INTERNATIONAL STANDARD

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Metallic materials — Brinell hardness test —

Part 2: Verification and calibration of testing machines

Matériaux métalliques — Essai de dureté Brinell —
Partie 2: Vérification et étalonnage des machines d'essai

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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 6506-2 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 6506-2:1999) 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 2: Verification and calibration of testing machines

1 Scope

This part of ISO 6506 specifies a method of verification and calibration of testing machines used for determining Brinell hardness in accordance with ISO 6506-1.

It specifies a direct method for checking the main functions of machine operation and an indirect method suitable for the overall checking of the machine. The indirect method may be used independently for periodic routine checking of machine operation while in service.

If a testing machine is also to be used for other methods of hardness testing, it should be verified independently for each method.

This part of ISO 6506 is also applicable to portable hardness testing machines.

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 the verification of uniaxial testing machines*

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

ISO 6506-3, *Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

3 General conditions

Before a Brinell hardness testing machine is verified, the machine shall be checked to ensure that it is properly set up in accordance with the manufacturer's instructions.

Especially, it should be checked that:

a) the plunger holding the ball slides correctly in its guide;

b) the ball-holder with a ball (from a lot verified in accordance with 4.3) is firmly mounted in the plunger;

c) the test force is applied and removed without shock, vibration or overrun and in such a manner that the readings are not influenced;

d) if the measuring system is integrated into the machine:

— the change from removing the test force to measuring mode does not influence the readings;

— the illumination does not affect the readings; and

— the centre of the indentation is in the centre of the field of view, if necessary.

4 Direct verification

4.1 General

4.1.1 Direct verification should be carried out at a temperature of (23 ± 5) °C. If the verification is made outside this temperature range, this shall be reported in the verification report.

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

4.1.3 Direct verification involves:

a) the calibration of the test force;

b) the verification of the indenter ball;

c) the calibration of the measuring system;

d) the verification of the testing cycle.

4.2 Calibration of the test force

4.2.1 Each test force shall be measured within the working range of the testing machine. Whenever applicable, this shall be done at no less than three positions of the plunger uniformly spaced throughout its range of movement during testing.

4.2.2 Three measurements shall be made for each force at each position of the plunger. Immediately before each measurement is taken, the plunger shall be moved in the same direction as during testing.

4.2.3 The force shall be measured by one of the following two methods:

— by means of a force-proving instrument in accordance with ISO 376:2004 class 1, or

— by balancing against a force, accurate to ± 0,2 %, applied by means of calibrated masses or another method with the same accuracy.

4.2.4 Each measurement of a force shall be within ± 1,0 % of the nominal test force, as defined in ISO 6506-1.

4.3 Verification of the indenter ball

4.3.1 The indenter consists of a ball and an indenter holder. The verification applies only to the ball.

4.3.2 For the purpose of verifying the size and the hardness of the balls, a sample selected at random from a batch shall be tested. The balls verified for hardness shall be discarded.

4.3.3 The balls shall be polished and free from surface defects.

4.3.4 The user shall either measure the balls to ensure that they meet the following requirements or shall obtain balls from a supplier certifying that the following conditions are met.

4.3.4.1 The diameter shall be determined by taking the mean value of not less than three single values of diameter measured at different positions on the ball. No single value shall differ from the nominal diameter by more than the tolerance given in Table 1.

Table 1 — Tolerances for different ball diameters

Ball diameter mm	Tolerance mm
10	± 0,005
5	± 0,004
2,5	± 0,003
1	± 0,003

4.3.4.2 The characteristics of the hardmetal balls shall be as follows.

a) Hardness: The hardness shall be not less than 1 500 HV , when determined using a test force of at least 4,903 N, in accordance with ISO 6507-1. The hardmetal ball may be tested directly on this spherical surface or by sectioning the ball and testing on the ball interior.

b) Density: ρ = (14,8 ± 0,2) g/cm^3.

The following chemical composition is recommended:

— tungsten carbide (WC) balance;

— total other carbides 2,0 %;

— cobalt (Co) 5,0 % to 7,0 %.

4.4 Calibration of the measuring system

4.4.1 The scale of the measuring system shall be graduated to permit estimation of the diameter of the indentation to within ± 0,5 %.

