INTERNATIONAL STANDARD

ISO 6506-3

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Metallic materials — Brinell hardness test —

Part 3: Calibration of reference blocks

Matériaux métalliques — Essai de dureté Brinell —

Partie 3: Étalonnage des blocs de référence

Reference number
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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.

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 6506-3 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This second edition cancels and replaces the first edition (ISO 6506-3:1999) which has been technically revised.

ISO 6506 consists of the following parts, under the general title *Metallic materials — Brinell hardness test*:

— *Part 1: Test method*

— *Part 2: Verification and calibration of testing machines*

— *Part 3: Calibration of reference blocks*

— *Part 4: Table of hardness values*

Introduction

Attention is drawn to the fact that in this part of ISO 6506, only the use of the hardmetal ball indenter is specified.

The designation of the Brinell hardness is HBW and should not be confused with the former designation HB, or HBS when a steel ball indenter was used.

Metallic materials — Brinell hardness test —

Part 3: Calibration of reference blocks

1 Scope

This part of ISO 6506 specifies a method for the calibration of reference blocks to be used in the indirect verification of Brinell hardness testing machines as described in ISO 6506-2.

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 376:2004, *Metallic materials — Calibration of force-proving instruments used for verification of uniaxial testing machines*

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 6506-1:2005, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6506-2:2005, *Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines*

3 Manufacture of reference blocks

3.1 The block shall be specially manufactured for use as a hardness-reference block.

NOTE Attention is drawn to the need to use a manufacturing process which will give the necessary homogeneity, stability of structure and uniformity of surface hardness.

3.2 Each metal block to be calibrated shall be of a thickness not less than:

— 16 mm for 10 mm balls;

— 12 mm for 5 mm balls;

— 6 mm for smaller balls.

NOTE 12 mm for 10 mm balls may be used only if the hardness of the reference block is greater than 150 HBW.

3.3 The reference blocks shall be free of magnetism. It is recommended that the manufacturer shall ensure that the blocks, if of steel, have been demagnetized at the end of the manufacturing process.

3.4 The flatness of the two surfaces and the parallelism of the reference block shall be in accordance with Table 1.

Table 1 — Requirements for the reference blocks

Diameter of ball mm	Tolerance in flatness of the surfaces mm	Tolerance in parallelism mm over 50 mm	Permissible surface roughness, Ra [a] µm	
			Test surface	Bottom surface
10	0,040	0,050	0,3	0,8
5	0,030	0,040	0,2	0,8
< 5	0,020	0,030	0,1	0,8

[a] Sampling length: l = 0,80 mm (see ISO 4287).

3.5 The test surface shall be free from scratches which interfere with the measurement of the indentations (see Table 1).

3.6 To verify that no material is subsequently removed from the reference block, the thickness at the time of calibration shall be marked on it to the nearest 0,1 mm, or an identifying mark shall be made on the test surface [see 8.1.e)].

4 Calibration machine

4.1 In addition to fulfilling the general requirements specified in Clause 3 of ISO 6506-2:2005, the calibration machine shall also meet the requirements given in 4.2 to 4.8.

4.2 The machine shall be verified directly in intervals not exceeding twelve months.

Direct verification involves:

a) calibration of the test force;

b) verification of the indenter;

c) calibration of the measuring device;

d) verification of the testing cycle, if this is not possible, at least the force versus time behaviour.

4.3 The instruments used for verification and calibration shall be traceable to national standards.

4.4 Each test force shall be measured using an elastic proving device (of ISO 376:2004, Class 0,5 or better) and the measurement shall agree with the nominal value to within ± 0,1 %.

4.5 The indenters shall be verified and shall meet the requirements given in 4.3 of ISO 6506-2:2005, with the exception that the tolerances on the diameter of the balls shall meet requirements given in Table 2.

Table 2 — Tolerances for different ball diameters

Ball diameter mm	Tolerance mm
10	± 0,003
5	± 0,002
2,5	± 0,001
1	± 0,001

4.6 The scale of the measuring microscope shall be graduated to read to 0,002 mm for indentations made with 10 mm and 5 mm balls and 0,001 mm for indentations made with balls of less than 5 mm diameter.

The scale of the measuring microscope shall be verified by measurements made on a stage micrometer at a minimum of five intervals over each working range. The accuracy of the measuring device in relation to the diameters of indentation shall be as given in Table 3.

Table 3 — Accuracy of the measuring device

Diameter of indentation mm	Accuracy mm
$d < 1$	± 0,000 5
$1 \leqslant d < 2{,}5$	± 0,001 0
$d \geqslant 2{,}5$	± 0,002 0

4.7 The testing cycle shall conform to the testing cycle described in ISO 6506-1 and shall be timed with an uncertainty less than ± 0,5 s.

