INTERNATIONAL STANDARD ISO 2713

Copper and copper alloys — Rockwell hardness test (B, F and G scales)

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

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.

International Standard ISO 2713 was drawn up by Technical Committee ISO/TC 26, *Copper and copper alloys*, and circulated to the Member Bodies in June 1972.

It has been approved by the Member Bodies of the following countries :

Austria	Hungary	Romania
Belgium	India	South Africa, Rep. of
Brazil	Ireland	Sweden
Chile	Morocco	Switzerland
Czechoslovakia	Netherlands	Turkey
Denmark	New Zealand	United Kingdom
Egypt, Arab Rep. of	Norway	U.S.A.
Finland	Poland	U.S.S.R.
France	Portugal	

The Member Body of the following country expressed disapproval of the document on technical grounds :

Australia

Copper and copper alloys — Rockwell hardness test (B, F and G scales)

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the method for carrying out the Rockwell hardness test (B, F and G scales) for copper and copper alloys using a steel ball indenter.

For C scale tests using a diamond cone indenter reference should be made to ISO/R 80.

2 REFERENCES

ISO/R 80, *Rockwell hardness test (B and C scales) for steel.*

ISO/R 286, *ISO System of limits and fits — Part 1 : General, tolerances and deviations.*

ISO/R 674, *Calibration of standardized blocks to be used for Rockwell B and C scale hardness testing machines.*

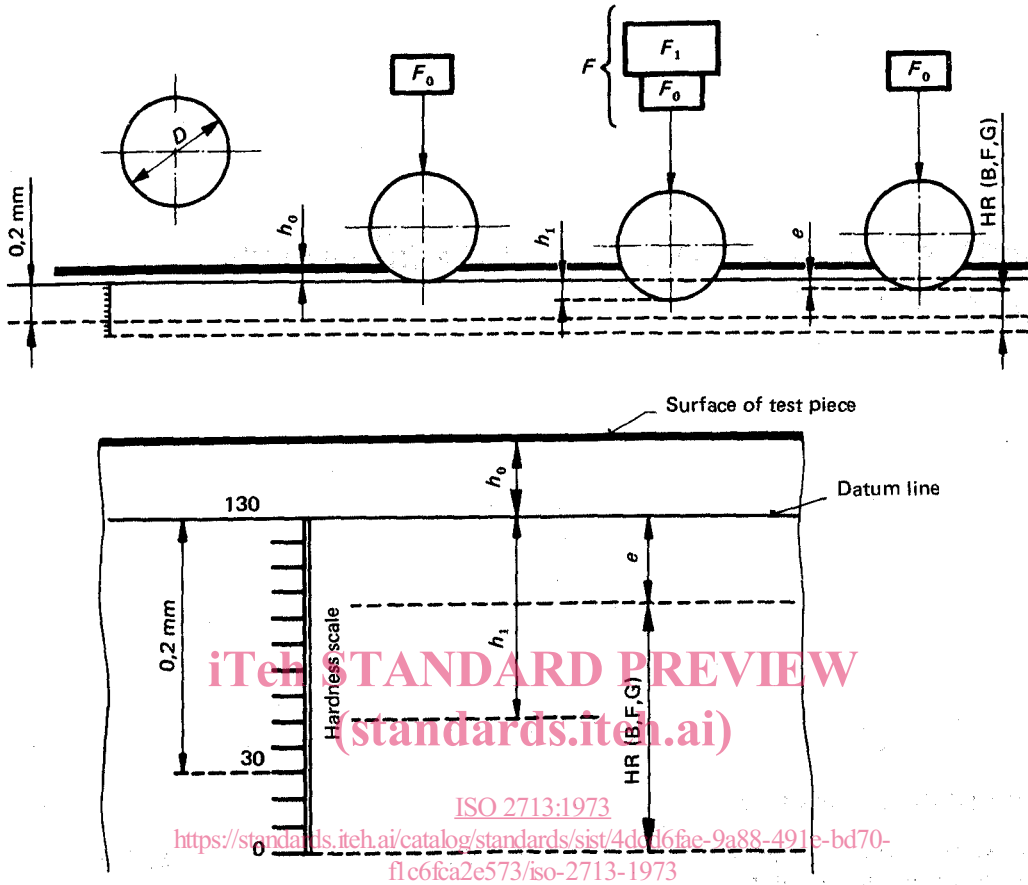ISO/R 716, *Verification of Rockwell B and C scale hardness testing machines.*

