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

Reference number
ISO 6506-2:1999(E)

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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 3.

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.

International Standard 6506-2 was prepared by the Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This first edition of ISO 6506-2 cancels and replaces ISO 156:1982, of which it constitutes a technical revision as follows:

— Deletion of the steel ball indenter.

— Deletion of the 2 mm ball indenter.

— Addition of clause 6 concerning the intervals between the verifications.

— Addition of annex A, giving an example of a method for an indirect verification of the measuring device.

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*

Annex A of this part of ISO 6506 is for information only.

Introduction

The force values in this part of ISO 6506 were calculated from kilogram force values. They were introduced before the SI-system was adopted. It was decided to keep the values based on the old units for this part of ISO 6506 but for the next revision it will be necessary to consider the advantage of introducing rounded values of test force and possible consequences on the hardness scales.

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 checking the overall machine operation. 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 shall be verified independently for each method.

This part of ISO 6506 is applicable to portable hardness testing machines with the exception of the requirement in 6.1 a) in which the word “relocation” does not apply.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6506. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6506 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 376, *Metallic materials — Calibration of force-proving instruments used for the verification of uniaxial testing machines.*

ISO 3878, *Hardmetals — Vickers hardness test.*

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

ISO 6506-3:1999, *Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks.*

3 General conditions

Before a Brinell hardness testing machine is verified, the machine shall be checked to ensure the following:

a) the machine is properly set up;

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

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

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

e) for measuring devices integrated into the machine:

— the readings are not influenced between the removal of the test force to the measurement of indentation;

— the readings are not affected by illumination;

— 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;

c) the calibration of the measuring device;

d) the verification of the testing cycle.

4.2 Calibration of the test force

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

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

— with a force-proving instrument conforming to class 1 of ISO 376, or

— balancing against a force, accurate to ± 0,2 %, applied using calibrated masses by mechanical means.

4.2.3 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.

4.2.4 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 indenters

4.3.1 The indenter consists of a ball and an indenter holder.

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 ball(s) 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 no 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 the different ball indenter diameter

Dimensions in millimetres

Ball indenter diameter	Tolerance
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:

— hardness: the hardness shall be no less than 1 500 HV 10, when determined in accordance with ISO 3878;

— density: $\rho = (14{,}8 \pm 0{,}2)$ g/cm^3.

NOTE 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 device

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

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

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

4.4.4 In addition to this direct verification, an indirect verification of the measuring device may be carried out in accordance with the procedure defined in annex A.

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 ± 0,5 s.

5 Indirect verification

5.1 Indirect verification shall 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 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 of corrosion product.

5.2 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.

5.3 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.

5.4 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.

5.5 The repeatability of the testing machine under the particular verification conditions is determined by the following quantity:

$$d_5 - d_1$$

The overall mean value diameter $\overline{d}$ is defined as follows:

$$\overline{d} = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5}$$

where d_1, d_2, d_3, d_4, d_5 have been defined in 5.4.

The repeatability of the testing machine to be verified shall be as specified in Table 2.

Table 2 — Repeatability and error of the testing machine

Hardness of the reference block HBW	Permissible repeatability of the testing machine mm	Permissible error of the testing machine % of H
⩽ 125	0,030 $\overline{d}$	3
125 < HBW ⩽ 225	0,025 $\overline{d}$	2,5
> 225	0,020 $\overline{d}$	2

5.6 The error of the testing machine under the particular verification conditions is characterized by the following quantity:

$$\overline{H} - H$$

where

$\overline{H}$ is the mean hardness value of the five indentations as follows:

$$\overline{H} = \frac{H_1 + H_2 + H_3 + H_4 + H_5}{5}$$

where

H_1, H_2, H_3, H_4, H_5 are the hardness values corresponding to d_1, d_2, d_3, d_4, d_5;

H is the specified hardness 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.

6 Intervals between verifications

6.1 Direct verification

The direct verification shall be carried out:

a) when the machine is installed or after having been dismantled and reassembled or after relocation;

b) when the result of the indirect verification is not satisfactory;

c) when indirect verification has not been made for a period greater than 12 months.

Each direct verification shall be followed by an indirect verification.

6.2 Indirect verification

The period between two indirect verifications depends on the maintenance standard and number of times the machine is used. In any case, this period shall not exceed 12 months.

7 Verification report/calibration certificate

The verification report/calibration certificate shall include the following information:

a) a reference to this International Standard, i.e. ISO 6506-2;

b) the method of verification (direct and/or indirect);

c) the identification data for the hardness testing machine;

d) the means of verification (reference blocks, elastic proving devices, etc.);

e) the diameter of the ball indenter and test force;

f) the verification temperature;

g) the result obtained;

h) the date of verification and reference to the verification institution.