INTERNATIONAL STANDARD

ISO 14839-3

First edition
2006-09-15

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

Part 3: Evaluation of stability margin

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

Partie 3: Évaluation de la marge de stabilité

Reference number
ISO 14839-3:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 14839-3 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*

— Part 3: *Evaluation of stability margin*

Additional parts are currently in preparation.

Introduction

While passive bearings, e.g. ball bearings or oil-film bearings, are essentially stable systems, magnetic bearings are inherently unstable due to the negative stiffness resulting from static magnetic forces. Therefore, a feedback control is required to provide positive stiffness and positive damping so that the active magnetic bearing (AMB) operates in a stable equilibrium to maintain the rotor at a centred position. A combination of electromagnets and a feedback control system is required to constitute an operable AMB system.

In addition to ISO 14839-2 on evaluation of vibration of the AMB rotor systems, evaluation of the stability and its margin is necessary for safe and reliable operation of the AMB rotor system; this evaluation is specified in this part of ISO 14839, the objectives of which are as follows:

a) to provide information on the stability margin for mutual understanding between vendors and users, mechanical engineers and electrical engineers, etc.;

b) to provide an evaluation method for the stability margin that can be useful in simplifying contract concerns, commission and maintenance;

c) to serve and collect industry consensus on the requirements of system stability as a design and operating guide for AMB equipped rotors.

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

Part 3: Evaluation of stability margin

1 Scope

This part of ISO 14839 establishes the stability requirements of rotating machinery equipped with active magnetic bearings (AMB). It specifies a particular index to evaluate the stability margin and delineates the measurement of this index.

It is applicable to industrial rotating machines operating at nominal power greater than 15 kW, and not limited by size or operational rated speed. It covers both rigid AMB rotors and flexible AMB rotors. Small-scale rotors, such as turbo molecular pumps, spindles, etc., are not addressed.

This part of ISO 14839 concerns the system stability measured during normal steady-state operation in-house and/or on-site.

The in-house evaluation is an absolute requirement for shipping of the equipment, while the execution of on-site evaluation depends upon mutual agreement between the purchaser and vendor.

This part of ISO 14839 does not address resonance vibration appearing when passing critical speeds. The regulation of resonance vibration at critical speeds is established in ISO 10814.

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 10814, *Mechanical vibration — Susceptibility and sensitivity of machines to unbalance*

3 Preceding investigation

The AMB rotor should first be evaluated for damping and stability properties for all relevant operating modes. There are two parts to this assessment.

First, the run-up behaviour of the system should be evaluated based on modal sensitivities or amplification factors (Q-factors). This concerns all eigen frequencies that are within the rotational speed range of the rotor. These eigen frequencies are evaluated by the unbalance response curve around critical speeds measured in a rotation test.

When the unbalance vibration response is measured as shown in Figure 1, the sharpness of each vibration peak corresponding to eigen frequencies of the two rigid modes and the first bending mode is evaluated; this is commonly referred to as Q-factor evaluation. These damping (stability) requirements for an AMB system during run-up are covered by ISO 10814 (based on Q-factors), and are not the subject of this part of ISO 14839.