4.4.2 The measuring system shall be verified by measurements made on an object micrometer at a minimum of five intervals over each working range. The maximum error of each interval shall not exceed 0,5 %.

4.4.3 When measuring a projected area, the maximum error shall not exceed 1 % of the area.

4.4.4 Hand held microscopes should be calibrated in accordance to the procedure of this standard and the tolerances of the manufacturer.

4.5 Verification of the testing cycle

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

5 Indirect verification

5.1 Indirect verification should be carried out at a temperature of (23 ± 5) °C by means of reference blocks calibrated in accordance with ISO 6506-3. If the verification is made outside of this temperature range, this shall be reported in the verification report.

The test and bottom surfaces of the reference blocks and the surfaces of indenters shall not contain any additives or corrosion products.

5.2 On each reference block, the reference indentation shall be measured. For each block, the difference between the mean measured value and the certified mean diameter shall not exceed 0,5 %.

5.3 The testing machine shall be verified for each test force and for each size of ball used. For each test force, at least two reference blocks shall be selected from the following hardness ranges:

— ⩽ 200 HBW

— 300 ⩽ HBW ⩽ 400

— ⩾ 500 HBW

The two reference blocks shall be taken from different hardness ranges, if possible.

NOTE When the hardness test in question makes it impossible to reach the higher hardness range defined in the above-mentioned ranges (for $0{,}102 \times F/D^2 = 5$ or 10), the verification may be carried out with only one reference block from the lower hardness range.

5.4 On each reference block, five indentations shall be uniformly distributed over the test surface and measured. The test shall be made in accordance with ISO 6506-1.

5.5 For each reference block, let d_1, d_2, d_3, d_4, d_5 be the mean values of the measured diameters of the indentations, arranged in increasing order of magnitude, and

$$\bar{d} = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5} \quad (1)$$

5.6 The repeatability r of the testing machine under the particular verification conditions is calculated as:

$$r = d_5 - d_1. \quad (2)$$

The repeatability, expressed as a percentage of $\bar{d}$, is calculated as:

$$r_{\mathrm{rel}} = 100 \times \frac{d_5 - d_1}{\bar{d}}, \text{ in \%} \quad (3)$$

5.7 The repeatability of the testing machine is satisfactory when r_{rel} is as specified in Table 2.

5.8 The error, E, of the testing machine under the particular verification conditions is calculated by the following formula:

$$E = \bar{H} - H_{\mathrm{c}} \quad (4)$$

The percent error, E_{rel}, is calculated by the following equation:

$$E_{rel} = 100 \times \frac{\overline{H} - H_c}{H_c}, \text{ in \%} \quad (5)$$

where

H_c is the reported certified hardness value of the reference block.

The error of the testing machine, expressed as a percentage of the specified hardness of the reference block, shall not exceed the values given in Table 2.

Table 2 — Repeatability and error of the testing machine

Hardness of the reference block HBW	**Permissible repeatability r_{rel}, of the testing machine** %	**Permissible error, E_{rel}, of the testing machine** % of H
$\leqslant$ 125	3,0	$\pm$ 3,0
125 < HBW $\leqslant$ 225	2,5	$\pm$ 2,5
> 225	2,0	$\pm$ 2,0
HBW: Brinell hardness.		

5.9 The determination of the uncertainty of measurement of the calibration results of the hardness testing machine is given in Annex A.

6 Intervals between verifications

The specifications for the direct verifications are given in Table 3.

Indirect verification shall be performed at least once every 12 months and after a direct verification has been performed.

Table 3 — Direct verifications of hardness testing machines

Requirements of verification	**Force**	**Measuring system**	**Test cycle**	**Indenter** [a]
before setting to work first time	x	x	x	x
after dismantling and reassembling, if force, measuring system or test cycle are affected	x	x	x	
failure of indirect verification [b]	x	x	x	
indirect verification > 14 months ago	x	x	x	

[a] In addition, it is recommended that the indenter be directly verified after two years of use.

[b] Direct verification of these parameters may be carried out sequentially (until the machine passes indirect verification) and is not required if it can be demonstrated (e.g. by tests with a calibrated indenter) that the indenter was the cause of the failure.