INTERNATIONAL

RECOMMENDATION

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Verification of identers for hardness testing machines

Systems: Brinell - Rockwell B, F,and T
Vickers - Rockwell C, A, and N

Vérification des pénétrateurs des machines d'essai de dureté

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ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

Foreword

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VERIFICATION

of INDENTERS for HARDNESS TESTING MACHINES

Scope.

This Recommendation deals with indenters used in hardness testing machines, subject to state metrological controls [(*)], and used to determine hardness on the Brinell, Vickers, Rockwell B, F, and T and on the Rockwell C, A, and N scales.

It sets forth :

the technical and metrological requirements and the verification instructions that are applicable to these indenters,

the administrative requirements that apply in full or in part to these indenters, together with requirements concerning their use.

— SECTION I —

TECHNICAL AND METROLOGICAL REQUIREMENTS

1. Materials.

1.1. Indenters for the Brinell and Rockwell B, F, and T systems must be made of steel with hardness equal to or greater than 850 HV10.

1.2. Vickers and Rockwell C, A, and N system indenters must be made of diamond.

2. Form.

2.1. Brinell system

Brinell system indenters must be balls with nominal diameters of one of the following values :
10, 5, 2.5, 2 [(**)], or 1 mm.

They must be polished and free from surface defects.

2.2. Vickers system

Vickers system indenters must be in the shape of a right pyramid with a square base and must have an angle of 136° between two opposite faces.

(*) See OIML Recommendations No. 37, 38, and 39.

(**) Some countries still use a diameter of 2 mm in place of 2.5 mm.

They must be polished over such a surface area that no unpolished part comes into contact with the material being tested when the indenter penetrates to a depth of 0.3 mm. The indenter must be free from cracks and wear.

2.3. Rockwell B, F, and T systems

Rockwell B, F, and T system indenters must be balls with a nominal diameter of 1.5875 mm (1/16").

Indenters must be polished and free of surface defects.

2.4. Rockwell C, A, and N systems

Rockwell C, A, and N system indenters must be in the shape of a right circular cone,
the angle of the tip must be 120°,
the tip of the cone must be rounded in the shape of a spherical dome with a radius of 0.2 mm.
The cone surface must joint to the surface of the spherical dome tangentially.

Indenters must be polished over a surface area such that, when the indenter penetrates to a depth of 0.3 mm, no unpolished part comes into contact with the material being tested.
The polished surface must be free from defects, cracks and wear.

3. Mounting.

3.1. Vickers and Rockwell C, A, and N system indenters must be so mounted that their geometrical axis coincides with that of the holder.

Brinell and Rockwell B, F, and T system indenters must be so mounted that their centre is on the geometrical axis of the holder.
The method of mounting used must ensure that the position of the indenter is not changed by the action of the maximum admissible force for the hardness testing system corresponding to the type of indenter involved.

3.1.1. Brinell and Rockwell B, F, and T system indenters may be mounted so that they can be interchanged [(*)].

3.1.2. Vickers and Rockwell C, A, and N system indenters must be mounted firmly in their holders.

3.2. The design of the holder must ensure that they remain firmly fixed in the pressure piston of the force mechanism of the testing machine, even under the action of the maximum permissible test force for the system involved.

3.2.1. When the mount is fitted with a shank, the shoulder at one end of this shank must be flat and perpendicular to the geometrical axis of the mount.
The dimensions of this shank must comply with the national requirements of each country.

4. Markings.

The manufacturer's name or trademark and the serial number of indenters for the Vickers and Rockwell C, A, and N hardness test methods must be marked on their holders.

(*) In this case these indenters must, in principle, be presented for verification in individual boxes. However, a number of indenters may be contained in a single box, provided that they all have the same nominal diameter, and are presented for verification at the same time.

