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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 1024

ROCKWELL SUPERFICIAL HARDNESS TEST

(N AND T SCALES)

FOR STEEL

1st EDITION

March 1969

For each individual country the only valid standard is the national standard of that country.

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BRIEF HISTORY

The ISO Recommendation R 1024, *Rockwell superficial hardness test (N and T scales) for steel*, 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, in 1967, to the adoption of a Draft ISO Recommendation.

In March 1968, this Draft ISO Recommendation (No. 1353) 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 :

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

One Member Body opposed the approval of the Draft :

Romania

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

ISO Recommendation R 1024 March 1969

ROCKWELL SUPERFICIAL HARDNESS TEST

(N AND T SCALES)

FOR STEEL

1. PRINCIPLE OF TEST

The test consists in forcing an indenter of standard type (cone or ball) into the surface of a test piece in two operations and measuring the permanent increase e of the depth of indentation of this indenter under the conditions specified below.

The unit of measurement for e is 0.001 mm, from which a number known as the Rockwell superficial hardness is deduced.

2. SYMBOLS AND DESIGNATIONS

TABLE 1 – **Test with diamond cone (Rockwell N)**

Number	Symbol	Designation
1	–	Angle at the tip of the diamond cone (120°)
2	–	Radius of curvature at the tip of the cone (0.200 mm)
3	F_o	Preliminary load = 3 kgf (29.42 N)
4	F_1	Additional load = 12, 27 or 42 kgf (117.68, 264.78 or 411.88 N)
5	F	Total load = $F_o + F_1$ = 3 + 12 = 15 kgf (147.1 N), or 3 + 27 = 30 kgf (294.2 N), or 3 + 42 = 45 kgf (441.3 N)
6	–	Depth of indentation under preliminary load before application of additional load
7	–	Increase in depth of indentation under additional load
8	e	Permanent increase of depth of indentation under preliminary load after removal of additional load, this increase being expressed in units of 0.001 mm
9	HRFN*	Rockwell superficial hardness FN = 100 – e

* i.e. HR 15 N, HR 30 N or HR 45 N.

