INTERNATIONAL STANDARD

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Metallic materials — Hardness test — Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T)

Matériaux métalliques — Essai de dureté — Essai superficiel Rockwell (échelles 15N, 30N, 45N, 15T, 30T et 45T)

INTERNATIONAL ISO

Reference number
ISO 1024 : 1989 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 1024 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals.*

It cancels and replaces ISO Recommendation R 1024 : 1969 and International Standard ISO 2712 : 1973, of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
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Metallic materials — Hardness test — Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T)

1 Scope

This International Standard specifies a method for the Rockwell superficial hardness test (scales and field of application according to table 1) for metallic materials.

Table 1 — Conditions for Rockwell superficial hardness test

Hardness scale	Hardness symbol	Type of indenter	Preliminary test force, F_0 (N)	Additional test force, F_1 (N)	Total test force, F (N)	Field of application (Rockwell superficial hardness range)
15N	HR15N	Diamond cone	29,42	117,7	147,1	70 to 94 HR15N
30N	HR30N	Diamond cone	29,42	264,8	294,2	42 to 86 HR30N
45N	HR45N	Diamond cone	29,42	411,9	441,3	20 to 77 HR45N
15T	HR15T	Steel ball 1,587 5 mm	29,42	117,7	147,1	67 to 93 HR15T
30T	HR30T	Steel ball 1,587 5 mm	29,42	264,8	294,2	29 to 82 HR30T
45T	HR45T	Steel ball 1,587 5 mm	29,42	411,9	441,3	1 to 72 HR45T

The field of application for each scale and test force is dependent on the hardness and thickness of the test piece or surface layer tested. Guidance for the choice of scale is given in annex A.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard given below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1079 : 1989, *Metallic materials — Hardness test — Verification of Rockwell superficial hardness testing machines (scales 15N, 30N, 45N, 15T, 30T and 45T).*

3 Symbols and their meanings

3.1 See tables 1 and 2 and figures 1 and 2.

Table 2 — Symbols used

Symbol	Meaning
α	Angle of the diamond cone
R	Radius of curvature at the tip of the diamond cone
D	Diameter of steel ball
F_0	Preliminary test force
F_1	Additional test force
F	Total test force
h_0	Depth of indentation under preliminary test force before application of additional test force
h_1	Increase in depth of indentation under additional test force
e	Permanent increase in depth of indentation under preliminary test force after removal of additional test force, expressed in units of 0,001 mm
HR..N HR..T	Rockwell superficial hardness = 100 − e

3.2 The Rockwell superficial hardness is denoted by the symbol HR preceded by the hardness value and followed by a number (representing the total test force) and a letter together indicating the scale.

