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Kovinski materiali - Preskus trdote po Rockwellu - 2. del: Preverjanje in umerjanje naprav za preskušanje (ISO/DIS 6508-2:2022)

Metallic materials - Rockwell hardness test - Part 2: Verification and calibration of testing machines and indenters (ISO/DIS 6508-2:2022)

Metallische Werkstoffe - Härteprüfung nach Rockwell - Teil 2: Überprüfung und Kalibrierung der Prüfmaschinen und Eindringkörper (ISO/DIS 6508-2:2022)

Matériaux métalliques - Essai de dureté Rockwell - Partie 2: Vérification et étalonnage des machines d'essai et des pénétrateurs (ISO/DIS 6508-2:2022)

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Metallic materials — Rockwell hardness test —

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

Matériaux métalliques — Essai de dureté Rockwell —

Partie 2: Vérification et étalonnage des machines d'essai et des pénétrateurs

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 3, *Hardness testing*.

This third edition cancels and replaces the first edition (ISO 6508-2:2005), which has been technically revised.

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

— *Part 1: Test method*

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

— *Part 3: Calibration of reference blocks*

Metallic materials — Rockwell hardness test —

Part 2:
Verification and calibration of testing machines and indenters

1 Scope

This part of ISO 6508 specifies two separate methods of verification of testing machines (direct and indirect) for determining Rockwell hardness in accordance with ISO 6508-1, together with a method for verifying Rockwell hardness indenters.

The direct verification method is used to determine whether the main parameters associated with the machine function, such as applied force, depth measurement, and testing cycle timing, fall within specified tolerances. The indirect verification method uses a number of calibrated reference hardness blocks to determine how well the machine can measure a material of known hardness.

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 stationary and portable hardness testing machines.

Attention is drawn to the fact that the use of tungsten carbide composite for ball indenters is considered to be the standard type of Rockwell indenter ball. Steel indenter balls may continue to be used only when complying with the Special HR30TSm and HR15TSm test for thin products of ISO 6508-1, .

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6508-3, *Metallic materials — Rockwell hardness test — Part 3: Calibration of reference blocks*

3 General conditions

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

Especially, it should be checked that the test force can be applied and removed without shock, vibration, or overload and in such a manner that the readings are not influenced.

4 Direct verification of the testing machine

4.1 General

4.1.1 Direct verification involves calibration and verification of the following:

a) test forces;

b) depth-measuring system;

c) testing cycle;

d) machine hysteresis test.

4.1.2 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.

4.1.3 The instruments used for calibration shall be traceable to national standards.

4.1.4 An indirect verification according to Clause 5 shall be performed following a successful direct verification.

4.2 Calibration and verification of the test force

4.2.1 Each 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 not less than three positions of the plunger spaced throughout its range of movement during testing. For testing machine designs where the force is not influenced by the position of the plunger, e.g. controlled loading systems with closed-loop control, the test force can be calibrated in one position. The preliminary test force shall be held for at least 2 s.

4.2.2 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.

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

— by means of a force-proving device according to ISO 376 class 1 or better and calibrated for reversibility;

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

Evidence should be available to demonstrate that the output of the force-proving device does not vary by more than 0,2 % in the period 1 s to 30 s following a stepped change in force.

4.2.4 A relative error value, expressed as a percentage, shall be calculated for each measured force by the general Formula (1)

$$\Delta F_{\mathrm{rel},i,j} = 100 \times \frac{F_{i,j} - F_{\mathrm{RS}}}{F_{\mathrm{RS}}} \quad (1)$$

where $\Delta F_{\mathrm{rel},i,j}$ is the relative error of each force measurement value, $F_{i,j}$, (whether it is a preliminary force value, F_0, or the total force value, F) with respect to the reference force value, F_{RS}, to be measured. The indices i and j of the force measurement value, $F_{i,j}$ indicate the j-th force measurement at the i-th plunger height position.

4.2.5 The maximum permissible relative error on each measurement of the preliminary test force, F_0, (before application and after removal of the additional test force, F_1) as calculated by Formula (1) shall be ±2,0 %,. The range of all force measurements (highest value minus lowest value) shall be ≤ 1,5 % of F_0.

4.2.6 The maximum permissible relative error on each measurement of the total test force, F, as calculated by Formula (1), shall be ±1,0 %. The range of the force measurements (highest value minus lowest value) shall be ≤ 0,75 % of F.

4.3 Calibration and verification of the depth-measuring system

4.3.1 The depth-measuring system shall be calibrated by making known incremental movements of the indenter or the indenter holder.

4.3.2 The instrument or gauge blocks used to verify the depth-measuring system shall have a maximum expanded uncertainty of 0,000 3 mm when calculated with a 95 % confidence level.

NOTE The use of gauge blocks to verify the depth measuring system may not be appropriate for all types of Rockwell hardness machines.

4.3.3 Calibrate the testing machine's depth measurement system at not less than four evenly spaced intervals covering the full range of the normal working depth for the required scales to be calibrated in the testing machine. Three cycles of depth readings shall be taken over the evenly spaced intervals of the depth measuring system.

NOTE The maximum depth required for each scale is different, ranging from 0,25 mm for Rockwell Regular scale B to 0,04 mm for Rockwell Superficial scale 15N.

