Designation: A 540/A 540M – 06

Standard Specification for Alloy-Steel Bolting Materials for Special Applications[1]

This standard is issued under the fixed designation A 540/A 540M; 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 This specification[2] covers regular and special-quality alloy steel bolting materials which may be used for nuclear and other special applications. Bolting materials as used in this specification cover rolled or forged bars, rotary pierced or extruded seamless tubes, bored bars, or forged hollows from forged or rolled bar segments to be manufactured into bolts, studs, washers, and nuts.

1.2 Several grades of steel are covered. The grade and class shall be specified by the purchaser.

1.3 Supplementary requirements of an optional nature are provided for use when special quality is desired. These supplementary requirements call for additional tests to be made and when desired shall be so stated in the order, together with the acceptance limits required.

1.4 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.

1.5 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 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

E 45 Test Methods for Determining the Inclusion Content of Steel

2.2 *AIAG Standard:*

AIAG B-5 02.00 Primary Metals Identification Tag Application Standard[4]

2.3 *ANSI Standards:*[5]

B 1.1 Unified Screw Threads

B 18.2.1 Square and Hex Bolts and Screws Including Hex Cap Screws and Lag Bolts

B 18.2.2 Square and Hex Nuts

B 18.3 Hexagon Socket and Spline Socket Screws

3. Ordering Information

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

3.1.1 Condition (Section 5),

3.1.2 Heat treatment (Section 6),

3.1.3 Supplementary Requirements (S1 to S9),

3.1.4 Reports required (Section 17),

3.1.5 End use, and

3.1.6 Any special requirements.

3.2 The purchaser is referred to the listed supplementary requirements.

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 test 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 this specification and Specification A 962/A 962M, this specification shall prevail.

5. Manufacture

5.1 The material shall be supplied hot-rolled or hot-forged or cold-finished at the option of the producer. However, if desired by the purchaser, cold finishing may be specified.

[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-540 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.

[4] Available from Automotive Industry Action Group, 26200 Lahser, Suite 200, Southfield, MI 48034.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

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6. Heat Treatment

6.1 Material which is ordered in the annealed condition shall have a structure suitable for machining. Such annealed bolting material is not intended to be used without subsequent quenching and tempering as specified in 6.2

6.2 Material which is ordered in the liquid-quenched and tempered condition shall be uniformly reheated from a temperature below the cooling transformation range to the proper austenitizing temperature. It shall be quenched in a liquid medium under substantially uniform conditions and then uniformly reheated for tempering. The minimum tempering temperature shall be 850 °F [455 °C].

6.3 Material that has been straightened after quenching and tempering shall be stress relieved by reheating to a temperature not lower than 100 °F [55 °C] under the tempering temperature.

7. Chemical Composition

7.1 The steel shall conform to the chemical requirements prescribed in Table 1.

8. Tensile Requirements

8.1 Material furnished in the annealed condition shall be capable of meeting the specified tensile properties for the class as specified in Table 2 when heat treated in accordance with 6.2 and 6.3 (see Supplementary Requirement S4).

8.2 Material in the quenched and tempered or quenched, tempered and stress-relieved condition shall conform to properties shown in Table 2 for the specified class.

9. Hardness Requirements

9.1 The hardness shall be determined on the surface of the material after removal of decarburization.

9.2 The hardness of material in the annealed condition shall not be greater than 235 HB.

9.3 The hardness of material in the quenched and tempered or quenched, tempered and stress-relieved condition shall be within the limits in Table 2 for the specified class.

10. Impact Requirements

10.1 Annealed material after proper heat treatment shall be capable of meeting the impact requirements in Table 2 or of Supplementary Requirement S8, if so specified (see Supplementary Requirement S4).

10.2 Material in the quenched and tempered or quenched, tempered, and stress-relieved condition shall conform to the impact requirements in Table 2, or of Supplementary Requirement S8 if so specified.

10.3 The percent of shear (ductility or fibrous) fracture shall be computed. The computed value shall be recorded for all impact specimens.

