



**International  
Standard**

**ISO 7544**

**Rolling bearings — Test and  
assessment methods for cleanliness**

*Roulements — Méthodes d'essai et d'évaluation de la propreté*

**First edition  
2024-09**

Reference number  
ISO 7544:2024(en)

Full document details: [ISO 7544-2024](#)

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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 document 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](http://www.iso.org/directives)).

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This document was prepared by Technical Committee ISO/TC 4, *Rolling bearings*.

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](http://www.iso.org/members.html).

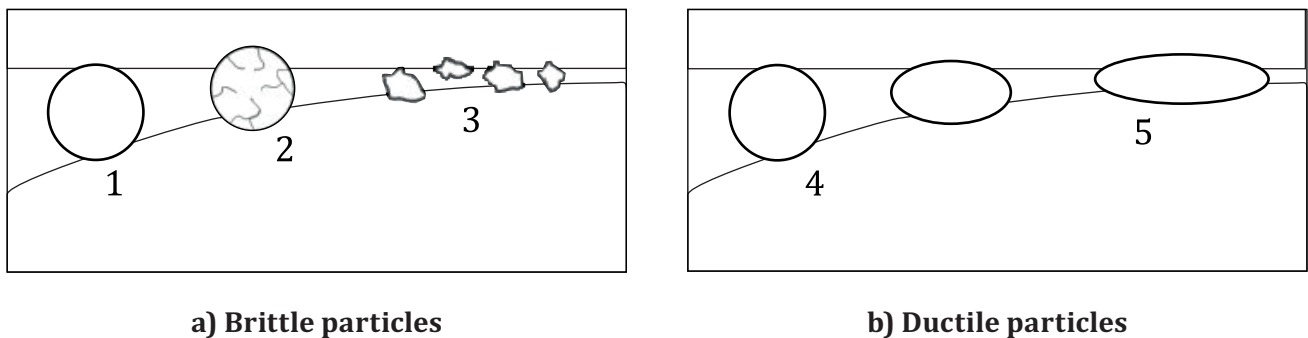
## Introduction

This document is based on ISO 16232. However, the inspection and evaluation methods in ISO 16232 cannot be directly transferred to the rolling bearings industry, because of the different uses of rolling bearings in a wide variety of applications. This document has been prepared to describe a common and general approach for the inspection of cleanliness of rolling bearings.

The cleanliness requirements on rolling bearings increase steadily. The cleanliness of rolling bearings has a direct influence on achieving reliable performance, especially in association with vibration and noise, as well as the life of rolling bearings according to ISO 281. Therefore, the cleanliness of rolling bearings is necessary to a certain level. Various test and assessment methods of rolling bearing cleanliness lead to differences in inspection and assessment results. To avoid incomparable inspection results, the extraction procedure, the test fluid and the parameter settings for the test equipment are described in this document.

[Figure 1](#) shows that the type of contaminant particle is crucial in determining the particle size and counting. After several times of over rolling, brittle particles break into small pieces as shown in [Figure 1 a\)](#); in comparison to the measured thickness, their effective size is reduced significantly. Ductile particles can be deformed as shown in [Figure 1 b\)](#).

Particulate contaminants (debris), entrapped into the contact between the rolling elements and the raceways, are the main cause for surface-initiated damages, which produce many rolling bearings failures. Subject to the elastic properties of the rolling element and raceway materials, entrapped particles, under the heavily loaded contacts, deform mainly in the inlet zone and remain nearly the same as they pass through the Hertzian contact zone, leaving the indentations on the mating surfaces. It seems clear that brittle particles, like corundum ( $\text{Al}_2\text{O}_3$ ) and silicon carbide ( $\text{SiC}$ ), tend to fracture and break into smaller pieces during the entrainment into the contact. Ductile particles, like copper, plastics and textile fibres are heavily deformed during the entrainment and extruded subsequently from the contact, as shown in [Figure 1](#); see Reference [9] for further information.



### Key

- 1 initial deformation
- 2 debris fracture
- 3 fragments entering contact
- 4 debris starting to deform
- 5 elastic deformation closure around flattened particle giving dents on mating surfaces

**Figure 1 — Deformation mechanisms of brittle and ductile particles**

This document does not give the cleanliness limits for rolling bearings. The cleanliness required for a specific application is dependent on many factors. Cleanliness limits can be agreed between the supplier and customer.

