Designation: A 320/A 320M – 08

Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service[1]

This standard is issued under the fixed designation A 320/A 320M; 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 specification[2] covers alloy steel bolting materials for pressure vessels, valves, flanges, and fittings for low-temperature service. The term "bolting material" as used in this specification covers rolled, forged, or strain hardened bars, bolts, screws, studs, and stud bolts. The bars shall be hot-wrought. The material may be further processed by centerless grinding or by cold drawing. Austenitic stainless steel may be solution annealed or annealed and strain-hardened. When strain hardened austenitic stainless steel is ordered, the purchaser should take special care to ensure that Appendix X1 is thoroughly understood.

1.2 Several grades are covered, including both ferritic and austenitic steels designated L7, B8, etc. Selection will depend on design, service conditions, mechanical properties, and low-temperature characteristics. The mechanical requirements of Table 1 indicate the diameters for which the minimum mechanical properties apply to the various grades and classes, and Table 2 stipulates the requirements for Charpy impact energy absorption. The manufacturer should determine that the material can conform to these requirements before parts are manufactured. For example, when Grade L43 is specified to meet the Table 2 impact energy values at −150 °F [−101 °C], additional restrictions (such as procuring a steel with lower P and S contents than might normally be supplied) in the chemical composition for AISI 4340 are likely to be required.

NOTE 1—The committee formulating this specification has included several grades of material that have been rather extensively used for the present purpose. Other compositions will be considered for inclusion by the committee from time to time as the need becomes apparent. Users should note that hardenability of some of the grades mentioned may restrict the maximum size at which the required mechanical properties are obtainable.

1.3 Nuts for use with this bolting material are covered in Section 10 and the nut material shall be impact tested.

1.4 Supplementary Requirements (S1, S2, and S3) of an optional nature are provided. They shall apply only when specified in the inquiry, contract and order.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished to inch-pound units.

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 962/A 962M Specification for Common Requirements for Steel Fasteners or Fastener Materials, or Both, Intended for Use at Any Temperature from Cryogenic to the Creep Range

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Steel Forgings and Wrought Fittings for Piping Applications and Bolting Materials for Piping and Special Purpose Applications.

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[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-320 in Section II of that Code.

[3] 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.**

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E 566 Practice for Electromagnetic (Eddy-Current) Sorting of Ferrous Metals
F 436 Specification for Hardened Steel Washers
F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

2.2 *ANSI Standards:*
B1.1 Screw Threads[4]
B18.22.1 Plain Washers[4]

3. Ordering Information

3.1 It is the purchaser's responsibility to specify in the purchase order all information necessary to purchase the needed materials. Examples of such information include, but are not limited to, the following:

3.1.1 Quantity and size,

3.1.2 Heat-treated condition, that is, for the austenitic stainless steels, solution-treated (Class 1); solution-treated after finishing (Class 1A); and annealed and strain-hardened (Class 2),

3.1.3 Description of items required (bars, bolts, screws, or studs),

3.1.4 Nuts and washers, if required by the purchaser, in accordance with Section 10, and

3.1.5 Special requirements, in accordance with 5.1.1, 5.1.2, 5.1.3, and 12.1.

4. Common Requirements

4.1 Material and fasteners supplied to this specification shall conform to the requirements of Specification A 962/A 962M. These requirements include methods, finish, thread dimensions, marking certification, optional supplementary requirements, and others. Failure to comply with the requirements of Specification A 962/A 962M constitutes nonconformance with this specification. In case of conflict between the requirements in this specification and Specification A 962/A 962M, this specification shall prevail.

4.2 For L7M bolting, the final heat treatment, which may be the tempering operation if conducted at 1150 °F [620 °C] minimum, shall be done after machining and forming operations, including thread rolling and any type of cutting.

