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An American National Standard

Standard Test Methods for Mechanical Testing of Steel Products—Metric[1]

This standard is issued under the fixed designation A1058; 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.

1. Scope*

1.1 These test methods cover mechanical tests described in ASTM, EN,[2] ISO,[3] and JIS[4] standards that utilize the SI system of units. The test methods in each system are not exact equivalents. Each standards system (ASTM, EN, ISO, and JIS) shall be used independently of the other. Combining requirements from any two or more systems may result in nonconformance with the purchase order.

1.2 These test methods cover procedures for the mechanical testing of steels, stainless steels, and related alloys. The various mechanical tests herein described are used to determine properties required in the product specifications. Variations in testing methods are to be avoided, and standard methods of testing are to be followed to obtain reproducible and comparable results. In those cases in which the testing requirements for certain products are unique or at variance with these general procedures, the product specification testing requirements shall control.

1.3 Only one of the testing procedure tracks shall be followed: ASTM, EN, ISO, or JIS. When a test method or practice is not available in one of the tracks then an appropriate test method or practice from an alternative track shall be used. The respective tests are listed in the column shown in Table 1.

NOTE 1—The test methods in each system are not exact equivalents.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 Attention is directed to Practice ISO 17025 when there may be a need for information on criteria for evaluation of testing laboratories.

1.6 *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:*[5]

A833 Practice for Indentation Hardness of Metallic Materials by Comparison Hardness Testers

A1038 Test Method for Portable Hardness Testing by the Ultrasonic Contact Impedance Method

E8/E8M Test Methods for Tension Testing of Metallic Materials

E10 Test Method for Brinell Hardness of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E23 Test Methods for Notched Bar Impact Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E110 Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers

E190 Test Method for Guided Bend Test for Ductility of Welds

E290 Test Methods for Bend Testing of Material for Ductility

2.2 *Other Documents:*

[1] These test methods are under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and are the direct responsibility of Subcommittee A01.13 on Mechanical and Chemical Testing and Processing Methods of Steel Products and Processes.

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[2] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsi-global.com.

[3] Available from International Organization for Standardization, 1 rue de Varembé, Case postale, CH-1211, Genève 20, Switzerland, http://www.iso.org.

[4] Available from Japanese Standards Association, 4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440, Japan, http://www.jsa.or.jp.

[5] 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.**

TABLE 1 Tests and Applicable Standards

Test	Sections	ASTM	EN	ISO	JIS
Tension	5 to 12	E8/E8M	10002-1	6892	Z 2241
Bend	13	E190 E290	7438[A]	7438	Z 2248
Bend (tube)	13	…	10232	8491	…
Hardness	14				
Brinell	15	E10	6506-1[A]	6506-1	Z 2243
Rockwell	16	E18	6508-1[A]	6508-1	Z 2245
Portable	17	A833 E110 A1038	…	…	…
Impact	18 to 26	E23	10045-1	148-1	Z 2242
Keywords	27	…	…	…	…

[A] These standards are designated EN ISO; this identifies the adoption of ISO standards by EN. "EN ISO" is part of the designation.

