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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION
R 48

DETERMINATION OF HARDNESS OF VULCANIZED NATURAL AND SYNTHETIC RUBBERS

1st EDITION

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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 48, *Determination of Hardness of Vulcanized Natural and Synthetic Rubbers*, was drawn up by the Technical Committee ISO/TC 45, *Rubber*, the Secretariat of which is held by the British Standards Institution (B.S.I.).

The draft proposal put forward by the Secretariat was considered and amended at the meetings held in London (1948), the Hague (1949), Akron (1950), Oxford (1951) and Paris (1953).

On 28 August 1954, the Draft ISO Recommendation proposed by the Technical Committee ISO/TC 45 was submitted to all ISO Member Bodies.

In consideration of comments presented by the U.S.A. Member Body a slight amendment was made to the formula relating $\log_{10} M$ to the hardness in International Rubber Hardness Degrees and the Draft was approved, subject to some editorial modifications, by the following 26 (out of a total of 34) Member Bodies:

Austria	*Ireland	Spain
Belgium	Israel	Sweden
*Canada	Italy	Switzerland
Denmark	Japan	Union of South Africa
Finland	Mexico	United Kingdom
France	Netherlands	U.S.A.
Germany	*New Zealand	U.S.S.R.
Hungary	Pakistan	Yugoslavia
India	Portugal	

No Member Body opposed the Draft.

The Draft ISO Recommendation was then submitted to the ISO Council which decided, at its meeting in July 1957, to accept it as an ISO RECOMMENDATION.

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* These Member Bodies stated that they had no objection to the Draft being approved.

ISO Recommendation R 48 July 1957

DETERMINATION OF HARDNESS OF VULCANIZED NATURAL AND SYNTHETIC RUBBERS

FOREWORD

The standard hardness test is based on a measurement of the penetration of a rigid ball into the rubber test piece under specified conditions. The measured penetration is converted into International Rubber Hardness Degrees (IRH), the scale of degrees being so chosen that 0 represents a material having an elasticity modulus of zero and 100 represents a material of infinite elasticity modulus, and so that the following conditions are fulfilled over most of the normal range of hardness:

(*a*) one International Rubber Hardness Degree always represents approximately the same proportionate difference in Young's modulus;

(*b*) readings in International Rubber Hardness Degrees are approximately the same as those of the Shore durometer type "A".

For substantially elastic isotropic materials like well-vulcanized natural rubbers, the hardness in International Rubber Hardness Degrees bears a known relation to Young's modulus, although for markedly plastic or anisotropic rubbers the relationship will be less precisely known.

1. SUMMARY

The hardness test consists in measuring the difference between the depths of penetration of the ball into the rubber under a small initial load and a large final load. From this difference the hardness in International Rubber Hardness Degrees is derived by using either Table 2, page 6, or the graph based on this table, or a scale, reading directly in International Rubber Hardness Degrees and derived from the table, fitted to the penetration-measuring instrument.

The relation between the difference of penetration and the hardness expressed in International Rubber Hardness Degrees is based on:

(1) the known relation, for a perfectly elastic isotropic material, between penetration P (in hundredths of a millimetre) and Young's modulus M (in kilogrammes-force per square centimetre),

namely $\quad *F/M = 0.00017\, R^{0.65}\, P^{1.35}$

where $\quad F$ = indenting force (kgf)

$\quad R$ = radius of ball (cm)

(2) the use of a probit (integrated normal error) curve to relate $\log_{10} M$ and the hardness in International Rubber Hardness Degrees, as shown in the diagram on page 7, this curve being defined thus:

(*a*) value of $\log_{10} M$ corresponding to midpoint of curve = either 1.37 (M expressed in kgf/cm²) or 2.52 (M expressed in lb/in²), i.e. M = 23.3 kgf/cm² or 330 lb/in²

(*b*) maximum slope = 57 International Rubber Hardness Degrees per unit increase in $\log_{10} M$

2. TEST PIECE

The test piece has its upper and lower surfaces flat, smooth and parallel to one another, two pieces of rubber (but not more than two) may be superposed to obtain the necessary thickness.

The standard test piece is between 8 mm and 10 mm thick, the lateral dimensions being such that no test is made at a distance from the edge of the test piece less than the appropriate distance shown in Table 1 hereunder.

Non-standard test pieces may be thicker or thinner than the standard, but in no case less than 2 mm thick. The lateral dimensions are such that no test is made at a distance from the edge less than the appropriate distance shown in Table 1 hereunder.

TABLE 1

Total thickness of test piece		Minimum distance from point of impact to edge of test piece	
Millimetres	Inches	Millimetres	Inches
2.5	0.1	6.5	0.25
5	0.2	7.6	0.3
8	0.3	9.0	0.35
10	0.4	10.0	0.4
15	0.6	11.5	0.45
25	1.0	12.7	0.5

Tests intended to be comparable must be made on test pieces of the same thickness.

* This formula is approximate and is included as an indication.