5. Materials and Manufacture

5.1 *Heat Treatment*:

5.1.1 The bolting material shall be allowed to cool to room temperature after rolling or forging. Grades L7, L7A, L7B, L7C, L7M, L43, L1, L70, L71, L72, and L73 shall be reheated to above the upper critical temperature and liquid quenched and tempered. Grades B8, B8C, B8M, B8T, B8F, B8P, B8LN, and B8MLN shall receive a carbide solution treatment. Products made from such material are described as Class 1. This shall consist of holding the material for a sufficient time at a temperature at which the chromium carbide will go into solution and then cooling in air or in a liquid medium at a rate sufficient to prevent reprecipitation of the carbide. Material thus treated is described as Class 1. If specified in the purchase order, material shall be solution treated in the finished condition; material so treated is described as Class 1A.

5.1.2 When increased mechanical properties are desired, the austenitic bolting materials shall be solution annealed and strain hardened if specified in the purchase order; material so treated is identified as Class 2.

5.1.3 If scale-free bright finish is required, this shall be specified in the purchase order.

5.1.4 For L7M bolting, the final heat treatment, which may be the tempering or stress-relieving operation conducted at 1150 °F [620 °C] minimum, shall be done after machining or rolling of the threads and any type of cutting.

6. Mechanical Requirements

6.1 *Tensile Properties*:

6.1.1 The material as represented by the tension specimens shall conform to the requirements as to tensile properties prescribed in Table 1 at room temperature after heat treatment (see 5.1.1). Alternatively, Class 2 Strain Hardened Headed Fasteners shall be tested full size after strain hardening to determine tensile strength and yield strength and shall conform to the requirements prescribed in Table 1. Should the results of full size tests conflict with results of tension specimen tests, full size test results shall prevail.

6.1.2 *Number of Tests*:

6.1.2.1 For heat-treated bars, one tension test and one impact test consisting of three specimens shall be made for each diameter of each heat represented in each tempering charge. In the continuous type treatment, a charge shall be defined as 6000 lb [2700 kg].

6.1.2.2 For studs, bolts, screws, etc., one tension test and one set of three impact specimens shall be made for each diameter of each heat involved in the lot. Each lot shall consist of the following:

Diameter, in. [mm]	Lot Size, lb [kg]
1⅛ [30] and under	1500 [680] or fraction thereof
Over 1⅛ [30] to 1¾ [45], incl	4500 [2040] or fraction thereof
Over 1¾ [45] to 2½ [65], incl	6000 [2700] or fraction thereof
Over 2½ [65]	100 pieces or fraction thereof

6.1.2.3 *Full Size Specimens, Headed Fasteners*—Headed fasteners 1 ½ in. in body diameter and smaller, with body length three times the diameter or longer, and which are produced by upsetting or forging (hot or cold) shall be subjected to full size testing in accordance with 6.1.3. This testing shall be in addition to tensile testing as specified in 6.1.1. The lot size shall be shown in 6.1.2.2. Failure shall occur in the body or threaded sections with no failure, or indications of failure, such as cracks, at the junction of the head and shank.

6.1.3 *Full Size Fasteners, Wedge Tensile Testing*—When applicable, see 6.1.2.3. Headed fasteners shall be wedge tested full size in accordance with Annex A3 of Test Methods and Definitions A 370 and shall conform to the tensile strength shown in Table 1. The minimum full size breaking strength (lbf) for individual sizes shall be as follows:

$$Ts = UTS \times As \quad (1)$$

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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TABLE 1 Mechanical Requirements

