its limits by 1,6 or a multiple. Because of their special nature, the arrangements to be made for installing machines of this quality grade shall 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, checking must be carried out not only on the machine, but also on each element of the installation.

TABLE – Recommended limits of vibration severity (for guidance purposes only)

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

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

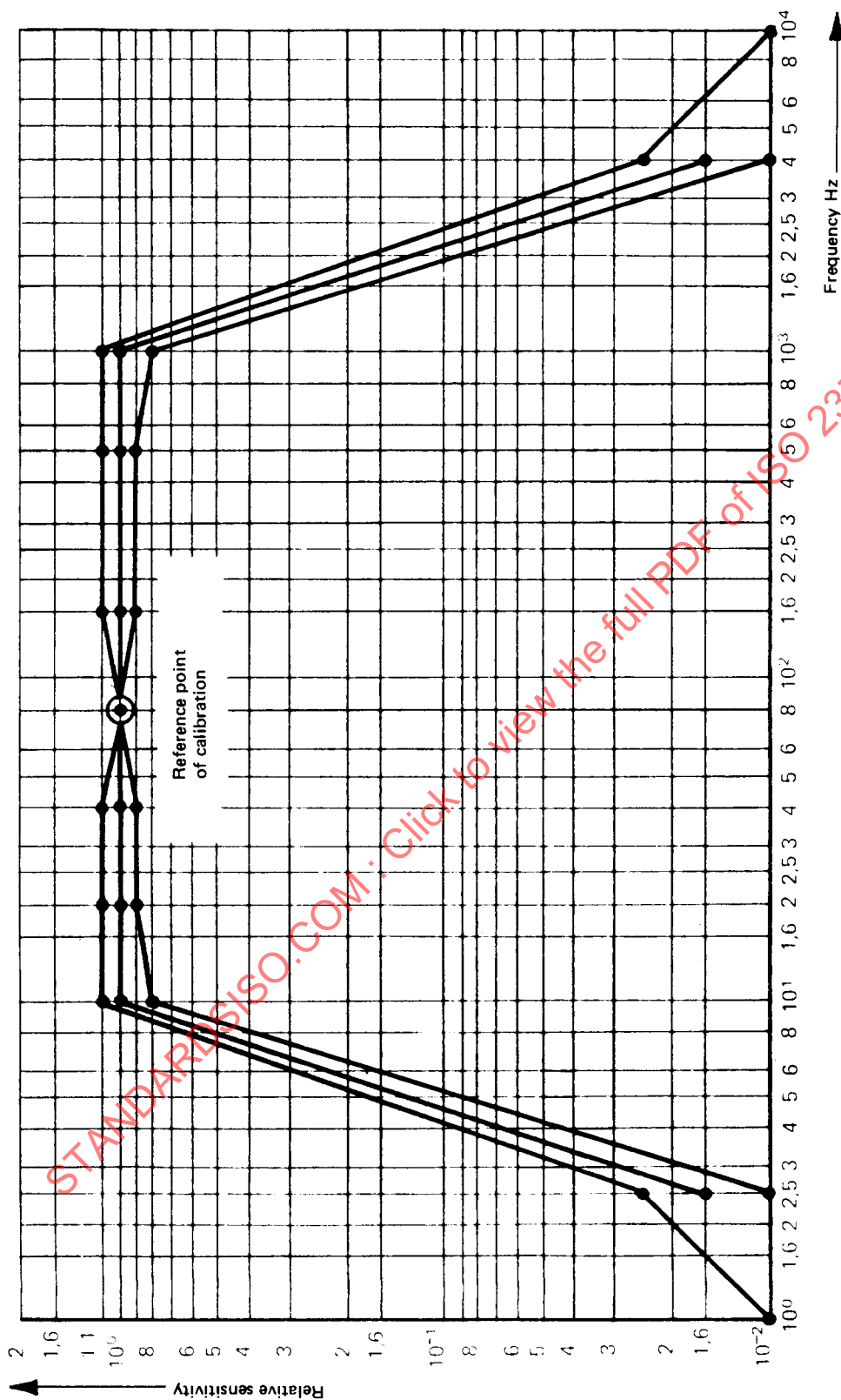


FIGURE 1 — Sensitivity — frequency characteristic for the vibration measuring system