

Designation: A193/A193M - 10a

Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications¹

This standard is issued under the fixed designation A193/A193M; 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 and stainless steel bolting for pressure vessels, valves, flanges, and fittings for high temperature or high pressure service, or other special purpose applications. See Specification A962/A962M for the definition of bolting. Bars and wire shall be hot-wrought and may be further processed by centerless grinding or by cold drawing. Austenitic stainless steel may be carbide solution treated or carbide solution treated and strain-hardened. When strain hardened austenitic steel is ordered, the purchaser should take special care to ensure that Appendix X1 is thoroughly understood.

1.2 Several grades are covered, including ferritic steels and austenitic stainless steels designated B5, B8, and so forth. Selection will depend upon design, service conditions, mechanical properties, and high temperature characteristics.

1.3 The following referenced general requirements are indispensable for application of this specification: Specification A962/A962M.

NOTE 1—The committee formulating this specification has included fifteen steel types 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.

NOTE 2—For grades of alloy-steel bolting suitable for use at the lower range of high temperature applications, reference should be made to Specification A354.

NOTE 3—For grades of alloy-steel bolting suitable for use in low temperature applications, reference should be made to Specification A320/A320M.

1.4 Nuts for use with bolting are covered in Section 14.

1.5 Supplementary Requirements are provided for use at the option of the purchaser. The supplementary requirements shall apply only when specified in the purchase order or contract.

1.6 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply.

1.7 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. 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.

2. Referenced Documents

- 2.1 ASTM Standards:³
- A153/A153M Specification for Zinc Coating (Hot-Dip) on
- A194/A194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- A320/A320M Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
- A354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
- A788/A788M Specification for Steel Forgings, General Requirements
- A962/A962M Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range
- **B633** Specification for Electrodeposited Coatings of Zinc on Iron and Steel

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

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.

Current edition approved May 15, 2010. Published June 2010. Originally approved in 1936. Last previous edition approved in 2010 as A193/A193M-10. DOI: 10.1520/A0193_A0193M-10a.

 $^{^2}$ For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-193 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.

- B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- **B696** Specification for Coatings of Cadmium Mechanically Deposited
- B766 Specification for Electrodeposited Coatings of Cadmium
- E18 Test Methods for Rockwell Hardness of Metallic Materials
- E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials
- E112 Test Methods for Determining Average Grain Size
- E139 Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
- E150 Recommended Practice for Conducting Creep and Creep-Rupture Tension Tests of Metallic Materials Under Conditions of Rapid Heating and Short Times⁴
- E151 Recommended Practice for Tension Tests of Metallic Materials at Elevated Temperatures with Rapid Heating and Conventional or Rapid Strain Rates⁴
- E292 Test Methods for Conducting Time-for-Rupture Notch Tension Tests of Materials
- E328 Test Methods for Stress Relaxation for Materials and Structures
- **E566** Practice for Electromagnetic (Eddy-Current) Sorting of Ferrous Metals
- E709 Guide for Magnetic Particle Testing
- F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
- F1940 Test Method for Process Control Verification to Prevent Hydrogen Embrittlement in Plated or Coated Fasteners

F1941 Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/ UNR))

- F2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
 - 2.2 ASME Standards:⁵
 - B18.2.1 Square and Hex Bolts and Screws
 - B18.2.3.1M Metric Hex Cap Screws

B18.3 Hexagon Socket and Spline Socket Screws

B18.3.1M Metric Socket Head Cap Screws

2.3 AIAG Standard:⁶

AIAG B-5 02.00 Primary Metals Identification Tag Application Standard

3. General Requirements and Ordering Information

3.1 The inquiry and orders shall include the following, as required, to describe the desired material adequately:

3.1.1 Heat-treated condition (that is carbide solution treated (Class 1), carbide solution treated after finishing (Class 1A), and carbide solution treated and strain-hardened (Classes 2, 2B and 2C), for the austenitic stainless steels; Classes 1B and 1C apply to the carbide solution-treated nitrogen-bearing stainless steels; Class 1D applies to material carbide solution treated by cooling rapidly from the rolling temperature),

3.1.2 Description of items required (that is, bars, bolts, screws, or studs),

3.1.3 Nuts, if required by purchaser, in accordance with 14.1,

3.1.4 Supplementary requirements, if any, and

3.1.5 Special requirements, in accordance with 7.1.5.1, 7.2.6, 9.1, 14.1, and 15.1.

3.2 *Coatings*—Coatings are prohibited unless specified by the purchaser (See Supplementary Requirements S13 and S14). When coated fasteners are ordered the purchaser should take special care to ensure that Appendix X2 is thoroughly understood.

