Designation: E103 – 84 (Reapproved 2002)

Standard Test Method for Rapid Indentation Hardness Testing of Metallic Materials[1]

This standard is issued under the fixed designation E103; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the procedure for rapid indentation hardness testing of metallic materials as an alternative to Test Method E10 on standard Brinell hardness. It includes methods for the verification of rapid indentation hardness testing machines, Part B, and the calibration of reference hardness test blocks, Part C.

1.2 The values stated in SI units are to be regarded as standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E4 Practices for Force Verification of Testing Machines

E10 Test Method for Brinell Hardness of Metallic Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *calibration*—determination of the values of the significant parameters by comparison with values indicated by a reference instrument or by a set of reference standards.

3.1.2 *rapid indentation hardness test*—an indentation hardness test using calibrated machines to force a hard steel or carbide ball, under specified conditions, into the surface of the material under test and to measure the depth of the indentation. The depth measured can be from the surface of the test specimen or from a reference position established by the application of a preliminary test force.

3.1.3 *verification*—checking or testing to assure conformance with the requirements of the method.

4. Significance and Use

4.1 This test method is used when it is desired to make hardness tests very rapidly, as in the inspection of the output of a heat-treating furnace.

4.2 This test method is not to be regarded as a standard Brinell hardness test method.

4.3 Since the test forces and method of display of the depth measurement differ between manufacturers of rapid indentation hardness testing equipment, the test results from equipment from different manufacturers are not comparable.

A. GENERAL DESCRIPTION AND TEST PROCEDURE

5. Apparatus

5.1 *Testing Machine*—Equipment for rapid indentation hardness testing is used essentially to measure hardness by determining the depth of indentation of a penetrator into the specimen. The test force can be applied either as a single total test force whereby the depth is measured usually from the surface of the test specimen or as a preliminary and total test force whereby the depth is measured as the increase from the preliminary to the total test force. The magnitude of the indenting test force or test forces is determined by agreement. The design and construction of the testing machine shall be such that no rotational or lateral movement of the indenter or test specimen occurs while the test force is being applied or removed.

5.2 *Penetrator*:

5.2.1 The standard ball penetrator shall be 10 mm in diameter. Other values of ball penetrator may be used as provided in 7.1.

5.2.2 The balls used shall be free of surface imperfections and conform to the requirements prescribed in 13.1.2.

5.3 *Mechanism for Measuring the Depth of the Indentation*—The depth of the indentation is determined by a measuring device that shall conform to the requirements prescribed in 13.1.3.

[1] This test method is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.06 on Indentation Hardness Testing.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5.4 When diameters of indentations are measured to ascertain the accuracy of hardness values of test specimens or of reference hardness test blocks, the measuring microscope shall comply with 3.3 of Test Method E10 and comparable values as determined from Table 1 of Test Method E10.

6. Test Specimens

6.1 *Finish*—When necessary, the surface on which the indentation is to be made shall be filed, ground, machined, or polished with an abrasive material. The surface in contact with the test support shall be clean, dry, and free of any conditions which may affect the test results.

6.2 *Thickness*—The thickness of the specimen shall be at least ten times the depth of the indentation and such that no bulge or other mark showing the effect of the test force appears on the side of the piece opposite the indentation.

7. Procedure

7.1 *Magnitude of Test Force*—The total test force is usually 3000, 1500, or 500 kgf (29.42, 14.71, or 4.903 kN). The preliminary test force, if used, is usually determined by test requirements. It is desirable that the total test force be of such magnitude that the diameter of the indentation ranges from 25.0 to 60.0 % of the ball diameter (for example, 2.50 to 6.00 mm in the case of the 10-mm diameter penetrator). Table 1 gives the preferred total test force and Brinell hardness number with the 10-mm diameter penetrator. For certain sizes and conditions of test specimens, it may be desirable to use different test forces and penetrators with diameters smaller or larger than 10 mm; in these cases it is recommended that the following relationships be maintained between the diameter of the ball, D, measured in kilograms, and the applied test force, P, measured in kilograms-force:

Range (Brinell Hardness Number)	P/D^2
96 to 600	30
48 to 300	15
16 to 100	5

7.2 *Spacing of Indentations*—The distance from the center of the indentation to the edge of the specimen, or edge of another indentation, shall be at least two and one-half times the diameter of the indentation.

7.3 *Application of the Test Force(s)*—Apply the test force(s) to the test specimen without shock or vibration.

7.4 *Alignment*—The angle between the load line and the normal to the specimen shall not exceed 2°.

8. Determination of Hardness Limits

8.1 In order to establish the limit(s) of acceptable hardness for a given part or piece, test specimens representing the extreme(s) of acceptability shall be tested in the rapid indentation hardness tester that is to be used. The results obtained shall be considered the limits of acceptability.

TABLE 1 Preferred Total Test Forces for 10-mm Ball

Total Test Force, kgf (kN)	Recommended Range, Brinell Hardness Number
3000 (29.42)	96 to 600
1500 (14.71)	48 to 300
500 (4.903)	16 to 100

9. Report

9.1 Report the following information:

9.1.1 The test force (or test forces when preliminary and total test forces are applied) in kilogram-force,

9.1.2 The diameter of the ball penetrator and whether steel or carbide balls are being used, and

9.1.3 The depth of penetration in millimetres, or either a converted Brinell hardness number or other hardness number established by the manufacturer. In the last two cases, the hardness relationship shall be reported or referenced.

10. Precision and Bias

10.1 *Precision*—Since the test results are not comparable between equipment from different manufacturers, an interlaboratory comparison test program is not appropriate. Therefore, a precision statement cannot be determined for this test method.

10.2 *Bias*—There is no basis for defining the bias for this test method.

B. VERIFICATION OF RAPID INDENTATION HARDNESS TESTING MACHINES

11. Scope

11.1 Part B covers two procedures for the verification of rapid indentation hardness testing machines. These are as follows:

11.1.1 Separate verification of test force application, penetrator, and depth-measuring device.

11.1.2 Verification by reference test block method.

11.2 New or rebuilt machines shall be checked by the separate verification method.

11.3 Machines in use in production testing may be checked by either method.

12. General Requirements

12.1 Before a rapid indentation hardness testing machine is verified, examine the machine to ensure the following:

12.1.1 Set up the machine properly.

12.1.2 Mount the ball holder, with a new ball, in the plunger.

12.1.3 Apply and remove the test force without shock or vibration and in such a manner that the readings are not affected.

13. Verification

13.1 *Separate Verification of Test Force Application, Penetrator, and Depth-Measuring Device*:

13.1.1 *Test Force Application*—Rapid indentation hardness testing machines shall be verified at the applied preliminary test force, when applicable, and at the applied total test force. Check the applied test force(s) periodically with a proving ring, or by an elastic calibration device in the manner described in Practices E4. The difference between the nominal test force and the measured test force, or forces, shall not exceed ±2 % of the nominal test force or forces.

13.1.2 *Penetrator*:

13.1.2.1 The diameter of the standard ball shall be 10 mm with a deviation from this value of not more than 0.005 mm in any diameter. Other sizes of ball may be used as provided in 7.1.