EXAMPLE

70 HR30N = Rockwell superficial hardness of 70 measured on the 30N scale with a total test force of 294,2 N

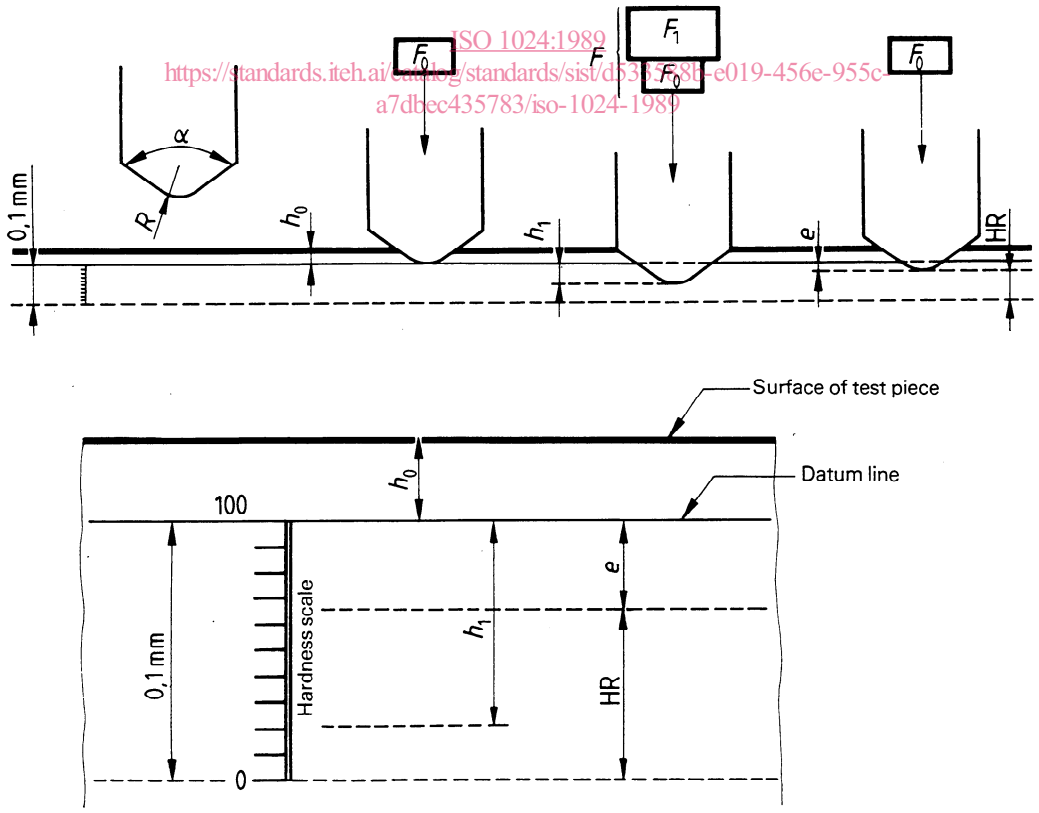


Figure 1 — Test with diamond cone

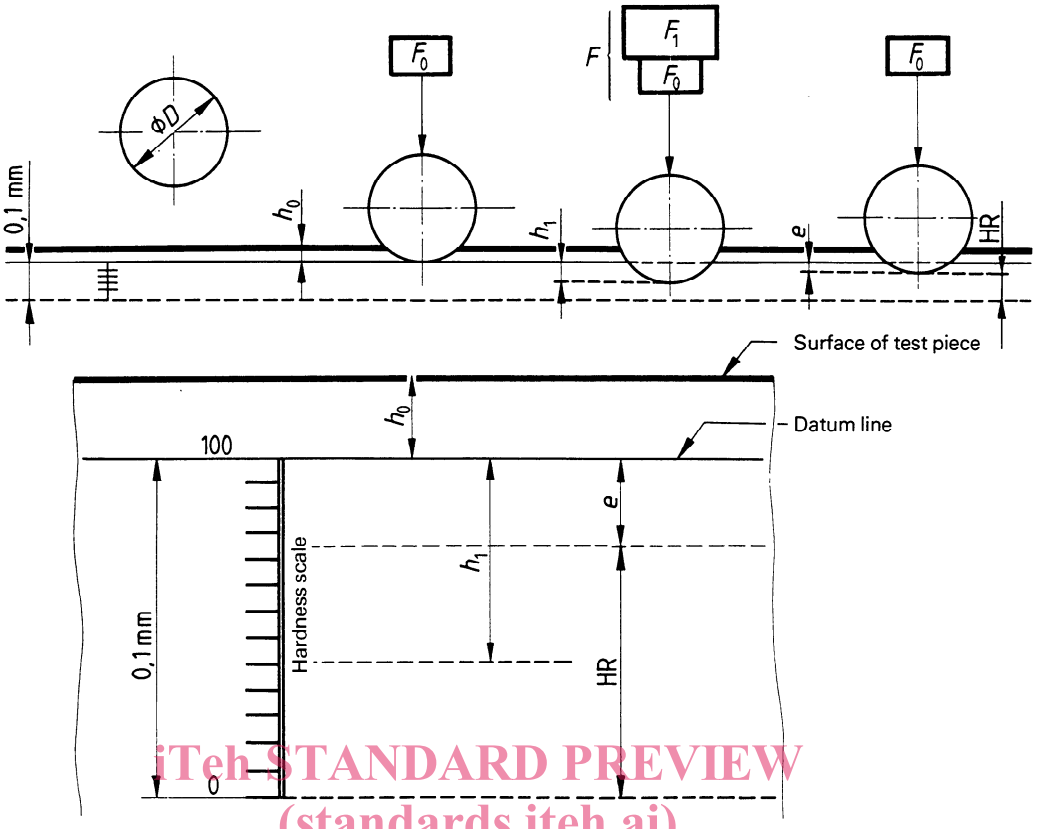


Figure 2 — Test with steel ball

4 Principle

An indenter (diamond cone or steel ball) is forced into the surface of a test piece in two steps under specified conditions (see clause 7), and the permanent increase e in the depth of indentation is measured. The unit of measurement for e is 0,001 mm. From the value of e, a number known as the Rockwell superficial hardness is derived.