ASME Boiler and Pressure Vessel Code Section VIII, Division I[6]
EN 10002-1 Metallic Materials—Tensile Testing—Part 1: Method of Test (at Ambient Temperature)
EN 10045-1 Metallic Materials—Charpy Impact Test—Part 1: Test Method
EN 10045-2 Charpy Impact Test on Metallic Materials—Method for the Verification of Impact Testing Machines
EN 10232 Metallic Materials—Tube (in Full Section)—Bend Test
EN ISO 2566-1 Steel—Conversion of Elongation Values—Part 1: Carbon and Low Alloy Steels
EN ISO 2566-2 Steel—Conversion of Elongation Values—Part 2: Austenitic Steels
EN ISO 6506-1 Metallic Materials—Brinell Hardness Test—Part 1: Test Method
EN ISO 6508-1 Metallic Materials—Rockwell Hardness Test—Part 1: Test Method (Scales A, B, C, D, E, F, G, H, K, N, T)
EN ISO 7438 Metallic Materials—Bend Test
ISO 148-1 Metallic Materials—Charpy Pendulum Impact Test—Part 1: Test Method
ISO 148-2 Metallic Materials—Charpy Pendulum Impact Test—Part 2: Verification of Test Machines
ISO 2566-1 Steel—Conversion of Elongation Values—Part 1: Carbon and Low Alloy Steels
ISO 2566-2 Steel—Conversion of Elongation Values—Part 2: Austenitic Steels
ISO 6506-1 Metallic Materials—Brinell Hardness Test—Part 1: Test Method
ISO 6508-1 Metallic Materials—Rockwell Hardness Test—Part 1: Test Method (Scales A, B, C, D, E, F, G, H, K, N, T)
ISO 6892 Metallic Materials—Tensile Testing at Ambient Temperature
ISO 7438 Metallic Materials—Bend Test
ISO 8491 Metallic Materials—Tube (in Full Section)—Bend Test
ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories
JIS B 7722 Charpy Pendulum Impact Test—Verification of Testing Machines
JIS Z 2201 Test Pieces for Tensile Test for Metallic Materials
JIS Z 2241 Method of Tensile Test for Metallic Materials
JIS Z 2242 Method of Charpy Pendulum Impact Test for Metallic Materials
JIS Z 2243 Brinell Hardness Test—Test Method
JIS Z 2245 Rockwell Hardness Test—Test Method
JIS Z 2248 Method of Bend Test for Metallic Materials

3. General Precautions

3.1 The ASTM track is the default track; if other than the ASTM track is used that track shall be reported.

3.2 Certain methods of fabrication, such as bending, forming, and welding, or operations involving heating, may affect the properties of the material under test. Therefore, the product specifications cover the stage of manufacture at which mechanical testing is to be performed. The properties shown by testing prior to fabrication may not necessarily be representative of the product after it has been completely fabricated.

3.3 Improper machining or preparation of test specimens may give erroneous results. Care should be exercised to assure good workmanship in machining. Improperly machined specimens should be discarded and other specimens substituted.

3.4 Flaws in the specimen may also affect results. If any test specimen develops flaws, the retest provision of the applicable product specification shall govern.

3.5 If any test specimen fails because of mechanical reasons such as failure of testing equipment or improper specimen preparation, it may be discarded and another specimen taken.

[6] Available from American Society of Mechanical Engineers, ASME International, Three Park Avenue, New York, NY 10016-5990, USA, http://www.asme.org.

4. Orientation of Test Specimens

4.1 The terms "longitudinal test" and "transverse test" are used only in material specifications for wrought products and are not applicable to castings. When such reference is made to a test coupon or test specimen, the following definitions apply:

4.1.1 *Longitudinal Test*, unless specifically defined otherwise, signifies that the lengthwise axis of the specimen is parallel to the direction of the greatest extension of the steel during rolling or forging. The stress applied to a longitudinal tension test specimen is in the direction of the greatest extension, and the axis of the fold of a longitudinal bend test specimen is at right angles to the direction of greatest extension.

4.1.2 *Transverse Test*, unless specifically defined otherwise, signifies that the lengthwise axis of the specimen is at right angles to the direction of the greatest extension of the steel during rolling or forging. The stress applied to a transverse tension test specimen is at right angles to the greatest extension, and the axis of the fold of a transverse bend test specimen is parallel to the greatest extension.

4.2 The terms "radial test" and "tangential test" are used in material specifications for some wrought circular products and are not applicable to castings. When such reference is made to a test coupon or test specimen, the following definitions apply:

4.2.1 *Radial Test*, unless specifically defined otherwise, signifies that the lengthwise axis of the specimen is perpendicular to the axis of the product and coincident with one of the radii of a circle drawn with a point on the axis of the product as a center.

4.2.2 *Tangential Test*, unless specifically defined otherwise, signifies that the lengthwise axis of the specimen is perpendicular to a plane containing the axis of the product and tangent to a circle drawn with a point on the axis of the product as a center.