Class and Grade, Diameter, in [mm]	Heat Treatment	Minimum Tempering Temperature °F [°C]	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa] (0.2 % offset)	Elongation in 2 in. or 50 mm min, %	Reduction of Area, min, %	Hardness max
Ferritic Steels							
L7, L7A, L7B, L7C, L70, L71, L72, L73			125 [860]	105 [725]	16	50	321 HB or 35 HRC
2½ [65] and under[A]	quenched and tempered	1100 [593]					
L43			125 [860]	105 [725]	16	50	321 HB or 35 HRC
4 [100] and under[A]	quenched and tempered	1100 [593]					
L7M			100 [690]	80 [550]	18	50	235 HB[B] or 99 HRB
2½ [65] and under[A]	quenched and tempered	1150 [620]					
L1			125 [860]	105 [725]	16	50	. . .
1 [25] and under[A]	quenched and tempered						
Austenitic Steels[C]							
Class 1: B8, B8C, B8M, B8P, B8F, B8T, B8LN, B8MLN, all diameters	carbide solution treated		75 [515]	30 [205]	30	50	223 HB[D] or 96 HRB
Class 1A: B8A, B8CA, B8MA, B8PA, B8FA, B8TA, B8LNA, B8MLNA, all diameters	carbide solution treated in the finished condition		75 [515]	30 [205]	30	50	192 HB or 90 HRB
Class 2: B8, B8C, B8P, B8F, B8T:	carbide solution treated and strain hardened						
¾ [20] and under			125 [860]	100 [690]	12	35	321 HB or 35 HRC
over ¾ to 1 [20 to 25], incl			115 [795]	80 [550]	15	30	321 HB or 35 HRC
over 1 to 1¼ [25 to 32], incl			105 [725]	65 [450]	20	35	321 HB or 35 HRC
over 1¼ to 1½ [32 to 40], incl[A]			100 [690]	50 [345]	28	45	321 HB or 35 HRC
Class 2: B8M:	carbide solution treated and strain hardened						
¾ [20] and under			110 [760]	95 [655]	15	45	321 HB or 35 HRC
over ¾ to 1 [20 to 25], incl			100 [690]	80 [550]	20	45	321 HB or 35 HRC
over 1 to 1¼ [25 to 32], incl			95 [655]	65 [450]	25	45	321 HB or 35 HRC
over 1¼ to 1½ [32 to 40], incl[A]			90 [620]	50 [345]	30	45	321 HB or 35 HRC

[A] These upper diameter limits were established on the basis that these were the largest sizes commonly available that consistently met specification property limits. They are not intended as absolute limits beyond which bolting materials could no longer be certified to the specification.

[B] To meet the tensile requirements, the Brinell hardness shall not be less than 200 HB or 93 HRB.

[C] Class 1 products are made from solution-treated material. Class 1A products are solution treated in the finished condition for corrosion resistance; heat treatment is critical for enhancing this physical property and meeting the mechanical property requirements. Class 2 products are made from solution-treated material that has been strain hardened. Austenitic steels in the strain-hardened condition may not show uniform properties throughout the cross section, particularly in sizes over ¾ in. [20 mm] in diameter.

[D] For sizes ¾ in. [20 mm] in diameter and smaller, a maximum hardness of 241 HB (100 HRB) is permitted.

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TABLE 2 Impact Energy Absorption Requirements

Size of Specimen, mm	Minimum Impact Value Required for Average of Each Set of Three Specimens, ft·lbf [J]	Minimum Impact Value Permitted for One Specimen Only of a Set, ft·lbf [J]
All Grades Except L1[A]		
10 by 10	20 [27]	15 [20]
10 by 7.5	16 [22]	12 [16]
Grade L1		
10 by 10	40 [54]	30 [41]
10 by 7.5	32 [44]	24 [32]

[A] See 6.2.1.1 for permitted exemptions.

where:
Ts = Wedge tensile strength
UTS = Tensile strength specified in Table 1, and
As = Stress area, square inches, as shown in ANSI B1.1 or calculated as follows:

$$As = 0.785\ (D-(0.974/n))^2 \quad (2)$$

where:
D = Nominal thread size, and
n = The number of threads per inch.

6.2 *Impact Properties*:

6.2.1 *Requirements*:

6.2.1.1 Material of Grades L7, L7A, L7B, L7C, L7M, L43, L70, L71, L72, and L73 shall show a minimum impact energy absorption of 20 ft · lbf [27 J] and of Grade L1 a minimum impact energy absorption of 40 ft · lbf [54 J] at the test temperature when tested by the procedure specified in the applicable portions of Sections 19 to 28 of Test Methods and Definitions A 370. The temperature of the coolant used for chilling the test specimens shall be controlled within ±3 °F [1.5 °C]. Impact tests are not required for carbide solution treated or strain hardened Grades B8, B8F, B8P, B8M, B8T, B8LN, and B8MLN for temperatures above −325 °F [−200 °C]; for carbide solution treated Grades B8, B8P, B8C, and B8LN above −425 °F [−255 °C]; for all ferritic and austenitic steel grades of bolting ½ in. [12.5 mm] and smaller in diameter. All other material furnished under this specification shall be tested. Test temperatures for ferritic grades are listed in Table 3. Exceptions to this requirement are permissible, and the impact tests may be made at specified temperatures different than those shown in Table 3, provided the test temperature is at least as low as the intended service temperature and the bolting is suitably marked to identify the reported test temperature. When impact testing is required for austenitic grades, test criteria shall be agreed upon between the supplier and purchaser.

6.2.1.2 The impact test requirements for standard and subsize Charpy test specimens are prescribed in Table 2.

TABLE 3 Recommended Test Temperature for Stock Parts

Grade	Test Temperature	
	°F	°C
L7M, L70, L71, L72, L73	−100	−73
L7, L7A, L7B, L7C	−150	−101
L43	−150	−101
L1	−100	−73

6.2.2 *Number of Tests*:

6.2.2.1 The test requirements for heat-treated bars are given in 6.1.2.1.

6.2.2.2 For test requirements on studs, bolts, screws, etc., see 6.1.2.2.

6.2.2.3 Impact tests are not required to be made on heat-treated bars, bolts, screws, studs, and stud bolts ½ in. [12.5 mm] and under in diameter.

6.2.3 *Test Specimens*—For sections 1 in. [25 mm] or less in diameter, test specimens shall be taken at the axis; for sections over 1 in. [25 mm] in diameter, midway between the axis and the surface.

6.3 *Hardness Requirements*:

6.3.1 The hardness shall conform to the requirements prescribed in Table 1. Hardness testing shall be performed in accordance with either Specification A 962/A 962M or with Test Methods F 606.

6.3.2 The maximum hardness of Grade L7M shall be 235 HB or 99 HRB (conversion in accordance with Table Number 2B of Test Methods and Definitions A 370). Minimum hardness shall not be less than 200 HB or 93 HRB. Conformance to this hardness shall be ensured by testing each bolt or stud by Brinell or Rockwell B methods in accordance with 6.3.1.

6.3.2.1 The use of 100 % electromagnetic testing for hardness as an alternative to 100 % indentation hardness testing is permissible when qualified by sampling using indentation hardness testing. Each lot tested for hardness electromagnetically shall be 100 % examined in accordance with Practice E 566. Following electromagnetic testing for hardness, a random sample of a minimum of 100 pieces in each purchase lot (as defined in 6.1.2.2) shall be tested by indentation hardness methods. All samples must meet hardness requirements to permit acceptance of the lot. If any one sample is outside of the specified maximum or minimum hardness, the lot shall be rejected and either reprocessed and resampled, or tested 100 % by indentation hardness methods.

6.3.2.2 In the event a controversy exists relative to minimum strength, tension tests shall prevail over hardness readings. Products which have been tested and found acceptable shall have a line under the grade symbol.

7. Chemical Composition

7.1 Each alloy shall conform to the chemical composition requirements prescribed in Table 4.

8. Workmanship, Finish, and Appearance

8.1 Bolts, screws, studs, and stud bolts shall be pointed and shall have a workmanlike finish.

9. Retests

9.1 If the results of the mechanical tests of any test lot do not conform to the requirements specified, the manufacturer may retreat such lot not more than twice, in which case two additional tension tests and one additional impact test consisting of three specimens shall be made from such lot, all of which shall conform to the requirements specified.

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10. Nuts and Washers

10.1 Bolts, studs, and stud bolts of Grades L7, L7A, L7B, L7C, L43, L1, L70, L71, L72, and L73 shall be equipped with ferritic alloy nuts conforming to Grade 4 or Grade 7 of Specification A 194/A 194M or a grade of steel similar to the studs. Grade 7M nuts at a hardness not exceeding 235 HB (or equivalent) shall be used with Grade L7M bolts, studs, and stud bolts. All nut materials, including those which may be supplied under Specification A 194/A 194M, shall be subject to the impact requirements of this specification in the following manner: impact tests shall be made on test specimens taken from the bar or plate from the heat of steel used for manufacturing the nuts, and heat treated with the nut blanks.