3. APPARATUS

The essential parts of the apparatus are:

(*a*) a vertical plunger terminating in a rigid ball 2.44 mm ± 0.06 mm in diameter;

(*b*) means for applying loads of 30 g and 570 g ± 5 g to the ball; it is essential to allow for the weight of the plunger and of any fitting attached to it and for the force of any spring acting on it, in order that the loads *actually applied to the ball* shall be as specified;

(*c*) means, e.g. a dial gauge, for indicating the movement of the plunger, either in metric or in inch units or reading directly in International Rubber Hardness Degrees;

(*d*) a foot about 20 mm in diameter, normal to the axis of the plunger and having a central hole about 5 mm in diameter for the passage of the plunger, the foot forming part of the penetration-measuring gauge; the foot rests on the test piece and exerts a pressure on it of 200 g/cm² to 300 g/cm²;

(*e*) means, e.g. an electrically operated buzzer, for gently vibrating the apparatus to overcome any slight friction (this can be omitted in instruments where friction is completely eliminated).

4. PROCEDURE

The test piece is first conditioned. The upper and lower surfaces of the test piece are slightly dusted with talc and the test piece supported on a horizontal rigid surface. The foot is first lowered so as to rest on the surface of the test piece. The plunger and indenting ball are pressed for 5 seconds vertically on to the rubber, the load on the ball being 30 g.

If the gauge is graduated directly in International Rubber Hardness Degrees, the bezel of the gauge is then turned so that the pointer indicates 100 (care being taken not to exert any vertical pressure on the gauge). An additional load of 540 g ± 5 g is then applied and maintained for 30 seconds, the reading on the gauge is the hardness in International Rubber Hardness Degrees.

During the loading periods the apparatus is gently vibrated to overcome any friction.

If the gauge is graduated in metric or in inch units, the movement D (in hundredths of a millimetre) of the plunger caused by applying the additional 540 g load as described above is read off and converted into International Rubber Hardness Degrees by using Table 2, page 6, or the graph constructed therefrom.

TABLE 2

D 0.01 mm	International Rubber Hardness Degrees	D 0.01 mm	International Rubber Hardness Degrees	D 0.01 mm	International Rubber Hardness Degrees	D 0.01 mm	International Rubber Hardness Degrees
0	100	50	71.0	100	48.8	150	35.6
1	100	51	70.4	101	48.5	151	35.4
2	99.9	52	69.8	102	48.1	152	35.2
3	99.8	53	69.3	103	47.8	153	35.0
4	99.6	54	68.7	104	47.5	154	34.8
5	99.3	55	68.2	105	47.1	155	34.6
6	99.0	56	67.6	106	46.8	156	34.4
7	98.6	57	67.1	107	46.5	157	34.3
8	98.1	58	66.6	108	46.2	158	34.1
9	97.7	59	66.0	109	45.9	159	33.9
10	97.1	60	65.5	110	45.6	160	33.7
11	96.5	61	65.0	111	45.3	161	33.5
12	95.9	62	64.5	112	45.0	162	33.3
13	95.3	63	64.0	113	44.7	163	33.2
14	94.7	64	63.5	114	44.4	164	33.0
15	94.0	65	63.0	115	44.1	165	32.8
16	93.4	66	62.5	116	43.8	166	32.7
17	92.7	67	62.0	117	43.5	167	32.5
18	92.0	68	61.5	118	43.3	168	32.3
19	91.3	69	61.1	119	43.0	169	32.2
20	90.6	70	60.6	120	42.7	170	32.0
21	89.8	71	60.1	121	42.5	171	31.9
22	89.2	72	59.7	122	42.2	172	31.7
23	88.5	73	59.2	123	41.9	173	31.6
24	87.8	74	58.8	124	41.7	174	31.4
25	87.1	75	58.3	125	41.4	175	31.3
26	86.4	76	57.9	126	41.1	176	31.1
27	85.7	77	57.5	127	40.9	177	31.0
28	85.0	78	57.0	128	40.6	178	30.9
29	84.3	79	56.6	129	40.4	179	30.7
30	83.6	80	56.2	130	40.1	180	30.6
31	82.9	81	55.8	131	39.9	181	30.5
32	82.2	82	55.4	132	39.6	182	30.3
33	81.5	83	55.0	133	39.4	183	30.2
34	80.9	84	54.6	134	39.1	184	30.1
35	80.2	85	54.2	135	38.9	185	30.0
36	79.5	86	53.8	136	38.7	186	29.9
37	78.9	87	53.4	137	38.4	187	29.8
38	78.2	88	53.0	138	38.2	188	29.6
39	77.6	89	52.7	139	38.0	189	29.5
40	77.0	90	52.3	140	37.8	190	29.4
41	76.4	91	52.0	141	37.5	191	29.3
42	75.8	92	51.6	142	37.3	192	29.2
43	75.2	93	51.2	143	37.1	193	29.1
44	74.5	94	50.9	144	36.9	194	29.0
45	73.9	95	50.5	145	36.7	195	28.9
46	73.3	96	50.2	146	36.5	196	28.8
47	72.7	97	49.8	147	36.2	197	28.8
48	72.2	98	49.5	148	36.0	198	28.7
49	71.6	99	49.1	149	35.8	199	28.6
						200	28.5

RELATION OF $\log_{10} M$
TO HARDNESS IN INTERNATIONAL RUBBER HARDNESS DEGREES