10.4 The amount of lateral expansion shall be measured. The measured value shall be recorded for all impact specimens.

10.5 The percent shear and the amount of lateral expansion shall be reported for information purposes (see 17.1).

TABLE 1 Chemical Requirements[A]

Identification Symbol Grade	B21 (Cr-Mo-V) Chromium-Molybdenum-Vanadium		B22 (4142-H) Chromium-Molybdenum		B23 (E-4340-H) Chromium-Nickel-Molybdenum		B24 (4340 Mod.) Chromium-Nickel-Molybdenum		B24V (4340V Mod.) Chromium-Nickel-Molybdenum-Vanadium	
	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] %		Product Variation, Over or Under,[B] %
Carbon	0.36–0.44	0.02	0.39–0.46	0.02	0.37–0.44	0.02	0.37–0.44	0.02	0.37–0.44	0.02
Manganese	0.45–0.70	0.03	0.65–1.10	0.04	0.60–0.95	0.04	0.70–0.90	0.04	0.60–0.95	0.04
Phosphorus, max	0.025[C]	0.005	0.025[C]	0.005	0.025[C]	0.005	0.025[C]	0.005	0.025[C]	0.005
Sulfur, max	0.025[C]	0.005	0.025[C]	0.005	0.025[C]	0.005	0.025[C]	0.005	0.025[C]	0.005
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[D]	0.02
Chromium	0.80–1.15	0.05	0.75–1.20	0.05	0.65–0.95	0.05	0.70–0.95	0.05	0.60–0.95	0.05
Nickel	. . .	. . .	. . .	. . .	1.55–2.00	0.05	1.65–2.00	0.05	1.55–2.00	0.05
Molybdenum	0.50–0.65	0.03	0.15–0.25	0.02	0.20–0.30	0.02	0.30–0.40	0.02	0.40–0.60	0.03
Vanadium	0.25–0.35	0.03	. . .	. . .	. . .	. . .	. . .	. . .	0.04–0.10	0.01

[A] The intentional addition of Bi, Se, Te, and Pb is not permitted.
[B] Unless otherwise specified, separate determinations may vary from the specified ranges, except that elements in any heat must not vary both above and below the specified range.
[C] Phosphorus and sulfur content is 0.04 % max when open-hearth steel is specified.
[D] Silicon content is 0.35 % max if vacuum-carbon deoxidized.

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TABLE 2 Mechanical Property Requirements

NOTE 1—The minimum average of 3 specimens shall not be less than 35 ft·lbf [47 J]. One specimen from a set of 3 may be less than 35 ft·lbf [47 J] but not less than 30 ft·lbf [41 J].

NOTE 2— The minimum average of 3 specimens shall not be less than 30 ft·lbf [41 J]. One specimen from a set of 3 may be less than 30 ft·lbf [41 J] but not less than 25 ft·lbf [34 J].

NOTE 3—The minimum average of 3 specimens shall not be less than 25 ft·lbf [34 J]. One specimen from a set of 3 may be less than 25 ft·lbf [34 J] but not less than 20 ft·lbf [27 J].

NOTE 4—No minimum values established. Tests shall be run for information only.