4. Common Requirements

4.1 Bolting supplied to this specification shall conform to the requirements of Specification A962/A962M. These requirements include test methods, finish, thread dimensions, macroetch (alloy steels only), marking, certification, optional supplementary requirements, and others. Failure to comply with the requirements of Specification A962/A962M constitutes nonconformance with this specification. In case of conflict between this specification and Specification A962/A962M, this specification shall prevail.

5. Manufacture (Process)

5.1 The steel shall be produced by any of the following processes: open-hearth, basic-oxygen, electric-furnace, or vacuum-induction melting (VIM). The molten steel may be vacuum-treated prior to or during pouring of the ingot or strand casting.

5.2 *Quality*—See Specification A962/A962M for requirements.

6. Discard

6.1 A sufficient discard shall be made to secure freedom from injurious piping and undue segregation.

7. Heat Treatment

7.1 Ferritic Steels

7.1.1 Ferritic steels shall be allowed to cool to a temperature below the cooling transformation range immediately after rolling or forging. Materials shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as a *quenching charge*), quenched in a liquid medium under substantially uniform conditions for each quenching charge, and tempered. The minimum tempering temperature shall be as specified in Tables 2 and 3.

 $^{^{\}rm 4}$ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

⁵ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http:// www.asme.org.

⁶ Available from Automotive Industry Action Group (AIAG), 26200 Lahser Rd., Suite 200, Southfield, MI 48033, http://www.aiag.org.