TENSION TEST

5. Description

5.1 The tension test related to the mechanical testing of steel products subjects a machined or full-section specimen of the material under examination to a measured load sufficient to cause rupture. The resulting properties sought are defined in Test Methods E8/E8M, EN 10002-1, ISO 6892, or JIS Z 2241 as applicable.

5.2 In general, the testing equipment and methods are given in Test Methods E8/E8M, EN 10002-1, ISO 6892 and JIS Z 2241. However, there are certain exceptions to these practices; these exceptions are covered in this standard.

6. Testing Apparatus and Operations

6.1 *Loading Systems*—There are two general types of loading systems, mechanical (screw power) and hydraulic. These differ chiefly in the variability of the rate of load application. The older screw power machines are limited to a small number of fixed free running crosshead speeds. Some modern screw power machines, and all hydraulic machines permit stepless variation throughout the range of speeds.

6.2 The tension testing machine shall be maintained in good operating condition, used only in the proper loading range, and calibrated periodically in accordance with the latest revision of the appropriate practices.

NOTE 2—Many machines are equipped with stress-strain recorders for autographic plotting of stress-strain curves. It should be noted that some recorders have a load measuring component entirely separate from the load indicator of the testing machine. Such recorders are calibrated separately.

6.3 *Loading*—It is the function of the gripping or holding device of the testing machine to transmit the load from the heads of the machine to the specimen under test. The essential requirement is that the load shall be transmitted axially. This implies that the centers of the action of the grips shall be in alignment, insofar as practicable, with the axis of the specimen at the beginning and during the test and that bending and twisting be held to a minimum.

6.4 *Speed of Testing*—The speed of testing shall not be greater than that at which load and strain readings can be made accurately. In production testing, speed of testing is commonly expressed *(1)* in terms of free running crosshead speed (rate of movement of the crosshead of the testing machine when not under load), or *(2)* in terms of rate of separation of the two heads of the testing machine under load, or *(3)* in terms of rate of stressing the specimen, or *(4)* in terms of rate of straining the specimen. The following limitations on the speed of testing are recommended as adequate for most steel products:

NOTE 3—Tension tests using closed-loop machines (with feedback control of rate) should not be performed using load control, as this mode of testing will result in acceleration of the crosshead upon yielding and elevation of the measured yield strength.

6.4.1 Any convenient speed of testing may be used up to one half the specified yield point or yield strength. When this point is reached, the free-running rate of separation of the crossheads shall be adjusted so as not to exceed 0.025 mm per second per 25 mm of reduced section, or the distance between the grips for test specimens not having reduced sections. This speed shall be maintained through the yield point or yield strength. In determining the tensile strength, the free-running rate of separation of the heads shall not exceed 13 mm per min per 25 mm of reduced section, or the distance between the grips for test specimens not having reduced sections. In any event, the minimum speed of testing shall not be less than 1⁄10 the specified maximum rates for determining yield point or yield strength and tensile strength.

6.4.2 It shall be permissible to set the speed of the testing machine by adjusting the free running crosshead speed to the above specified values, inasmuch as the rate of separation of heads under load at these machine settings is less than the specified values of free running crosshead speed.

6.4.3 As an alternative, if the machine is equipped with a device to indicate the rate of loading, the speed of the machine from half the specified yield point or yield strength through the yield point or yield strength may be adjusted so that the rate of stressing does not exceed 11 MPa per second. However, the minimum rate of stressing shall not be less than 1 MPa per second.

7. Test Specimen Parameters

7.1 *Selection*—Test coupons shall be selected in accordance with the applicable product specifications.

7.2 *Size and Tolerances*—Test specimen dimensions and tolerances shall comply with the requirements of the relevant standards.

7.3 *Procurement of Test Specimens*—Specimens shall be prepared from portions of the material. They are usually machined so as to have a reduced cross section at mid-length in order to obtain uniform distribution of the stress over the cross section and to localize the zone of fracture. Care shall be taken to remove by machining all distorted, cold-worked, or heat-affected areas from the edges of the section used in evaluating the test.

7.4 *Aging of Test Specimens*—Unless otherwise specified, it shall be permissible to age tension test specimens. The time-temperature cycle employed must be such that the effects of previous processing will not be materially changed. It may be accomplished by aging at room temperature 24 to 48 h, or in shorter time at moderately elevated temperatures by boiling in water, heating in oil or in an oven.