Grade	Class	Diameter	Tensile Strength, min	Yield Strength, 0.2 % offset, min	Elongation, min, %	Reduction of Area, min, %	Surface Brinell Hardness		Charpy V-Notch +10 °F [−12.2 °C]
							min	max	
			Inch-Pound Units						
		in.	ksi	ksi	In 2 in.				
B21	5	to 2, incl	120	105	15	50	241	285	Note 4
(Cr-Mo-V)		over 2 to 6, incl	115	100	15	50	248	302	Note 4
		over 6 to 8, incl	115	100	15	50	255	311	Note 4
	4	to 3, incl	135	120	13	45	269	331	Note 4
		over 3 to 6, incl	135	120	13	45	277	352	Note 4
	3	to 3, incl	145	130	12	40	293	352	Note 4
		over 3 to 6, incl	145	130	12	40	302	375	Note 4
	2	to 4, incl	155	140	11	40	311	401	Note 4
	1	to 4, incl	165	150	10	35	321	429	Note 4
B22	5	to 2, incl	120	105	15	50	248	293	Note 1
(4142-H)		over 2 to 4, incl	115	100	15	50	255	302	Note 4
	4	to 1, incl	135	120	13	45	269	341	Note 1
		over 1 to 4, incl	135	120	13	45	277	363	Note 4
	3	to 2, incl	145	130	12	40	293	363	Note 4
		over 2 to 4, incl	145	130	12	40	302	375	Note 4
	2	to 3, incl	155	140	11	40	311	401	Note 4
	1	to 1½ , incl	165	150	10	35	321	401	Note 4
B23	5	to 6, incl	120	105	15	50	248	311	Note 1
(E-4340-H)		over 6 to 8, incl	115	100	15	50	255	321	Note 1
		over 8 to 9½ , incl	115	100	15	50	262	321	Note 4
	4	to 3, incl	135	120	13	45	269	341	Note 1
		over 3 to 6, incl	135	120	13	45	277	352	Note 1
		over 6 to 9½ , incl	135	120	13	45	285	363	Note 4
	3	to 3, incl	145	130	12	40	293	363	Note 2
		over 3 to 6, incl	145	130	12	40	302	375	Note 2
		over 6 to 9½ , incl	145	130	12	40	311	388	Note 4
	2	to 3, incl	155	140	11	40	311	388	Note 4
		over 3 to 6, incl	155	140	11	40	311	401	Note 4
		over 6 to 9½ , incl	155	140	11	40	321	415	Note 4
	1	to 3, incl	165	150	10	35	321	415	Note 4
		over 3 to 6, incl	165	150	10	35	331	429	Note 4
		over 6 to 8, incl	165	150	10	35	341	444	Note 4
B24	5	to 6, incl	120	105	15	50	248	311	Note 1
(4340 Mod.)		over 6 to 8, incl	115	100	15	50	255	321	Note 1
		over 8 to 9½ , incl	115	100	15	50	262	321	Note 1
	4	to 3, incl	135	120	13	45	269	341	Note 1
		over 3 to 6, incl	135	120	13	45	277	352	Note 1
		over 6 to 8, incl	135	120	13	45	285	363	Note 1
		over 8 to 9½ , incl	135	120	13	45	293	363	Note 4
	3	to 3, incl	145	130	12	40	293	363	Note 2
		over 3 to 8, incl	145	130	12	40	302	388	Note 2
		over 8 to 9½ , incl	145	130	12	40	311	388	Note 4
	2	to 7, incl	155	140	11	40	311	401	Note 2
		over 7 to 9½ , incl	155	140	11	40	321	415	Note 4
	1	to 6, incl	165	150	10	35	321	415	Note 3
		over 6 to 8, incl	165	150	10	35	331	429	Note 4
B24V	3	to 4, incl	145	130	12	40	293	363	Note 1
(4340V Mod.)		over 4 to 8, incl	145	130	12	40	302	375	Note 2
		over 8 to 11, incl	145	130	12	40	311	388	Note 3
	2	to 4, incl	155	140	11	40	311	388	Note 2
		over 4 to 8, incl	155	140	11	40	311	401	Note 3
		over 8 to 11, incl	155	140	11	40	321	415	Note 4