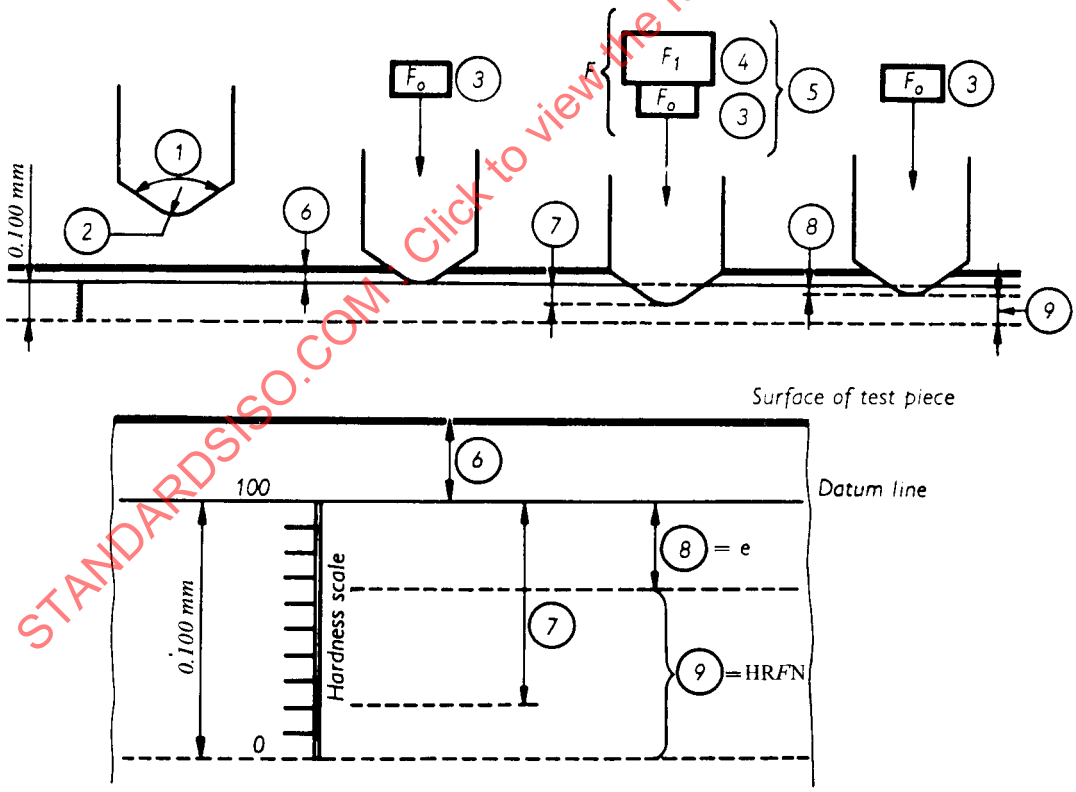

FIG. 1

TABLE 2 – **Test with steel ball (Rockwell T)**

Number	Symbol	Designation
1	D	Diameter of ball = 1.5875 mm ($\frac{1}{16}$ in)
3	F_o	Preliminary load = 3 kgf (29.42 N)
4	F_1	Additional load = 12, 27 or 42 kgf (117.68, 264.78 or 411.88 N)
5	F	Total load = $F_o + F_1$ = 3 + 12 = 15 kgf (147.1 N), or 3 + 27 = 30 kgf (294.2 N), or 3 + 42 = 45 kgf (441.3 N)
6	–	Depth of indentation under preliminary load before application of additional load
7	–	Increase in depth of indentation under additional load
8	e	Permanent increase of depth of indentation under preliminary load after removal of additional load, the increase being expressed in units of 0.001 mm
9	HRFT*	Rockwell superficial hardness FT = 100 – e

* i.e. HR 15 T, HR 30 T or HR 45 T.

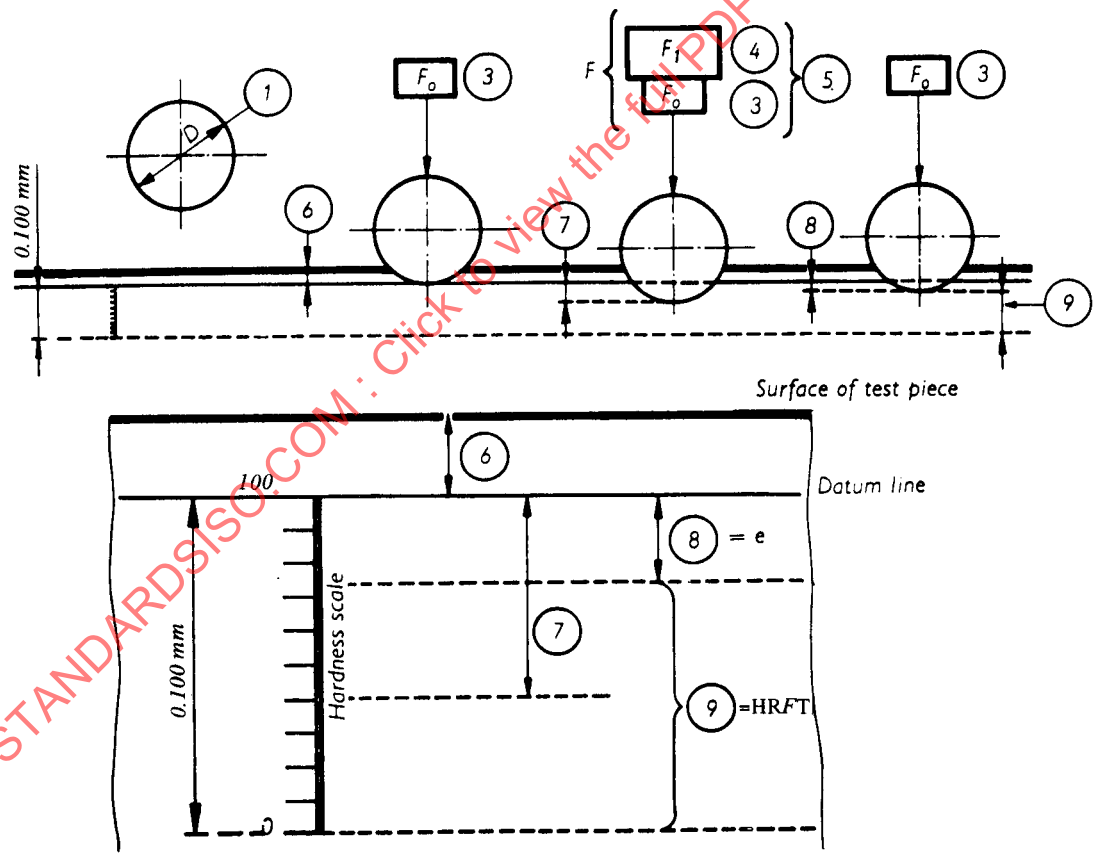

Fig. 2

NOTE. – The Rockwell superficial hardness is denoted by the symbol HR preceded by the hardness value and supplemented by the total load (in kgf) and the letter which together denote the particular hardness scale.