A193/A193M - 10a

TABLE 1Chemical Requirements (Composition, percent) A

Туре					Ferritic	Steels				
Grade							B6 and B6X			
Description	-					12 % Chromium				
UNS Designation					641000 (410)					
		Range		Product Variation,		Range	Product	Variation		
		0		Over or Under ^B		5	Over or l	Under ^B		
Carbon		0.10 min		0.01 under		.08–0.15	0.01 ove			
Manganese, max		1.00		0.03 over		.00	0.03 ove			
Phosphorus, max		0.040		0.005 over		.040	0.005 ov			
Sulfur, max Silicon		0.030 1.00 max	,	0.005 over 0.05 over		.030 .00 max	0.005 ov 0.05 ove			
		4.0-6.0	C C	0.10		1.5–13.5	0.05 0ve	I		
Chromium Molybdenum		0.40-0.6	5	0.05			0.15			
_						-				
					Ferritic					
Grade		B7, B7M				316				
Description	-	Chromiu	m-Molybdenu			Chromium-Molybdenum				
		Range		Product Variation, Over or Under ^B		lange	Product V Over or I	,		
Carbon		0.37-0.4	-	0.02		.36–0.47	0.02			
Manganese		0.65–1.1	0	0.04		.45–0.70	0.03			
Phosphorus, max		0.035		0.005 over		.035	0.005 ov			
Sulfur, max		0.040	-	0.005 over		.040	0.005 ov	er		
Silicon		0.15-0.3		0.02		.15-0.35	0.02			
Chromium Molybdenum		0.75–1.2 0.15–0.2		0.05 0.02		0.80–1.15 0.50–0.65	0.05 0.03			
Vanadium		0.13-0.2				.25–0.35	0.03			
Aluminum, max % ^E				lanuar		.015				
,			A	ustenitic Steels, ^F Cla	sses 1, 1A, 1D	D, and 2				
Туре	B8, B8A	(https://	A B8C, B8CA			D, and 2 IA, B8M2, B8M3	B8P, B8P/	4		
Type Grade	,	(https://	at a v	idards.		IA, B8M2, B8M3	B8P, B8P4 S30500	4		
Type Grade	,	04) Product Variation, Over or Under ^B	B8C, B8CA	idards.	B8M, B8M	IA, B8M2, B8M3		A Product Variatio Over or Under ^B		
Type Grade JNS Designation	S30400 (30	Product Variation,	B8C, B8CA S34700 (34	7) Product Variation,	B8M, B8M S31600 (3	IA, B8M2, B8M3 I16) Product Variation,	S30500	Product Variatio		
Type Grade JNS Designation Carbon, max	S30400 (30 Range	Product Variation, Over or Under ^B	B8C, B8CA S34700 (34 Range	7) Product Variation, Over or Under ^B 0.01 over 0.04 over	B8M, B8M S31600 (3 Range 0.08 2.00	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B	S30500 Range	Product Variation Over or Under ^B		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max	S30400 (30 Range 0.08 2.00 0.045	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over	B8M, B8M S31600 (3 Range 0.08 2.00 0.045	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over	S30500 Range 0.12 2.00 0.045	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max	S30400 (30 Range 0.08 2.00 0.045 0.030	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.010 over 0.005 over	S30500 Range 0.12 2.00 0.045 0.030	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over		
Type Grade JNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Silicon, max	S30400 (30 Range 0.08 2.00 0.045 0.030 1.00	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00	7) Product Variation, Over or Under ^B 0.01 over 0.010 over 0.010 over 0.005 over 0.05 over	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over	S30500 Range 0.12 2.00 0.045 0.030 1.00	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over		
Type Grade JNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Silicon, max Chromium	Range 0.08 2.00 0.045 0.030 1.00 18.0–20.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel	Range 0.08 2.00 0.045 0.030 11.00 18.0–20.0 8.0–11.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0-19.0 11.0-13.0	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Silicon, max Chromium Nickel Molybdenum	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15 	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15 0.10	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Silicon, max Chromium Nickel Molybdenum	Range 0.08 2.00 0.045 0.030 11.00 18.0–20.0 8.0–11.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15 0.05 under	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0-19.0 11.0-13.0	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.20 0.15 	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15 0.05 under	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15 0.10	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Gulfur, max Silicon, max Chromium Nickel Molybdenum Columbium + tantalum	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.20 0.15 	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0-19.0 9.0-12.0 10 x carbon content, mir 1.10 max	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 0.05 under 1;	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15 0.10	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0 B8N, B8NA	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.20 0.15 n 0.05 under n; Name (1, 1) (1,	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.05 over 0.20 0.15 0.10 	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0 B8N, B8NA	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 0.05 under 1; N, B8MNA	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.005 over 0.05 over 0.20 0.15 0.10 B8MLCuN, B8I	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade JNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade JNS Designation	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0 B8N, B8NA	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max Internet Steel B8M S316 Dn, Bap	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.20 0.15 n 0.05 under n; Is, ^F Classes 1A, 1B, 1 IN, B8MNA 651 (316N)	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.05 over 0.15 0.10 B8MLCuN, B8I S31254 n, Range	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 MLCuNA	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.20 0.15		