7.5 *Measurement of Dimensions of Test Specimens*—Test specimens shall be measured in accordance with the requirements of 7.5.1 and 7.5.2 for ASTM or the appropriate paragraphs of ISO 6892, EN 10002-1, or JIS Z 2241 as applicable.

7.5.1 *Rectangular Tension Test*—These forms of specimens are shown in Test Methods E8/E8M. To determine the cross-sectional area, the center width dimension shall be measured to the nearest 0.15 mm for the 200-mm gauge length specimen and 0.025 mm for the 50-mm gauge length specimen. The center thickness dimension shall be measured to the nearest 0.025 mm for both specimens.

7.5.2 *Round Tension Test Specimens*—These forms of specimens are shown in Test Methods E8/E8M. To determine the cross-sectional area, the diameter shall be measured at the center of the gauge length to the nearest 0.025 mm.

7.6 *General*—Test specimens shall be either substantially full size or machined, as prescribed in the product specifications for the material being tested.

~~7.6.1Improperly prepared test specimens often cause unsatisfactory test results. It is important, therefore, that care be exercised in the preparation of specimens, particularly in the machining, to assure good workmanship.~~

~~7.6.2It is desirable to have the cross-sectional area of the specimen smallest at the center of the gauge length to ensure fracture within the gauge length. This is provided for by the taper in the gauge length permitted for each of the specimens described in the following sections.~~

~~7.6.3For low ductility materials it is desirable to have fillets of large radius at the ends of the gauge length.~~

7.6.1 It is desirable to have the cross-sectional area of the specimen smallest at the center of the gauge length to ensure fracture within the gauge length. This is provided for by the taper in the gauge length permitted for each of the specimens described in the following sections.

7.6.2 For low ductility materials it is desirable to have fillets of large radius at the ends of the gauge length.

8. Plate-Type Specimen

8.1 The standard plate-type test specimen is shown in Test Methods E8/E8M, EN 10002-1, ISO 6892, or JIS Z 2241. This specimen is used for testing metallic materials in the form of plate, structural and bar-size shapes, and flat material having a nominal thickness of 5 mm or over. When product specifications so permit, other types of specimens may be used.

9. Sheet-Type Specimen

9.1 The standard sheet-type test specimen is shown in Test Methods E8/E8M, EN 10002-1, ISO 6892, or JIS Z 2241. This specimen is used for testing metallic materials in the form of sheet, plate, flat wire, strip, band, and hoop ranging in nominal thickness from 0.13 to 19 mm. When product specifications so permit, other types of specimens may be used, as specified in Test Methods E8/E8M.

10. Round Specimens

10.1 The standard diameter round test specimen as shown in Test Methods E8/E8M, EN 10002-1, ISO 6892, or JIS Z 2241 is used quite generally for testing metallic materials, both cast and wrought.

10.2 Small size specimens proportional to standard specimens may be used when it is necessary to test material from which the standard specimens cannot be prepared. Other sizes of small round specimens may be used. In any such small size specimen it is important that the gauge length for measurement of elongation be five times the diameter of the specimen.

10.3 The type of specimen ends outside of the gauge length shall accommodate the shape of the product tested, and shall properly fit the holders or grips of the testing machine so that axial loads are applied with a minimum of load eccentricity and slippage.

11. Gauge Marks

11.1 Test specimens shall be marked in accordance with the requirements of the relevant standards.

12. Determination of Tensile Properties

12.1 The determination and description of the tensile properties shall be in accordance with the requirements of the relevant standards.

12.2 Subject to agreement between the purchaser and supplier, elongation values may be converted from a 4d gauge length to a 5d gauge length or vice versa by use of the multiplication factors shown in Table 2.

