

---

---

**Mechanical vibration — Evaluation  
of machine vibration by measurements  
on rotating shafts —**

**Part 5:  
Machine sets in hydraulic power  
generating and pumping plants**

*Vibrations mécaniques — Évaluation des vibrations des machines  
par mesurages sur les arbres tournants —*

*Partie 5: Machines équipant les centrales hydroélectriques  
et les stations de pompage*



**PDF disclaimer**

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

This document is a preview generated by EVS

© ISO 2005

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

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](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland



# Contents

Page

<b>Foreword</b> .....	<b>iv</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>2</b>
<b>3 Measurement procedures</b> .....	<b>2</b>
3.1 General .....	2
3.2 Measurement type .....	2
3.3 Measurement planes.....	3
3.4 Measuring equipment.....	3
<b>4 Evaluation criteria</b> .....	<b>3</b>
4.1 Turbine operating conditions .....	3
4.2 Pump operating conditions.....	4
4.3 Special operating conditions.....	4
<b>Annex A (normative) Evaluation criteria for relative shaft vibration of hydraulic turbine sets under specified operating conditions</b> .....	<b>5</b>
<b>Annex B (informative) Special features of shaft vibration of hydraulic machine sets</b> .....	<b>10</b>
<b>Annex C (informative) Analysis procedure and applied regression technique</b> .....	<b>12</b>
<b>Annex D (informative) Objectives of this edition of ISO 7919-5</b> .....	<b>14</b>
<b>Bibliography</b> .....	<b>16</b>



## 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 7919-5 was prepared jointly 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*, and Technical Committee IEC/TC 4, *Hydraulic turbines*. The draft was circulated for voting to the national bodies of ISO and IEC separately.

This second edition cancels and replaces the first edition (ISO 7919-5:1997), of which it constitutes a technical revision. Evaluation criteria have been modified, substituting the former four evaluation zones by a more global division of the whole evaluation area into two major ranges, with changed definitions and divided by the former B/C borderline. Inside the two major ranges A-B and C-D, the old borderlines A/B and C/D are kept to indicate different statistically based severity grades. More information on the objectives of this revision is given in Annex D.

ISO 7919 consists of the following parts, under the general title *Mechanical vibration — Evaluation of machine vibration by measurements on rotating shafts*:

- *Part 1: General guidelines*
- *Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1 500 r/min, 1 800 r/min, 3 000 r/min and 3 600 r/min*
- *Part 3: Coupled industrial machines*
- *Part 4: Gas turbine sets*
- *Part 5: Machine sets in hydraulic power generating and pumping plants*



# Mechanical vibration — Evaluation of machine vibration by measurements on rotating shafts —

## Part 5:

## Machine sets in hydraulic power generating and pumping plants

### 1 Scope

This part of ISO 7919 gives guidelines for applying evaluation criteria for shaft vibration measured at, or close to, the bearings of machines or machine sets in hydraulic power generating and pumping plants under normal operating conditions. These guidelines are presented in terms of both steady-state running vibration and any amplitude changes that can occur in these steady vibration values.

NOTE 1 The numerical values specified are not intended to serve as the only basis for vibration evaluation since, in general, the vibratory condition of a machine is assessed by consideration of both the shaft vibration and the associated structural vibration (see ISO 7919-1 and ISO 10816-3).

This part of ISO 7919 is applicable to machines or machine sets in hydraulic power generating and pumping plants where the hydraulic machines have speeds from 60 r/min to 1 800 r/min, shell- or shoe-type sleeve bearings, and main engine power of at least 1 MW. The position of the shaft line can be vertical, horizontal or at an arbitrary angle between these two directions.

Machine sets covered by this part of ISO 7919 include a combination of

- hydraulic turbines and generators,
- pumps and electrical machines operating as motors,
- pump-turbines and motor-generators, and
- hydraulic turbines, pumps and motor-generators (classic pump-storage machine sets),

including auxiliary equipment (e.g. starting turbines or exciters lying in the shaft line).

This part of ISO 7919 is also applicable to turbines or pumps connected to generators or electrical motors via gears and/or radially flexible couplings.

NOTE 2 Electrical machines with speeds between 1 000 r/min and 1 800 r/min are evaluated according to the criteria specified in ISO 7919-3.

This part of ISO 7919 is not applicable to

- pumps in thermal power plants or industrial installations (for these machines, see ISO 7919-3),
- hydraulic machines or machine sets having rolling element bearings, or
- hydraulic machines with water-lubricated bearings.



As specified in ISO 7919-1, shaft vibration of machines or machine sets in hydraulic power generating and pumping plants can be determined with regard to the following tasks:

- task A: changes in vibrational behaviour;
- task B: excessive kinetic load;
- task C: the monitoring of radial clearance.

## 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*

ISO 10817-1, *Rotating shaft vibration measuring systems — Part 1: Relative and absolute sensing of radial vibration*

IEC 60994, *Guide for field measurement of vibrations and pulsations in hydraulic machines (turbines, storage pumps and pump-turbines)*

## 3 Measurement procedures

### 3.1 General

The measurement procedures to be followed and the instrumentation to be used shall be as described in ISO 7919-1 and IEC 60994.

### 3.2 Measurement type

Relative and absolute shaft vibration measurements are carried out on hydraulic machine sets using non-contacting transducers. Shaft-riding probes with seismic transducers cannot generally be used due to the very low frequency range of the measuring equipment required for low-speed hydraulic machinery.

For relative measurements, transducers should be mounted directly on the bearing shell or the bearing pad. If the transducers are installed on the bearing support structure or bearing housing, as it is common for vertical machines, care shall be taken that the relative motion between the bearing shell or pad and the transducer itself is small compared with the shaft motion. If this is not so, the measured signal cannot be said to be representative of the relative movement between the shaft and bearing shell or bearing pad, respectively. This requirement can be assessed by static analysis of the structure or additional measurements; the latter is usually difficult and expensive.

With regard to the transducer support structures, it is advisable that the lowest natural frequency of those vibration modes that create significant movements in the working direction of shaft displacement transducers be greater than seven times the synchronous rotational frequency, and should not be a direct multiple of the synchronous rotational frequency.

The absolute vibration of the support frame should always be measured using seismic transducers installed on the support frame as close as possible to the shaft movement transducer and in the same direction of action. The readings from the seismic transducers may be used after conversion into displacements to evaluate the absolute shaft displacement.

**NOTE** Apart from the shaft vibration, the vibration of the bearing support is frequently monitored as well. The vibration measurement at the lower guide bearings of vertical machines can, however, be misinterpreted. The vibration value measured at the bearings and their supports, which are rigidly embedded in the building, is sometimes produced by hydraulic forces, directly transmitted from the hydraulic machine via the foundation, and is not produced by radial shaft vibration.