Type Grade JNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade JNS Designation	S30400 (30 Range 0.08 2.00 0.045 1.00 18.0–20.0 8.0–11.0 B8N, B8NA S30451 (304N	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.05 over 0.05 over 0.20 0.15 Au Au	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max Internet Steel B8M S316 Dn, Bap	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.05 over 0.05 over 0.05 over 0.15 10.05 under 115 115 116, F Classes 1A, 1B, 1 110, 100, 100, 100, 100, 100, 100, 100,	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 16.0–18.0 10.0–14.0 2.00–3.00 	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.05 over 0.15 0.10 B8MLCuN, B8I S31254 n, Range	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 MLCuNA	Product Variatic Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation Carbon, max	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0 B8N, B8NA S30451 (304N Range	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 Au Au Product Variatio Over or Under ^E	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max Istenitic Steel B8M S316 S316 S316	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.005 over 0.00 over 0.20 0.15 n 0.05 under n; Is, ^F Classes 1A, 1B, 1 IN, B8MNA 651 (316N) ge Pi 0.0	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.005 over 0.20 0.15 0.10 B8MLCuN, B8I S31254 In, Range	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0-19.0 11.0-13.0 MLCuNA Pro Ove 0.00	Product Variatio Over or Under ^E 0.01 over 0.04 over 0.05 over 0.05 over 0.20 0.15 		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Silicon, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max	S30400 (30 Range 0.08 2.00 0.045 h0.030 18.0-20.0 8.0-11.0 B8N, B8NA S30451 (304N Range 0.08 2.00 0.045	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.05 over 0.05 over 0.20 0.15 Au Product Variation Over or Under ^E 0.01 over 0.01 over	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max Istenitic Steel B8M S316 0.08 2.00 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.045 0.03 0.045 0.04	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.05 over 0.05 over 0.05 over 0.05 over 0.05 over 0.05 over 0.15 0.05 under 0.05 under n; 0.05 under ls, ^F Classes 1A, 1B, 1 1N, B8MNA 651 (316N) 0 5 0.	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2 roduct Variatio ver or Under ^B 01 over .01 over	IA, B8M2, B8M3 II6) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.05 over 0.05 over 0.15 0.10 B8MLCuN, B8I S31254 In, Range 0.020 1.00 0.030	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 MLCuNA Pro Ove 0.00 0.00 0.00	Product Variatio Over or Under ^E 0.01 over 0.04 over 0.005 over 0.20 0.15 duct Variation, er or Under ^B 05 over 3 over 05 over		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max	S30400 (30 Range 0.08 2.00 0.045 h0.030 18.0-20.0 8.0-11.0 B8N, B8NA S30451 (304N Range 0.08 2.00 0.045 0.030	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.05 over 0.05 over 0.20 0.15 Au Au I) Product Variatio Over or Under ^E 0.01 over 0.01 over 0.010 over 0.010 over 0.010 over	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max stenitic Steel B8M S310 0.08 2.00 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.045 0.03 0.045 0.046 0.046 0.046 0.046 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.045 0.04 0.04 0.045	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.01 over 0.05 over 0.05 over 0.05 over 0.05 over 0.15 0.05 under 0.15 10.05 under 0.15 11, B8MNA 651 (316N) ge 0 0.05 0.0 0.0 0.0	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2 roduct Variatio ver or Under ^B 01 over .04 over .010 over .005 over	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.20 0.15 0.10 B8MLCuN, B8I S31254 in, Range 0.020 1.00 0.030 0.010	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 MLCuNA Pro Ove 0.00 0.00 0.00 0.00 0.00 0.00	Product Variatio Over or Under ^E 0.01 over 0.04 over 0.005 over 0.20 0.15 duct Variation, er or Under ^B 05 over 05 over 05 over 02 over		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max	S30400 (30 Range 0.08 2.00 0.045 0.030 1.00 18.0-20.0 8.0-11.0 S30451 (304N Range 0.08 2.00 0.045 0.030 1.00	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 Au Product Variation Over or Under ^E 0.01 over 0.01 over 0.01 over 0.01 over 0.010 over 0	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0-19.0 9.0-12.0 10 x carbon content, mir 1.10 max Istenitic Steel B8M S310 0.08 2.00 0.045 0.030 0.045 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.030 0.045 0.045 0.030 0.045 0.045 0.030 0.045 0.04 0.04 0.04 0.04 0.04 0.03 1.00	