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TABLE 2 *Continued*

Grade	Class	Diameter	Tensile Strength, min	Yield Strength, 0.2 % offset, min	Elongation, min, %	Reduction of Area, min, %	Surface Brinell Hardness		Charpy V-Notch +10 °F [–12.2 °C]
							min	max	
	1	to 4, incl	165	150	10	35	321	415	Note 3
		over 4 to 8, incl	165	150	10	35	331	429	Note 4
		over 8 to 11, incl	165	150	10	35	331	444	Note 4
				Metric Units					
		mm	MPa	MPa	In 50 mm				
B21	5	to 50, incl	825	725	15	50	241	285	Note 4
(Cr-Mo-V)		over 50 to 150, incl	795	690	15	50	248	302	Note 4
		over 150 to 205, incl	795	690	15	50	255	311	Note 4
	4	to 75, incl	930	825	13	45	269	331	Note 4
		over 75 to 150, incl	930	825	13	45	277	352	Note 4
	3	to 75, incl	1000	895	12	40	293	352	Note 4
		over 75 to 150, incl	1000	895	12	40	302	375	Note 4
	2	to 100, incl	1070	965	11	40	311	401	Note 4
	1	to 100, incl	1140	1035	10	35	321	429	Note 4
B22	5	to 50, incl	825	725	15	50	248	293	Note 1
(4142-H)		over 50 to 100, incl	795	690	15	50	255	302	Note 4
	4	to 25, incl	930	825	13	45	269	341	Note 1
		over 25 to 100, incl	930	825	13	45	277	363	Note 4
	3	to 50, incl	1000	895	12	40	293	363	Note 4
		over 50 to 100, incl	1000	895	12	40	302	375	Note 4
	2	to 75, incl	1070	965	11	40	311	401	Note 4
	1	to 38, incl	1140	1035	10	35	321	401	Note 4
B23	5	to 150, incl	825	725	15	50	248	311	Note 1
(E-4340-H)		over 150 to 200 incl	795	690	15	50	255	321	Note 1
		over 200 to 240, incl	795	690	15	50	262	321	Note 4
	4	to 75, incl	930	825	13	45	269	341	Note 1
		over 75 to 150, incl	930	825	13	45	277	352	Note 1
		over 150 to 240, incl	930	825	13	45	285	363	Note 4
	3	to 75, incl	1000	895	12	40	293	363	Note 2
		over 75 to 150, incl	1000	895	12	40	302	375	Note 2
		over 150 to 240, incl	1000	895	12	40	311	388	Note 4
	2	to 75, incl	1070	965	11	40	311	388	Note 4
		over 75 to 150, incl	1070	965	11	40	311	401	Note 4
		over 150 to 240, incl	1070	965	11	40	321	415	Note 4
	1	to 75, incl	1140	1035	10	35	321	415	Note 4
		over 75 to 150, incl	1140	1035	10	35	331	429	Note 4
		over 150 to 200, incl	1140	1035	10	35	341	444	Note 4
B24	5	to 150, incl	825	725	15	50	248	311	Note 1
(4340 Mod.)		over 150 to 200, incl	795	690	15	50	255	321	Note 1
		over 200 to 240, incl	795	690	15	50	262	321	Note 1
	4	to 75, incl	930	825	13	45	269	341	Note 1
		over 75 to 150, incl	930	825	13	45	277	352	Note 1
		over 150 to 200, incl	930	825	13	45	285	363	Note 1
		over 200 to 240, incl	930	825	13	45	293	363	Note 4
	3	to 75, incl	1000	895	12	40	293	363	Note 2
		over 75 to 200, incl	1000	895	12	40	302	388	Note 2
		over 200 to 240, incl	1000	895	12	40	311	388	Note 4
	2	to 180, incl	1070	965	11	40	311	401	Note 2
		over 180 to 240, incl	1070	965	11	40	321	415	Note 4
	1	to 150, incl	1140	1035	10	35	321	415	Note 3
		over 150 to 200, incl	1140	1035	10	35	331	429	Note 4
B24V	3	to 100, incl	1000	895	12	40	293	363	Note 1
(4340V Mod.)		over 100 to 200, incl	1000	895	12	40	302	375	Note 2
		over 200 to 240, incl	1000	895	12	40	311	388	Note 3
	2	to 100, incl	1070	965	11	40	311	388	Note 2
		over 100 to 200, incl	1070	965	11	40	311	401	Note 3
		over 200 to 280, incl	1070	965	11	40	321	415	Note 4
	1	to 100, incl	1140	1035	10	35	321	415	Note 3
		over 100 to 200, incl	1140	1035	10	35	331	429	Note 4
		over 200 to 280, incl	1140	1035	10	35	331	444	Note 4