Example : 70 HR 30 N = a Rockwell superficial hardness of 70 measured on the N scale with a diamond cone indenter and a total load of 30 kgf.

3. TESTING EQUIPMENT

3.1 Indenter (N scale)

3.1.1 The conical indenter is a diamond in the form of a right circular cone with a rounded tip. The diamond cone has an included angle of 120 ± 0.5° and its axis is in line with the axis of the indenter within 0.5°. The tip of the cone is spherical with a radius of 0.200 mm. The contour of the whole of the tip of the cone should not depart by more than 0.002 mm from the theoretical profile. The surface of the cone should blend in a truly tangential manner with the surface of the spherical tip (see Note below).

3.1.2 The indenter should be free from cracks or other surface defects.

NOTE. – The form of the point and the size of the radius of the indenter have an important effect on the Rockwell hardness number obtained. The anisotropy of diamonds makes difficult the machining of the indenter to precise symmetrical form.

For this reason it is necessary to compare the performance of the indenter with that of an accepted indenter at more than one level of hardness by means of standardized blocks.

3.2 Indenter (T scale)

3.2.1 In general, the ball indenter is a hardened and polished steel ball having a diameter of 1.5875 mm ($\frac{1}{16}$ in). A ball of harder material, e.g. tungsten carbide, may be used, in which case the material of the ball should be stated in the report of the test, inasmuch as balls of such material will result in lower hardness numbers than those obtained on steel balls. No diameter of the ball should differ from the nominal diameter by more than ± 0.003 mm (± 0.000 12 in)* (see also Note below).

3.2.2 The ball is of hardened steel with a hardness of at least 850 HV 10 (taking into account the curvature of the ball) (see ISO Recommendation R 716, *Verification of Rockwell B and C scale hardness testing machines*). The maximum value of the mean diagonal made with a Vickers indenter at 10 kgf is 0.141 mm. The ball should be polished and free from surface defects. Any ball showing any deformation after the test greater than the tolerance specified under clause 3.2.1 above or any surface defect should be rejected and the corresponding test discarded.

NOTE. – A new ball for an indenter should be selected from a batch which has been verified (see ISO Recommendation R 716) to the tolerance given in clause 3.2.1. It is advisable to ensure that the ball is representative of the batch. The nominal diameter of the ball should, therefore, be checked to an accuracy of ± 0.01 mm.

4. TEST REQUIREMENTS

4.1 The test is normally carried out at room temperature which will be within the limits of 0 and 40 °C. When considered necessary to carry out the test under controlled conditions, it should be carried out at a temperature of 20 ± 2 °C in temperate climates and 27 ± 2 °C in tropical climates.

Throughout the test, the apparatus should be protected from shock or vibration.

4.2 The indenter, when normal to and in contact with the surface to be tested, is subjected without shock or vibration to a preliminary load

$$F_o = 3 \pm 0.06 \text{ kgf}$$

Care should be taken, during the operation, that this load is not exceeded.

* This tolerance corresponds to Grade 6 of ISO Recommendation R 286, *ISO System of limits and fits – Part 1 : General, Tolerances and Deviations.* Balls for ball bearings normally satisfy this tolerance.

4.3 The dial of the indicator (depth gauge) is set at the initial position of the scale and the load increased without shock or vibration, within 2 to 8 seconds, by the value of the additional load F_1, thus obtaining a total load

$$F = F_o + F_1 = \begin{cases} 15 \pm 0.1 \text{ kgf, or} \\ 30 \pm 0.2 \text{ kgf, or} \\ 45 \pm 0.3 \text{ kgf} \end{cases}$$

4.4 Whilst maintaining the preliminary load F_o (see clause 4.2), the additional load F_1 is removed according to the following :

(*a*) for materials which, under the conditions of the test, show no time-dependent plasticity, F_1 is removed within 2 seconds after the indicator (depth gauge) comes to rest;

(*b*) in special cases, where the material, under the conditions of the test, shows time-dependent plasticity, F_1 is removed 20 to 25 seconds after the indicator commences to move.

4.5 The permanent increase of depth of indentation e is read from the dial and the Rockwell hardness number deduced. The indicator (depth gauge) should be accurate to ± 0.5 of a scale unit, i.e. to ± 0.0005 mm. Most dial scales give a direct reading of the Rockwell hardness number.

4.6 The test should be carried out on a surface which is smooth and even, and free from oxide scale and foreign matter. Care should be taken, in preparing the surface, to avoid any change in condition, e.g. due to heating or cold working.