10.2 Bolts, studs, and stud bolts of Grades B8, B8C, B8T, B8P, B8F, B8M, B8LN, and B8MLN shall be equipped with austenitic alloy nuts conforming to Grades 8, 8C, 8T, 8F, 8M, 8LN, and 8MLN for Specification A 194/A 194M. Impact tests are not required for Grades 8F, 8M, 8T, and 8MLN for temperatures above −325 °F [−200 °C] and for Grades 8, 8P, 8C, and 8LN above −425 °F [−255 °C].

10.3 If the purchaser requires nuts with a Charpy impact energy absorption of not less than 20 ft · lbf [27 J] at temperatures below −150 °F [−100 °C], he may require that the nuts conform to Grades 8, 8C, 8M, 8P, 8T, 8F, 8LN, or 8MLN of Specification A 194/A 194M.

10.4 Washers for use with ferritic steel bolting shall conform to Specification F 436.

10.5 Washers for use with austenitic steel bolting shall be made of austenitic steel as agreed upon between the manufacturer and purchaser.

10.6 Washer dimensions shall be in accordance with requirements of ANSI B18.22.1, unless otherwise specified in the purchase order.

11. Threads

11.1 Where practical, all threads shall be formed after heat treatment. Class 1A, Grades B8A, B8CA, B8MA, B8PA, B8FA, B8TA, B8LNA, and B8MLNA are to be solution-treated in the finished condition.

TABLE 4 Chemical Requirements (Composition, %)[A]

Type	Ferritic Steels											
Grade	L7, L7M, L70		L7A, L71		L7B, L72		L7C, L73		L43		L1	
Description . . .	Chromium-Molybdenum[B]		Carbon-Molybdenum (AISI 4037)		Chromium-Molybdenum (AISI 4137)		Nickel-Chromium-Molybdenum (AISI 8740)		Nickel-Chromium-Molybdenum (AISI 4340)		Low-Carbon Boron	
	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under
Carbon	0.38–0.48[C]	0.02	0.35–0.40	0.02	0.35–0.40	0.02	0.38–0.43	0.02	0.38–0.43	0.02	0.17–0.24	0.01
Manganese	0.75–1.00	0.04	0.70–0.90	0.03	0.70–0.90	0.03	0.75–1.00	0.04	0.60–0.85	0.03	0.70–1.40	0.04
Phosphorus max	0.035	0.005 over	0.035	0.005 over	0.035	0.005 over	0.035	0.005 over	0.035	0.005 over	0.035	0.005 over
Sulfur, max	0.040	0.005 over	0.040	0.005 over	0.040	0.005 over	0.040	0.005 over	0.040	0.005 over	0.050	0.005 over
Silicon	0.15–0.35	0.02	0.15–0.35	0.02	0.15–0.35	0.02	0.15–0.35	0.02	0.15–0.35	0.02	0.15–0.30	0.02
Nickel	. . .	. . .	. . .	. . .	. . .	. . .	0.40–0.70	0.03	1.65–2.00	0.05	. . .	. . .
Chromium	0.80–1.10	0.05	. . .	. . .	0.80–1.10	0.05	0.40–0.60	0.03	0.70–0.90	0.03	. . .	. . .
Molybdenum	0.15–0.25	0.02	0.20–0.30	0.02	0.15–0.25	0.02	0.20–0.30	0.02	0.20–0.30	0.02	. . .	. . .
Boron	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.001–0.003	. . .

