

INTERNATIONAL
RECOMMENDATION

OIML R 9

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Verification and calibration of 'Brinell' hardness
standardized blocks

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

Vérification et étalonnage des blocs de référence de dureté "Brinell"
(destinés au tarage des machines d'essai dans le système Brinell de la dureté des matériaux)



Foreword

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VERIFICATION AND CALIBRATION OF 'BRINELL' HARDNESS STANDARDIZED BLOCKS

FIELD OF APPLICATION

The present specifications apply to the verification and calibration of "hardness standardized blocks" intended for the calibration of "Brinell" system testing machines for the 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. The thickness, flatness and roughness of the test surface, and the parallelism of the two surfaces, must satisfy the conditions given in the table below.

Nominal diameter of the ball indenters	Minimum thickness of the block	Parallelism of the two surfaces mm / 50 mm	Test surface	
			Maximum error in flatness	Maximum roughness R _a
10 mm	16 mm	0.05	0.05 mm	0.3 μm
5	12	0.025	0.025	0.15
less than 5	6	0.010	0.005	0.15

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

^(*) Note

The present Recommendation in no way prejudices the decisions to be made about legal units of measurement 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 SI 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 HB - indicating that is is a Brinell hardness standardized block - followed by : the diameter in mm of the indenter, the value of the test force and the value in seconds of the duration of application of this force^(*).

A free space must be reserved in front of the initials HB for a 3 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 application of the verification stamp.

(*) For example: HB10/3000/30 = 10 mm ball pressed by a test force of 3000 kgf applied for 30 seconds.

CHAPTER B
HARDNESS CHARACTERISTICS

4 Hardness index

4.1. The HB hardness index of a block is defined as the arithmetic mean value of 5 or 8 indentations carried out with a standard Brinell system testing machine :

- 5 indentations if the area of the test surface is less than 100 cm²,
- 8 indentations if the area of the test surface is more than 100 cm²,

these indentations being uniformly distributed over the whole test surface.

4.1.1. Determination of this index will be effected while maintaining the test conditions - the diameter of the ball, the value of the test force^(*) (*) and its duration of application - indicated on the block (Paragraph 3.1.3).

5 Repeatability of hardness

5.1. The repeatability of hardness is defined as the value expressed in mm of the difference between the mean of the diameters of the largest and the mean of the diameters of the smallest of the 5 or 8 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 mm of the arithmetic mean of the means of the diameters of 5 or 8 indentations.

5.2.1. The relative repeatability of hardness must not exceed :

- 2% for a hardness index less than or equal to 225,
- 1% for a hardness index above 225.

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 :

- for an index less than or equal to 225 ± 2%
- for an index above 225 ± 1%

with respect to the initial index determined at the first calibration.

In all other cases the stability is inadequate.

(*) *Translator's Note* : The "test force" is referred to as the 'load' in ISO Recommendation R.726 - 1968.

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 test force, the form of the indenter and the device for measuring the indentations can be checked by direct measurements.

7.2. The test force must be applied by means of weights, the mass of which is adjusted according to the value of the force,
it must be accurate to within $\pm 0.1\%$.

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

The mechanism controlling the application of this force must be such that the approach speed of the indenter (immediately before its contact with the test surface) as well as its speed of penetration are less than 1 millimetre per second.

7.4. The microscope or the projector of the device intended to measure the indentations must be adjusted in such a way as to produce uniform illumination of the entire field of vision as well as maximum contrast between the indentation and the test surface.

The graduation and the accuracy of the device for measuring the diameters must satisfy the minimum conditions indicated in the table below :

Nominal diameter of the ball indenters mm	Measuring device	
	Value of the graduation division mm	Accuracy of the differences between readings corresponding to any two lines on the scale mm
10	0.002	± 0.002
5	0.002	± 0.002
less than 5	0.001	± 0.001

7.5. The indenters must be hardened spherical steel balls with a minimum hardness of 850 HV 10 ; the diameter of these balls must not vary by more than ± 0.001 mm from their nominal diameter (dimensional tolerance) ;

No part may be oval and the whole surface must be contained in an annular zone of tolerance with a width of 0.003 mm (form tolerance).

The surface must be highly polished and free from defects, wear or damage.

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. It is recommended that each indentation should be measured by at least two observers (and the mean of the results should be taken).

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. Periodic 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 HB marked 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 on 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)

Test conditions		Arithmetic mean of the mean diameters of the indentations \bar{d} mm	Hardness index of the standardized block HB*	Repeatability requirement	
Diameter of the ball indenter mm	Test force kgf			Maximum difference between the average mm	Equivalence in hardness HB
10	3000	3.05	400	0.030 (1%)	8
		3.83	250	0.038	5
		5.88	100	0.118 (2%)	4
5	750	1.53	400	0.015 (1%)	8
		1.92	250	0.019	5
		2.94	100	0.058 (2%)	4
2.5	187.5	0.76	400	0.008 (1%)	8
		0.96	250	0.009	5
		1.47	100	0.029 (2%)	4

$$* HB = 2 F / \pi D \left(D - \sqrt{D^2 - \bar{d}^2} \right)$$

\bar{d} = arithmetic mean, expressed in mm, of the mean diameters of 5 or 8 indentations

F = test load, expressed in kilogramm-force, applied for a specified time (in this case 3000 – 750 – 187.5 kgf applied for 30-35s)

the indentations are made with a spherical indenter with a diameter D (in this case 10 – 5 – 2.5 mm).

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