

Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings —

Part 2: Evaluation of vibration

ICS 17.160

National foreword

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The UK participation in its preparation was entrusted by Technical Committee GME/21, Mechanical vibration and shock, to Subcommittee GME/21/5, Vibration of machines, which has the responsibility to:

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Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings —

Part 2: Evaluation of vibration

*Vibrations mécaniques — Vibrations de machines rotatives équipées de
paliers magnétiques actifs —*

Partie 2: Évaluation des vibrations



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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.

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The main task of technical committees is to prepare International Standards. 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.

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.

ISO 14839-2 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*.

ISO 14839 consists of the following parts, under the general title *Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings*:

- *Part 1: Vocabulary*
- *Part 2: Evaluation of vibration*

The following part is under preparation:

- *Part 3: Evaluation of stability margin.*

Introduction

This part of ISO 14839 concerns steady-state values of rotor vibrations and the AMB coil currents and voltage measured during nominal steady-state operation, but not the transient condition while passing critical speeds. The regulations of these transient vibrations passing at the critical speeds are established in ISO 10814 in which the modal sensitivity, the so-called amplification factor (Q-factor), is then evaluated. This topic is beyond the scope of this part of ISO 14839.

Because of the stiff support of oil-film bearings with small clearances [e.g. bearing radial clearance (C) divided by the journal radius (R), $C/R \approx 0,001$], shaft vibration should be regulated within low levels to avoid oil-film rupture of the lubricant and metal contact inside the bearing. In contrast, the relatively soft support of AMBs and correspondingly large clearances (e.g. $C/R \approx 0,005$), a larger vibration level is often observed in AMB rotors, but is quite normal and acceptable. The lower stiffness introduces no major problems in the transmission force to the machine foundation. Compared to the oil-film bearing rotor standards (see the ISO 7919-1 series), this part of ISO 14839 provides greater values of zone limits for vibration assessment and acceptance.

Mechanical vibration — Vibration of rotating machinery equipped with active magnetic bearings —

Part 2: Evaluation of vibration

1 Scope

This part of ISO 14839 sets out general guidelines for measuring and evaluating rotating machinery equipped with active magnetic bearings (AMBs) with respect to the following two indices:

- shaft vibratory displacement measured at or close to the AMBs, and
- working current and voltage measured in magnetic coils or power supply amplifiers.

Both indices are measured under nominal operating conditions in house and/or on site. These guidelines are presented in terms of both steady-state running values of these indices and any magnitude changes which may occur in these steady-state operations.

This part of ISO 14839 is applicable to industrial rotating machines generating or consuming nominal power greater than 15 kW, and is not limited by size or operational rated speed (i.e. comprising turbo-compressors, turbo-pumps, steam turbines, turbo-generators, turbo-fans, electric drives and other rotors supported by AMBs). This part of ISO 14839 establishes the vibration, current and voltage evaluation of the rotating machinery equipped with AMBs, specified by a comparatively large power capacity as described above, excluding small-scale rotors such as turbo-molecular pumps, spindles and flywheels.

This part of ISO 14839 covers both AMB-equipped rigid rotors and AMB-equipped flexible rotors.

2 Normative references

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*

3 Measurement and evaluation procedures

3.1 Description of rotor-AMB system

A typical rotor system supported by AMBs is illustrated in Figure 1. An AMB is located at each end of the shaft and includes an adjacent displacement transducer and an emergency (auxiliary) ball bearing. The axial AMB is omitted in this figure. The control network for driving the AMB device is shown in Figure 2. As shown in these figures, each displacement transducer detects the shaft journal position at the bearing locations and its signal is fed back to the controller. Deviation from the bearing centre is delivered to the controller. This controller might, for example, implement a proportional, integral and differential actions (PID) control algorithm. The controller drives the power amplifiers to supply the coil current. If the shaft moves downward, the upper electromagnetic coil is activated to lift the rotor upward by the magnetic force. Since, in this manner, the magnetic force acts