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TABLE 3 Permissible Variation in Diameter of Rolled Bars[A]

Specified Diameter, in. [mm]	Size Tolerance				Out-of-Round	
	Over		Under			
			in.	mm	in.	mm
1 to 1⅛ [25 to 29], incl	0.010	0.25	0.010	0.25	0.015	0.38
Over 1⅛ to 1¼ [29 to 32], incl	0.011	0.28	0.011	0.28	0.016	0.41
Over 1¼ to 1⅜ [32 to 35], incl	0.012	0.30	0.012	0.30	0.018	0.46
Over 1⅜ to 1½ [35 to 38], incl	0.014	0.36	0.014	0.36	0.021	0.53
Over 1½ to 2 [38 to 50], incl	1/64	0.4	1/64	0.4	0.023	0.58
Over 2 to 2½ [50 to 65], incl	1/32	0.8	0		0.023	0.58
Over 2½ to 3½ [65 to 90], incl	3/64	1.2	0		0.035	0.89
Over 3½ to 4½ [90 to 115], incl	1/16	1.6	0		0.046	1.17
Over 4½ to 5½ [115 to 140], incl	5/64	1.9	0		0.058	1.47
Over 5½ to 6½ [140 to 165], incl	1/8	3.2	0		0.070	1.78
Over 6½ to 8¼ [165 to 210], incl	5/32	3.7	0		0.085	2.16
Over 8¼ to 9½ [210 to 240], incl	3/16	4.8	0		0.100	2.54

[A] Consult the manufacturer on forged bars, cold-finished bars, bored bars, seamless tubes, and forged hollows.

11. Dimensions and Tolerances

11.1 *Permissible Tolerances for Straightness*:

11.1.1 Annealed material shall have an out-of-straightness tolerance of ⅛ in. in any 5 ft or ⅛ × (number of feet of length/5) in. [2mm/m].

11.1.2 Quenched, tempered and stress-relieved material shall have an out-of-straightness tolerance of ¼ in. in any 5 ft or ¼ × (number of feet of length/5) in. [4 mm/m].

11.2 Unless otherwise specified, headed bolts shall be semi-finished, hexagon in shape, and in accordance with the dimensions of ANSI B 18.2.1. Unless otherwise specified, nuts shall be hexagonal in shape, and in accordance with the dimensions of ANSI B 18.2.2. Unless otherwise specified, the ANSI Standard heavy bolt and nut series shall be used. If socket head fasteners are required, the dimensions shall be in accordance with ANSI B 18.3, as specified by the purchaser.

11.3 All bolts, stud bolts and accompanying nuts, unless otherwise specified, shall be threaded in accordance with ANSI B 1.1, Class 2A or 2B fit.

12. Workmanship, Finish, and Appearance

12.1 The material shall be uniform in quality and free of defects that would be detrimental to the intended service. If magnetic particle inspection for such defects is desired, Supplementary Requirement S6 should be specified.

12.2 *Surface Quality*—Material shall be free of seams, laps, cracks, or other defects that are not removable within the machining cleanup allowance specified in Table 4.

13. Surface Condition

13.1 Material shall be cleaned and furnished in the scale-free condition.

14. Number of Tests

14.1 *Mechanical Tests on Quenched and Tempered Material*:

14.1.1 One test coupon shall be removed from each end of one bar, one seamless tube, or one bored bar or from each of two forged hollows from each size of each heat in each tempering charge, or each 10 000 lb [4540 kg], whichever is less. One tension test and one impact test consisting of three

