



Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service¹

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 specification² 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 9 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 This specification is expressed in both inch-pound units and in SI units. However, 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:

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for³

A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service⁴

A 276 Specification for Stainless Steel Bars and Shapes⁵

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products⁵

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products⁵

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials⁶

E 566 Practice for Electromagnetic (Eddy-Current) Sorting of Ferrous Metals⁷

F 436 Specification for Hardened Steel Washers⁸

2.2 American National Standards Institute Standards:

B18.2.1 Square and Hex Bolts and Screws⁹

B18.3 Hexagon Socket and Spline Socket Screws⁹

B18.22.1 Plain Washers⁹

¹ This specification is under the jurisdiction of ASTM Committee A-1 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 Annual Book of ASTM Standards, Vol 01.05.

⁴ Annual Book of ASTM Standards, Vol 01.01.

⁵ Annual Book of ASTM Standards, Vol 01.03.

⁶ Annual Book of ASTM Standards, Vol 03.01.

⁷ Annual Book of ASTM Standards, Vol 03.03.

⁸ Annual Book of ASTM Standards, Vol 15.08.

⁹ Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

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TABLE 1 Mechanical Requirements

Class and Grade, Diameter, in [mm]	Heat Treatment	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 2 ½ [65] and under ^A	quenched and tempered	125 [860]	105 [725]	16	50	...
L43 4 [100] and under ^A	quenched and tempered	125 [860]	105 [725]	16	50	...
L7M 2 ½ [65] and under ^A	quenched and tempered at 1150°F [620°C], min	100 [690]	80 [550]	18	50	235 HB ^B or 99 HRB
L1 1 [25] and under ^A	quenched and tempered	125 [860]	105 [725]	16	50	...
Austenitic Steels^C						
Class 1: B8, B8C, B8M, B8P, B8F, B8T, B8LN, B8MLN, all diameters	carbide solution treated	75 [515]	30 [205]	35	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]	35	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 1 ¼ [25 to 32], incl		105 [725]	65 [450]	20	35	321 HB or 35 HRC
over 1 ¼ to 1 ½ [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 1 ¼ [25 to 32], incl		95 [655]	65 [450]	25	45	321 HB or 35 HRC
over 1 ¼ to 1 ½ [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.

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.

2.3 AIAG Standard:**AIAG B-5 02.00 Primary Metals Identification Tag Application Standard¹⁰****3. Ordering Information**

3.1 The inquiry and order for material under this specification shall include the following as required to describe the material adequately:

3.1.1 Specification designation latest issue, and analysis by grade as selected from Table 3,

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 Quantity (number of pieces or weight),

¹⁰ Available from Automotive Industry Action Group, 26200 Lahser, Suite 200, Southfield, MI 48034.

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

3.1.5 Dimensions (diameter, length of point, overall length, finish, shape, and threads),

3.1.6 Nuts and washers, if required by purchaser, in accordance with Section 9.

3.1.7 End use,

3.1.8 Supplementary requirements, if any, and

3.1.9 Special requirements, in accordance with 4.3.1, 4.3.2, 4.3.3, 7.3, 10.1, 11.1, and 14.1.

4. Materials and Manufacture

4.1 *Process*—The steel shall be produced by any of the

following primary processes: open-hearth, basic-oxygen, electric-furnace, or vacuum-induction melting (VIM). The primary melting may incorporate separate degassing or refining. The molten steel may be vacuum-treated prior to or during pouring of the ingot. The basic oxygen process shall be limited to steels containing not over 6 % chromium.

4.2 *Discard*—A sufficient discard shall be made to secure freedom from injurious piping and undue segregation.

4.3 *Heat Treatment*:

TABLE 3 Chemical Requirements (Composition, %)^A

Type	Fertic Steels											
Identification Symbol	L7, L7M, L70		L7A, L71		L7B, L72		L7C, L73		L43		L1	
Grade	Chromium-Molybdenum (AISI 4140, 4142, or 4145)		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 ^B	Range, %	Product Variation, % Over or Under ^B	Range, %	Product Variation, % Over or Under ^B	Range, %	Product Variation, % Over or Under ^B	Range, %	Product Variation, % Over or Under ^B	Range, %	Product Variation, % Over or Under ^B
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	...

Type	Austenitic Steels, Classes 1, 1A, and 2 ^D			
Identification Symbol	B8, B8A		B8C, B8CA	
Grade	Unstabilized 18 Chromium-8 Nickel (AISI Type 304)		Stabilized 18 Chromium-8 Nickel (AISI Type 347)	
	Range, %	Product Variation, % Over or Under ^B	Range, %	Product Variation, % Over or Under ^B
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	8.0–10.5	0.15	9.0–13.0	0.15
Chromium	18.0–20.0	0.20	17.0–19.0	0.20
Columbium + tantalum	...	...	10 × carbon content, min	0.05 under