4.3.4 Some testing machines have a long-stroke depth measuring system where the location of the working range of the depth measuring system varies to suit the sample. This type of testing machine shall be able to electronically verify that the depth measuring device is continuous over the full range. These types of testers shall be verified using the following steps:

a) At the approximate top, midpoint, and bottom of the total stroke of the measuring device, verify the depth measurement system at no less than four evenly spaced intervals of approximately 0,05 mm at each of the three locations.

b) Operate the actuator over its full range of travel to monitor whether the displacement measurement is continuous. The displacement indication shall be continuously indicated over the full range.

4.3.5 Calculate the difference, $\Delta L_{i,j}$, between each depth measurement value, $L_{i,j}$. and the reference value of the calibration device, L_{RS}, in accordance with the general Formula (2):

$$\Delta L_{i,j} = L_{i,j} - L_{RS} \tag{2}$$

The indices i and j of the depth measurement value, $L_{i,j}$ indicate the j-th depth measurement at the i-th interval of the depth measuring system.

The depth-measuring system shall correctly indicate within ±0,001 mm for the 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 Calibration and verification of the testing cycle

4.4.1 The testing cycle is to be calibrated by the testing machine manufacturer at the time of manufacture and when the testing machine undergoes repair which may have affected the testing cycle. Calibration of the complete testing cycle is not required as part of the direct verification at other times, see Table 10.

4.4.2 The testing cycle shall conform to the testing cycle defined in ISO 6508-1.

4.4.3 For testing machines that automatically control the testing cycle, the measurement uncertainty ($k = 2$) of the timing instrument used to verify the testing cycle shall not exceed 0,2 s. It is recommended that the measured times for the testing cycle, plus or minus the measurement uncertainty ($k = 2$) of the calibration measurements, not exceed the timing limits specified in ISO 6508-1.

4.4.4 For testing machines that require the user to manually control the testing cycle, the testing machine shall be verified to be capable of achieving the defined testing cycle.

4.5 Calibration and verification of the machine hysteresis

4.5.1 The machine shall be checked to ensure that the readings are not affected by a hysteresial flexure of testing machine components (e.g. frame, specimen holder, etc.) during a test. The influence of any hysteresis behaviour shall be checked by making repeated hardness tests using a spherical indenter of at least 10 mm diameter, bearing directly against the specimen holder or through a spacer such that no permanent deformation occurs. A parallel block placed between the indenter holder and the specimen holder may be used instead of a blunt indenter. The material of the blunt indenter and of the spacer or parallel block shall have a hardness of at least 60 HRC.

4.5.2 Perform repeated Rockwell tests using the setup defined in 4.5.1. The tests shall be conducted using the Rockwell scale with the highest test force that is used during normal testing. Repeat the hysteresis verification procedure for a maximum of 10 measurements and average the last three tests.

4.5.3 The average of the last three tests shall indicate a hardness number of (130 ± 1,0) Rockwell units when the regular Rockwell ball scales B, E, F, G, H, and K are used, or within (100 ± 1,0) Rockwell units when any other Rockwell scale is used.

5 Indirect verification of the testing machine

5.1 General

5.1.1 Indirect verification involves the calibration and verification of the testing machine by performing tests on reference blocks.

5.1.2 Indirect verification should 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 will be used. For each scale to be verified, reference blocks from each of the hardness ranges given in Table 1 shall be used. The hardness values of the blocks shall be chosen to approximate the limits of the intended use. It is recommended to perform the same test cycle used when the reference blocks were calibrated.

Only the calibrated surfaces of the test blocks are to be used for testing.

5.2.2 On each reference block, a minimum of five indentations, made in accordance with ISO 6508-1, shall be uniformly distributed over the test surface and each hardness number observed to within 0,2 HR 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 specimen holder are seating correctly. The results of these preliminary indentations shall be ignored.

Table 1 — Hardness ranges for different scales

Rockwell hardness scale	Hardness range of reference block	Rockwell hardness scale	Hardness range of reference block
A	20 to 40 HRA 45 to 75 HRA 80 to 95 HRA	K	40 to 60 HRKW 65 to 80 HRKW 85 to 100 HRKW
B	10 to 50 HRBW 60 to 80 HRBW 85 to 100 HRBW	15N	70 to 77 HR15N 78 to 88 HR15N 89 to 94 HR15N
C	10 to 30 HRC 35 to 55 HRC 60 to 70 HRC	30N	42 to 54 HR30N 55 to 73 HR30N 74 to 86 HR30N
D	40 to 47 HRD 55 to 63 HRD 70 to 77 HRD	45N	20 to 31 HR45N 32 to 61 HR45N 63 to 77 HR45N
E	70 to 77 HREW 84 to 90 HREW 93 to 100 HREW	15T	67 to 80 HR15TW 81 to 87 HR15TW 88 to 93 HR15TW
F	60 to 75 HRFW 80 to 90 HRFW 94 to 100 HRFW	30T	29 to 56 HR30TW 57 to 69 HR30TW 70 to 82 HR30TW
G	30 to 50 HRGW 55 to 75 HRGW 80 to 94 HRGW	45T	10 to 33 HR45TW 34 to 54 HR45TW 55 to 72 HR45TW
H	80 to 94 HRHW 96 to 100 HRHW		

5.3 Repeatability

5.3.1 For each reference block, let H_1, H_2, H_3, H_4,.....H_n be the values of the measured hardness arranged in increasing order of magnitude.

The repeatability range, *r*, of the testing machine in Rockwell units, under the particular verification conditions, is determined by Formula (3):

$$r = H_n - H_1 \tag{3}$$

The mean hardness value of all indentations $\overline{H}$ is defined according to Formula (4):

$$\overline{H} = \frac{H_1 + H_2 + H_3 + H_4 + ... + H_n}{n} \tag{4}$$