INTERNATIONAL STANDARD

ISO 21940-31

First edition
2013-08-15

Mechanical vibration — Rotor balancing —

Part 31: Susceptibility and sensitivity of machines to unbalance

Vibrations mécaniques — Équilibrage des rotors —
Partie 31: Susceptibilité et sensibilité des machines aux balourds

Reference number
ISO 21940-31:2013(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

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2, www.iso.org/directives.

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received, www.iso.org/patents.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This first edition of ISO 21940-31 cancels and replaces ISO 10814:1996, of which it constitutes a technical revision. The main change is modification to the modal amplification factors to make this part of ISO 21940 more consistent with relevant parts of ISO 7919, e.g. machines predicted to operate in ISO 7919-2[2] zone A would be classified as very low (range A) and machines predicted to operate in ISO 7919-2[2] zone B would be classified as low (range B).

ISO 21940 consists of the following parts, under the general title *Mechanical vibration — Rotor balancing*:

— *Part 1: Introduction*[1)]

— *Part 2: Vocabulary*[2)]

— *Part 11: Procedures and tolerances for rotors with rigid behaviour*[3)]

— *Part 12: Procedures and tolerances for rotors with flexible behaviour*[4)]

— *Part 13: Criteria and safeguards for the in-situ balancing of medium and large rotors*[5)]

— *Part 14: Procedures for assessing balance errors*[6)]

---

1) Revision of ISO 19499:2007, *Mechanical vibration — Balancing — Guidance on the use and application of balancing standards*

2) Revision of ISO 1925:2001, *Mechanical vibration — Balancing — Vocabulary*

3) Revision of ISO 1940-1:2003 + Cor.1:2005, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

4) Revision of ISO 11342:1998 + Cor.1:2000, *Mechanical vibration — Methods and criteria for the mechanical balancing of flexible rotors*

5) Revision of ISO 20806:2009, *Mechanical vibration — Criteria and safeguards for the in-situ balancing of medium and large rotors*

6) Revision of ISO 1940-2:1997, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 2: Balance errors*

— *Part 21: Description and evaluation of balancing machines*[7)]

— *Part 23: Enclosures and other protective measures for the measuring station of balancing machines*[8)]

— *Part 31: Susceptibility and sensitivity of machines to unbalance*[9)]

— *Part 32: Shaft and fitment key convention*[10)]

7) Revision of ISO 2953:1999, *Mechanical vibration — Balancing machines — Description and evaluation*

8) Revision of ISO 7475:2002, *Mechanical vibration — Balancing machines — Enclosures and other protective measures for the measuring station*

9) Revision of ISO 10814:1996, *Mechanical vibration — Susceptibility and sensitivity of machines to unbalance*

10) Revision of ISO 8821:1989, *Mechanical vibration — Balancing — Shaft and fitment key convention*

Introduction

Rotor balancing during manufacture (e.g. as described in ISO 1940-1[1] and ISO 11342[4]) is normally sufficient to attain acceptable in-service vibration magnitudes if other sources of vibration are absent. However, additional balancing during commissioning may become necessary and after commissioning, some machines may require occasional or even frequent rebalancing *in situ*.

If vibration magnitudes are unsatisfactory during commissioning, the reason may be inadequate balancing or assembly errors. Another important cause may be that an assembled machine is especially sensitive to relatively small residual unbalances which are well within normal balance tolerances.

If vibration magnitudes are unsatisfactory, the first step often is an attempt to reduce the vibration by balancing *in situ*. If high vibration magnitudes can be reduced by installing relatively small correction masses, high sensitivity to unbalance is indicated. This can arise, for example, if a resonance rotational speed is close to the normal operating speed and the damping in the system is low.

A sensitive machine which is also highly susceptible to its unbalance changing, may require frequent rebalancing *in situ*. This may be caused, for example, by changes in wear, temperature, mass, stiffness, and damping during operation.

If the unbalance and other conditions of the machine are essentially constant, occasional trim balancing may be sufficient. Otherwise it may be necessary to modify the machine to change the resonance speed, damping or other parameters to obtain acceptable vibration magnitudes. Therefore, there is a need to consider permissible sensitivity values of the machine.

The repeatability of the unbalance sensitivity of a machine is influenced by several factors and may change during operation. Some thermal machines, especially those with sleeve bearings, have modal vibration characteristics which vary with particular operational parameters (e.g. steam pressure and temperature, partial steam admission or oil temperature). For electrical machines, other parameters such as the excitation current may influence the vibration behaviour. In general, the machine vibration characteristics are influenced by the design features of the machine, including coupling of the rotor and its support conditions including the foundation. It should be noted that the rotor support conditions may vary with time (e.g. wear and tear).

This part of ISO 21940 is only concerned with once-per-revolution vibration caused by unbalance; however, it should be recognized that unbalance is not the only cause of once-per-revolution vibration.

Mechanical vibration — Rotor balancing —

Part 31: Susceptibility and sensitivity of machines to unbalance

1 Scope

This part of ISO 21940 specifies methods for determining machine vibration sensitivity to unbalance and provides evaluation guidelines as a function of the proximity of relevant resonance rotational speeds to the operating speed. This part of ISO 21940 is only concerned with once-per-revolution vibration caused by unbalance. It also makes recommendations on how to apply the numerical sensitivity values in some particular cases.

It includes a classification system that can be applied to machines which is related to their susceptibility to a change in unbalance. Machines are classified into three types of susceptibility and five ranges of sensitivity. The sensitivity values are intended for use on simple machine systems, preferably with rotors having only one resonance speed over their entire operating speed range. The sensitivity values can also be used for machines that have more resonance speeds in their operating speed range if the resonance speeds are widely separated (e.g. by more than 20 %).

The sensitivity values given are not intended to serve as acceptance specifications for any machine group, but rather to give indications regarding how to avoid gross deficiencies as well as specifying exaggerated or unattainable requirements. They can also serve as a basis for more involved investigations (e.g. when in special cases a more exact determination of the required sensitivity is necessary). If due regard is paid to the values given, satisfactory running conditions can be expected in most cases.

The consideration of the sensitivity values alone does not guarantee that a given magnitude of vibration in operating is not exceeded. Many other sources of vibration can occur which lie outside the scope of this part of ISO 21940.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1925, *Mechanical vibration — Balancing — Vocabulary*[11)]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1925 apply.

NOTE Some of the terms used are explained in Annex A.

4 Machine susceptibility classification

4.1 General

Machine susceptibility classification is based on the likelihood of a machine experiencing significant unbalance during operation. Machines with low susceptibility are allowed higher sensitivity values

11) To become ISO 21940-2 when revised.