International Standard 156

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Metallic materials — Hardness test — Verification of Brinell hardness testing machines

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Foreword

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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 156 was developed by Technical Committee ISO/TC 164, *Mechanical testing of metals*, and was circulated to the member bodies in July 1981.

It has been approved by the member bodies of the following countries :

Australia	Hungary	Romania
Austria	India	South Africa, Rep. of
Brazil	Italy	Spain
Canada	Japan	Sri Lanka
China	Korea, Rep. of	Sweden
Czechoslovakia	Mexico	Switzerland
Egypt, Arab Rep. of	Netherlands	United Kingdom
France	Norway	USA
Germany, F.R.	Poland	USSR

No member body expressed disapproval of the document.

This International Standard cancels and replaces ISO Recommendation R 156-1960, of which it constitutes a technical revision.

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Metallic materials — Hardness test — Verification of Brinell hardness testing machines

1 Scope and field of application

This International Standard specifies a method of verification of testing machines for determining Brinell hardness in accordance with ISO 6506.

It describes a direct verification method for checking the main functions of the machine, and an indirect verification method suitable for the overall checking of the machine.

If a testing machine is also to be used for other methods of hardness testing, it shall be verified independently for each method.

2 References

ISO 409/1, *Metallic materials — Hardness test — Tables of Vickers hardness values for use in tests made on flat surfaces — Part 1 : HV 5 to HV 100.*

ISO 410, *Metallic materials — Hardness test — Tables of Brinell hardness values for use in tests made on flat surfaces.*

ISO 726, *Metallic materials — Hardness test — Calibration of standardized blocks to be used for Brinell hardness testing machines.*

ISO 3878, *Hardmetals — Vickers hardness test.*[1)]

ISO 6506, *Metallic materials — Hardness test — Brinell test.*

ISO 6507/1, *Metallic materials — Hardness test — Vickers test — Part 1 : HV 5 to HV 100.*

3 General conditions

Before a Brinell hardness testing machine is verified, it shall be checked to ensure that :

a) the machine is properly set up;

b) the plunger holding the ball is capable of sliding in its guide, by its own weight, but without any appreciable clearance;

c) the ball-holder, with a new ball from a batch which has been examined, is firmly mounted in the plunger;

d) the test force can be applied and removed without shock or vibration and in such a manner that the readings are not influenced;

e) if the measuring device is integral with the machine

1) the change from removing the test force to measuring does not influence the readings,

2) the illumination does not affect the readings,

3) the centre of the indentation is in the centre of the field of view.

4 Direct verification

Direct verification involves :

— verification of the test force;

— verification of the indenter;

— verification of the measuring device.

1) At present at the stage of draft. (Revision of ISO 3878-1976.)

4.1 Verification of the test force

4.1.1 Each test force shall be measured and, whenever applicable, this shall be done at not less than three positions of the plunger throughout its range of movement during testing.

4.1.2 The test force shall be measured by one of the following two methods :

— measuring by means of an elastic proving device previously calibrated to an accuracy of ± 0,2 %;

or

— balancing against a force, accurate to ± 0,2 %, applied by means of standardized masses with mechanical advantage.

4.1.3 Three readings shall be taken for each test force at each position of the plunger. Immediately before each reading is taken, the plunger shall have been moved in the same direction as during testing.

4.1.4 Each measurement of a force shall be within ± 1,0 % of the nominal test force, as given in table 1.

4.2 Verification of the indenters

4.2.1 For the purpose of verifying the size and the hardness of the indenters it is considered sufficient to test a sample selected at random from a batch. The ball(s) verified for hardness shall be discarded.

4.2.2 The ball shall be polished and free from surface defects.

4.2.3 The user shall either measure the balls to ensure that they meet the following requirements, or he shall obtain balls from a supplier who can certify that the following conditions are met.

4.2.3.1 The diameter, when measured at not less than three positions, shall not differ from the nominal diameter by more than the tolerance given in table 2.

4.2.3.2 For steel balls, the hardness shall be not less than 850 HV 10, when determined in accordance with ISO 6507/1, and applying the appropriate correction for curvature as given in ISO 409/1. See table 3.

4.2.3.3 For hardmetal balls, the hardness shall be not less than 1 500 HV, when determined in accordance with ISO 3878.

The chemical composition of the hardmetal ball shall be :

— Tungsten carbide (WC) balance

— Total other carbides 2,0 % max.