5 Apparatus

5.1 Testing machine, capable of applying predetermined forces as shown in table 1, and in accordance with ISO 1079.

5.2 Conical diamond indenter, in accordance with ISO 1079, having an angle of 120° and a radius of curvature at the tip of 0,200 mm.

5.3 Steel ball indenter, in accordance with ISO 1079, with a diameter of 1,587 5 mm.

5.4 Measuring device, in accordance with ISO 1079.

6 Test piece

6.1 The test shall be carried out on a surface which is smooth and even, free from oxide scale and foreign matter and, in particular, completely free from lubricants (except for tests on certain reactive materials, such as titanium, where lubricants may be required). If lubricants have been used it shall be stated in the test report.

NOTE — Titanium tends to adhere to the tip of the diamond cone indenter. Repeated testing of titanium can result in a build-up of material on the indenter which can adversely affect the accuracy of test results. This build-up also causes the force on the indenter to be uneven, often shortening its useful life. A thin film of lubricant, such as kerosene, has been found to be effective in preventing this problem.

6.2 Preparation shall be carried out in such a way that any alteration of the surface hardness due, for example, to heat or cold-working is minimized.

6.3 After the test, no deformation shall be visible on the surface of the test piece opposite the indentation.

The minimum thickness of the test piece or of the layer under test shall be about 10 times the depth of indentation (see annex A and 7.2).

6.4 For tests on convex cylindrical surfaces the corrections given in annex B, tables B.1 and B.2, shall be applied. In the absence of corrections for tests on spherical and concave surfaces, tests on such surfaces shall be the subject of special agreement.

6.5 Special care shall be taken when testing sheet metal that is curved. The concave side of the curved metal shall face towards the indenter. If such specimens are reversed an error will be introduced due to the flattening of the metal on the anvil.

7 Procedure

7.1 In general, the test shall be carried out at ambient temperature within the limits of 10 °C to 35 °C. Tests carried out under controlled conditions shall be made at a temperature of 23 °C ± 5°C.

7.2 The test piece shall be placed on a rigid support and supported in such a manner that the surface to be indented is in a plane normal to the axis of the indenter and the line of the indenting force. The contact surfaces shall be clean and free from foreign matter (scale, oil, dirt, etc.) (see note in 6.1). It is important that the test piece lies firmly on the support so that displacement cannot occur during the test.

Flat pieces shall be tested on a flat anvil that has a smooth, flat bearing surface whose plane is perpendicular to the axis of the indenter. For pieces that are not perfectly flat, a flat anvil having an elevated "spot" about 4 mm to 6 mm in diameter is used. This spot shall be polished, smooth, flat and free from pits and heavy scratches. It shall have a Rockwell hardness of at least 60 HRC.

When testing special materials thinner than ten times the depth of indentation using the steel ball indenter, the product standard may specify the use of a diamond "spot" anvil. When such an anvil is used it shall be recorded in the report. It should be noted that the reading obtained may differ from a reading obtained under normal conditions.

Products of cylindrical shape shall be suitably supported, for example on centering V-blocks of steel with a Rockwell hardness of at least 60 HRC. Special attention shall be given to the correct centering, bearing and alignment of the indenters, the test piece, the centering V-blocks and the specimen holder of the testing machine since any misalignment may lead to incorrect results.

7.3 Bring the indenter into contact with the test surface and apply the preliminary test force F_0 = 29,42 N without shock or vibration.