12.2.1 *Example 1*—Conversion of Carbon and low alloy steel elongation derived from 4d gauge length to a 5d gauge length elongation value:

$$23\ \% \times 0.916 = 21\ \%$$

12.2.2 *Example 2*—Conversion of Austenitic steel elongation derived from 5d gauge length to a 4d gauge length elongation value:

$$23\ \% \times 1.029 = 24\ \%$$

12.3 *Reduction of Area*—Fit the ends of the fractured specimen together and measure the mean diameter or the width and thickness at the smallest cross section to the same accuracy as the original dimensions. The difference between the area thus found and the area of the original cross section expressed as a percentage of the original area is the reduction of area.

BEND TEST

13. Description

13.1 The bend test is one method for evaluating ductility, but it cannot be considered as a quantitative means of predicting service performance in all bending operations. The severity of the bend test is primarily a function of the angle of bend and inside diameter to which the specimen is bent, and of the cross section of the specimen. These conditions are varied according to location and orientation of the test specimen and the chemical composition, tensile properties, hardness, type, and quality of the steel specified. Test Method E190, Test Methods E290, EN ISO 7438, EN 10232 (tube), ISO 7438, or ISO 8491 (tube) and JIS Z 2248 may be consulted for methods of performing the test.

13.2 Unless otherwise specified, it shall be permissible to age bend test specimens. The time-temperature cycle employed must be such that the effects of previous processing will not be materially changed. It may be accomplished by aging at room temperature 24 to 48 h, or in shorter time at moderately elevated temperatures by boiling in water or by heating in oil or in an oven.

13.3 Bend the test specimen at room temperature to an inside diameter, as designated by the applicable product specifications, to the extent specified without major cracking on the outside of the bent portion. The speed of bending is ordinarily not an important factor.

HARDNESS TEST

14. General

14.1 A hardness test is a means of determining resistance to penetration and is occasionally employed to obtain a quick approximation of tensile strength. Table 3, Table 4, Table 5, and Table 6 are for the conversion of hardness measurements from one scale to another or to approximate tensile strength. These conversion values have been obtained from computer-generated curves and are presented to the nearest 0.1 point to permit accurate reproduction of those curves. Since all converted hardness values must be considered approximate, however, all converted Rockwell hardness numbers shall be rounded to the nearest whole number.

14.2 *Hardness Testing*:

14.2.1 If the product specification permits alternative hardness testing to determine conformance to a specified hardness requirement, the conversions listed in Table 3, Table 4, Table 5, and Table 6 shall be used.

14.2.2 When recording converted hardness numbers, the measured hardness and test scale shall be indicated in parentheses, for example: 353 HBW (38 HRC). This means that a hardness value of 38 was obtained using the Rockwell C scale and converted to a Brinell hardness of 353.

15. Brinell Test

15.1 The Brinell Test shall be carried out in accordance with the requirements of Test Method E10, EN ISO 6506-1, ISO 6506-1, or JIS Z 2243.

15.1.1 A range of hardness can properly be specified only for quenched and tempered or normalized and tempered material. For annealed material a maximum figure only should be specified. For normalized material a minimum or a maximum hardness may be specified by agreement. In general, no hardness requirements should be applied to untreated material.

TABLE 2 Conversion Factors for 4d and 5d Gauge Lengths (ISO 2566-1 and ISO 2566-2)

Conversion from	4d to 5d	5d to 4d
Carbon and low alloy steels	0.916	1.093
Austenitic steels	0.972	1.029

TABLE 3 Approximate Hardness Conversion Numbers for Nonaustenitic Steels[A] (Rockwell C to Other Hardness Numbers)

