Designation: ~~E110 – 10~~ E110 – 14

Standard Test Method for ~~Indentation~~ Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers[1]

This standard is issued under the fixed designation E110; 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 U.S. Department of Defense.

1. ~~Scope~~ Scope*

1.1 This test method ~~covers determination of the indentation~~ defines the requirements for portable instruments that are intended to be used to measure the Rockwell or Brinell hardness of metallic materials by ~~means of portable~~ performing indentation tests on the surface of materials in the field or outside of a test lab, or in cases where the size or weight of the test piece prevents it from being tested on a standard E10 or E18 hardness ~~testers.~~tester.

1.2 The principles used to measure the Rockwell or Brinell hardness are the same as those defined in the E18 standard test method for Rockwell or E10 standard test method for Brinell.

NOTE 1—Standard test methods E10 and E18 will be referred to in this test method as the standard methods.

1.3 The portable hardness testers covered by this test method are verified only by the indirect verification method. Although the portable hardness testers are designed to employ the same test conditions as those defined in the standard test methods, the forces applied by the portable Rockwell and Brinell testers and the depth measuring systems of the portable Rockwell testers may not meet the tolerance requirements of the standard methods. Portable hardness testers shall use indenters that meet the requirements of the standard test methods.

1.4 This test method ~~applies only to those~~ does not apply to portable hardness testers ~~which~~ that measure hardness by a means or procedure that is different than those defined in E10 or E18~~apply the same nominal forces and use the~~ For example, this test method does not apply to the methods defined in ASTM standard Practice A833~~same indenters as are~~, Test Methods A956 ~~used in~~and A1038 ~~the methods~~or B647 ~~listed in Section 2~~.

1.5 A report section is included to define how to indicate that the test result was obtained by using a portable device that conforms to this document.

1.6 Annex A1 is included that defines the periodic indirect verification and daily verification requirements for these instruments.

1.7 *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]

~~E10~~A833 ~~Test Method~~ Practice for ~~Brinell~~Indentation Hardness of Metallic Materials by Comparison Hardness Testers

~~E18~~A956 Test ~~Methods~~Method for ~~Rockwell~~Leeb Hardness Testing of ~~Metallic Materials~~Steel Products

~~E92~~A1038 Test Method for ~~Vickers Hardness of Metallic Materials~~Portable Hardness Testing by the Ultrasonic Contact Impedance Method ~~(Withdrawn 2010)~~

B647 Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage

E10

E18 Test Methods for Rockwell Hardness of Metallic Materials

[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.

Current edition approved ~~Jan. 1, 2010~~July 1, 2014. Published ~~February 2010~~July 2014. Originally approved in 1955. Last previous edition approved in ~~1997~~2010 as E110–~~82 (2002).~~10. DOI: ~~10.1520/E0110-10.~~10.1520/E0110-14.

[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.

***A Summary of Changes section appears at the end of this standard**

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E140 Hardness Conversion Tables for Metals ~~(Relationship~~Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, ~~Rockwell~~ Superficial Hardness, Knoop Hardness, ~~and Scleroscope Hardness)~~Scleroscope Hardness, and Leeb Hardness

~~NOTE 1—Test Methods E10, E18, and E92 will be referred to in this test method as the "standard methods."~~
~~NOTE 2—The standard methods of making the three hardness tests do not preclude the use of portable hardness testers. However, the machines usually used, and considered preferable for these tests, are generally designed so that the magnitude of the indenting force is fixed by dead weights acting on a small piston connected to a hydraulic loading cylinder, or by dead weights acting through a multiple lever system. Portable hardness testers of the types covered in this method do not employ dead weights to fix the indenting forces. This imposes certain limitations and necessitates certain precautions, which are set forth in this test method. All requirements of the standard methods except those modified by the following sections shall apply to the use of portable hardness testers.~~

2.2 *ISO Standards:*[3]
ISO/IEC 17025 : General requirements for the competence of testing calibration laboratories
ISO/IEC 17011 : Conformity assessment -- General requirements for accreditation bodies accrediting conformity assessment bodies

~~3. Apparatus~~

~~3.1 Portable hardness testers are used principally for testing articles that are too large or unwieldy to be tested in the usual types of testing machines, for testing parts of fixed structures, or for testing under any conditions which require that the indenting force be applied in a direction other than vertical. In order that they may be portable and also in order that the indenting forces may be applied in any direction, these testers are designed in such a way that dead weights are not used in applying or limiting the indenting force.~~

~~3.2 The indenting force may be applied by means of a hydraulic cylinder with a pressure gage to indicate the magnitude of the force. The hydraulic cylinder may also be equipped with a spring-forced relief valve to fix the magnitude of the force. Alternatively the indenting force may be applied by means of a screw through a calibrated spring with a dial gage or other means of measuring the deflection of the spring to indicate the magnitude of the force.~~

~~3.3 Portable hardness testers are generally provided with various means of holding the indenter in contact with the surface to be tested. The testers may be clamped to the object to be tested, attached to an adjacent fixed object or attached to the surface to be tested by a magnet. For testing inside a cavity the tester may be placed against one wall of the cavity to make a test on the opposite wall.~~

3. Significance and Use

3.1 Portable hardness testers are used for testing materials that because of their size, location or other requirements such as test point are unable to be tested using traditional fixed instruments.