5. Tolerances and maximum permissible errors.

5.1. Brinell and Rockwell B, F, and T spherical indenters

The diameters of Brinell and Rockwell B, F, and T system spherical indenters must not deviate from their nominal diameters by more than the values indicated in the following table :

System	Nominal diameter	Tolerance	Minimum hardness HV 10
	mm	mm	kgf/mm^2
Brinell	10	± 0.004	870
	5	± 0.004	882
	2.5	± 0.003	907
	(2)	± 0.003	920
	1	± 0.003	960
Rockwell B, F, and T	1.5875	± 0.0035	933

Note : This table also gives minimum hardness HV 10 for spherical indenters.

5.2. Vickers pyramidal indenters

5.2.1. The tolerance for the angle between two opposite faces of the indenter is ± 0.5°, the nominal value of the angle being 136° (see point 2.2).

5.2.2. The difference between the angles of inclination of any two faces of the indenter with respect to its axis must not exceed an absolute value of 0.5°.

5.2.3. If the four faces do not meet at the same point, the length of the edge between two opposing faces must not exceed 0.002 mm.

5.2.4. Each section perpendicular to the axis of the indenter must be a quadrilateral with angles which do not deviate from 90° by more than ± 0.5°.

5.2.5. The angle between the axis of the indenter and that of the holder must not exceed 0.5°.

5.2.6. The length of the shortest edge of the pyramid determines the diagonal of the largest imprint which can be produced with the indenter.

5.3. Rockwell C, A, and N conical indenters

5.3.1. The tolerance on the angle at the cone tip is ± 0.5°, the nominal angle being 120° (see point 2.4).

The tolerance on the radius of the spherical dome is ± 0.01 mm, with the nominal radius being 0.2 mm (see point 2.4).

Local deviations, not exceeding ± 0.002 mm, of the shape of the profile of the dome from that of the circumference at nominal radius are permissible. However, any such deviations must not hinder determination of the effective radius of the dome when it is observed with a total optical magnification of at least 150.

At the same magnification the lines of the cone profile should appear to be rectilinear and tangent to the profile of the dome.

5.3.2. The angle between the axis of the indenter and the axis of the holder must not exceed 0.5°.

5.3.3. The error in the indication of hardness for the Rockwell C system must not exceed ± 1 Rockwell C unit (0.002 mm) over the 30 HRC to 65 HRC range.

5.4. The tolerances and maximum permissible errors given in points 5.1. to 5.3.3. must be observed at the times of verification and, in service, between successive verifications.

—SECTION II —

VERIFICATION INSTRUCTIONS

6. Qualitative examination.

6.1. Freedom from surface defects, cracks, and signs of wear (points 2.1., 2.2., 2.3. and 2.4.) is checked with a stereoscopic microscope with a magnification of approximately 120.

6.2. The hardness (point 1.1.) of spherical indenters is checked, in keeping with the Vickers system, by sampling and using a test force of 98 N (10 kgf) [(*)].

6.3. On Vickers system indenters, if a verification certificate is requested (point 9.1.), it is necessary to measure the length of the shortest edge of the pyramid (point 2.2.).

6.4. On Rockwell C, A, and N system indenters, the surface of the cone must be examined to ensure that it is polished to a sufficient height (point 2.4.).

6.5. Holders for Vickers and Rockwell C, A and N indenters must carry the required markings (point 4).

6.5.1. When the indenter holder has a shank, the shoulder at the end of the shank should be checked for flatness and for perpendicularity with respect to the holder ; this should be done by detecting any gaps between mating surfaces by means of light that can be transmitted through the gaps.

In addition, when certain shank dimensions are specified in national standards, these must be verified by means of gauges (point 3.2.1.).

6.6. The indenter must be rotated about the axis of its holder to ascertain that the indenter axis coincides with that of its holder (point 3.1.),

given that :

for Vickers indenters, the bisector of the angle formed by two opposite edges of the pyramid is taken as the indenter axis,

and for Rockwell C, A, and N indenters, the bisector of the angle formed by any two opposite generators of the cone is taken as the indenter axis.

