INTERNATIONAL

RECOMMENDATION

OIML R 39

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Verification of hardness testing machine

Rockwell systems B, F, T
C, A, N

Vérification des machines d'essai de dureté

OIML R 39 Edition 1981 (E)

ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

Foreword

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VERIFICATION of HARDNESS TESTING MACHINES

Rockwell systems B, F, T

C, A, N

0. Subject of the Recommendation.

This Recommendation deals with the verification of machines used to test hardness using the Rockwell B, F, T, C, A, and N systems and subject to state metrological control.

It sets forth :

— the technical and metrological requirements and the 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
positioning device	intended to bring the test piece into the test position
force application mechanism	intended to apply the initial and additional forces to the test piece by means of the indenter
measuring device	intended to measure the permanent increase in the depth of the indentation produced by the indenter

2. Construction requirements.

2.1. General

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

2.1.2. Locking device

To avoid the influence, on the measurements, of elastic deformation of the frame, etc. by the forces, the machine may include a device which locks the test piece against the upper part of the frame by developing a locking force greater than the forces applied during the test.

2.2. Support device

2.2.1. The support can include a flat surface or, when appropriate, a special device suitable to 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 on the test piece remains perpendicular to the direction of the test force.

Deformation of the frame must not appreciably affect measurement results. Deformation can be reduced by use of a locking device. The effect of frame deformation is checked by replacing the Rockwell indenter with a dummy indenter with a flat surface which is applied directly to the support, as is done during a normal test. Differences between readings before application and after removal of the additional force must not exceed :

1.5 Rockwell units when not using a locking device and

0.5 Rockwell units when using a locking device.

The correctness of the dummy indenter position as well as of the support must be checked by several preliminary tests.

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 initial and additional test forces by means of either weights or springs (they may be communicated by a mechanical or hydraulic system).

2.4.2. Applied forces [*]

Rockwell	Initial force N (kgf)	Additional force N (kgf)	Total force N (kgf)
C	98 (10)	1372 (140)	1470 (150)
A	98 (10)	490 (50)	588 (60)
B	98 (10)	828 (90)	980 (100)
F	98 (10)	490 (50)	588 (60)
15 N	29.4 (3)	117.6 (12)	147 (15)
15 T	29.4 (3)	117.6 (12)	147 (15)
30 N	29.4 (3)	264.6 (27)	294 (30)
30 T	29.4 (3)	264.6 (27)	294 (30)
45 N	29.4 (3)	411.6 (42)	441 (45)
45 T	29.4 (3)	411.6 (42)	441 (45)

These values must be clearly marked on the force application mechanism.

2.4.3. The force application mechanism must be such that the initial force and the total force can be applied and removed without shock or vibration and can be held constant for the specified time interval corresponding to the applicable Rockwell system.

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

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

2.4.5. 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.

[*] 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).

2.5. Measuring device

2.5.1. The measuring device can be a dial indicator or any other similar device ; mechanical, electrical, or optical transmission systems are acceptable.

It must permit the measurement, in Rockwell units [*], of the permanent increase in the depth of the indentations made by the indenter and it must indicate directly the Rockwell hardness of the test piece on the scale of the system to which the machine corresponds [**].

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 value of the scale division must not exceed one Rockwell unit ; the length corresponding to one Rockwell unit must be at least 1.5 mm.

2.5.4. Scale numbering must be in Rockwell hardness numbers.

— 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, 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 characterictics of the machine.

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[*] Rockwell unit = 0.002 mm for systems C, A, B, and F
0.001 mm for systems N and T

[**] Rockwell hardness : 130 — e for system B
100 — e for systems C, A, N, F, and T,
where e is the permanent increase in the depth of the indentation expressed in the Rockwell units of the applicable system.

— 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 °C ± 5°C.

A reference temperature of 27 °C ± 5 °C may be used in tropical countries.

5. Maximum permissible errors.

5.1. Initial and periodic verification

5.1.1. Initial and total forces must satisfy the following conditions :

	— newtons —	— (kilogram-force) —
Initial force:	29.4 ± 0.6	(3 ± 0.06)
	98 ± 2	(10 ± 0.2)
Total force:	147 ± 1	(15 ± 0.1)
	294 ± 2	(30 ± 0.2
	441 ± 3	(45 ± 0.3)
	558 ± 5	(60 ± 0.5)
	980 ± 7	(100 ± 0.65)
	1470 ± 9	(150 ± 0.9)

5.1.2. Measuring device

The maximum permissible error on indications of the measuring device is ± 0.5 Rockwell units, that is,

± 0.001 mm for systems C, A, B, and F

± 0.0005 mm for systems N and T.

