INTERNATIONAL STANDARD

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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)

Matériaux métalliques — Essai de dureté Rockwell —
Partie 2: Vérification et étalonnage des machines d'essai (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 6508-2 was prepared by the Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This first edition of ISO 6508-2 cancels and replaces ISO 716:1986 and ISO 1079:1989, of which it constitutes a technical revision as follows:

— Combination of the two different International Standards for the verification of the hardness testing machines (ISO 716:1986 and ISO 1079:1989) into this part of ISO 6508.

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

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

1 Scope

This part of ISO 6508 specifies a method of verification of testing machines for determining Rockwell hardness (scales A, B, C, D, E, F, G, H, K, N, T).

It specifies a direct method for checking the main functions of the machine and an indirect method suitable for the overall checking of the machine. The indirect method may be used on its own for periodic routine checking of the machine 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 6508 is applicable to portable hardness testing machines with the exception of requirements 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 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 6507-1:1997, *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 6508-3, *Metallic materials — Rockwell hardness test — Part 3: Calibration of reference blocks (scales A, B, C, D, E, F, G, H, K, N, T).*

3 General conditions

Before a Rockwell 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 indenter is capable of sliding in its guide;

c) the indenter-holder is firmly mounted in the plunger;

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

e) the readings are not affected either by movements of the test piece or by deformation of the frame. When a device is supplied, which locks the test piece against the upper part of the frame, the locking force shall exceed the total test force. The influence of deformations may be checked by using a plunger with a spherical tip (diameter of at least 10 mm), instead of the indenter, bearing against the anvil through a spacer and using the locking device when it is supplied. The material of the plunger and of the spacer shall have a hardness of at least 60 HRC. The readings of the measuring device (with preliminary force applied) before application and after removal of the additional force shall not differ by more than 1,5 Rockwell units (without locking equipment) and 0,5 Rockwell unit (with locking equipment).

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 of 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 the national standards.

4.1.3 Direct verification involves:

a) calibration of the test force;

b) verification of the indenter;

c) calibration of the depth-measuring device;

d) verification of the testing cycle.

4.2 Calibration of the test force

4.2.1 The preliminary test force F_0 (see 4.2.4) and each total test force F used (see 4.2.5) 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. The preliminary test force shall be held for at least 2 s.

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

— measuring with a force-proving device of class 1 in accordance with ISO 376 or,

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

4.2.3 Three readings shall be taken for each force at each position of the plunger. Immediately before each reading is taken, the plunger shall be moved in the same direction as during testing.

4.2.4 The tolerance on the preliminary test force F_0 (before application and after removal of the additional test force F_1) shall be ± 2,0 %.

4.2.5 The tolerance on the total test force F shall be ± 1,0 %. Each individual value of F shall be within this tolerance.

4.3 Verification of the indenters

4.3.1 Diamond cone indenter (scales A, C, D, N)

To verify the reliable performance of the conical indenter in conformance with this part of ISO 6508 a direct and an indirect verification shall be carried out.

4.3.1.1 Direct verification

4.3.1.1.1 The surfaces of the diamond cone and spherical tip shall be polished for a penetration depth of 0,3 mm and shall blend in a truly tangential manner. Both surfaces shall be free from surface defects.

4.3.1.1.2 The verification of the shape of the indenter can be made by direct measurement or by measurement of its projection on a screen. The verification shall be made at no less than four equally spaced sections.

4.3.1.1.3 The diamond cone shall have an included angle of (120 ± 0,35)°.

Deviations from the straightness of the generatrix of the diamond cone, adjacent to the blend, shall not exceed 0,002 mm over a minimum length of 0,4 mm.

4.3.1.1.4 The angle between the axis of the diamond cone and the axis of the indenter-holder (normal to the seating surface) shall not exceed 0,5°.

4.3.1.1.5 The tip of the indenter shall be spherical. Its radius shall be determined from single values, measured in the axial section planes defined in 4.3.1.1.2. The distance between the concentric circles shall be no more than 0,004 mm. Each single value shall be within (0,2 ± 0,015) mm. The mean value out of at least four single values shall be within (0,2 ± 0,01 mm).

NOTE 1 The radius can be obtained by determining the intersection of two segments of the concentric circles.