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TABLE 4 *Continued*

Type	Austenitic Steels, Classes 1, 1A, and 2[D]			
Grade	B8, B8A		B8C, B8CA	
UNS Designation	S 30400(304)		S 34700(347)	
	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under
Carbon, max	0.08	0.01 over	0.08	0.01 over
Manganese, max	2.00	0.04 over	2.00	0.04 over
Phosphorus, max	0.045	0.010 over	0.045	0.010 over
Sulfur, max	0.030	0.005 over	0.030	0.005 over
Silicon, max	1.00	0.05 over	1.00	0.05 over
Nickel	8.0–11.0	0.15	9.0–12.0	0.15
Chromium	18.0–20.0	0.20	17.0–19.0	0.20
Columbium + Tantalum	. . .	. . .	10 × carbon content, min. –1.10 max	0.05 under

Type	Austenitic Steels, Classes 1, 1A, and 2[D]									
Grade	B8T, B8TA		B8P, B8PA		B8F, B8FA				B8M, B8MA	
UNS Designation	S 32100(321)		S 30500		S 30300(303)		S 30323(303Se)		S 31600(316)	
	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under
Carbon, max	0.08	0.01 over	0.08	0.01 over	0.15	0.01 over	0.15	0.01 over	0.08	0.01 over
Manganese, max	2.00	0.04 over	2.00	0.04 over	2.00	0.04 over	2.00	0.04 over	2.00	0.04 over
Phosphorus, max	0.045	0.010 over	0.045	0.010 over	0.20	0.010 over	0.20	0.010 over	0.045	0.010 over
Sulfur	0.030, max	0.005 over	0.030, max	0.005 over	0.15, min	0.020	0.06, max	0.010 over	0.030, max	0.005 over
Silicon, max	1.00	0.05 over	1.00	0.05 over	1.00	0.05 over	1.00	0.05 over	1.00	0.05 over
Nickel	9.0–12.0	0.15	10.5–13.0	0.15	8.0–10.0	0.10	8.0–10.0	0.10	10.0–14.0	0.15
Chromium	17.0–19.0	0.20	17.0–19.0	0.20	17.0–19.0	0.20	17.0–19.0	0.20	16.0–18.0	0.20
Molybdenum	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	2.00–3.00	0.10
Selenium	. . .	. . .	. . .	. . .	. . .	. . .	0.15–0.35	0.03 under	. . .	. . .
Titanium	5 × carbon content, min	0.05 under	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Nitrogen	0.10, max	0.01	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Type	Austenitic Steels, Classes 1 and 1A			
Grade	B8LN, B8LNA		B8MLN, B8MLNA	
UNS Designation	S 30453		S 31653	
	Range, %	Product Variation, % Over or Under	Range, %	Product Variation, % Over or Under
Carbon, max	0.030	0.005 over	0.030	0.005 over
Manganese, max	2.00	0.04 over	2.00	0.04 over
Phosphorus, max	0.045	0.010 over	0.045	0.010 over
Sulfur, max	0.030	0.005 over	0.030	0.005 over
Silicon, max	1.00	0.05 over	1.00	0.05 over
Nickel	8.0–10.5	0.15	10.0–14.0	0.15
Chromium	18.0–20.0	0.20	16.0–18.0	0.20
Molybdenum	. . .	. . .	2.00–3.00	0.10
Nitrogen	0.10–0.16	0.01	0.10–0.16	0.01

[A] The intentional addition of Bi, Se, Te, and Pb is not permitted except for Grade B8F, in which selenium is specified and required.

[B] Typical steel compositions used for this grade include 4140, 4142, 4145, 4140H, 4142H, and 4145H.

[C] For the L7M grade, a minimum carbon content of 0.28 % is permitted provided that the required tensile properties are met in the section sizes involved; the use of AISI 4130 or 4130H is allowed.

[D] Class 1 are made from solution-treated material. Class 1A products (B8A, B8CA, B8MA, B8PA, B8FA, and B8TA) are solution-treated in the finished condition. Class 2 products are solution-treated and strain-hardened.

12. Product Marking

12.1 The identification symbol shall be as shown in Table 4. In the case of Class 2, Grades B8, B8C, B8M, B8P, B8F, and B8T strain hardened as provided in Table 1, a line shall be stamped under the grade symbol in order to distinguish it from Class 1 and Class 1A bolting which has not been strain hardened. In the case of Class 1A, the marking B8A, B8CA, B8MA, B8PA, B8FA, B8TA, B8LNA, and B8MLNA identifies the material as being in the solution-treated condition in the finished state. Grade L7M which has been 100 % evaluated in

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conformance with this specification shall have a line under the grade symbol to distinguish it from L7M produced to previous revisions not requiring 100 % hardness testing.

