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RECOMMENDATION

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Verification of hardness testing machines
Brinell System

Vérifications des machines d'essai de dureté



Foreword

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OIML publications may be obtained from the Organization's headquarters:

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

VERIFICATION of HARDNESS TESTING MACHINES

Brinell System

0. Subject of the Recommendation.

This Recommendation deals with the verification of machines used to test hardness using the Brinell system and subject to state metrological controls.

It sets forth :

- the technical and metrological requirements and requirements concerning verification and supervision in service that are applicable to these hardness testing machines,
- the administrative requirements that apply fully or partially to these machines together with requirements concerning their installation.

— CHAPTER I —

TECHNICAL REQUIREMENTS

1. Description and terms.

Hardness testing machines must include the following devices :

support device	intended to support and, in certain cases, hold the test piece in place
positioning device	intended to bring the test piece into the test position
force application mechanism	intended to apply the test force to the test piece by means of the indenter
measuring device	intended to measure the diameter of test indentations produced by the indenter, after the test force has been removed.

2. Construction requirements.

2.1. General

2.1.1. The positioning device and the force application mechanism must be mounted together on a frame or similar structure.

The measuring device can be mounted together with the devices mentioned above or separately as an independent unit.

2.2. Support device

2.2.1. The support can include a flat surface or, when appropriate, a special device suitable for the test piece.

2.2.2. The construction of the support device must be such that the test piece rests firmly on its support and cannot shift during the test.

2.2.3. The support device must be mounted on the positioning device so that the surface to be tested on the test piece is perpendicular to the direction of the test force.

2.3. Positioning device

2.3.1. The test piece positioning device must be such that, during the positioning process and during the test, the surface to be tested of the test piece remains perpendicular to the direction of the test force.

2.3.2. If the positioning device includes a screw turned with a handwheel, then, during the lowering operation, the screw should move in its guide under its own weight, but with no appreciable play.

2.4. Force application mechanism

2.4.1. The force application mechanism can develop the test force by means of either weights or springs (it may be communicated by a mechanical or hydraulic system).

2.4.2. The test force can have the values given in the following table :

Indenter diameter mm	Test force (*) in N (kgf)				
10	29400 (3 000)	9800 (1000)	4900 (500)	2450 (250)	1225 (125)
5	7350 (750)	2450 (250)	1225 (125)	613 (62.5)	306,5 (31.25)
2.5	1839 (187.5)	613 (62.5)	306,5 (31.25)	153,2 (15.625)	76,6 (7.8125)
2 (**)	1 176 (120)	392 (40)	196 (20)	98 (10)	49 (5)
1	294 (30)	98 (10)	49 (5)	24,5 (2.5)	12,25 (1.25)

The value of the test force used must be clearly marked (on the force application mechanism).

2.4.3. The force application mechanism must be such that the test force can be applied and removed without shock or vibration.

The time required to increase the force from 0 to test-force level must be sufficiently long to avoid the risk of the applied force, because of inertial effects, exceeding the nominal test value by more than the maximum permissible error ; it should be between 5 and 8 seconds.

(*) 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).

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

2.4.4. The test force application mechanism must be capable of maintaining the force constant for specified time intervals in particular for 30 seconds.

2.4.5. The indenter must satisfy the requirements of OIML Recommendation No. 36.

2.4.6. The indenter must be mounted on the pressure element of the force application mechanism such that there can be no relative movement between these parts during the whole test.

2.5. Measuring device

2.5.1. The measuring device can be a measuring microscope or a projecting device suitable for measuring applications.

It must permit the measurement of the diameters of test indentations in millimeters or in micrometers.

2.5.2. The scale of the measuring device must be regular.

The width of the scale marks and of the pointer, or of direct-reading scale marks, must not exceed one tenth of the length of the scale division.

2.5.3. The length of the scale division must be at least 0.7 mm.

2.5.4. The value of the scale division and the width of the scale marks must be such that the maximum permissible error of $\pm 0.5 \%$ specified in point 5.1.2. is not exceeded when diameters of indentations are measured.