5.1.3. Indenter

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

Indenters for systems C, A, and N must be verified individually ; indenters for systems B, F, and T may be drawn from a lot verified by sampling (see OIML Recommendation No. 36, point 7.1.1.).

5.1.4. Maximum permissible error on the result

5.1.4.1. The result (arithmetic mean of 5 measurements) of the measurement, with the machine being verified, of the hardness of a standard hardness reference block [*], must not differ from the hardness value determined during calibration of this block by a value greater than those indicated hereafter :

[*] See OIML International Recommendations Nos. 11 and 12.

Rockwell system	nominal hardness of reference block	Maximum permissible error (Rockwell units)
C	from 20 to 55 inclusive from 55 exclusive to 70 inclusive	± 2.0 ± 1.5
A	from 60 to 78 inclusive from 78 exclusive to 88 inclusive	± 2.0 ± 1.5
15 N	from 66 to 92 inclusive	± 2.0
30 N	from 39 to 84 inclusive	± 2.0
45 N	from 17 to 75 inclusive	± 2.0
B	from 35 to 60 inclusive from 60 exclusive to 100 inclusive	± 3.0 ± 2.0
F	from 60 to 90 inclusive from 90 exclusive to 113 inclusive	± 3.0 ± 2.0
15 T	from 50 to 94 inclusive	± 3.0
30 T	from 10 to 84 inclusive	± 3.0
45 T	from 0 to 75 inclusive	± 3.0

5.1.4.2. The difference between the largest and the smallest values of the permanent increase in the depth of indentation observed during a series of five measurements must not exceed the following values :

Rockwell system	maximum permissible difference between extreme values of the permanent increase in depth of indentation
C	3.0 %
A	3.0 % or 1.0 HRA units
N	4.0 % or 1.2 HRN units
B	6.0 %
F	6.0 % or 2.0 HRF units
T	6.0 % or 2.4 HRT units

note : the relative values are referred to the mean for the series of measurements concerned. Where a relative value and an absolute value are given, the greater of the two is permissible.

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 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 forces are 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 forces, the point of application of the initial 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 ± 0.1 %.

9.2.1. Initial force must be determined :

1 — before application of the additional force :

by three measurements, with the depth measuring device and with the position of the pressure element corresponding to the beginning of a hardness measurement ;

2 — after application and then removal of the additional force :

(if the force measuring device used does not support the total force, only part of the additional force may be applied) ;

this measurement must be made for three positions of the pressure element that are uniformly distributed over the full range of indication of the depth measuring device.

For each of these measurements the requirements of point 5.1.1. concerning the nominal values of these forces and their tolerances must be observed.

9.2.2. The total force must be determined :

for three positions of the pressure element corresponding to the beginning, midpoint, and end of the effective read-out range of the depth measuring device and with the hardness testing machine operated under normal conditions of use.

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

For each of these measurements the requirements of point 5.1.1. concerning the nominal values of these forces and their tolerances must be observed.

10. Examination of the depth measuring device.

The depth measuring device may be examined by means of a precision instrument for which the error of indication, after correction, must not exceed ± 0.0002 mm.

1 1 . 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 for at least one of the Rockwell systems for which the instrument is intended.

This examination must cover at least three verified hardness reference blocks that have different values uniformly distributed over the full intended range of use of the Rockwell system concerned.

11.1.1. On each reference block two indentations must first be made, the results of which are not taken into account, and then five measurements are carried out.

11.2. The results of each of these measurements must satisfy the requirements of point 5.1.4.

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

— CHAPTER V —

ADMINISTRATIVE REQUIREMENTS [*]

Pattern approval - Verification - Supervision

12. Pattern approval.

Each pattern of hardness testing machine from each manufacturer shall be subj-ject 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. Initial 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.

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.

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[*] Fully or partially applicable to hardness testing machines subject to verification within the framework of national regulations.

[**] See OIML International Recommendations Nos 11 and 12 (for Rockwell system B and C reference blocks).

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. For Rockwell system C, A, and N hardness tests, only verified indenters may be used.

For Rockwell system B, F, and T hardness tests, indenters may be drawn from a lot verified by sampling.

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 Recommendation No. 36.

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