Rockwell C Scale, 150-kgf Load, Diamond Penetrator	Vickers Hardness Number	Brinell Hardness, 3000-kgf Load, 10-mm Ball	Knoop Hardness, 500-gf Load and Over	Rockwell A Scale, 60-kgf Load, Diamond Penetrator	Rockwell Superficial Hardness			Approximate Tensile Strength, ksi (MPa)
					15N Scale, 15-kgf Load, Diamond Penetrator	30N Scale 30-kgf Load, Diamond Penetrator	45N Scale, 45-kgf Load, Diamond Penetrator	
68	940	. . .	920	85.6	93.2	84.4	75.4	. . .
67	900	. . .	895	85.0	92.9	83.6	74.2	. . .
66	865	. . .	870	84.5	92.5	82.8	73.3	. . .
65	832	739	846	83.9	92.2	81.9	72.0	. . .
64	800	722	822	83.4	91.8	81.1	71.0	. . .
63	772	706	799	82.8	91.4	80.1	69.9	. . .
62	746	688	776	82.3	91.1	79.3	68.8	. . .
61	720	670	754	81.8	90.7	78.4	67.7	. . .
60	697	654	732	81.2	90.2	77.5	66.6	. . .
59	674	634	710	80.7	89.8	76.6	65.5	351 (2420)
58	653	615	690	80.1	89.3	75.7	64.3	338 (2330)
57	633	595	670	79.6	88.9	74.8	63.2	325 (2240)
56	613	577	650	79.0	88.3	73.9	62.0	313 (2160)
55	595	560	630	78.5	87.9	73.0	60.9	301 (2070)
54	577	543	612	78.0	87.4	72.0	59.8	292 (2010)
53	560	525	594	77.4	86.9	71.2	58.6	283 (1950)
52	544	512	576	76.8	86.4	70.2	57.4	273 (1880)
51	528	496	558	76.3	85.9	69.4	56.1	264 (1820)
50	513	482	542	75.9	85.5	68.5	55.0	255 (1760)
49	498	468	526	75.2	85.0	67.6	53.8	246 (1700)
48	484	455	510	74.7	84.5	66.7	52.5	238 (1640)
47	471	442	495	74.1	83.9	65.8	51.4	229 (1580)
46	458	432	480	73.6	83.5	64.8	50.3	221 (1520)
45	446	421	466	73.1	83.0	64.0	49.0	215 (1480)
44	434	409	452	72.5	82.5	63.1	47.8	208 (1430)
43	423	400	438	72.0	82.0	62.2	46.7	201 (1390)
42	412	390	426	71.5	81.5	61.3	45.5	194 (1340)
41	402	381	414	70.9	80.9	60.4	44.3	188 (1300)
40	392	371	402	70.4	80.4	59.5	43.1	182 (1250)
39	382	362	391	69.9	79.9	58.6	41.9	177 (1220)
38	372	353	380	69.4	79.4	57.7	40.8	171 (1180)
37	363	344	370	68.9	78.8	56.8	39.6	166 (1140)
36	354	336	360	68.4	78.3	55.9	38.4	161 (1110)
35	345	327	351	67.9	77.7	55.0	37.2	156 (1080)
34	336	319	342	67.4	77.2	54.2	36.1	152 (1050)
33	327	311	334	66.8	76.6	53.3	34.9	149 (1030)
32	318	301	326	66.3	76.1	52.1	33.7	146 (1010)
31	310	294	318	65.8	75.6	51.3	32.5	141 (970)
30	302	286	311	65.3	75.0	50.4	31.3	138 (950)
29	294	279	304	64.6	74.5	49.5	30.1	135 (930)
28	286	271	297	64.3	73.9	48.6	28.9	131 (900)
27	279	264	290	63.8	73.3	47.7	27.8	128 (880)
26	272	258	284	63.3	72.8	46.8	26.7	125 (860)
25	266	253	278	62.8	72.2	45.9	25.5	123 (850)
24	260	247	272	62.4	71.6	45.0	24.3	119 (820)
23	254	243	266	62.0	71.0	44.0	23.1	117 (810)
22	248	237	261	61.5	70.5	43.2	22.0	115 (790)
21	243	231	256	61.0	69.9	42.3	20.7	112 (770)
20	238	226	251	60.5	69.4	41.5	19.6	110 (760)

[A] This table gives the approximate interrelationships of hardness values and approximate tensile strength of steels. It is possible that steels of various compositions and processing histories will deviate in hardness-tensile strength relationship from the data presented in this table. The data in this table should not be used for austenitic stainless steels, but have been shown to be applicable for ferritic and martensitic stainless steels. The data in this table should not be used to establish a relationship between hardness values and tensile strength of hard drawn wire. Where more precise conversions are required, they should be developed specially for each steel composition, heat treatment, and part.