# Rolling bearings — Test and assessment methods for cleanliness

## 1 Scope

This document specifies procedures and equipment for cleanliness inspections of rolling bearings. It describes, in particular, test methods and assessment techniques.

This document is applicable to the test and assessment of various types of open bearings and capped bearings before grease filling, as well as the test and assessment of rolling bearing parts.

This document is not applicable for linear motion rolling bearings.

## 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 5593:2023, *Rolling bearings — Vocabulary*

ISO 16232:2018, *Road vehicles — Cleanliness of components and systems*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5593, ISO 16232 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

### 3.1

#### **component**

rolling bearing, *rolling bearing part* (3.3) or subunit of a rolling bearing

### 3.2

#### **extraction curve measurement**

procedure for verifying the efficiency and suitability of extraction parameters by repeating the extraction a maximum of six times in an identical manner with the same test object

### 3.3

#### **rolling bearing part**

individual part comprising a rolling bearing but excluding all accessories

Note 1 to entry: The main rolling bearing parts are outer ring, inner ring, rolling elements and cage (if necessary, further parts of the rolling bearing like shield, seal etc.).

[SOURCE: ISO 5593:2023, 3.2.1.1, modified — Note 1 to entry has been added.]

### 3.4 surface

exterior area and interior area of the *component* ([3.1](#))

### 3.5 controlled surface

*surface* ([3.4](#)) of the rolling bearings or rolling bearing parts that is subject to a cleanliness requirement

## 4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms apply.

|                    |                                                                                                     |
|--------------------|-----------------------------------------------------------------------------------------------------|
| $A$                | unit of reference “1 000 cm <sup>2</sup> controlled surface” when specifying the CCC                |
| CCC                | component cleanliness code                                                                          |
| CCC <sub>a</sub>   | component cleanliness code for all particles                                                        |
| CCC <sub>m</sub>   | component cleanliness code for shiny (metallic) particles without fibres                            |
| CCC <sub>o</sub>   | component cleanliness code for other particles without fibres                                       |
| CCC <sub>wof</sub> | component cleanliness code for all particles without fibres                                         |
| $D$                | nominal outside diameter, in millimetres (mm)                                                       |
| $m$                | residue mass (net mass of particle load), in milligrams (mg)                                        |
| $m_1$              | initial mass (tare mass of analysis filter), in milligrams (mg)                                     |
| $m_2$              | final mass (gross mass, i.e. total mass of occupied analysis filter), in milligrams (mg)            |
| $P_U$              | power of ultrasonic device, in watts (W)                                                            |
| $V_B$              | filling quantity of test vessel, in litres (l)                                                      |
| $V_U$              | filling quantity of bath, in litres (l)                                                             |
| $x$                | particle size, e.g. $150\ \mu\text{m} \leq x < 200\ \mu\text{m}$ , in micrometres ( $\mu\text{m}$ ) |
| $\varphi_U$        | power density of the ultrasonic bath, in watts per litre (W/l)                                      |

## 5 Main steps of cleanliness inspection

The cleanliness inspection is made with the following steps (see [Figure 2](#)):

- a) selection - taking the test lot for analysis;
- b) extraction - removing the particles from the test component;
- c) filtration - of the particles;
- d) analysis - of the particles;
- e) documentation - of the inspection parameters and results.

The cleanliness inspections shall be performed using the materials and equipment described in this document and in a suitable environment by skilled staff; for more information, see ISO 16232. The test environment shall be in accordance with ISO 16232:2018, 11.2.4.