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.01 over 0.05 over 0.05 over 0.05 over 0.05 over 0.15 0.05 under 1.5 10.05 under 0.65 11, B8MNA 651 (316N) 12 0.05 0.05 0.0 0.05 0.0	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2 roduct Variatio ver or Under ^B 01 over .01 over .010 over .010 over .05 over	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.005 over 0.20 0.15 0.10 B8MLCuN, B8I S31254 In, Range 0.020 1.00 0.030 0.010 0.80	S30500 Range 0.12 2.00 0.045 0.030 1.00 1.00 1.00 1.00 1.00 N VILCuNA Pro Ove 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	Product Variatio Over or Under ^E 0.01 over 0.04 over 0.05 over 0.05 over 0.20 0.15 duct Variation, er or Under ^B 05 over 3 over 05 over 22 over 5 over		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Chromium	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0 B8N, B8NA S30451 (304N Range 0.08 2.00 0.045 0.030 1.00 18.0–20.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 Au Product Variatio Over or Under ^E 0.01 over 0.01 over 0.01 over 0.010 over 0.010 over 0.005 over 0.20 0.005 over 0.005 over 0.20	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max astenitic Steel B8M S310 0.08 2.00 0.045 0.03 0.03 0.03 0.03 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045	7) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.05 over 0.20 0.15 0.05 under 1 1; 1 Is, ^F Classes 1A, 1B, 1 1 Is, ^F Classes 1A, 1B, 1 0 651 (316N) 0 10, 0 0 10, 0 0	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2 roduct Variatio ver or Under [#] 01 over .01 over .010 over .005 over .20	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.005 over 0.20 0.15 0.10 B8MLCuN, B8I S31254 In, Range 0.020 1.00 0.030 0.010 0.80 19.5–20.5	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 MLCuNA Pro Ove 0.000 0.00	Product Variatio Over or Under ^E 0.01 over 0.04 over 0.05 over 0.05 over 0.20 0.15 duct Variation, er or Under ^B 05 over 05 over 05 over 05 over 05 over 05 over 05 over		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Silicon, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Sulfur, max Silicon, max Chromium Nickel	S30400 (30 Range 0.08 2.00 0.045 1.00 18.0–20.0 8.0–11.0 B8N, B8NA S30451 (304N Range 0.08 2.00 0.045 0.030 1.00 18.0–20.0 8.0–11.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.05 over 0.20 0.15 Au Product Variatio Over or Under ^E 0.01 over 0.04 over 0.010 over 0.05 over 0.10 over 0.110 over 0	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max stenitic Steel B8M S310 0,08 2.00 0,04 0,03 0,03 0,04 0,03 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,03 0,04 0,04 0,03 0,04 0,03 0,04 0,04 0,04 0,04 0,04 0,04 0,03 0,04 0,04 0,04 0,03 0,04 0,05 0,04 0,04 0,04 0,05 0,04 0,04 0,05 0,04 0,04 0,05 0,04 0,04 0,05 0,04 0,04 0,04 0,05 0,04 0,04 0,05 0,04 0,04 0,05 0,04 0,05 0,04 0,05 0,05 0,04 0,05 0,04 0,05	Froduct Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.20 0.15 0.005 under 1; Is, F Classes 1A, 1B, 1 IN, B8MNA 651 (316N) ge 0. 0. 0. 0.0 0.0 0.15	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2 roduct Variatio ver or Under ^B 01 over .01 over .04 over .01 over .05 over .20	IA, B8M2, B8M3 II6) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.05 over 0.05 over 0.05 over 0.15 0.10 B8MLCuN, B8I S31254 In, Range 0.020 1.00 0.030 0.010 0.80 19.5–20.5 17.5–18.5	S30500 Range 0.12 2.00 0.045 0.030 1.00 1.00 1.0-13.0 WLCuNA Pro Ove 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.0	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.010 over 0.05 over 0.20 0.15 		
Type Grade UNS Designation Carbon, max Manganese, max Phosphorus, max Sulfur, max Sulfur, max Sulfur, max Chromium Nickel Molybdenum Columbium + tantalum Type Grade UNS Designation	S30400 (30 Range 0.08 2.00 0.045 0.030 18.0–20.0 8.0–11.0 B8N, B8NA S30451 (304N Range 0.08 2.00 0.045 0.030 1.00 18.0–20.0	Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 Au Product Variatio Over or Under ^E 0.01 over 0.01 over 0.01 over 0.010 over 0.010 over 0.005 over 0.20 0.005 over 0.005 over 0.20	B8C, B8CA S34700 (34 Range 0.08 2.00 0.045 0.030 1.00 17.0–19.0 9.0–12.0 10 x carbon content, mir 1.10 max Internet Steel B8M S316 Dn, Range 0.08 2.00 0.045 0.03 0.03 0.045 0.03 0.045 0.03 0.045 0.03 0.045 0.04	Frequencies Product Variation, Over or Under ^B 0.01 over 0.04 over 0.010 over 0.005 over 0.05 over 0.010 0.05 over 0.010 0.05 over 0.010 0.05 over 0.010 0.05 over 0.020 0.15 0.000 10.05 under 0.15 11, B8MNA 651 (316N) ge P 0.0 0.0 1.10, 0.0 0.0 1.11, 0.0 0.0 1.12, 0.0 0.0	B8M, B8M S31600 (3 Range 0.08 2.00 0.045 0.030 1.00 16.0–18.0 10.0–14.0 2.00–3.00 1D, and 2 roduct Variatio ver or Under [#] 01 over .01 over .010 over .005 over .20	IA, B8M2, B8M3 I16) Product Variation, Over or Under ^B 0.01 over 0.04 over 0.005 over 0.005 over 0.20 0.15 0.10 B8MLCuN, B8I S31254 In, Range 0.020 1.00 0.030 0.010 0.80 19.5–20.5	S30500 Range 0.12 2.00 0.045 0.030 1.00 17.0–19.0 11.0–13.0 MLCuNA Pro Ove 0.000 0.00	Product Variatio Over or Under ^B 0.01 over 0.04 over 0.005 over 0.05 over 0.20 0.15 duct Variation, er or Under ^B 05 over 05 over 05 over 05 over 05 over 05 over 00		