4.7 For tests on cylindrical surfaces the corrections given in the Annex, Table A1 or A2, should be applied. In the absence of corrections for tests on spherical and concave surfaces, tests on such surfaces should be the subject of special agreement.

4.8 The test piece should be placed on a rigid support. The contact surfaces should be clean and free from foreign matter (scale, oil, dirt, etc.). It is important that the test piece lies firmly on the support so that displacement cannot occur during the test.

4.8.1 In the case of the N scale test, the support should consist of a spot anvil of hardened steel of approximately 4.5 mm ($\frac{3}{16}$ in) diameter.

4.8.2 In the case of the T scale test, a similar spot anvil should be used for tests on materials (including test blocks) having a thickness and hardness greater than that stated in the Annex, Table A4. For thinner or softer materials the use of a diamond anvil of approximately 4.5 mm ($\frac{3}{16}$ in) diameter is recommended. When such an anvil is used it should be noted in the report of the hardness value.

4.8.3 After each change or removal and replacement of the indenter or the support, it should be ascertained that the new indenter (or the new support) is correctly mounted in its housing.

4.9 The thicknesses of the test piece or of the layer under test are given in Tables A3 and A4 of the Annex. No deformation should be visible at the back of the test piece after the test. However, by agreement between the purchaser and the supplier, hardness readings obtained on some materials which show deformation may be accepted, but such readings, whilst valuable for some comparative or control purposes, are not necessarily correct readings of Rockwell superficial hardness.

4.10 The distance between the centres of two adjacent indentations should be at least 3 times the diameter of the indentation, and the distance from the centre of any indentation to the edge of the test piece should be at least 2.5 times the diameter of the indentation, unless otherwise agreed.

4.11 The satisfactory condition of the indenter should be verified frequently. Any irregularities in the shape of the indentation may indicate poor conditions of the indenter. If the examination of the indenter confirms this, then the test should be rejected and the indenter renewed.

NOTES

1. There is no general process for accurately converting Rockwell superficial hardness into other scales of hardness or tensile strength. These conversions therefore should be avoided, except for special cases where a reliable basis for the conversion has been obtained by comparison tests.

2. For the verification of Rockwell superficial hardness testing machines and the calibration of standardized blocks, see ISO Recommendations R 1079, *Verification of Rockwell superficial N and T scale hardness testing machines*, and R . . .,* *Calibration of standardized blocks to be used for Rockwell superficial N and T scale hardness testing machines.*

* At present Draft ISO Recommendation No. 1355.

ANNEX

TABLE A1 – **Corrections* to be added to Rockwell superficial 15 N, 30 N and 45 N values obtained on cylindrical test pieces** of various diameters**

Dial reading	Diameter of cylindrical test pieces					
	3.2 mm ($\frac{1}{8}$ in)	6.4 mm ($\frac{1}{4}$ in)	10 mm ($\frac{3}{8}$ in)	13 mm ($\frac{1}{2}$ in)	19 mm ($\frac{3}{4}$ in)	25 mm (1 in)
20	(6.0)***	3.0	2.0	1.5	1.5	1.5
25	(5.5)	3.0	2.0	1.5	1.5	1.0
30	(5.5)	3.0	2.0	1.5	1.0	1.0
35	(5.0)	2.5	2.0	1.5	1.0	1.0
40	(4.5)	2.5	1.5	1.5	1.0	1.0
45	(4.0)	2.0	1.5	1.0	1.0	1.0
50	(3.5)	2.0	1.5	1.0	1.0	0.5
55	(3.5)	2.0	1.5	1.0	0.5	0.5
60	3.0	1.5	1.0	1.0	0.5	0.5
65	2.5	1.5	1.0	0.5	0.5	0.5
70	2.0	1.0	1.0	0.5	0.5	0.5
75	1.5	1.0	0.5	0.5	0.5	0
80	1.0	0.5	0.5	0.5	0	0
85	0.5	0.5	0.5	0.5	0	0
90	0	0	0	0	0	0

* These corrections are approximate only and represent the averages, to the nearest 0.5 Rockwell superficial hardness number, of numerous actual observations on test pieces having the inch dimensions given in the Table.

** When testing cylindrical test pieces the accuracy of the test will be seriously affected by the alignment of elevating screw, V-anvil, indenter, surface finish, and the straightness of the cylinder.

*** The corrections given in parentheses should not be used except by agreement.

NOTE. – For diameters other than those given in the Table, corrections may be derived by linear interpolation.