TECHNICAL REPORT

ISO/TR 17243-3

First edition
2020-02

Machine tool spindles — Evaluation of machine tool spindle vibrations by measurements on spindle housing —

Part 3: Gear-driven spindles with rolling bearings operating at speeds between 600 r/min and 12 000 r/min

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Broches pour machines-outils — Évaluation des vibrations d'une broche pour machine-outil par mesurage sur le corps de broche —

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9220a58128/iso-tr-17243-3-2020

Partie 3: Broches à roulements à entraînement par engrenages opérant à des vitesses entre 600 tr/min et 12 000 tr/min

Reference number
ISO/TR 17243-3:2020(E)

© ISO 2020

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9229a58128/iso-tr-17243-3-2020

COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2020 – All rights reserved

Contents

Page

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/ea7f007c-f4d2-4ee8-b476-2d9229d50128/iso-tr-17243-3-2020

© ISO 2020 – All rights reserved

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9229a58128/iso-tr-17243-3-2020

 © ISO 2020 – All rights reserved

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 of 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 www.iso.org/iso/foreword.html.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d0220e58488/iso-tr-17243-3-2020

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 17243 series can be found on the ISO website.

© ISO 2020 – All rights reserved

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9229a58128/iso-tr-17243-3-2020

Machine tool spindles — Evaluation of machine tool spindle vibrations by measurements on spindle housing —

Part 3: Gear-driven spindles with rolling bearings operating at speeds between 600 r/min and 12 000 r/min

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This document provides information on how to assess the severity of machine tool spindle vibrations measured on the spindle housing. It gives specific guidance for assessing the severity of vibration measured on the spindle housing at customer sites or at the machine tool manufacturer's test facilities.

Its vibration criteria apply to gear-driven spindles intended for stationary machine tools with nominal operating speeds between 600 r/min and 12 000 r/min.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

It is applicable to those spindles of the rolling bearing types only, to spindles assembled on metal cutting machine tools, and for testing, periodic verification, and continuous monitoring.

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9220a58138/iso-tr-17243-3-2020

It does not address:

— geometrical accuracy of axes of rotation (see ISO 230-7);

— unacceptable cutting performance with regards to surface finish and accuracy;

— vibration severity issues of machine tool spindles operating at speeds below 600 r/min or exceeding 12 000 r/min (due to lack of supporting vibration data); or

— frequency domain analyses such as fast Fourier transform (FFT) analyses, envelope analyses or other similar techniques.

Annex A presents an introduction to alternative bearing condition assessment techniques.

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 1925, *Mechanical vibration — Balancing — Vocabulary*

ISO 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 2954, *Mechanical vibration of rotating and reciprocating machinery — Requirements for instruments for measuring vibration severity*

ISO 13372, *Condition monitoring and diagnostics of machines — Vocabulary*

© ISO 2020 – All rights reserved

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1925, ISO 2041, ISO 2954, ISO 13372 and the following apply.

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/

3.1
alarm
<spindle condition monitoring> condition where the vibration velocity magnitude [*LTSC* (3.6.1)] indicates increased dynamic load on the bearings and/or vibration acceleration magnitude [*STSC* (3.6.2)] indicates a moderate spindle bearing degradation

3.2
alert
<spindle condition monitoring> condition where a significant change in spindle vibration magnitude [*STSC* (3.6.2) or *LTSC* (3.6.1)], with respect to normal values, has been detected

3.3
gear-driven spindle
machine tool spindle with one or more power transmitting gear units in the power train

Note 1 to entry: Gear-driven spindles can also incorporate coupling and/or belts in the power train.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.4
long term
<spindle condition monitoring> time period of longer than six months

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9229a58128/iso-tr-17243-3-2020

Note 1 to entry: Time period can differ for specific spindle types and/or operational conditions.

3.5
short term
<spindle condition monitoring> time period of six months or shorter

Note 1 to entry: Time periods can differ for specific spindle types and/or operational conditions.