NOTE 2 The single value is the mean value of the two radii of the concentric circles.

4.3.1.2 Indirect verification

NOTE The hardness values given by the testing machine depend not only on the dimensions given in 4.3.1.1.3 and 4.3.1.1.5, but also on the surface roughness and the position of the crystallographic axes of the diamond, and the seating of the diamond in its holder.

To examine this influence, the indirect verification of the indenter shall be performed on four reference blocks which shall be calibrated for the hardness levels given in Table 1 or on blocks giving equivalent total depths of indentation.

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 ± 0,8 Rockwell unit. The indentations made with the indenter to be verified and with that of the reference indenter should be adjacent.

The hardness testing machines used for this indirect verification shall comply with the following tolerances for the test forces:

F_0: ± 1,0 %

F : ± 0,5 %

The test shall be performed in accordance with ISO 6508-1.

4.3.2 Ball indenters (scales B, E, F, G, H, K, T) (steel or hardmetal)

4.3.2.1 For the purpose of verifying the size and the hardness of the balls, one sample selected at random from a batch shall be tested. The ball(s) verified for hardness shall be discarded.

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

4.3.2.3 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.

4.3.2.3.1 The diameter, measured at no less than three positions, shall not differ from the nominal diameter by more than the tolerance given in Table 2.

Table 2 — Tolerances for the different ball diameters

Dimensions in millimetres

Rockwell hardness scale	Ball diameter	Tolerance
B	1,587 5	± 0,003 5
F	1,587 5	± 0,003 5
G	1,587 5	± 0,003 5
T	1,587 5	± 0,003 5
E	3,175	± 0,004
H	3,175	± 0,004
K	3,175	± 0,004

4.3.2.3.2 The hardness of 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 as given in annex B of ISO 6507-1:1997 (see Table 3).

4.3.2.3.3 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 (see Table 3);

— 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 %

Table 3 — Values of mean diagonal (HV) for the determination of the hardness of ball indenters

Dimensions in millimetres

Ball diameter	Maximum value of mean diagonal made on the ball with a Vickers indenter at 98,07 N (HV 10)	
	Steel ball	Hardmetal ball
3,175	0,153	0,109
1,587 5	0,150	0,107

4.4 Calibration of the depth-measuring device

4.4.1 The depth-measuring device shall be calibrated over no less than three intervals, including the intervals corresponding to the lowest and highest hardness for which the scales are normally used, by making known incremental movements of the indenter in the direction of increasing hardness values.

4.4.2 The instrument used to verify the depth-measuring device shall have an accuracy of 0,000 2 mm. The depth-measuring device shall correctly indicate within ± 0,001 mm for scales A to K and within ± 0,000 5 mm for scales N and T, i. e. within ± 0,5 of a scale unit, over each range.

4.4.3 If it is not possible to verify directly the depth-measuring device, a modified indirect verification can be made by the hardness test with reference blocks and with a reference indenter (see 5.2).

4.5 Verification of the testing cycle

The testing cycle shall conform to the testing cycle given in ISO 6508-1 and shall be timed with an uncertainty less than ± 0,5 s.

5 Indirect verification

5.1 General

Indirect verification shall be carried out at a temperature of (23 ± 5) °C by means of reference blocks calibrated in accordance with ISO 6508-3. If the verification is made outside of this temperature range, this shall be reported in the verification report.

5.2 Procedure

5.2.1 For the indirect verification of a testing machine, the following procedures shall be applied.

The testing machine shall be verified for each scale for which it shall be used. For each scale to be verified, reference blocks from the three hardness ranges given in Table 4 shall be used. The hardness values of the blocks shall be chosen to approximate the limits of the intended use.

5.2.2 For purposes of routine checking, a hardness testing machine may be checked at one hardness value only, corresponding approximately to that of the tests to be made.

5.2.3 On each reference block, five indentations shall be uniformly distributed over the test surface and each hardness number observed to within 0,2 of a scale unit. Before making these indentations, at least two preliminary indentations shall be made to ensure that the machine is working freely and that the reference block, the indenter and the anvil are seated correctly. The results of these preliminary indentations shall be ignored. The test shall be made in accordance with ISO 6508-1.