INTERNATIONAL STANDARD

ISO 20816-4

First edition
2018-06

Mechanical vibration — Measurement and evaluation of machine vibration —

Part 4: Gas turbines in excess of 3 MW, with fluid-film bearings

Vibrations mécaniques — Mesurage et évaluation des vibrations de machines —

Partie 4: Turbines à gaz à paliers à film fluide, excédant 3 MW

Reference number
ISO 20816-4:2018(E)

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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.

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 (see 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 (see 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.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee 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 20816-4 cancels and replaces ISO 7919-4:2009 and ISO 10816-4:2009, which have been technically revised. It also incorporates the Amendments ISO 7919-4/Amd.1:2017 and ISO 10816-4/Amd.1:2017.

The main change is that the scope has been reduced to exclude large gas turbines with power outputs greater than 40 MW, fluid-film bearings and rated speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min or 3 600 r/min. Such gas turbines are now covered by ISO 20816-2.

A list of all parts in the ISO 20816 series can be found on the ISO website.

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Introduction

Documents in the ISO 20816 series have been and are being developed to combine and supersede the ISO 7919 and ISO 10816 series.

ISO 20816-1 is the basic part of the ISO 20816 series that gives the general requirements for evaluating the vibration of various machine types when the vibration measurements are made on both non-rotating and rotating parts. ISO 20816-2 deals with the measurement and evaluation of machine vibration of large gas turbines with certain rotational speeds.

This document provides specific provisions for assessing the vibration of the bearing housings or pedestals and rotating shafts of those gas turbines which are not covered by ISO 20816-2. Measurements at these locations characterize the state of vibration reasonably well. Evaluation criteria, based on previous experience, are presented. These can be used for assessing the vibratory condition of such machines. In those cases where there is a high ratio between the mass of the bearing supports and the rotor, lower values of vibration of the bearing housings or pedestals can be appropriate.

Two criteria are provided for assessing the machine vibration when operating under steady-state conditions. One criterion considers the magnitude of the observed vibration; the second considers changes in the magnitude. In addition, different criteria are provided for transient operating conditions.

The evaluation procedures presented in this document are based on broad-band measurements. However, because of advances in technology, the use of narrow-band measurements or spectral analysis has become increasingly widespread, particularly for the purposes of vibration evaluation, condition monitoring and diagnostics. The specification of criteria for such measurements is beyond the scope of this document. They are provided in greater detail in the relevant parts of ISO 13373 which establish provisions for the vibration condition monitoring of machines.

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Mechanical vibration — Measurement and evaluation of machine vibration —

Part 4: Gas turbines in excess of 3 MW, with fluid-film bearings

1 Scope

This document is applicable to land-based gas turbines with fluid-film bearings and power outputs greater than 3 MW and an operating speed under load between 3 000 r/min and 30 000 r/min. In some cases (see the list of exclusions below), this includes other rotating machinery coupled either directly or through a gearbox. The evaluation criteria provided in this document are applicable to the vibration of the main input and output bearings of the gearbox but are not applicable to the vibration of the internal gearbox bearings nor to the assessment of the condition of those gears. Specialist techniques required for evaluating the condition of gears are outside the scope of this document.

This document is not applicable to the following:

i) gas turbines with power outputs greater than 40 MW at rated speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min or 3 600 r/min (see ISO 20816-2);

ii) aero-derivative gas turbines (including gas turbines with dynamic properties similar to those of aero-derivatives);

NOTE ISO 3977-3 defines aero-derivatives as aircraft propulsion gas generators adapted to drive mechanical, electrical or marine propulsion equipment. Large differences exist between heavy-duty and aero-derivative gas turbines, for example, in casing flexibility, bearing design, rotor-to-stator mass ratio and mounting structure. Different criteria, therefore, apply for these two turbine types.

iii) gas turbines with outputs less than or equal to 3 MW (see ISO 7919-3 and ISO 10816-3);

iv) turbine driven generators (see ISO 20816-2, ISO 7919-3 and ISO 10816-3);

v) turbine driven pumps (see ISO 10816-7);

vi) turbine driven rotary compressors (see ISO 7919-3 and ISO 10816-3);

vii) the evaluation of gearbox vibration (see this clause) but does not preclude monitoring of gearbox vibration;

viii) the evaluation of combustion vibration but does not preclude monitoring of combustion vibration;

ix) rolling element bearing vibration.

This document establishes provisions for evaluating the severity of the following *in-situ* broad-band vibrations:

a) structural vibration at all main bearing housings or pedestals measured radial (i.e. transverse) to the shaft axis;

b) structural vibration at thrust bearing housings measured in the axial direction;

c) vibration of rotating shafts radial (i.e. transverse) to the shaft axis at, or close to, the main bearings.

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These are in terms of the following:

— vibration under normal steady-state operating conditions;

— vibration during other (non-steady-state) conditions when transient changes are taking place, including run up or run down, initial loading and load changes;

— changes in vibration which can occur during normal steady-state operation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 20816-1:2016, *Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Measurement procedures

4.1 General

The measurement procedures and instrumentation shall comply with the general requirements given in ISO 20816-1.

ISO 20816-1, as well as this document, cover vibration of non-rotating parts and rotating shafts. However, this does not mean that both sets of measurements shall be taken on any particular machine. The choice of whether to measure vibration of non-rotating parts, rotating shafts or a combination of both is dependent on the particular application and shall always be agreed between the machine supplier and purchaser prior to installation. As a general guidance, it should be noted that bearing cap vibration is more sensitive where the rotor mass is large and the pedestal is flexible, whereas relative shaft vibration is more sensitive where the pedestal is large and stiff, and the rotor light and flexible.

The characteristics of the measurement system should be known with regard to the effects of the environment. Care should be taken to ensure that the measurement equipment is not unduly influenced by external sources, including

a) temperature variations,

b) electromagnetic fields,

c) airborne and structure-borne noise, e.g. from gear mesh vibration or combustion vibration or neighbouring machines,

d) transducer power source variations,

e) cable impedance,

f) transducer cable length,

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