7. Dimensional examination.

7.1. Spherical indenters (Brinell and Rockwell B, F, and T)

For spherical indenters at least three different diameters must be measured with a comparator which must have a maximum permissible error not exceeding ± 0.001 mm.

7.1.1. If 10 or more interchangeable spherical indenters with the same nominal diameter are submitted together for verification (note to point 3.1.1.), the diameters of the batch can be checked on the basis of a 20 % sample.

(*) *Note :* This Recommendation uses the newton as the unit of force. Values are also given in kilogram-force (or in kiloponds).

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

7.2. Pyramidal indenters (Vickers)

For Vickers system indenters, the dihedral angles between opposite faces of the pyramid (point 5.2.) can be determined :

a) either by measuring the plane angles formed by the opposite edges of the pyramid — using a microscope or profile projector with a magnification of at least 100 — and then calculating from these the value of the dihedral angle ; the dihedral angle falls within the range 136° ± 0.5°, if the angle formed by two opposite edges lies within the limits 148° 07' ± 22' ;

b) or by direct measurement using other methods ;

c) the uncertainty of angle measurement must not exceed ± 6'.

7.2.1. The two angles formed by two pairs of opposite faces must be equal to within ± 0.5° (point 5.2.2.).

7.2.2. The length of any edge joining two opposite faces (point 5.2.3.) must be observed under a magnification of at least 200.

7.3. Conical indenters (Rockwell C, A, and N)

For Rockwell C, A, and N system indenters the data determining the geometric form (point 5.3.) of the indenter cone must be obtained by measurement on at least four axial sections, using a microscope, a profile projector, or some other suitable method.

For measurement of the cone angle, an optical magnification of at least 100 is necessary ; for examination of the spherical dome, the magnification must be at least 150.

7.3.1. In determining the cone angle, the part of the generators more than 0.3 mm distant from the spherical end of the indenter is not taken into consideration (point 2.4.).

The median line of two opposite generators must coincide with the holder axis to within ± 0.5° (point 7.3.2.).

7.3.2. The uncertainty in angle measurements must not exceed ± 6’.

7.3.3. A check of overall operation (point 5.3.3.) is made with at least three hardness reference blocks that have hardness numbers in the 30 HRC - 65 HRC range and have the repeatability indicated in OIML International Recommendation No. 12.

The arithmetic means of the hardness numbers obtained with at least five indentations made on each reference block with the indenter being examined must be compared with the hardness numbers for these reference blocks, as determined with a standard indenter.

— SECTION III —

ADMINISTRATIVE REQUIREMENTS [*]

8. Stamping.

When the indenter is firmly fixed in its holder (Vickers and Rockwell C, A, and N : point 3.1.2. and, in certain cases, Brinell and Rockwell B, F, and T : point 3.1.1.), the verification mark is stamped on the holder.

9. Certificate of Verification.

9.1. A verification certificate can be issued on special request.

9.1.1. This certificate should certify only that the indenter meets the verification requirements, without giving detailed results of measurements made during verification.

9.1.1.1. However, this certificate should indicate :

a) for a Vickers indenter :

The mean value of the dihedral angle (arithmetic mean of the two angles formed by the two pairs of opposite faces) (point 7.2.).

b) for a Rockwell C, A, or N indenter :

The value of the cone angle (point 7.3.).

10. Invalidation of verification.

10.1. The verification loses its validity if it is found that the indenter has surface defects or any other form of deterioration.

10.2. Readjusted (or repolished) indenters must be submitted for reverification.

— SECTION V —

REQUIREMENTS CONCERNING USE

11. Use.

11.1. When mounting an indenter on a hardness testing machine, particular attention must be paid to the accuracy with which the holder is positioned in the pressure piston of the mechanism that applies the force [**].

11.2. Any indenter found to have surface defects or any other form of deterioration must be replaced, even if these defects or deteriorations appear insignificant.

(*) Applicable in full or in part to indenters subject to verification in accordance with national regulations.

(**) See OIML Recommendations No. 37, 38, and 39.

Contents