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Metallic materials — Rockwell hardness test —

Part 3:
Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T)

Matériaux métalliques — Essai de dureté Rockwell —
Partie 3: Étalonnage des blocs de référence (échelles A, B, C, D, E, F, G, H, K, N, T)

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 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 ISO 6508-3 was prepared by the Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This first edition of ISO 6508-3 cancels and replaces ISO 674:1988 and ISO 1355:1989, of which it constitutes a technical revision as follows:

— Combination of the two different International Standards for the calibration of the hardness reference blocks (ISO 674:1988 and ISO 1355:1989) into this part of ISO 6508.

— Change of maximum permissible values of non-uniformity of the reference blocks in Table 2.

— Addition of clause 9 concerning the validity of the reference blocks.

— Addition of the hardmetal ball as indenter.

ISO 6508 consists of the following parts, under the general title *Metallic materials — Rockwell hardness test:*

— *Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

— *Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T)*

— *Part 3: Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T)*

Annex A forms a normative part of this part of ISO 6508.

Introduction

The force values in this part of ISO 6508 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 6508 but for the next revision it will be necessary to consider the advantage of introducing rounded values of test force and the consequence on the hardness scales.

Attention is drawn to the fact that in this part of ISO 6508, the use of hardmetal balls as indenters is equivalent to the use of steel balls; however, it is indicated that the measurements made with the two ball types give different results.

Metallic materials — Rockwell hardness test —

Part 3:
Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T)

1 Scope

This part of ISO 6508 specifies a method for the calibration of reference blocks to be used for the indirect verification of Rockwell hardness testing machines (scales A, B, C, D, E, F, G, H, K, N, T), as specified in ISO 6508-2.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6508. 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 6508 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 verification of uniaxial testing machines.*

ISO 3878, *Hardmetals — Vickers hardness test.*

ISO 4287:1997, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters.*

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

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T).*

ISO 6508-2:1999, *Metallic materials — Rockwell hardness test — Part 2: Verification and calibration of testing machines (scales A, B, C, D, E, F, G, H, K, N, T).*

Guide to the Expression of Uncertainty in Measurement, ISO, 1993.

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 no less than 6 mm.

NOTE Reference blocks should have a thickness of 6 mm to 16 mm. To minimize the effect of hardness change with increasing number of indents, a minimum thickness of 12 mm should be used.

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

3.4 The tolerance in flatness of the surfaces shall not exceed 0,01 mm. The bottom of the blocks shall not be convex.

The tolerance parallelism shall not exceed 0,02 mm on 50 mm.

3.5 The test and lower surfaces shall be free from damage such as notches, scratches, oxide layers, etc. which interfere with the measurement of the indentations. The surface roughness Ra shall not exceed 0,000 3 mm for the test surface and 0,000 8 mm for the bottom surface: sampling length l = 0,8 mm (see ISO 4287).

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 clause 8).

4 Calibration machine

4.1 In addition to fulfilling the general requirements specified in clause 3 of ISO 6508-2:1999, the calibration machine shall also meet the requirements given in 4.2.

4.2 The machine shall be verified directly at intervals not exceeding 12 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.

4.3 The equipment used for the verification and calibration of the calibration machine shall be traceable to national standards.

4.4 The preliminary force F_0 as defined in ISO 6508-1 shall be correct to within ± 0,2 % at the initial application and after the additional force F_1 has been removed.

The total test force F shall be correct to within ± 0,1 % of the nominal test force defined in ISO 6508-1.

The force shall be measured with force-proving instruments of class 0,5 in accordance with ISO 376 or by another method having the same accuracy.

4.5 The diamond cone indenter shall meet the following requirements:

a) The diamond cone shall have a mean included angle of (120 ± 0,1)°. In each measured section the included angle shall be (120 ± 0,17)°.

When the roundness of the cone is not measured, at least eight axial section planes equidistant from each other, shall be measured.

When the error in roundness of the cone does not exceed 0,004 mm, adjacent to the blend, two sections, normal to the indenter axis, shall be measured.

NOTE The error of roundness is defined as the greatest radial distance between the conical surface and the circumscribing circle.

Deviations from straightness of the generatrix of the diamond cone, adjacent to the blend, shall not exceed 0,000 5 mm over a minimum length of 0,4 mm.

b) The tip of the indenter is spherical. Its radius is determined from single values, measured in the axial section planes defined in 4.5 a). The radius can be obtained by determining the intersection of two segments of the concentric circles. The distance between the concentric circles shall not be more than 0,002 mm. The single value is the mean value of the two radii of the concentric circles. Each single value shall be within (0,2 ± 0,007) mm. The mean value of at least eight single values shall be within (0,2 ± 0,005) mm.