3 PRINCIPLE

The test consists in forcing a ball into the surface of a test piece in two operations and measuring the permanent increase e of the depth of indentation by means of a depth gauge under defined conditions.

The unit of measurement for e is 0,002 mm; from the measurement of e, a number, known as the Rockwell hardness, is deduced.

The test is carried out at ambient temperature, unless otherwise specified.

4 SYMBOLS AND DESIGNATIONS

FIGURE

Symbol	Designation
D	Diameter of ball = 1,587 5 mm (1/16 in)
F_0	Preliminary load = 98,06 N (10 kgf)
F_1	Additional load = 882,52 N (90 kgf) for the B scale, or = 490,33 N (50 kgf) for the F scale, or = 1 372,9 N (140 kgf) for the G scale
F	Total load = $F_0 + F_1$ = 98,06 + 882,52 = 980,58 N (100 kgf) for the B scale, or = 98,06 + 490,33 = 588,39 N (60 kgf) for the F scale, or = 98,06 + 1 372,9 = 1 470,96 N (150 kgf) for the G scale
h_0	Depth of indentation under preliminary load before application of additional load
h_1	Increase in depth of indentation under additional load
e	Permanent increase of depth of indentation under preliminary load after removal of additional load, the increase being expressed in units of 0,002 mm
HRB HRF HRG	Rockwell hardness Rockwell hardness = 130 − e Rockwell hardness

NOTE — The Rockwell hardness is denoted by the symbol HRB, HRF or HRG, preceded by the hardness value.

Example : 70 HRF = a Rockwell hardness of 70 measured on the F-scale.

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5 TESTING EQUIPMENT

5.1 Testing machines

The testing machine shall be verified in accordance with the principles of ISO/R 716.

5.2 Standardized blocks for verification of testing machines

Standardized blocks shall be calibrated in accordance with ISO/R 674 except that, if copper or copper alloy blocks are used, the duration of the application of the additional load (section 8 of ISO/R 674) shall be in accordance with 6.5 a) of this International Standard.

5.3 Indenter

The indenter shall be a steel ball having a diameter of 1,587 5 mm (1/16 in) mounted rigidly in a suitable holder. No diameter of the ball shall differ from the nominal diameter by more than ± 0,003 mm (± 0.000 12 in).[1] The ball shall be of hardened steel with a hardness of at least 850 HV 10 taking into account the curvature of the ball in assessing its Vickers hardness. (The maximum value of the mean diagonal of the indentation made by a Vickers indenter under a test load of 98 N (10 kgf) is 0,141 mm.) The ball shall be polished and free from surface defects.

5.4 Indicator (depth gauge)

The indicator shall be graduated in units of 0,002 mm; depth readings on the indicator dial, over the working range (see the figure and 6.6) shall be accurate to ± 0,5 of a scale unit, i.e. to ± 0,001 mm.

5.5 Test piece support

The test piece shall be placed on a rigid support. The contact surface shall 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.

6 TEST REQUIREMENTS

6.1 The test is normally made at room temperature. When it is considered necessary to make the test under controlled temperature, this shall be $20 \pm 2\,°C$ in temperate climates and $27 \pm 2\,°C$ in tropical climates.

6.2 The test shall be made on a surface which is smooth and even, and free from oxide scale and foreign matter. Care shall be taken in preparing the surface to avoid any change in condition, for example due to heating or cold working.

6.3 Bring the indenter into contact with the test surface, and apply the preliminary load $F_0 = 98,06 \pm 1,96$ N $(10 \pm 0,2$ kgf) in a direction normal to the test surface, without shock or vibration. Care shall be taken that this load is not exceeded.

