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VERIFICATION OF ROCKWELL SUPERFICIAL N AND T SCALE HARDNESS TESTING MACHINES

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BRIEF HISTORY

The ISO Recommendation R 1079, *Verification of Rockwell superficial N and T scale hardness testing machines*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of a Draft ISO Recommendation.

In January 1968, this Draft ISO Recommendation (No. 1354) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Austria	Greece	Poland
Belgium	Hungary	South Africa, Rep. of
Canada	India	Spain
Chile	Israel	Sweden
Colombia	Italy	Switzerland
Czechoslovakia	Korea, Rep. of	Thailand
Denmark	Netherlands	Turkey
France	New Zealand	U.A.R.
Germany	Norway	United Kingdom

Two Member Bodies opposed the approval of the Draft :

Romania
U.S.A.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in May 1969, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 1079 May 1969

VERIFICATION OF ROCKWELL SUPERFICIAL N AND T SCALE HARDNESS TESTING MACHINES

1. SCOPE

This ISO Recommendation applies to the verification of testing machines for determining Rockwell superficial hardness in accordance with ISO Recommendation R 1024, *Rockwell superficial hardness test (N and T scales) for steel*.

It describes the indirect method which is suitable for machines in service, and the direct method which is suitable for the initial verification of new machines by the manufacturer and for the verification of rebuilt machines.

2. DIRECT VERIFICATION

Direct verification involves

(*a*) verification of the load-applying mechanism (see clause 2.1),

(*b*) verification of the indenter (see clause 2.2),

(*c*) verification of the measuring device (see clause 2.3).

Before verification is carried out, certain details of the testing machine should be checked (see Annex A).

2.1 Verification of the load-applying mechanism

2.1.1 The verification of the load-applying mechanism at the required loads should be carried out either by means of standardized weights (masses) or by means of an elastic device or proving levers.

2.1.2 The preliminary load and each total load should be measured and, wherever possible, this should be done at not less than three positions of the plunger throughout its range of movement.

2.1.3 The loads should be measured by one of the following three methods :

(*a*) balancing against standardized weights (masses) accurate to ± 0.1 %;

(*b*) balancing against a load, accurate to ± 0.2 %, applied by means of standardized weights (masses) with mechanical advantage;

(*c*) measuring the applied load by means of the deformation of an elastic device which has been previously calibrated to an accuracy of ± 0.2 %.

2.1.4 Three readings should be taken for each load at each position of the plunger (see clause 2.1.2). Immediately before each reading is taken, the plunger should have been moved in the same direction as during testing.

2.1.5 Each reading of the preliminary load before application and after removal of the additional load should be

3.00 ± 0.06 kgf

Each reading of the total load should be

15.0 ± 0.1 kgf
30.0 ± 0.2 kgf
45.0 ± 0.3 kgf

2.2 Verification of the indenter

2.2.1 *N scale*

2.2.1.1 The verification of the form of the diamond cone can be made by direct measurement or by measurement of its projection on a screen. The verification should be made at not less than four sections.

2.2.1.2 The diamond cone should have an included angle of 120 ± 0.5° and should have its axis in line with the axis of the indenter within 0.5°. The tip of the cone should be spherical with a radius equal to 0.200 mm. The contour of the whole of the tip should not depart by more than 0.002 mm from the theoretical profile (see Figure, below). The surface of the cone should blend in a truly tangential manner with the surface of the spherical tip.

FIGURE

2.2.1.3 The hardness values given by the testing machine do not depend only on the dimensions given in clause 2.2.1.2, but also on the surface roughness and the position on the crystallographic axes of the diamond, and the seating of the diamond in its holder.

For this reason, a performance test is considered necessary. The indenter should be used in a standardizing machine, in which the load applied and the measuring device can be verified by fundamental measurement.

An indenter should be rejected if, during the performance test, the hardness values obtained differ by more than 1 Rockwell superficial unit (in the range 40 to 80 HR 30 N) from those of the standardized blocks calibrated with an accepted indenter.