3.6
spindle condition
root-mean-square (r.m.s) values for vibration velocity and acceleration of machine tool spindles as defined by specifications

3.6.1
long-term spindle condition
LTSC
parameter indicating the condition of a machine tool spindle in the *long term* (3.4)

3.6.2
short-term spindle condition
STSC
parameter indicating the condition of a machine tool spindle in the *short term* (3.6)

3.7
steady-state operating temperature
<spindle condition monitoring> condition where the machine tool spindle has been running for a sufficient time to reach a stable operating temperature

© ISO 2020 – All rights reserved

3.8
threshold for shutdown
<spindle condition monitoring> condition where the vibration velocity magnitude [*LTSC* (3.6.1)] indicates severe dynamic load on the bearings and/or vibration acceleration magnitude [*STSC* (3.6.2)] indicate a severe spindle bearing degradation

4 Preliminary operations

4.1 General

When measuring spindle vibration, the operational condition of the machine tool is of great importance. This document is applicable to all normal operational conditions of the machine tool when machining.

For any spindle vibration measurement intended to characterize the spindle condition according to this document, important operational conditions should be recorded. Such operational conditions include, but are not limited to, the characteristics listed in 4.2 to 4.12.

When using vibration measurement results for evaluation of spindle condition, other factors contributing to or interfering with the measured signals should be taken into consideration. Such factors include spindle motor current control signals with their associated frequencies, influences of machine foundation and the position of the other moving components affecting the dynamic response of the overall system, and possible high level of scatter due to low energy content in the frequency range of interest. If such interfering signals or conditions are suspected, frequency analysis techniques can be used to differentiate bearing signals from other contributing factors.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

4.2 Process load

All vibration measurements should be made under no-load conditions (no cutting, milling, or grinding).

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9229a58128/iso-tr-17243-3-2020

4.3 Spindle speed

This document is applicable for every speed within the nominal speed range of the machine tool/spindle. The manufacturer may specify non-continuous speed ranges such as 600 r/min to 9 000 r/min and 10 000 r/min to 12 000 r/min in order to avoid unreasonable limits at resonance speeds. Two such resonance speed intervals are allowed, together occupying a maximum of 10 % of the nominal operating speed range of the spindle. The possibility of excluding certain speed ranges only applies to the vibration velocity parameter as defined in 6.1, i.e. indicators for long term spindle condition (LTSC). The vibration acceleration parameter as defined in 6.2, i.e. indicators for short-term spindle condition (STSC), applies to any speed within the nominal speed range of the spindle.

When measuring vibration magnitude as a function of spindle speed, it is important to execute the spindle speed changes in such a way that a steady-state vibration of the spindle is reached before recording the measurements. The following are typical methods.

— **Step**: Increase or decrease the spindle speed in steps not greater than 3 % of spindle maximum speed with 10 s of constant speed at each such selected speed.

— **Acceleration**: Increase or decrease the spindle speed with a rate of not more than 20 % of maximum spindle speed per minute.

Both the above methods result in approximately 5 min measurement time.

4.4 Thermal conditions

Thermal conditions need to be agreed between manufacturer/supplier and user. If no conditions are specified, the tests should be made under conditions as near as possible to those of normal operation with regards to lubrication and warm-up. Therefore, the machine should have an idle running performance in accordance with the conditions of use and the instructions of the manufacturer until

© ISO 2020 – All rights reserved

the machine/spindle has reached steady-state operating temperature. See ISO 230-1 for the installation of the machine before testing and warming up of the spindle and other moving components.

4.5 Spindle position and orientation

Spindle position: This document is applicable for all possible linear axis positions.

Spindle orientation: This document is applicable for all possible spindle orientations.

Spindle direction of rotation: For spindles that can be operated in either direction, this document applies to both clockwise and counter clockwise spindle rotation.

Spindle position, orientation, and direction of rotation for vibration measurements need to be agreed between manufacturer/supplier and user.

4.6 Gear selection

This document is applicable for all possible gear selections of the machine tool.