TABLE 4 Rolled Bars[A]—Permissible Grinding Depth for Removal of Surface Defects

Diameter, in. [mm]	Minimum Stock Removal Per Side	
	in.	mm
1 to 1⅛ [25 to 29], incl	0.025	0.64
Over 1⅛ to 1¼ [29 to 32], incl	0.028	0.71
Over 1¼ to 1⅜ [32 to 35], incl	0.030	0.76
Over 1⅜ to 1½ [35 to 38], incl	0.033	0.84
Over 1½ to 2 [38 to 50], incl	0.042	1.07
Over 2 to 2½ [50 to 65], incl	0.052	1.32
Over 2½ to 3½ [65 to 90], incl	0.072	1.83
Over 3½ to 4½ [90 to 115], incl	0.090	2.29
Over 4½ to 5½ [115 to 140], incl	0.110	2.79
Over 5½ to 6½ [140 to 165], incl	0.125	3.18
Over 6½ to 8¼ [165 to 210], incl	0.155	3.94
Over 8¼ to 9½ [210 to 240], incl	0.203	5.16

[A] Consult the manufacturer on forged bars, cold-finished bars, bored bars, seamless tubes, and forged hollows.

Charpy V-notch specimens shall be taken from each test coupon. For testing in accordance with 16.1.1, two tests shall be obtained from two representative production pieces from each size of each heat in each tempering charge or each 10 000 lb [4540 kg], whichever is less.

14.1.2 *Hardness Test*:

14.1.2.1 Bars 2 in. [50 mm] and over and all seamless tubes or bored bars shall be tested near each end of each mill-treated length. Each forged hollow with thickness 2 in. [50 mm] or over shall be tested on the surface.

14.1.2.2 Bars under 2 in. [50 mm] shall be tested near each end of not less than 10 % of the bars. Forged hollows less than 2 in. [50 mm] thick shall be tested on the surface of not less than 10 % of the forgings.

14.2 *Hardness Tests of Annealed Material*:

14.2.1 Hardness tests shall be made on the annealed bars to assure compliance with 10.2.

15. Retests

15.1 If the results of the mechanical tests of any test lot do not conform to the specified requirements, the manufacturer shall reject the lot or he may retreat such a lot not more than

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twice. After the lot is retreated, all of the tests specified in 14 shall be repeated, and all shall conform to the specified requirements.

16. Test Specimens and Methods of Testing

16.1 A discard equivalent to the diameter of the bar when heat treated as a solid or a discard equivalent to the wall thickness when heat treated as a seamless tube, bored bar, or hollow forging shall be taken prior to removal of test coupons.

16.1.1 When production pieces are not of sufficient length to permit removal of test coupons in accordance with 16.1, the mid-length of the specimens shall be at the mid-length of the production pieces selected for destruction to provide test coupon material. The production pieces selected for test shall be identical with respect to the quenched contour and size except for length which shall equal or exceed the length of the represented production pieces.

16.2 Tension and impact specimens from bolting materials with cross sections of 1½ in. [38 mm] or less shall be taken so that their longitudinal axis is on a line representing the center of the diameter or thickness.

16.3 Tension test specimens from bolting materials with cross sections exceeding 1½ in. [38 mm] shall be taken so that their longitudinal axis is midway between mid-thickness and surface.

16.4 Impact specimens from bolting materials with cross sections exceeding 1½ in. [38 mm] shall be taken so that their longitudinal axis is midway between mid-thickness and surface or 1 in. [25 mm] below the surface plus the machining allowance per side, whichever is the lesser.

17. Certification

17.1 When requested in the purchaser's order, a test report shall be furnished to the purchaser to indicate the specification, grade, and the test results required by this specification plus any other tests which may be specified in writing by the purchaser. The specification designation included on the test reports shall include year date, and revision letter, if any.

18. Product Marking

18.1 Bars under 2 in. [50 mm] in diameter shall be bundled and tagged with the specification, grade, and mill heat number. The specification number marked on the tag need not include specification year date and revision number.

18.2 Bars 2 in. [50 mm] and over in diameter and all seamless tubes and bored bars shall be die-stamped with the mill heat number and grade on one surface.