2.2.2 *T scale*

2.2.2.1 For the purpose of verifying the size and hardness of the steel ball used in the indenter, it is considered sufficient to test a sample selected at random from a batch. The ball(s) tested for hardness should be discarded.

2.2.2.2 The balls should satisfy the following requirements :

(*a*) the diameter, when measured at not less than three positions, should not differ from the nominal diameter by more than ± 0.003 mm (± 0.00012 in);*

(*b*) the Vickers hardness of the balls should be not less than 850 HV 10 when measured in accordance with ISO Recommendation R 81,** *Vickers hardness test for steel*, and applying the appropriate correction for curvature as given in ISO Recommendation R 409, *Tables of Vickers hardness values (HV) for metallic materials*. The maximum value of the mean diagonal of the indentation made with a Vickers indenter at 10 kgf is therefore 0.141 mm for a 1.5875 mm (1/16 in) ball.

2.3 Verification of the measuring device

The depth-measuring device should be verified over not less than three ranges, including the ranges corresponding to the lowest and highest hardnesses for which the scales are normally used, by making known incremental movements of the indenter. The depth-measuring device should correctly indicate within ± 0.0005 mm, i.e. within ± 0.5 of a scale unit, over each range.

3. INDIRECT VERIFICATION

Indirect verification is carried out by means of standardized blocks calibrated in accordance with ISO Recommendation R . . . , *** *Calibration of standardized blocks to be used for Rockwell superficial N and T scale hardness testing machines*.

Before verification is carried out, certain details of the testing machine should be checked (see Annex A).

3.1 On each standardized metal block five indentations should be made and the hardness number observed to approximately 0.2 of a scale unit. Before making these indentations, at least two preliminary indentations should be made to ensure that the machine is working freely and that the standardized block, the indenter and the anvil are seating correctly. The results of these preliminary indentations should be ignored. The tests should be made in accordance with ISO Recommendation R 1024, *Rockwell superficial hardness test (N and T scales) for steel*.

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* This tolerance corresponds to Grade 6 of ISO Recommendation R 286, *ISO System of Limits and fits – Part I : General, Tolerances and Deviations*. Balls for ball bearings will normally satisfy this tolerance.

** 2nd edition, 1967.

*** At present Draft ISO Recommendation No. 1355.

3.2 For special purposes a hardness testing machine may be verified at one hardness value corresponding approximately to the tests to be made, but for general verification of a testing machine the following procedure should be adopted :

3.2.1 Of the six scales available, the 30 N and 30 T scales should be verified. In addition, two other scales should be verified. To ensure that all loads are used, these two scales should be one of the following combinations :

15 N and 45 N, or
15 N and 45 T, or
15 T and 45 T, or
15 T and 45 N

The 30 N and 30 T scales should each be verified by two standardized blocks, the four blocks required being chosen from the high range and low range of standardized blocks specified in clause 3.2.2 and 3.2.3 for the N scale and T scale respectively. The two other scales selected for verification should each be verified by two standardized blocks chosen from two of the ranges specified in clauses 3.2.2 and 3.2.3.

The selection of four scales and eight standardized blocks specified above is suggested as a minimum for the verification of a testing machine and other scales and standardized blocks may be added.

3.2.2 *N scale*

3.2.2.1 The testing machine should be verified using standardized blocks having hardnesses within each of the following hardness ranges :

68 to 75 HR 15 N
78 to 88 HR 15 N
89 to 94 HR 15 N

40 to 50 HR 30 N
55 to 73 HR 30 N
75 to 80 HR 30 N

17 to 31 HR 45 N
37 to 61 HR 45 N
63 to 70 HR 45 N

3.2.2.2 If the testing machine is to be used for determining Rockwell superficial hardness values less than 68 HR 15 N, 40 HR 30 N, or 17 HR 45 N, the machine should be verified using standardized blocks having a hardness approximately equal to that of the articles to be tested.