4.7 Tool or workpiece balancing

4.7.1 General

A tool or workpiece mounted in the spindle can influence the vibration measurements due to the unbalance of the tool or workpiece itself. It should be recorded whether or not a tool/workpiece is used during the measurements. If used, the mass, balancing grade according to ISO 21940-11 and angular orientation (if applicable) of tool/workpiece used during vibration measurements should be recorded.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

4.7.2 Spindle vibration measurements with a tool/workpiece mounted in the spindle

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ce8-b476-2d9229a56128/iso-tr-17243-3-2020

Care should be taken to avoid errors introduced by the unbalance of the tool/workpiece. For most machine tools/spindles, this implies that a balance quality grade of G2.5 or better according to ISO 21940-11:2016 is required. If possible, the same tool/workpiece should be used for each measurement of the same machine tool/spindle. If available, refer to the spindle manufacturer's recommendations.

4.7.3 Spindle vibration measurements without tool/workpiece

Spindles that can be operated throughout their entire operating speed range without any tool/workpiece mounted and which do not require tool/workpiece for balance can be measured without a tool/workpiece mounted in the spindle.

4.8 Spindle chuck

Spindle chuck mechanical settings — such as chuck front-end position with respect to spindle gauge line for clamped and unclamped positions — as well as jaw positions, should be recorded.

4.9 Spindle cooling

The spindle cooling system settings should be set appropriately and the performance confirmed. All settings should be recorded.

4.10 Drawbar

The drawbar status should be recorded as tool clamped, tool unclamped, or tool improperly clamped. It is recommended that all spindle vibration measurements be performed with tool clamped or without tool (see 4.7).

 © ISO 2020 – All rights reserved

4.11 Background vibration

If the measured vibration magnitude is greater than an acceptance criterion established by mutual agreement between the manufacturer/supplier and user, and background vibration is suspected, measurements should be made with the machine shut down to determine the degree of external influence. If the vibration magnitude with the machine shut down exceeds 10 % of the value measured when the machine is running, corrective action may be necessary to reduce the effect of background vibration.

NOTE In some cases, the effect of background vibration can be nullified by spectrum analysis or by eliminating the offending external source.

4.12 Idle operation

It can be beneficial to conduct vibration measurements with the spindle idle but other machine tool systems, such as pumps, fans, and hydraulic systems, active. Vibration data acquired this way can be useful when comparing spindle vibration changes over time.

Idle spindle vibration measurements should be taken at the same measurement locations/directions as running spindle vibration measurements (see 5.2).

5 Measurement and operational procedures

5.1 Measuring instruments

iTeh STANDARD PREVIEW
(standards.iteh.ai)

The measuring instrument should comply with the requirements of ISO 2954 for a specified frequency range of 10 Hz to 10 kHz.

Various methods exist for computing the r.m.s value of a specified frequency band. Refer to ISO 2954:2012, Annex A, for further information on how to test the r.m.s indicator of any measuring instrument.

ISO/TR 17243-3:2020
https://standards.iteh.ai/catalog/standards/sist/eaf48e72-14d2-4ee8-b476-
2d9229a58128/iso-tr-17243-3-2020

Care should be taken to ensure that the measurements are not influenced by environmental factors or other external factors including, but not limited to, the following:

— temperature variations;

— magnetic fields;

— sound pressure fields;

— sensor cable length;

— power supply noise.

See 5.3 for further information on sensor mounting procedures.

5.2 Measurement locations/directions

5.2.1 General

For vibration criteria presented in this document, measurements should be taken on the spindle housing at the front end of the spindle, as well as at the back end. Preferably, sensor longitudinal locations should coincide with spindle bearing longitudinal locations as close as possible. Measurements should be taken in a minimum of two radial directions at both ends of the spindle and in axial direction in at least one end of the spindle (see Figure 1). It is recognized that the back end of the spindle in many cases can be hard to access, requiring dismantling of covers, etc.

© ISO 2020 – All rights reserved