7.4 Set the measuring device to its datum position and, without shock or vibration, increase the force from F_0 to F in not less than 1 s or more than 8 s:

F = 147,1 N for scales 15N, 15T
F = 294,2 N for scales 30N, 30T
F = 441,3 N for scales 45N, 45T

7.5 While maintaining the preliminary force F_0, remove the additional force F_1 so that

— for materials which, under the conditions of the test, show no time-dependent plasticity, the duration of the total test force F shall be not less than 1 s nor greater than 3 s;

— for materials which, under the conditions of the test, show some time-dependent plasticity, the duration of the total test force F shall be not less than 1 s nor greater than 5 s;

— for materials which, under the conditions of the test, show considerable time-dependent plasticity, the duration of the test force F shall be not less than 10 s nor greater than 15 s.

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

7.7 The Rockwell hardness number is derived from the permanent increase in depth of indentation e, and is usually read directly from the measuring device. The derivation of the Rockwell hardness number is illustrated in figures 1 and 2.

7.8 Each time the indenter or test piece support is changed, it shall be ascertained that the new indenter or support is correctly mounted in its housing. The first two readings after such a change has been made shall be disregarded.

7.9 The distance between the centres of two adjacent indentations shall be at least three times the diameter of the indentation.

The distance from the centre of any indentation to the edge of the test piece shall be at least two and a half times the diameter of the indentation.

8 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) all details necessary for identification of the test sample;

c) the result obtained;

d) all operations not specified in this International Standard, or regarded as optional;

e) details of any occurrence which may have affected the result.