3.2.3 *T scale*

3.2.3.1 The testing machine should be verified using standardized blocks having hardnesses within each of the following hardness ranges :

73 to 80 HR 15 T
80 to 87 HR 15 T
87 to 93 HR 15 T

43 to 56 HR 30 T
57 to 70 HR 30 T
70 to 82 HR 30 T

12 to 33 HR 45 T
34 to 54 HR 45 T
54 to 72 HR 45 T

3.2.3.2 If the testing machine is to be used for determining Rockwell superficial hardness values less than 73 HR 15 T, 43 HR 30 T, or 12 HR 45 T, the machine should be verified using standardized blocks having a hardness approximately equal to that of the articles to be tested.

4. REPEATABILITY AND ERROR

For each standardized block, let $e_1, e_2, \ldots e_5$ be the values of the measured increase in depth of indentation, arranged in increasing order of magnitude, where "e" is in units of 0.001 mm as defined in ISO Recommendation R 1024, *Rockwell superficial hardness test (N and T scales) for steel.*

4.1 Repeatibility

The repeatibility of the testing machine under the particular verification conditions is determined by the following quantity :

$$e_5 - e_1$$

4.2 Error

The error of the testing machine under the particular verification conditions is expressed by the following quantity :

$$\bar{H} - H$$

where

$$\bar{H} = \frac{H_1 + H_2 + \ldots + H_5}{5}$$

$H_1, H_2, \ldots H_5$ being the hardness values corresponding to $e_1, e_2, \ldots e_5$;

H is the specified hardness of the standardized block.

5. ASSESSMENT OF VERIFICATION

5.1 Repeatability

The repeatability of the testing machine verified is not considered satisfactory unless the repeatability at each hardness at which the machine is verified is

- for the N scale, less than 4 % (but not less than 1.2 superficial hardness numbers)
- for the T scale, less than 6 % (but not less than 2.4 superficial hardness numbers)

of the mean value of the increase of depth of indentation used to determine the hardness value (see Appendix).

5.2 Error

The error of the testing machine verified should not be more than ± 2 units for the N scale and ± 3 units for the T scale.

NOTE. – The values of maximum permissible error quoted should be considered as tentative, and may be reduced when more experience has been gained.

ANNEX A

INSPECTION OF TESTING MACHINE

Before a Rockwell hardness testing machine is verified, the machine should be examined to ensure that

(*a*) it is properly set up;

(*b*) the dial gauge plunger on the depth-measuring device moves freely in any position;

(*c*) the plunger carrying the indenter is capable of sliding in its guide under its own weight but without any appreciable clearance;

(*d*) the indenter holder is mounted firmly in the plunger;

(*e*) when the indenter is a ball, the holder is fitted with a new ball whose diameter has been checked (see ISO Recommendation R 1024, *Rockwell superficial hardness test (N and T scales) for steel);*

(*f*) when the indenter is a diamond, it is well polished to such an extent that no unpolished part of its surface makes contact with the test piece when it indents to a depth of 0.3 mm;

(*g*) the load can be applied and removed without shock or vibration and in such a manner that the readings are not influenced;

(*h*) the readings are not affected by deformations of the frame. Such deformations may be prevented by using a device which locks the test piece against the upper part of the frame. The locking force should exceed the total load and remain constant. The influence of deformations may be checked by using a plain plunger, instead of the indenter, bearing directly against the anvil; the readings of the depth gauge before and after applications of the additional load should not differ by more than

1.5 Rockwell superficial unit, without using the locking device,

0.5 Rockwell superficial unit, using the locking device.

ANNEX B

NOTES ON DIAMOND INDENTERS

Experience has shown that a number of initially perfect indenters can become defective after use for a comparatively short time. This is due to small cracks, pits or other flaws in the surface. If such faults are detected in time, many indenters may be reclaimed by regrinding. If not, any small defects on the surface rapidly worsen and make the indenter useless.

Therefore,

(*a*) the condition of indenters should be checked at frequent intervals using appropriate optical devices (microscope, magnifying glass, etc.);

(*b*) if the flaw is not on the active part of the indenter, it may be ignored, but if it is on the active part, even if small, the indenter should not be used for calibration but should be reground;

(*c*) the verification of the indenter is no longer valid when the indenter has become unusable because of defects;

(*d*) reground or otherwise repaired indenters should be reverified.