(10a) A193/A193M – 10a

TABLE 1 Continued

Туре		Αι	Austenitic Steels ^F , Classes 1, 1A, and 2			
Grade		B	B8T, B8TA			
UNS Designation		S	S32100 (321)			
		Ra	ange	Product Variation, Over or Under ^B		
Carbon, max		0.0	08	0.01 over		
Manganese, max		2.	00	0.04 over		
Phosphorus, max		0.0	045	0.010 over		
Sulfur, max		0.0	030	0.005 over		
Silicon, max		1.0	00	0.05 over		
Chromium		17	′.0–19.0	0.20		
Nickel		9.0	0–12.0	0.15		
Titanium		5	x (C + N) min, 0.70 max	0.05 under		
Nitrogen		0.	10 max			
Туре		Austenitic Ste	eels ^F , Classes 1C and 1D)		
Grade	B8R, B8RA		B8S, B8SA			
UNS Designation	S20910		S21800			
	Range	Product Variation, Over or Under ^B	Range	Product Variation, Over or Under ^B		
Carbon, max	0.06	0.01 over	0.10	0.01 over		
Vanganese	4.0-6.0	0.05	7.0–9.0	0.06		
Phosphorus, max	0.045	0.005 over	0.060	0.005 over		
Sulfur, max	0.030	0.005 over	0.030	0.005 over		
Silicon	1.00 max	0.05 over	3.5-4.5	0.15		
Chromium	20.5-23.5	0.25	16.0-18.0	0.20		
Nickel	11.5–13.5	0.15	8.0-9.0	0.10		
Vlolybdenum	1.50-3.00	0.10				
Nitrogen	0.20-0.40	0.02	0.08-0.18	0.01		
Columbium + tantalum	0.10–0.30	0.05				
Vanadium	0.10-0.30	0.02				
Туре		Austenitic Stee	els ^F , Classes 1, 1A and 1	D		
Grade	B8LN, B8LNA		B8MLN, B8MLNA			
UNS Designation	S30453	ient Previ	S31653			
	Range	Product Variation, Over or Under ^B	Range	Product Variation, Over or Under ^B		
Carbon, max	0.030 <u>ASTM</u>	0.005 over	0.030	0.005 over		
Manganese	talog/sta ^{2.00} , rds/sist/6df3	0.04 over 0.04	61-52.001hc77f7eb	0.04 over 193m-10		
nosphorus, max	0.045	0.010 over	0.045	0.010 over		
Sulfur, max	0.030	0.005 over	0.030	0.005 over		
Silicon	1.00	0.05 over	1.00	0.05 over		
Chromium	18.0–20.0	0.20	16.0–18.0	0.20		
Nickel	8.0-11.0	0.15	10.0–13.0	0.15		
Molybdenum			2.00-3.00	0.10		
Nitrogen	0.10-0.16	0.01	0.10–0.16 0.01			

^B Product analysis—Individual determinations sometimes vary from the specified limits on ranges as shown in the tables. The several determinations of any individual element in a heat may not vary both above and below the specified range.

^c Typical steel compositions used for this grade include 4140, 4142, 4145, 4140H, 4142H, and 4145H.

^D For bar sizes over 3¹/₂ in. [90 mm], inclusive, the carbon content may be 0.50 %, max. For the B7M 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.