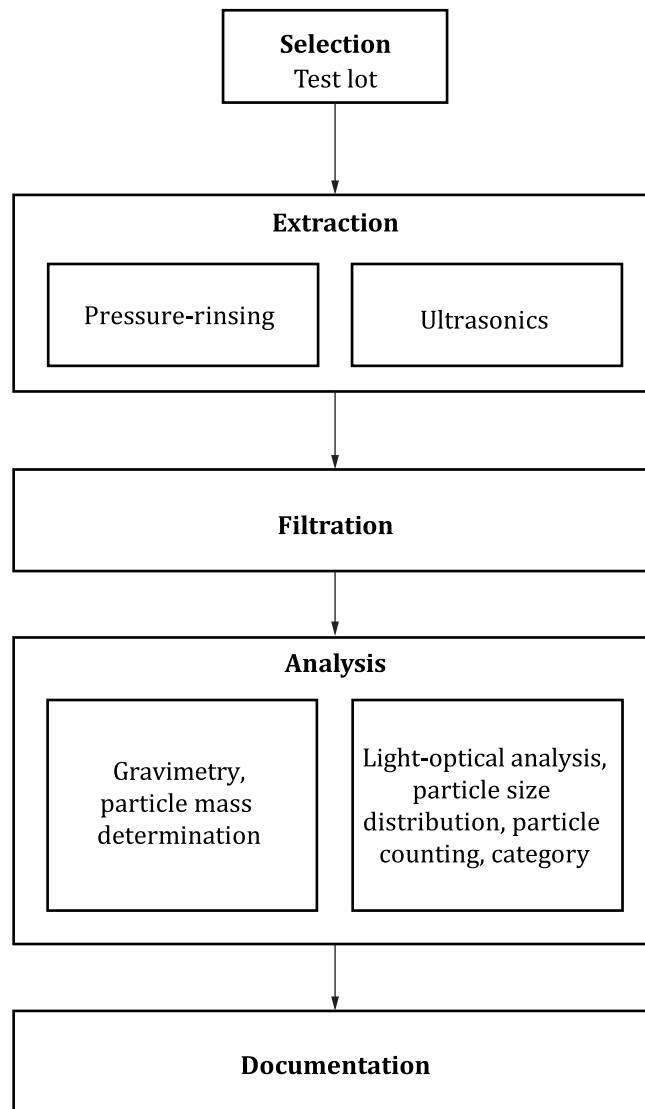


**Figure 2 — Main steps of cleanliness inspection**

To compare inspection results reliably, the same test fluid, extraction procedure and analysis parameter shall be applied.

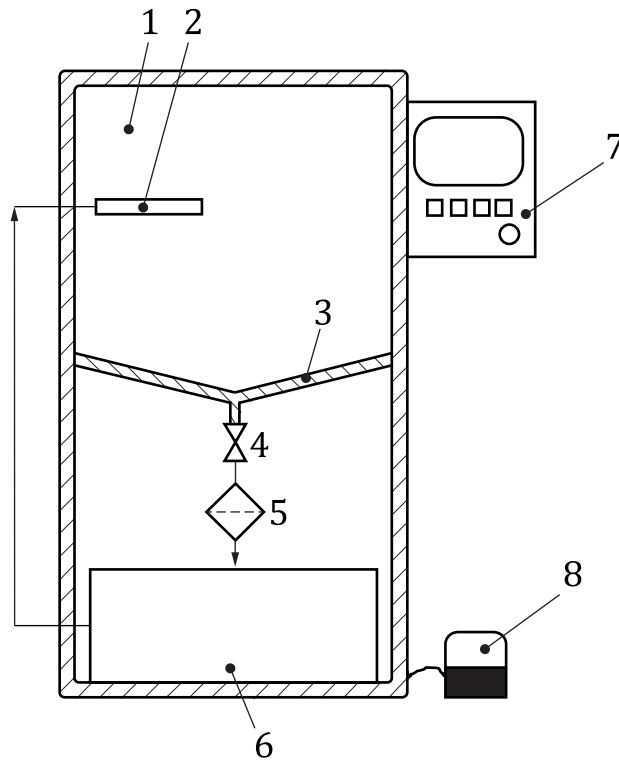
For further information about the analysis of the particles and the documentation, see [Annex A](#) and [Annex D](#).

## 6 Equipment and accessories

### 6.1 Equipment for extraction

#### 6.1.1 Equipment for pressure-rinsing method

A schematic diagram of a pressure-rinsing cabinet is shown in [Figure 3](#). Other equipment such as open cabinets, pressure vessels with a spraying gun, or laboratory wash bottles can also be used.



**Key**

- |   |                                     |   |                                                   |
|---|-------------------------------------|---|---------------------------------------------------|
| 1 | extraction chamber (clean air area) | 6 | media supply with                                 |
| 2 | manual pressure-rinsing nozzles     | — | test fluid                                        |
| 3 | collection trough                   | — | purification filter                               |
| 4 | stop cock                           | — | pump or pressure supply                           |
| 5 | analysis filter                     | 7 | controls for rinsing programs with emergency stop |
|   |                                     | 8 | foot switch                                       |

**Figure 3 — Example of a pressure-rinsing cabinet**

### 6.1.2 Equipment for ultrasonic method

A schematic diagram of an ultrasonic bath is shown in [Figure 4](#). Other equipment like extraction cabinets that uses the ultrasonic extraction method can also be used.