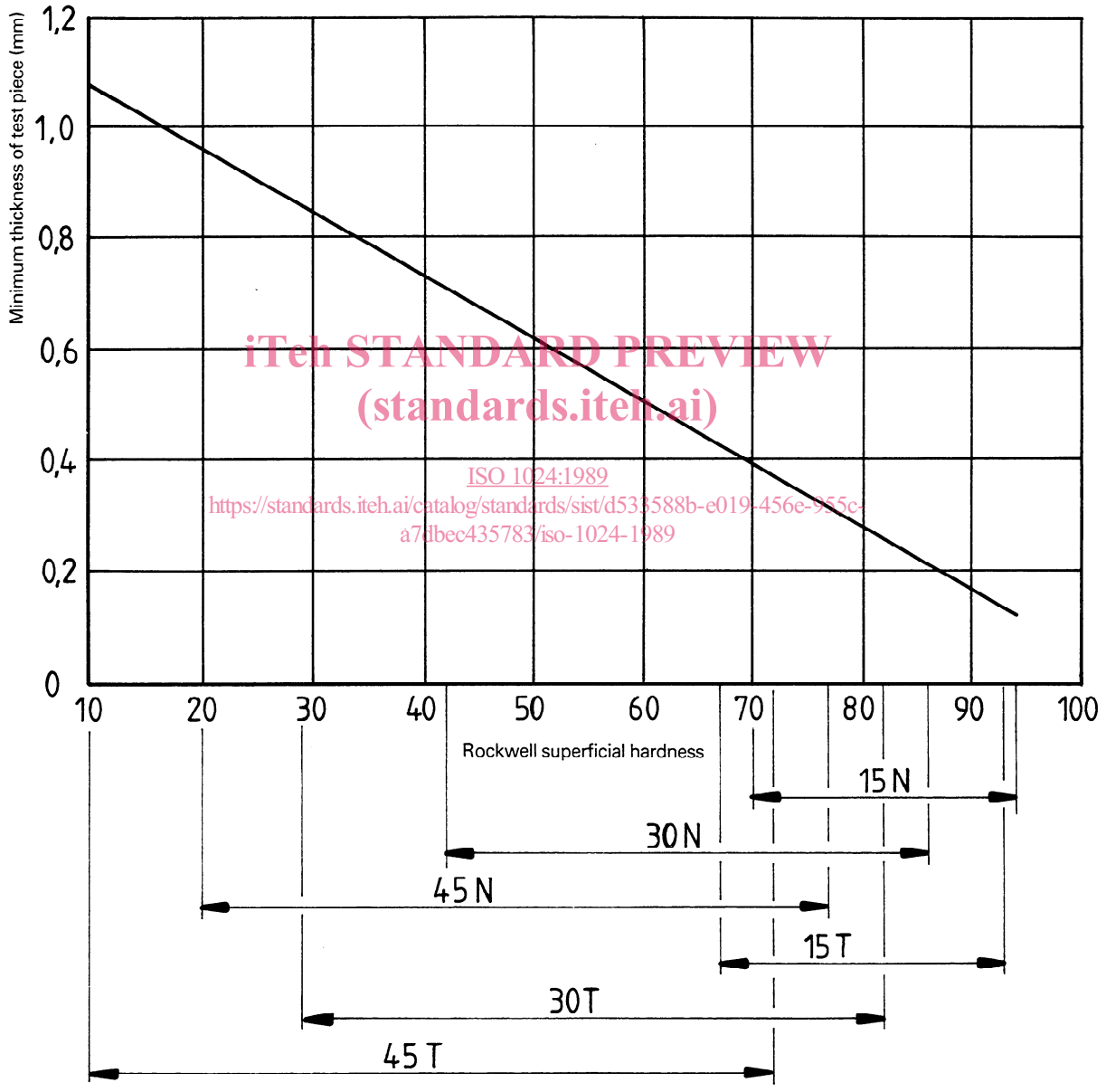
NOTES

1 There is no general process for accurately converting Rockwell hardness into other scales of hardness or into tensile strength. Such conversions therefore should be avoided, unless a reliable basis for conversion can be obtained by comparison tests.

2 There is evidence that some materials may be sensitive to the rate of straining, which causes small changes in the value of the yield stress. The resulting effect during the final stages of the formation of an indentation can lead to alterations in the hardness value.

Annex A
(normative)

Minimum thickness of the test piece in relation to the Rockwell superficial hardness



Annex B
(normative)

Corrections to be added to Rockwell superficial hardness values obtained on convex cylindrical surfaces

Table B.1 — Corrections[1)] to be added to Rockwell superficial hardness 15N, 30N and 45N values obtained on convex cylindrical surfaces[2)]

Rockwell superficial hardness reading	Radius of curvature[3)]					
	1,6 mm	3,2 mm	5 mm	6,5 mm	9,5 mm	12,5 mm
20	(6,0)[4)]	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	1,0
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

1) These corrections are approximate only and represent the averages, to the nearest 0,5 Rockwell superficial hardness units, of numerous actual observations on test surfaces having the curvature given in the table.

2) When testing convex cylindrical surfaces the accuracy of the test will be seriously affected by misalignment of elevating screw, V-anvil and indenter and by imperfections in the surface finish and straightness of the cylinder.

3) For radii other than those given in the table, corrections may be derived by linear interpolation.

4) The corrections given in parentheses shall not be used except by agreement.

Table B.2 — Corrections[1)] to be added to Rockwell superficial hardness 15T, 30T and 45T values obtained on convex cylindrical surfaces[2)]

Rockwell superficial hardness reading	Radius of curvature[3)]						
	1,6 mm	3,2 mm	5 mm	6,5 mm	8 mm	9,5 mm	12,5 mm
20	(13)[4)]	(9,0)	(6,0)	(4,5)	(3,5)	3,0	2,0
30	(11,5)	(7,5)	(5,0)	(4,0)	(3,5)	2,5	2,0
40	(10,0)	(6,5)	(4,5)	(3,5)	3,0	2,5	2,0
50	(8,5)	(5,5)	(4,0)	3,0	2,5	2,0	1,5
60	(6,5)	(4,5)	3,0	2,5	2,0	1,5	1,5
70	(5,0)	(3,5)	2,5	2,0	1,5	1,0	1,0
80	3,0	2,0	1,5	1,5	1,0	1,0	0,5
90	1,5	1,0	1,0	0,5	0,5	0,5	0,5

1) These corrections are approximate only and represent the averages, to the nearest 0,5 Rockwell superficial hardness units, of numerous actual observations on test surfaces having the curvature given in the table.

2) When testing convex cylindrical surfaces the accuracy of the test will be seriously affected by misalignment of elevating screw, V-anvil and indenter and by imperfections in the surface finish and straightness of the cylinder.

3) For radii other than those given in the table, corrections may be derived by linear interpolation.

4) The corrections given in parentheses shall not be used except by agreement.

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