12.2 For bolting materials, including threaded bars, that are furnished bundled and tagged or boxed, the tags and boxes shall carry the grade symbol for the material identification and the manufacturer's identification mark or name.

12.3 Nuts from materials that have been impact tested shall be marked with the letter "L."

12.4 For purposes of identification marking, the manufacturer is considered the organization that certifies the fastener was manufactured, sampled, tested, and inspected in accordance with the specification and the results have been determined to meet the requirements of this specification.

13. Keywords

13.1 additional elements; austenitic stainless steel; bolts—steel; chromium-molybdenum steel; fasteners—steel; markings on fittings; nickel-chromium-molybdenum alloy steel; pressure vessel service; stainless steel bolting material; starting material; steel bars—alloy; steel bolting material; steel flanges; steel valves; temperature service applications—low

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, and order.

S1. Impact Properties

S1.1 When impact properties are desired for austenitic steel grades exempt from testing under 6.2.1, test shall be made as agreed between the manufacturer and the purchaser.

S2. Lateral Expansion

S2.1 When lateral expansion measurements for ferritic steels are required in addition to the energy absorption requirements of 6.2.1.1, the minimum value for each specimen of a set must be .015 in. [0.38 mm]. The test temperature shall be specified by the purchaser and agreed upon by the producer.

NOTE S2.1—Grades L7, L7A, L7B will generally have difficulty meeting the minimum value at −150 °F [−101 °C]. Grade L43 may be preferred.

S3. Hardness Testing of Class 2 Bolting Materials for ASME Applications

S3.1 The maximum hardness shall be Rockwell C 35 immediately under the thread roots. The hardness shall be taken on a flat area at least ⅛ in. [3 mm] across, prepared by removing threads. No more material than necessary shall be removed to prepare the flat area. Hardness determinations shall be made at the same frequency as tensile tests.

APPENDIX

(Nonmandatory Information)

X1. STRAIN HARDENING OF AUSTENITIC STEELS

X1.1 Strain hardening is the increase in strength and hardness that results from plastic deformation below the recrystallization temperature (cold work). This effect is produced in austenitic stainless steels by reducing oversized bars or wire to the desired final size by cold drawing or other process. The degree of strain hardening achievable in any alloy is limited by its strain hardening characteristics. In addition, the amount of strain hardening that can be produced is further limited by the variables of the process, such as the total amount of cross-section reduction, die angle, and bar size. In large diameter bars, for example, plastic deformation will occur principally in the outer regions of the bar, so that the increased strength and hardness due to strain hardening is achieved predominantly near the surface of the bar. That is, the smaller the bar, the greater the penetration of strain hardening.

X1.2 Thus, the mechanical properties of a given strain hardened fastener are dependent not just on the alloy, but also on the size of bar from which it is machined. The minimum bar size that can be used, however, is established by the configuration of the fastener, so that the configuration can affect the strength of the fastener.

X1.3 For example, a stud of a particular alloy and size may be machined from a smaller diameter bar than a bolt of the same alloy and size because a larger diameter bar is required to accommodate the head of the bolt. The stud, therefore, is likely to be stronger than the same size bolt in a given alloy.

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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 320/A 320M – 07a, that may impact the use of this specification. (Approved March 15, 2008)

(*1*) Added Nitrogen for Grades B8T and B8TA in Table 4.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 320/A 320M – 07, that may impact the use of this specification. (Approved September 1, 2007)

(*1*) Added hardness requirements for "L" Grades in Table 1.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 320/A 320M – 05a, that may impact the use of this specification. (Approved March 1, 2007)

(*1*) Revised 5.1.4 to clarify that stress relief must follow any cutting.

(*2*) Added new Section 7 and renumbered subsequent sections.

(*3*) Revised the last section of Table 4.

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