4.8 The characteristics of the hardmetal balls are specified in 4.3.4.2 of ISO 6506-2:2005.

5 Calibration procedure

The reference blocks shall be calibrated in a calibration machine as described in Clause 4, at a temperature of (23 ± 5) °C, using the general procedure described in ISO 6506-1.

During calibration, the thermal drift should not exceed 1 °C.

The time from the initial application of force to the time the full test force is reached shall not be less than 6 s nor greater than 8 s. The duration of the test force shall be 10 s to 15 s.

The mechanism which controls the application of the force shall ensure that the speed of approach of the ball immediately before it touches the block is not more than 1 mm/s.

6 Number of indentations

On each reference block, five indentations shall be made uniformly distributed over the entire test surface.

To reduce the measurement uncertainty, more than five indentations should be made.

7 Uniformity of hardness

7.1 Let d_1, d_2, d_3, d_4 and d_5 be the values of the mean measured diameters of the indentations arranged in increasing order of magnitude.

The non-uniformity of the block under the particular conditions of calibration is characterized by

$$U = d_5 - d_1 \tag{1}$$

and is expressed as a percentage of $\bar{d}$

$$U_{\text{rel}} = 100 \times \frac{d_5 - d_1}{\bar{d}} \tag{2}$$

where

$$\bar{d} = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5} \tag{3}$$

7.2 The maximum permissible value of non-uniformity of a reference block shall be as specified in Table 4.

Table 4 — Maximum permissible value of non-uniformity

$\bar{d}$ mm	**Maximum permissible value of non-uniformity,** U_{rel} %
$\bar{d} < 0{,}5$	2,0
$0{,}5 \leqslant \bar{d} \leqslant 1$	1,5
$\bar{d} > 1$	1,0
NOTE For a hardness value less than 200 HBW, the maximum permissible value of non-uniformity may be 2,0 %.	

7.3 The determination of the uncertainty of measurement of hardness-reference blocks is given in Annex A.

8 Marking

8.1 Each reference block shall be marked with the following particulars:

a) arithmetic mean of the hardness values found in the standardizing test, for example: 348 HBW 5/750;

b) name or mark of the supplier or manufacturer;

c) serial number;

d) name or mark of the calibration agency;

e) thickness of the block, or an identifying mark on the test surface (see 3.6);

f) year of calibration, if not indicated in the serial number.

8.2 Any mark put on the side of the block shall be upright when the test surface is the upper face.

8.3 Each delivered reference block shall be accompanied by a document giving at least the following information:

a) a reference to this part of ISO 6506;

b) the identity of the block;

c) the date of calibration;

d) the arithmetic mean of the hardness values and the value characterizing the non-uniformity of the block (see 7.1);

e) information about the location of the reference indentation and the orientation of its measured diameters, together with the mean measured diameter.

9 Validity

The hardness-reference block is only valid for the scale for which it was calibrated.

The calibration validity should be limited to a duration of five years. Attention is drawn to the fact that, for Al- and Cu-alloys, the calibration validity could be reduced to two - three years.

Annex A
(informative)

Uncertainty of the mean hardness value of hardness-reference blocks

The metrological chain necessary to define and disseminate hardness scales is shown in Figure C.1 in ISO 6506-1:2005.

A.1 Direct verification of the hardness-calibration machine

A.1.1 Calibration of the test force

See ISO 6506-2:2005, Annex A.

A.1.2 Calibration of the optical measuring device

See ISO 6506-2:2005, Annex A.

A.1.3 Verification of the indenter

See ISO 6506-2:2005, Annex A.

A.1.4 Verification of the test cycle

See ISO 6506-2:2005, Annex A.

A.2 Indirect calibration of the hardness-calibration machine

NOTE In this annex, the index "CRM (Certified Reference Material)" means, according to the definitions of the hardness testing standards, "Hardness Reference Block".

By the indirect verification with primary hardness-reference blocks, the overall function of the hardness-calibration machine is checked and the repeatability as well as the deviation of the hardness-calibration machine from the actual hardness value are determined.

The uncertainty of measurement of the indirect calibration of the hardness-calibration machine follows from the equation:

$$u_{\mathrm{CM}} = \sqrt{u^2_{\mathrm{CRM-P}} + u^2_{x\,\mathrm{CRM-1}} + u^2_{\mathrm{CRM-D}} + u^2_{\mathrm{ms}}} \qquad \text{(A.1)}$$

where

$u_{\mathrm{CRM\text{-}P}}$ is the calibration uncertainty of the primary hardness-reference block according to the calibration certificate for k = 1;

$u_{x\mathrm{CRM\text{-}1}}$ is the repeatability of the hardness-calibration machine;

$u_{\mathrm{CRM\text{-}D}}$ is the hardness change of the primary hardness-reference block since its last calibration due to drift;

u_{ms} is the standard uncertainty due to the resolution of the optical measuring device.