18.3 Each hollow forging shall be die-stamped with the heat number or heat symbol code and grade.

18.4 Grade and manufacturer's identification symbols shall be applied to one end of studs ⅜ in. [10 mm] in diameter and larger and to the heads of bolts ¼ in. [6 mm] in diameter and larger. (If the available area is inadequate, the grade symbol may be marked on one end and the manufacturer's symbol marked on the other end.)

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

18.6 *Bar Coding*—In addition to the requirements in 18.1-18.5, bar coding is acceptable as a supplementary identification method. Bar coding should be consistent with AIAG B-5 02.00. If used on small items, the bar code may be applied to the box or a substantially applied tag.

19. Keywords

19.1 bolts—steel; chromium-molybdenum alloy steel; chromium-molybdenum-vanadium alloy steel; chromium-nickel-molybdenum-vanadium alloy steel; fasteners—steel; nickel-chromium-molybdenum alloy steel; nuclear applications; nuts—steel; steel bars—alloy; steel bolting material; tubes—extruded seamless; washers—steel

SUPPLEMENTARY REQUIREMENTS

These requirements shall not apply unless specified in the order, in which event the tests shall be made at the mill at the purchaser's expense unless otherwise agreed upon.

S1. Product Analysis

S1.1 Product analysis shall be made on each bar, seamless tube, bored bar, or the parent bar from which forged hollows are made. Individual pieces failing to conform to Table 1 shall be rejected.

S2. Macroetch Test

S2.1 The material shall be macroetch tested and shall meet the quality and cleanliness requirements as specified by the purchaser. The macroetch examination may be made on representative billets from which the material will be produced or it may be made on samples cut from the ends of the bars, seamless tubes, bored bars, or forged hollows. The samples shall be prepared in accordance with the procedure described in Method E 381.

NOTE S2.1—The quality and cleanliness may be specified by the purchaser as equal to or better than that indicated by a designated letter and plate number of Military Standard—430 (latest revision).

S3. Ultrasonic Test

S3.1 Each length shall be ultrasonically inspected in a manner agreeable to the purchaser and supplier.

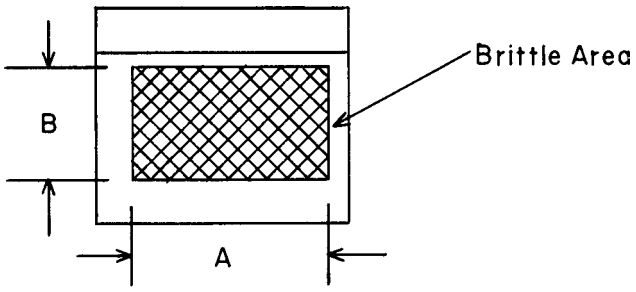
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S4. Demonstration of Capability

S4.1 When annealed material is ordered to 6.1, a sample piece at least 3 *D* long of a representative bar shall be heat treated in accordance with 6.2 and 6.3. Mechanical test samples taken as required by Section 16 shall meet the requirements of 8.2 and 10.2.

S5. Fracture Transition Temperature

S5.1 The fracture transition temperature for a 50 % fibrous (ductile shear) fracture shall be determined. The procedure for determination of the fracture transition temperature shall be to prepare four sets (three to a set) of Charpy V-notch specimens in accordance with Section 16. One set of three specimens shall be tested at approximately 70 °F [20 °C]. The absorbed energy in foot-pounds shall be recorded and the percent of fibrous fracture determined from Table S5.1 and Fig. S5.1. The other three sets shall be tested at successively lower or higher temperatures to bracket the temperature where the material will exhibit a 50 % fibrous fracture. The results of all test data are to be reported to the purchaser.



Measure Dimensions *A* and *B* to the nearest ½ mm.

FIG. S5.1 Calculation of Percent Fibrous Area

S6. Magnetic Particle Inspection

S6.1 Material may be supplied to cleanliness requirements by agreement between the purchaser and supplier. The cleanliness shall be determined by the magnetic particle method described in the latest issue of Practice E 45.