3.2 Portable hardness testers, by their nature, induce variation that could influence the test results; therefore, hardness measurements made in accordance with this test method are not considered to meet the requirements of E10 or E18. The user should compare the results of the precision and bias studies in E110, E10 and E18 to understand the differences in results expected between portable and fixed instruments.

3.3 Two test parameters that can significantly influence the measurement accuracy when using portable hardness testers are the alignment of the indenter to the test surface and the timing of the test forces. The user is cautioned to do everything possible to keep the centerline of the indenter perpendicular to the test surface and to apply the test forces using the same time cycle as defined in Test Method E10 or Test Methods E18.

3.4 Portable hardness testers are delicate instruments that are subject to damage when they are moved from one test site to another. Therefore, repeating the daily verification process during the testing sequence is recommended to insure that they are working properly.

3.5 Hardness testing at a specific location on a part may not represent the physical characteristics of the whole part or end product.

4. Principles of Test and Apparatus

4.1 The portable hardness tester shall be capable of applying the same test forces, use the same indenter types, and use the same methods for determining and calculating the hardness value as defined in Test Method E10 or Test Methods E18.

[3] ~~The last approved version of this historical standard is referenced on www.astm.org.~~Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

4.2 Portable hardness testers are generally provided with various means of holding the indenter in contact with the surface to be tested. For example, the testers may be clamped to the object to be tested, attached to an adjacent fixed object or attached to the surface to be tested by a magnet. For testing inside a cavity the tester may be placed against one wall of the cavity to make a test on the opposite wall.

4.3 Portable hardness testers of the types covered in this method do not employ dead weights to apply the indenting forces. This imposes certain limitations and necessitates certain precautions. All requirements of the standard methods except those modified by the following sections shall apply to the use of portable hardness testers.

4.3.1 Portable testers are not verified by direct verification.

4.3.2 A portable hardness tester does not have to undergo indirect verification each time it is moved.

4.3.3 Some portable Brinell hardness testers do not maintain the force. It is very important to follow manufacturer's instructions on how to operate the portable Brinell hardness tester.

4.4 *Rockwell Hardness Test Principle* (see Test Method E18)—the general principle of the Rockwell indentation hardness test is divided into three steps of force application and removal.

4.4.1 *Step 1*—The indenter is brought into contact with the test piece in a direction perpendicular to the surface, and the preliminary test force is applied. After preliminary test force, the baseline depth of indentation is measured.

4.4.2 *Step 2*—The force on the indenter is increased to additional test force to achieve the total test force.

4.4.3 *Step 3*—The additional test force is removed, returning to the preliminary test force. The final depth of indentation is measured. The preliminary test force is removed and the indenter is removed from the test piece. The Rockwell hardness value is derived in accordance with E18 from the difference in the final and baseline indentation depths while under the preliminary test force.

4.5 *Brinell Hardness Test Principle–(see Test Method E10)*—the general principle of the Brinell indentation hardness test consists of two steps.

4.5.1 *Step 1*—The indenter is brought into contact with the test piece in a direction perpendicular to the surface, and the test force is applied. The test force is then removed.

4.5.2 *Step 2*—The diameter of the indentation is measured. The Brinell hardness value is derived from the mean of the diameter measurements.

5. Test Piece

5.1 Accurate hardness test results are dependent on proper preparation of the test piece. All requirements for test pieces upon which the indentation will be made shall conform to the applicable standard methods.

6. ~~Procedure~~Test Procedures

6.1 A daily verification (see A1.1.3 and Table A1.1) of the testing machine shall be performed in accordance with the applicable standard methods. It is recommended that daily verification should be performed just prior to making the hardness tests at the test worksite where the hardness tests are to be made. The daily verification should be performed with the testing machine oriented in the position that it will be used. Repeating the daily verification between multiple tests in a sequence and after a test sequence is completed is recommended. The purpose of performing the daily verification at the test site is to ensure that environmental conditions (temperature), position or damage during travel and usage have not affected the ability of the test equipment to perform properly.

6.2 ~~Whatever means is used to hold the tester to the piece being tested, make sure that there is no relative motion between the tester and the piece when the force is applied.~~Relative motion between the tester and the test piece will affect the results of the test; therefore the tester shall be held and supported such that relative motion is minimized. This is particularly true for the portable Rockwell ~~type~~hardness tester. Mount the tester in such a position that the axis of the indenter is normal to the surface to be tested.

6.3 ~~*Application of Force, Portable Brinell Test*—Portable Brinell testers generally apply the force by means of a hydraulic cylinder equipped with both a pressure gage and a spring forced relief valve. With this arrangement it is not possible to maintain the force at the point where the relief valve opens for any appreciable time. Therefore bring up the force several times to the point where the pressure is released. It has been determined that for steel, when testing with a 3000-kgf force, three force applications are equivalent to holding the force 15 s as required in the standard method. For other materials and other forces, make comparison tests to determine the number of force applications required to give results equivalent to the standard method. Bring the force up gradually each time without jerking.~~Adhere to manufacturer's instructions manual for the proper operating procedures and testing precautions.

~~4.3 *Application of Force, Portable Rockwell Type Test*—Portable Rockwell type testers generally apply the force through a calibrated spring by means of a screw and are generally equipped with two indicators, one a dial gage that measures deflection of the spring to indicate the force, and the other a dial gage or micrometer screw to indicate the depth of penetration. Apply the preliminary test force as shown by the force indicator. Set the index on the depth indicator to the proper point. Then apply the total test force. Turn the loading screw in the opposite direction until the preliminary test force is again indicated on the force dial. Then~~