— Cobalt (Co) 5,0 to 7,0 %

Table 1

Hardness symbol	Ball diameter D mm	$\frac{0,102\ F}{D^2}$	Test force F Nominal value
HBS (HBW) 10/3 000	10	30	29,42 kN
HBS (HBW) 10/1 500	10	15	14,71 kN
HBS (HBW) 10/1 000	10	10	9,807 kN
HBS (HBW) 10/500	10	5	4,903 kN
HBS (HBW) 10/250	10	2,5	2,452 kN
HBS (HBW) 10/125	10	1,25	1,226 kN
HBS (HBW) 10/100	10	1	980,7 N
HBS (HBW) 5/750	5	30	7,355 kN
HBS (HBW) 5/250	5	10	2,452 kN
HBS (HBW) 5/125	5	5	1,226 kN
HBS (HBW) 5/ 62,5	5	2,5	612,9 N
HBS (HBW) 5/ 31,25	5	1,25	306,5 N
HBS (HBW) 5/ 25	5	1	245,2 N
HBS (HBW) 2,5/187,5	2,5	30	1,839 kN
HBS (HBW) 2,5/ 62,5	2,5	10	612,9 N
HBS (HBW) 2,5/ 31,25	2,5	5	306,5 N
HBS (HBW) 2,5/ 15,625	2,5	2,5	153,2 N
HBS (HBW) 2,5/ 7,812 5	2,5	1,25	76,61 N
HBS (HBW) 2,5/ 6,25	2,5	1	61,29 N
HBS (HBW) 2/120	2	30	1,177 kN
HBS (HBW) 2/ 40	2	10	392,3 N
HBS (HBW) 2/ 20	2	5	196,1 N
HBS (HBW) 2/ 10	2	2,5	98,07 N
HBS (HBW) 2/ 5	2	1,25	49,03 N
HBS (HBW) 2/ 4	2	1	39,23 N
HBS (HBW) 1/30	1	30	294,2 N
HBS (HBW) 1/10	1	10	98,07 N
HBS (HBW) 1/ 5	1	5	49,03 N
HBS (HBW) 1/ 2,5	1	2,5	24,52 N
HBS (HBW) 1/ 1,25	1	1,25	12,26 N
HBS (HBW) 1/ 1	1	1	9,807 N

Table 2

Ball diameter mm	Tolerance mm
10	± 0,005
5	± 0,004
2,5	± 0,003
2	± 0,003
1	± 0,003

Table 3

Ball diameter mm	Maximum value of mean diagonal made on the steel ball with a Vickers indenter at 98,07 N (HV 10) mm
10	0,146
5	0,145
2,5	0,143
2	0,142
1	0,139

4.3 Verification of the measuring device

The scale of the measuring device shall be graduated to permit estimation of the diameter of the indentation to within ± 0,5 %.

The measuring device shall be verified by measurements made on a stage micrometer at a minimum of five intervals over each working range. The maximum error shall not exceed 0,5 %.

5 Indirect verification

Indirect verification may be carried out by means of standardized blocks calibrated in accordance with ISO 726.

5.1 For the general verification of a testing machine, the following procedures shall be applied.

The testing machine shall be verified for each test force and for each size of ball normally used. For each test force, standardized blocks within the hardness ranges given in table 4, depending on the type of ball, shall be used.

Table 4

Steel ball	Hardmetal ball
100 to 200 HBS	100 to 200 HBW
250 to 350 HBS	300 to 400 HBW
	500 to 600 HBW

NOTE — When the hardness test in question makes it impossible to reach the higher hardness range defined in table 4 (for $0{,}102\ F/D^2 = 5$ or 10), the verification may be carried out with only one block from the lower hardness range.

Verification shall be carried out using the same type of ball (steel or hardmetal) as will be used for testing and this verification will be valid :

— for hardnesses ⩽ 450 HBS when steel balls are used

— for hardnesses ⩽ 650 HBW when hardmetal balls are used.

5.2 On each standardized block, five indentations shall be made and measured. The test shall be made in accordance with ISO 6506. Attention is drawn to ISO 410 which contains calculation tables for use in tests made on flat surfaces.

5.3 For each standardized block, let d_1, d_2 ... d_5 be the mean values of the measured diameter of the indentations, arranged in increasing order of magnitude.

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

$$d_5 - d_1$$

5.5 The repeatability of the testing machine verified is not considered satisfactory unless it satisfies the conditions given in table 5.

Table 5

Hardness of standardized block HBS (HBW)	Repeatability of the testing machine max.	Examples of equivalent hardnesses HBS		HBW	
		H	$H_1 - H_5$ max.	H	$H_1 - H_5$ max.
⩽ 225	$0{,}04\ \bar{d}$	100	9	100	9
		200	17	200	17
> 225	$0{,}02\ \bar{d}$	250	10	300	12
		350	14	400	17
				500	20
				600	24

where

$$\bar{d} = \frac{d_1 + d_2 + \ldots d_5}{5}$$

5.6 The error of the testing machine under the particular verification conditions is characterized by the following quantity

$$\bar{H} - H$$

where

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

H_1, H_2 ... H_5 being the hardness values corresponding to d_1, d_2 ... d_5

H being the specified hardness of standardized block.

5.7 The error of the testing machine, expressed as a percentage of the specified hardness of the standardized block, shall not be more than ± 3 %.

6 Test report

The test report shall include the following information :

a) reference to this International Standard;

b) method of verification (direct or indirect);

c) identification data of the hardness testing machine;

d) means of verification (test blocks, elastic proving devices etc);

e) type of indenter and test force;

f) the result obtained;

g) date of verification and reference to the testing institution.

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