The surfaces of the cone and the spherical tip shall blend in a truly tangential manner.

c) The inclination of the axis of the diamond cone to the axis of the indenter holder (normal to the seating surface) shall be within 0,3°.

d) Tests shall be made in accordance with the procedure described in clause 5, on a minimum of the four blocks given in Table 1.

Table 1 — Hardness levels for different scales

Scale	Hardness	Tolerances
HRC	23	± 3
HRC	55	
HR45N	43	
HR15N	91	

For each block the mean hardness value of three indentations made using the indenter to be verified, shall not differ from the mean hardness value of the three indentations obtained with the reference indenter by more than ± 0,4 Rockwell unit. The indentations with the indenter to be verified and with the reference indenter shall be carried out in such a way that the indentations of both indenters are in each case adjacent.

The tests shall be made in accordance with ISO 6508-1. Reference indenters shall be recalibrated at a frequency no greater than 5 years.

NOTE The reference indenter is the indenter or the indenters being recognized as the reference indenter(s) at a national level.

4.6 The steel ball indenter shall meet the requirements of ISO 6508-2.

The diameter of the steel ball indenter (scales B, E, F, G, H, K, T) when measured at no less than three positions, shall not differ from the nominal diameter by more than

— ± 0,002 mm for the ball of diameter 1,587 5 mm;

— ± 0,003 mm for the ball of diameter 3,175 mm.

The hardness of the steel ball shall be no less than 750 HV 10, when determined in accordance with ISO 6507-1, and applying the appropriate correction for curvature.

4.7 The characteristics of the hardmetal balls shall be the following:

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

— density: ρ = (14,8 ± 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 %

4.8 The measuring device shall have a resolution of ± 0,000 1 mm and an expanded uncertainty (2σ) of 0,000 2 mm, in accordance with the *Guide to the Expression of Uncertainty in Measurement*.

4.9 The testing cycle shall be timed with an uncertainty less than ± 0,5 s and shall conform to the testing cycle of clause 5.

5 Calibration procedure

5.1 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 6508-1.

5.2 The velocity of the indenter when reaching the surface shall not exceed 1 mm/s.

5.3 Bring the indenter into contact with the test surface and apply the preliminary test force F_0 without shock or vibration and without oscillation of the test force. The duration of the preliminary test force F_0 shall not exceed 3 s.

5.4 Bring the measuring device to its datum position and without shock, vibration or oscillation, increase the force from F_0 to F in no less than 1 s nor greater than 8 s.

The duration of the total force F shall be equal to (4 ± 2) s.

NOTE During the final stage of the indentation process (about the range of 0,6 F to 0,8 F) the indentation speed should be in the range of 0,02 mm/s to 0,04 mm/s.

5.5 The final reading shall be made no less than 3 s nor greater than 5 s after removing the additional test force F_1.

6 Number of indentations

On each reference block five indentations shall be made uniformly distributed over the test surface. The arithmetic mean of the five hardness values characterizes the hardness value of the block.

7 Uniformity of hardness

7.1 Let h_1, h_2, h_3, h_4, h_5 be the values of the measured permanent indentation depth arranged in increasing order of magnitude.

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

$$h_5 - h_1$$

and is expressed in percent of $\bar{h}$

where

$$\bar{h} = \frac{h_1 + h_2 + h_3 + h_4 + h_5}{5}$$

7.2 The maximum permissible value of non-uniformity of a reference block is given in Table 2 and are graphically presented in Figure A.1 and Figure A.2.

Table 2 — Maximum permissible value of non-uniformity

Rockwell hardness scale	Maximum permissible value of non-uniformity[a] $h_5 - h_1$
A	1,5 % $\bar{h}$ or 0,4 HRA
B	2 % $\bar{h}$ or 1,0 HRB
C	1 % $\bar{h}$ or 0,4 HRC
D	1 % $\bar{h}$ or 0,4 HRD
E	2 % $\bar{h}$ or 1,0 HRE
F	2 % $\bar{h}$ or 1,0 HRF
G	2 % $\bar{h}$ or 1,0 HRG
H	2 % $\bar{h}$ or 1,0 HRH
K	2 % $\bar{h}$ or 1,0 HRK
N	2 % $\bar{h}$ or 0,6 HRN
T	3 % $\bar{h}$ or 1,2 HRT

[a] The greater of the two values shall apply.

8 Marking

8.1 Each reference block shall be marked with the following:

a) the arithmetic mean of the hardness values found in the calibration test, for example: 66,3 HRC;

b) the name or mark of the supplier or manufacturer;

c) the serial number;

d) the name or mark of the calibration agency;

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

f) the 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 with a document giving at least the following information:

a) a reference to this International Standard, i.e. ISO 6508-3;

b) the identity of the block;

c) the date of calibration;

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

9 Validity

The hardness reference block is only valid for the scale for which it was calibrated and provided that the block fulfils the requirements of clause 3.

NOTE The calibration validity should be limited to a duration of 5 years.