^E Total of soluble and insoluble.

^F Classes 1 and 1D are solution treated. Classes 1, 1B, and some 1C (B8R and B8S) products are made from solution treated material. Class 1A (B8A, B8CA, B8MA, B8PA, B8TA, B8LNA, B8MLNA, B8MAA, and B8MNA) and some Class 1C (B9RA and B8SA) products are solution treated in the finished condition. Class 2 products are solution treated and strain hardened.

A193/A193M - 10a

TABLE 2 Mechanical Requirements — Inch Products

		•					
Grade	Diameter, in.	Minimum Tempering Temperature, °F	Tensile Strength, min, ksi	Yield Strength, min, 0.2 % offset, ksi	Elongation in 4D, min, %	Reducti of Are min, ^c	a, max
		Ferritic Steels	;				
B5 4 to 6 % chromium B6	up to 4, incl	1100	100	80	16	50	
13 % chromium	up to 4, incl	1100	110	85	15	50	
B6X I3 % chromium	up to 4, incl	1100	90	70	16	50	26 HRC
B7 Chromium-molybdenum	21/2 and under	1100	125	105	16	50	321 HB or
	over 21/2 to 4	1100	115	95	16	50	35 HRC 321 HB or
	over 4 to 7	1100	100	75	18	50	35 HRC 321 HB or
B7M ⁴ Chromium-molybdenum	n 4 and under	1150	100	80	18	50	35 HRC 235 HB or
	over 4 to 7	1150	100	75	18	50	99 HRB 235 BHN or 99 HRB
B16 Chromium-molybdenum-vanadium	21/2 and under	1200	125	105	18	50	321 HB or 35 HRC
	over 21/2 to 4	1200	110	95	17	45	321 HB or 35 HRC
	over 4 to 8	1200	100	85	16	45	321 HB or 35 HRC
Grade, Diameter, in.	Heat Treatment ^B	ndar	ensile rength, d.S. nin, ksi	Yield Strength, min, 0.2 % offset, ksi		duction Area, nin %	Hardness, max
Classes 1 and 1D; B8, B8M, B8P,	carbide solution treated	Austenitic Stee	75 V P	30	30	50 2	23 HB or 96 HR
BallN, B8MLN, all diameters	carbide solution neared				00	50 2	20110 01 00 1111
	carbide solution treated		75	30	30	50 2	223 HB or 96HRE
Class 1A: B8A, B8CA, B8MA,	carbide solution treated in the finished condition		75 <u>-75</u> 187-96fd-	30 5954bc77f7	30 eb/astm-al		192 HB or 90 HF 93m-10a
Classes 1B and 1D: B8N, B8MN, B8MLCuN, all diameters	carbide solution treated		80	35	30	40 2	23 HB or 96 HR
	carbide solution treated		100	55	35	55 2	271 HB or 28 HF
class 1C: B8RA, all diameters	carbide solution treated in the finished condition	Ł	100	55	35	55 2	271 HB or 28 HF
,	carbide solution treated		95	50	35	55 2	271 HB or 28 HR
,	carbide solution treated in the finished	ł	95	50	35	55 2	271 HB or 28 HR
lass 2: B8, B8C, B8P, B8T,	condition carbide solution treated and strain hardened		125	100	12	35 3	321 HB or 35 HF
4 and under over 3/4 to 1, incl			115	80	15	35 3	321 HB or 35 HF
over 1 to $1\frac{1}{4}$, incl over $1\frac{1}{4}$ to $1\frac{1}{2}$, incl			105 100	65 50	20 28	35 3	321 HB or 35 HR 321 HB or 35 HR
Class 2: B8M, B8MN, B8MLCuN ^D	carbide solution treated and strain		110	95	15		321 HB or 35 HF
4 and under over 3/4 to 1 incl	hardened		100	80	20	45 3	321 HB or 35 HF
Over 1 to 11/4, incl			95	65	25	45 3	321 HB or 35 HF
over 1¼ to 1½ , incl Class 2B: B8, B8M2 ^D	carbide solution treated and strain		90 95	50 75	30 25		321 HB or 35 HF 321 HB or 35 HF
,	hardened		90	75	20	40 .	