2.5.5. Measurement scale specifications for indenters of various diameters.

Diameter of indenter	Minimum range of measurement	Maximum value of scale division
mm	mm	mm
10	de 2.50 à 6.00	0.1
5	de 1.25 à 3.00	0.05
2.5	de 0.625 à 1.500	0.025
2 (*)	de 0.500 à 1.200	0.02
1	de 0.250 à 0.600	0.01

2.5.6. The illumination of the projection field of the measuring device must be uniform and sufficient to allow measurement of the diameters of test indentations with an accuracy commensurate with the maximum permissible errors for verification.

2.5.7. If the measuring device is mounted together with the other devices of the hardness testing machine, that is, on the same frame, etc., it must be located, in relation to the force application mechanism, such that the centre of test indentation coincides approximately with the centre of the projection field of the measuring device.

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

— CHAPTER II —
DESCRIPTIVE MARKINGS

3. Descriptive markings and stamping locations.

3.1. The following must be given on a descriptive plate :

- manufacturer's name or trademark
- pattern approval number, when appropriate
- serial number
- year of manufacture.

3.2. The serial number must be repeated on all detachable parts (weights, lenses, etc.).

3.3. The plate must be attached to the machine by a device on which the verification mark is stamped in such a way that the plate cannot be removed without affecting this mark.

3.4. The locations for stamping the protective marks must be specified at the time of pattern approval so as to prevent any tampering likely to change the metrological characteristics of the machine.

— CHAPTER III —
METROLOGICAL REQUIREMENTS

4. Reference temperature.

4.1. The reference temperature at which the maximum permissible errors must be observed (point 5) is $20\text{ °C} \pm 5\text{ °C}$.

A reference temperature of $27\text{ °C} \pm 5\text{ °C}$ may be used in tropical countries.

5. Maximum permissible errors.

5.1. Initial and periodic verification.

5.1.1. The maximum permissible error on the test force is $\pm 1.0\%$.

5.1.2. The maximum permissible error on the indications of the measuring device is $\pm 0.5\%$ of the length of the diameter to be measured.

5.1.3. Indenter

The indenter must satisfy the requirements of OIML Recommendation No. 36.

5.1.4. Maximum permissible error on the result.

5.1.4.1. The result (arithmetic mean of five measurements) of hardness measurement of a reference block ^(*), using the machine being verified, must not differ by more than $\pm 3.0\%$ from the corresponding value determined during calibration of this block.

^(*) See OIML International Recommendation No. 9.

5.1.4.2. The difference between the mean diameters of the maximum and minimum indentations — expressed as a percentage of the mean of the five mean diameters mentioned above — must not exceed the following values :

Reference block hardness HB	Max. value of the difference
Up to 225	4.0 %
Over 225	2.0 %

5.2. Maximum permissible errors in service

Maximum permissible errors in service, for results obtained, are the same as those given for initial and periodic verification (point 5.1.4.).

— CHAPTER IV —

VERIFICATION REQUIREMENTS

6. General examination.

6.1. The correct installation of the hardness testing machine must be checked.

6.1.1. The machine must be installed such that it is protected from shocks and vibrations.

6.1.2. For hardness testing machines where the test forces are obtained by the use of weights, it must be ensured that these forces are applied vertically ; if a control device is included (plumb line, level), it must make possible the correct positioning of the machine.

6.1.3. All parts of the hardness testing machine, in particular parts of the support device and the positioning device, must be clean and their contact surfaces must be free of dirt, oil, etc.

7. Examination of the support device.

7.1. For hardness testing machines where the test force is obtained by the use of weights, the flat surface of the plate must be located in a horizontal plane and its horizontality should be checked with a level.

7.2. In the case of a special support, it must be ensured that the surface of the test piece can be positioned in a plane perpendicular to the direction of the test force.

7.3. The supports for cylindrical test pieces must be constructed so that the upper generator of the cylinder, when the latter is positioned on the support, is perpendicular to the direction of the test force, the point of application of this force being on this generator.

8. Examination of the positioning device.

The functioning of the positioning device must be checked in accordance with point 2.3.

9. Examination of the force application mechanism.

9.1. The force application mechanism must satisfy the requirements of point 2.4.

9.2. The true value of the forces must be determined at their points of application by a method with a maximum error of $\pm 0.1 \%$.

