INTERNATIONAL

RECOMMENDATION

OIML R 12

Edition 1974 (E)

Verification and calibration of ‘Rockwell C’ hardness standardized blocks

(intended for the calibration of Rockwell C system testing machines for the hardness of materials)

Vérification et étalonnage des blocs de référence de dureté "Rockwell C"

(destinés au tarage des machines d'essai dans le système Rockwell C de la dureté des matériaux)

OIML R 12 Edition 1974 (E)

ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

Foreword

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Bureau International de Métrologie Légale
11, rue Turgot - 75009 Paris - France
Telephone: 33 (0)1 48 78 12 82 and 42 85 27 11
Fax: 33 (0)1 42 82 17 27
E-mail: biml@oiml.org
Internet: www.oiml.org

* *Note*: This publication is now under the responsibility of TC 10/SC 5 "*Hardness standardized blocks and hardness testing machines*".

VERIFICATION AND CALIBRATION OF 'ROCKWELL C' HARDNESS STANDARDIZED BLOCKS

FIELD OF APPLICATION

The present specifications apply to the verification and calibration of 'hardness standardized blocks' intended for the calibration of "Rockwell C" system testing machines for hardness of materials.*

CHAPTER A
CONSTRUCTION REQUIREMENTS

1 Materials

1.1. The standardized blocks must be made of a material of which the homogeneity and the stability over a period of time (ageing) are known ;

if this material is ferro-magnetic, the blocks must be demagnetised.

2 Form

2.1. The blocks must have two plane parallel surfaces, one of which will be used as a test surface, and the other as a supporting surface.

2.2. They must be at least 6 millimetres thick.

2.2.1. The parallelism of the two surfaces must be such that the thickness of the block does not vary by more than 0.010 mm per 50 mm of length in all directions,

errors in the flatness of each surface must not exceed 0.005 mm

the roughness of the test surface must not exceed $R_a = 0.3$ µm,

these conditions are not compulsory within a 1 mm margin around the edge of the block.

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* Note

The present Recommendation in no way prejudges decisions to be made about legal units of measurements for forces and for their application in the different "hardness systems".

At present, these systems use : the kilogram-force or its equivalent the kilopond,

1 kilogram-force (kgf) = 1 kilopond (kp) = 9.80665 newtons (N).

Translator's Note The Sl derived unit, with special name, for force is the newton (symbol N) (equivalent in terms of SI base units to $m.kg.s^{-2}$). The units kilogram-force and kilopond are from the 'technical metric system'.

2.3. The supporting surface must have a fine ground finish.

2.4. The test surface must not be spoiled by any deterioration or defect likely to affect the measurement of the indentations.

3 Markings

3.1. On one of the side surfaces of each standardized block, the manufacturer must indicate :

3.1.1. his name or his mark,

3.1.2. the manufacturing number,

3.1.3. the initials HRC — indicating that it is a Rockwell C hardness standardized block.

A free space must be kept in front of the initials HRC for a 4-digit number for inserting the hardness index determined during calibration.

3.1.4. The above markings must be applied in such a way that the test surface is on top when the letters are vertical and in normal reading position.

Note : one of the side surfaces must have a free space for the application of the verification stamp.

CHAPTER B

HARDNESS CHARACTERISTICS

4 Hardness index

4.1. The HRC hardness index of a block is defined as the arithmetic mean value of 5 indentations carried out with a standard Rockwell C system testing machine, and uniformly distributed over the whole test surface.

5 Repeatability of hardness

5.1. The repeatability of hardness is defined as the value expressed in Rockwell units of the difference between the largest and the smallest of the [*] remaining depths of penetration of the 5 indentations.

5.2. The relative repeatability of hardness is defined as the ratio, expressed in %, of the above defined value which indicates the repeatability of hardness to the value expressed in Rockwell units of the arithmetic mean, $\bar{e}$, of the remaining depths of penetration, e, of the 5 indentations.

5.2.1. The relative repeatability must not exceed 1.5 %.

6 Stability of hardness

6.1. The stability over a period of time of the hardness of the block must be such that, during the 2 year period between two successive periodic verifications the hardness index of the block does not vary by more than ± 1.5 % with respect to the initial index determined at the first calibration.

In all other cases, the stability is inadequate.

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[*] *Translator's Note* The 'remaining depth of penetration' is the increase in the depth of penetration of the indenter after it has been subjected to the test load and while it is still subject to the support load, compared with the initial penetration while it is subject to the support load and before it has been subjected to the test load.
This is defined as "e" in the Annex.

CHAPTER C

INSTRUCTIONS ON CALIBRATION

7 Calibration

7.1. The calibration of hardness standardized blocks must be carried out with a standard testing machine in which the support force(**) and the test force(**), the form of the indenter and the device for measuring the depth of the indentations can be checked by direct measurements(*).