6.4 Set the dial of the indicator at the initial position and increase the load, without shock or vibration, within a period of 4 to 8 s by the value of the additional load F_1, thus obtaining a total load :

$$F = F_0 + F_1 = \begin{array}{l} 980,58 \pm 6,37 \text{ N } (100 \pm 0,65 \text{ kgf}) \\ \text{for the B scale;} \\ 588,39 \pm 4,41 \text{ N } (60 \pm 0,45 \text{ kgf}) \\ \text{for the F scale;} \\ 1\,470,96 \pm 8,82 \text{ N } (150 \pm 0,90 \text{ kgf}) \\ \text{for the G scale.} \end{array}$$

6.5 While maintaining the preliminary load, F_0, remove the additional load, F_1, according to the following :

a) for materials which, under the conditions of the test, show some time dependent plasticity, remove F_1 6 to 8 s after the indicator commences to record.

b) in special cases where the material, under the conditions of the test, shows considerable time dependent plasticity, remove F_1 20 to 25 s after the indicator commences to record.

6.6 The Rockwell hardness number is derived from the permanent increase in depth of indentation, e, as $130 - e$, and is usually read directly from the dial. The derivation of the Rockwell hardness number is illustrated in the figure.

6.7 The B, F or G scales shall not be used for materials softer than 0 nor harder than 100 on a particular scale.

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

7 GENERAL REQUIREMENTS

7.1 The thickness of the test piece or of the layer under test should be at least eight times the permanent increase of depth e. No deformation shall be visible at the back of the test piece after the test.

7.2 The distance between the centres of two adjacent indentations shall be at least four times the diameter of the indentation, and the distance from the centre of any indentation to an edge of the test piece shall be at least two and a half times the diameter of the indentation, unless otherwise agreed.

7.3 For tests on cylindrical surfaces the corrections given in Table 2 in the Annex shall be applied. In the absence of corrections for tests on spherical surfaces, tests on such surfaces shall be the subject of special agreement.

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1) This tolerance corresponds to Grade 6 of ISO/R 286. Balls for ball bearings normally satisfy this tolerance.

7.4 The seating surface of the indenter support shall be checked regularly for burrs, and at the same time the ball indenter shall be inspected for surface defects or evidence of distortion. The results of any tests made with a damaged or distorted ball shall be discarded. The ball indenter should, in any case, be renewed at frequent intervals.

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

7.6 A new ball for an indenter shall be selected from a batch which has been verified to the tolerances given in 5.3. It is advisable to ensure that the ball is representative of the batch. The nominal diameter of the ball therefore shall be checked as being within a tolerance of ± 0,01 mm.

NOTE — There is no general process for accurately converting Rockwell hardness into other scales of hardness or into 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.

ANNEX

TABLE 2 — Corrections to be added to Rockwell B, F, and G scale values obtained
on cylindrical test pieces of various diameters

HRB HRF HRG	Diameter of cylindrical test piece						
	6 mm ($^1/_4$ in)	10 mm ($^3/_8$ in)	13 mm ($^1/_2$ in)	16 mm ($^5/_8$ in)	19 mm ($^3/_4$ in)	22 mm ($^7/_8$ in)	25 mm (1 in)
0					4,5	3,5	3,0
10				5,0	4,0	3,5	3,0
20				4,5	4,0	3,5	3,0
30			5,0	4,5	3,5	3,0	2,5
40			4,5	4,0	3,0	2,5	2,5
50			4,0	3,5	3,0	2,5	2,0
60		5,0	3,5	3,0	2,5	2,0	2,0
70		4,0	3,0	2,5	2,0	2,0	1,5
80	5,0	3,5	2,5	2,0	1,5	1,5	1,5
90	4,0	3,0	2,0	1,5	1,5	1,5	1,0
100	3,5	2,5	1,5	1,5	1,0	1,0	0,5

NOTE — Corrections greater than 5 HRB, HRF and HRG are not considered acceptable and are not therefore included in the above table.