9.2.1. The test force, transmitted to the pressure element by the force application mechanism, must be measured with the pressure element in three different positions :

at the beginning, mid-point, and end of the displacement range of this element ; these are between the position which it occupies when measuring a very hard test piece and its position when measuring a test piece of very low hardness (see point 11.1 for these extreme hardness values).

note : it must be ensured during the measurement of this test force that its direction is the same as that during an actual hardness measurement ^(*).

None of the test force measuring device (dynamometer) readings shall differ by 1.0 % or more from the nominal value of this force.

9.2.2. If several different test force values can be produced, each of these values must be checked in accordance with point 9.2.1.

10. Examination of the measuring device.

The following are verified :

10.1. Visually, the uniformity of the thickness of the graduation lines.

10.2. The accuracy of the measuring device at, at least, five points in the measurement range, by use of a stage micrometer.

10.3. The uniformity and intensity of the illumination of the projection field at, at least, three different points.

11. Check of the accuracy of the indications of hardness.

11.1. To check the correct functioning of the instrument and test the accuracy of its indications, a test must be carried out, at a specified value of force, on two calibrated reference blocks that have hardness values within the following limits :

- 100 - 200 HB for the first block
- 250 - 350 HB for the second block.

However, the averages of hardness of these blocks must differ by at least 100 HB.

^(*) Note : The influence of friction can be revealed by the change in dynamometer reading observed when the direction of the force application mechanism displacement is changed.

The value of the test force must be selected so that the size of the indentation permits measurement with an accuracy that clearly guarantees that the requirements of point 5.1.4. are satisfied.

11.1.1. Five measurements are made on each of the two reference blocks.

11.2. The hardness readings obtained during these two series of five measurements and the differences between the mean lengths of the diameters of the maximum and minimum indentations must meet the requirements of point 5.1.4.

— CHAPTER V —

ADMINISTRATIVE REQUIREMENTS ^(*)

Pattern approval - Verification – Supervision

12. Pattern approval.

Each pattern of hardness testing machine from each manufacturer shall be subject to the pattern approval procedure.

13. Verification of new or repaired instruments - Periodic verification.

13.1. Verification of new or repaired instruments

13.1.1. Verification is carried out at the place of manufacture (or repair), or at the place of installation (or use).

13.1.2. If verification was carried out at the place of manufacture (or repair), the machine must be verified again at the place of installation (or use) prior to use, in accordance with the requirements of point 15.

13.2. Periodic verification

Periodic verification is subject to national regulations. It is recommended that periodic verification be carried out every 2 years.

14. Stamping.

14.1. The verification mark is applied in such a manner that the descriptive plate cannot be removed without adversely affecting this mark.

14.2. Protective marks are applied in such a manner as to prevent any tampering likely to alter the metrological characteristics of the hardness testing machine.

^(*) Fully or partially applicable to hardness testing machines subject to verification within the framework of national regulations.

15. Supervision of instruments in service.

15.1. In the course of an inspection between periodic verifications, the correct operation of a hardness testing machine in service can be checked by means of verified hardness reference blocks ^(*). The maximum permissible errors in service (point 5.2.) must not be exceeded.

15.1.1. The accuracy test must be carried out in accordance with the requirements of point 11.

15.2. If maximum permissible errors in service are exceeded during this test, the hardness testing machine no longer satisfies requirements.

The reasons for the unsatisfactory functioning can be ascertained by successive examination of the various devices of the machine, in accordance with the requirements of points 6 to 10.

16. Obliteration of verification mark.

When the maximum permissible errors in service (point 5.2.) are exceeded in the course of an inspection, the verification mark on the machine loses its validity and must be obliterated.

— CHAPTER VI —

REQUIREMENTS CONCERNING USE

17. Installation.

The hardness testing machine must be installed so that it is protected from shocks and vibrations.

18. Indenters ^().**

18.1. Only indenters which have been verified individually or by sampling must be used. Indenters must be replaced when any defects are visible.

18.2. Special care must be taken when mounting an indenter in the pressure element.

^(*) See OIML International Recommendation No. 9.

^(**) See OIML Recommendation No. 36.

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