7.2. The support force and the test force must be applied by means of weights, the mass of which is adjusted according to the values of these forces ;

they must be accurate to within ± 0.1 %.

7.3. The forces must be applied and withdrawn without shock.

The mechanism controlling the application of these forces must have either :

(a) a device for reducing the speed of penetration, or

(b) a regulating device for keeping the speed of penetration constant.

In machines of the first type, the initial speed of the indenter, before it penetrates the block, must not exceed 1 mm/s,

in machines of the second type, the speed of penetration must be between 0.003 and 0.012 mm/s.

7.4. The apparatus for measuring the depth of the indentations must allow the vertical displacements of the indenter to be measured with an accuracy of ± 0.1 Rockwell unit (± 0.0002 mm).

7.5. The indenter must be a diamond, in the shape of a right cone with a circular base ; the apex angle of the cone must be 120 ° and must not vary from this value in each axial cross-section plane by more than ± 0.1°,

the apex of the cone must be in the shape of a spherical tip with a radius of 0.2 mm with an accuracy of ± 0.002 mm (dimensional tolerance and form tolerance) ;

the conical surface must join the spherical tip tangentially.

The surface must be highly polished and have no faults nor cracks.

7.5.1. The axis of the cone must coincide with the axis of the indenter mounting to within 0.3 °.

7.5.2. The indenter must be related to the international reference base for Rockwell C hardness through a practical test.

(*) This machine must moreover allow by the appropriate correction the relation of its results to the international reference base for Rockwell C hardness as soon as this is fixed.

(**) *Translator's Note* The ‘support force’ is referred to as the ‘preliminary load’ in ISO Recommendation R.674 - 1968.

The ‘test force’ is referred to as the ‘additional load’ in ISO Recommendation R.674 - 1968.

8 Making the measurement

8.1. The tests are carried out at a temperature of (20 ± 2) °C in temperate climates and (27 ± 2) °C in tropical climates.

8.2. Apply the support force, which must remain constant, for 10 to 20 seconds,

take, as quickly as possible, the initial reading 10 of the device for measuring depths of penetration (to ± 0.1 scale divisions).

apply the test force, which must remain constant, for 30 to 35 seconds,

withdraw the test force,

take, as quickly as possible, the final reading 1 of the device for measuring depths (to ± 0.1 scale divisions).

8.3. The hardness index is calculated from the indications of the standard testing machine used.*

* When the international reference base for Rockwell C hardness has been fixed, corrections, valid during the test, will be made to the results obtained in order to relate them to this Base.

CHAPTER D

LIABILITY TO METROLOGICAL CONTROLS

9 Metrological controls

When, in any country, hardness standardized blocks are submitted to State metrological controls, these must include, according to the internal legislation of that country, all or some of the following :

9.1. Pattern approval

Each pattern of hardness standardized block from each manufacturer will be subject to the pattern approval procedure.

Without special authorization, no modification may be made to an approved pattern.

9.2. Initial verification and calibration

New hardness standardized blocks must undergo the initial verification tests at the time when their hardness index is determined by calibration.

9.3. Periodific verifications

During these it will be ascertained whether the standardized blocks have retained their specified properties.

9.4 . The control procedures will be fixed by the national regulations of each country.

10 Marking the hardness index

10.1. The hardness index determined during calibration will be marked by the verification and calibration Service in the free space provided in front of the initials HRC on one of the side surfaces (Paragraph 3.1.3.)

11 Control marks

11.1. A control mark as proof of verification and calibration will be applied in the appropriate free space on one of the side surfaces (see Note page 5).

11.2. A guarantee mark will also be applied on the test surface in such a position that it does not interfere with the use of the block but will indicate that the surface has not been ground subsequently.

CHAPTER E

USE AND STORAGE

12 Use

Only the test surface may be used for indentations.

13 Storage

The standardized blocks must be carefully stored and protected against any damage or deterioration, both of the test surface and of the supporting surface.

ANNEX

Example of repeatability requirement

(See Chapter B)

Mean of the remaining depths of penetration of the indentations in units of the Rockwell scale	Hardness index of the block HRC*	Repeatability requirement in units of the Rockwell scale
35	65	0.5 (1.5 %)
40	60	0.6
45	55	0.7
65	35	1.0
70	30	1.0
80	20	1.2

* HRC = $100 - \bar{e}$

$\bar{e}$ = arithmetic mean of the remaining depths of penetration 'e' of 5 indentations, expressed in units of the Rockwell scale (0.002 mm).

e = remaining depth of penetration, which is the increase in the penetration of the indenter, after it has been subjected to the test load and while it is still under the support load.

The indentations are made with a conical diamond indenter under an initial support load of 10 kgf applied for 10-20 s, then increased by a test load of 140 kgf applied for 30-35 s.

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