NOTE S6.1—The material shall have the minimum stock removal specified in Table S6.1 prior to magnetic particle inspection.

S7. Elevated Temperature Test

S7.1 Three Charpy V-notch specimens shall be tested at 212 °F [100 °C] to determine the "upper shelf" fracture energy of the material. No specimen thus tested shall break at an energy less than 30 ft·lbf [41 J] .

TABLE S6.1 Rolled Bars[A]—Stock Removal for Magnetic Particle Inspection

Diameter, in. [mm]	Minimum Stock Removal Per Side	
	in.	mm
1 to 1½ [25 to 38], incl	0.075	1.90
Over 1½ to 2 [38 to 50], incl	0.090	2.29
Over 2 to 2½ [50 to 65], incl	0.125	3.18
Over 2½ to 3½ [65 to 90], incl	0.156	3.96
Over 3½ to 4½ [90 to 115], incl	0.187	4.75
Over 4½ to 6 [115 to 155], incl	0.250	6.35
Over 6 to 10 [155 to 255], incl	0.312	7.92

[A] Consult the manufacturer on forged bars, cold-finished bars, bored bars, seamless tubes, and forged hollows.

S8. Alternative Fracture Toughness Requirement

S8.1 The fracture toughness requirements (Charpy impact test) for material of the ASME Boiler and Pressure Vessel Code, Section III, Subarticle NB 2300, shall be used instead of the Charpy impact test requirement specified in Table 2.

TABLE S5.1 Percent Fibrous Fracture[A]
Dimension *A* Width, mm

Dimension *B* Height, mm	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10
1.0	98	98	97	96	96	95	94	94	93	93	92	91	91	90	89	89	88	87
1.5	97	96	95	94	93	93	92	91	90	89	88	87	86	85	85	83	82	81
2.0	96	95	94	93	91	90	89	88	86	85	84	82	81	80	79	78	76	75
2.5	95	94	92	91	89	87	86	84	83	81	80	79	76	75	73	72	70	69
3.0	94	93	91	90	87	85	83	81	79	78	76	74	72	70	68	66	64	63
3.5	93	91	89	87	85	83	80	78	75	74	72	69	67	65	63	61	58	56
4.0	93	90	87	85	83	80	78	75	72	70	68	65	62	60	57	55	52	50
4.5	92	89	86	83	80	78	75	72	69	66	63	61	58	55	52	49	46	43
5.0	91	88	84	81	78	75	72	69	66	63	59	56	53	50	48	44	40	38
5.5	90	86	83	79	75	72	69	66	63	59	55	52	48	45	42	38	35	31
6.0	89	85	81	78	74	70	66	63	59	55	51	47	44	40	36	33	29	25
6.5	88	84	80	76	72	68	63	59	55	51	47	43	40	35	31	27	23	19
7.0	87	82	79	74	69	65	61	56	52	47	43	39	34	30	26	21	16	12
7.5	86	81	76	72	67	62	58	53	48	44	40	34	30	25	23	16	11	6
8.0	85	80	75	70	65	70	55	50	45	40	35	30	25	20	15	10	5	0

[A] See Fig. S5.1.

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S9. Marking

S9.1 Grade and manufacturer's identification symbols shall be applied to one end of the studs and to the heads of bolts of all sizes. (If the available area is inadequate, the grade symbol may be marked on one end and the manufacturer's identification symbol marked on the other end). For bolts and studs smaller than ¼ in. [6 mm] in diameter and for ¼-in. [6 mm] studs requiring more than a total of three symbols, the marking shall be a matter of agreement between the purchaser and manufacturer.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 540/A 540M – 05, that may impact the use of this specification. (Approved March 1, 2006)

(*1*) Revised Section 3 and added new Section 4.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 540/A 540M – 04, that may impact the use of this specification. (Approved March 1, 2005)

(*1*) Revised Table 2 metric values and 11.1.1 and 11.1.2.

(*2*) Corrected reference in 14.1.1 from 16.2.1 to 16.1.1.

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