(A193/A193M – 10a

TABLE 2 Continued

Grade, Diameter, in.	Heat Treatment ⁸	Tensile Strength, min, ksi	Yield Strength, min, 0.2 % offset, ksi	Elongation in 4 D, min %	Reduction of Area, min %	Hardness, max
	Aus	stenitic Steels				
over 21/2 to 3 incl		80	55	30	40	321 HB or 35 HRC
Class 2C: B8M3 ^D	carbide solution treated and strain	85	65	30	60	321 HB or 35 HRC
2 and under over 2	hardened	85	60	30	60	321 HB or 35 HBC

^A To meet the tensile requirements, the Brinell hardness shall be over 200 HB (93 HRB).

^B Class 1 is solution treated. Class 1 A is solution treated in the finished condition for corrosion resistance; heat treatment is critical due to physical property requirement. Class 2 is solution treated and strain hardened. Austenitic steels in the strain-hardened condition may not show uniform properties throughout the section particularly in sizes over 3/4 in. in diameter.

^C For sizes ³/₄ in. in diameter and smaller, a maximum hardness of 241 HB (100 HRB) is permitted.

^D For diameters 1½ and over, center (core) properties may be lower than indicated by test reports which are based on values determined at ½ radius.

TABLE 3 Mechanical Requirements—Metric Products

		-					
Class	Diameter, [mm]	Minimum Tempering Temperature, °C	Tensile Strength, min, MPa	Yield Strength, min, 0.2 % offset, MPa	Elongatic in 4D, min, %	on Reduc of Ar min,	ea, max
		Ferritic Steels	i				
B5 4 to 6 % chromium B6	up to M100, incl	593	690	550	16	50	
13 % chromium	up to M100, incl	593	760	585	15	50	
B6X 13 % chromium B7	up to M100, incl	593	620	485	16	50	26 HRC
Chromium-molybdenum	M64 and under	593	860	720	16	50	321 HB or 35 HRC
	over M64 to M100	593	795	655	16	50	321 HB or 35 HRC
	over M100 to M180	en (⁵⁹³)	rev ⁶⁹⁰ e	515 V	18	50	321 HB or 35 HRC
B7M ⁴ Chromium-molybdenum	M100 and under	620	690	550	18	50	235 HB or 99 HRB
	over M100 to M180 ASTM A	193/A ⁶²⁰ 3N	<u>4-10a</u> 690	515	18	50	235 BHN or 99 HRB
B16 Chromium-molybdenum-vanadium	M64 and under	30c-3c88-4d	187-9 <mark>860</mark> -3	5954bc77f7	eb/astm-a	19 <u>3</u> -a	321 HB or 35 HRC
	over M64 to M100	650	760	655	17	45	321 HB or 35 HRC
	over M100 to M180	650	690	585	16	45	321 HB or 35 HRC
Class Diameter, mm	Heat Treatment ^B	:	Tensile Strength, min, MPa	Yield Strength, min, 0.2 % offset, MPa	,	eduction of Area, min %	Hardness, max
		Austenitic Stee	ls				
Classes 1 and 1D; B8, B8M, B8P, B8 B8MLN, all diameters	BLN, carbide solution treated		515	205	30	50	223 HB or 96 HRB
Class 1: B8C, B8T, all diameters	carbide solution treated		515	205	30		223 HB or 96HRB
Class 1A: B8A, B8CA, B8MA, B8PA, B8TA, B8LNA, B8MLNA, B8NA, B8M B8MLCuNA, all diameters		finished	515	205	30	50	192 HB or 90 HRE
Classes 1B and 1D: B8N, B8MN, B8MLCuN, all diameters	carbide solution treated		550	240	30	40	223 HB or 96 HRB
Classes 1C and 1D: B8R, all diameters Class 1C: B8RA, all diameters	ers carbide solution treated carbide solution treated in the condition	finished	690 690	380 380	35 35	55 55	271 HB or 28 HRC 271 HB or 28 HRC
Classes 1C and 1D: B8S, all diamete Classes 1C: B8SA,	ers carbide solution treated carbide solution treated in the	finished	655 655	345 345	35 35	55 55	271 HB or 28 HRC 271 HB or 28 HRC