Designation: A 437/A 437M – 06

Standard Specification for Alloy-Steel Turbine-Type Bolting Material Specially Heat Treated for High-Temperature Service[1]

This standard is issued under the fixed designation A 437/A 437M; 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 alloy-steel bolting material specially heat treated for high-temperature service, such as steam turbine, gas turbine, and similar uses. This material requires special processing and should not be used in general-purpose applications. The term "bolting material," as used in this specification, covers rolled or forged bars, bolts, nuts, screws, washers, studs, and stud bolts. The bars shall be hot wrought. The material may be further processed by centerless grinding or by cold drawing.

1.2 The high-temperature properties of the material covered by this specification are dependent upon special heat treatment, which is required. Although the high-temperature properties are not specified, they are implied by control of the chemistry, heat treatment, and room-temperature properties of the material.

NOTE 1—High-temperature tests shall not be required, unless made a matter of agreement between the manufacturer and the purchaser.

1.3 Three levels of bolting strength are covered, designated Grades B4B, B4C, and B4D. Selection will depend on the design and the stresses and service for which the product is to be used.

NOTE 2—When ordering material under this specification, or when incorporating this specification as a reference in any individual specification, the purchaser must designate the steel by identification symbol or analysis, or both, and definitely specify the minimum mechanical properties required as selected from Table 1.

1.4 Supplementary requirements of an optional nature are provided for use at the option of the purchaser. The supplementary requirements shall apply only when specified individually by the purchaser in the purchase order or contract.

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:* [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

3. Common Requirements

3.1 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.

4. Ordering Information

4.1 The inquiry and order should indicate the following:

4.1.1 Specification designation, grade and class, issue date and revision letter,

4.1.2 Quantity (weight or number of pieces),

4.1.3 Description (bars, bolts, nuts, etc.),

[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-437 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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TABLE 1 Tensile Requirements

Grade	Diameter, in. [mm]	Tensile Strength, min, ksi [MPa]	Yield Strength (0.2 % offset) min, ksi [MPa]	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %
B4B	...	145 [1000]	105 [720]	13	30
B4C	...	115 [790]	85 [585]	18	50
B4D	2½ [65] and under	125 [860]	105 [720]	18	50
	over 2½ to 4 [65 to 100]	110 [760]	95 [655]	17	45
	over 4 to 7 [100 to 180]	100 [690]	85 [585]	16	45

4.1.4 Dimensions,
4.1.5 Finish, and
4.1.6 Impact testing of nuts, if required (see Section 9).

5. Discard

5.1 A sufficient discard shall be made from each ingot to ensure freedom from injurious piping and undue segregation.

6. Heat Treatment

6.1 The material Grades B4B and B4C shall be heated to a temperature range of 1875 to 1925 °F [1025 to 1050 °C] and liquid quenched to below 600 °F [316 °C]. The material Grades B4B and B4C shall then be uniformly reheated for tempering at a tempering temperature at least 100 °F [55 °C] higher than the proposed operating temperature but not less than 1150 °F [620 °C], then air or furnace cooled to room temperature. The material shall be at the tempering temperature for a minimum of 2 h. Double tempering may be used to enhance properties.

6.2 Material Grade B4D shall be heated to a temperature range of 1700 to 1750 °F [925 to 954 °C] and oil quenched. The material shall then be uniformly reheated or tempered at a temperature of 1200 °F [650 °C] minimum, followed by air or furnace cooling to room temperature.

6.3 Stress relieving treatment of the bar material is required after any stretcher, roller, or rotary-straightening or cold-finishing operations performed after heat treatment for mechanical properties. Local gagging or press straightening to correct camber limitations in excess of 1/4 in. in any 5 ft [6 mm in any 1.5 m] shall be followed by a stress relieving heat treatment. The minimum stress relieving temperature shall be 100 °F [55 °C] below the minimum tempering temperature as shown in 6.1 for Grades B4B and B4C or in 6.2 for Grade B4D.

7. Chemical Composition

7.1 The material shall conform to the requirements as to chemical composition specified in Table 2.

8. Tensile Requirements

8.1 The material shall conform to the requirements as to tensile properties prescribed in Table 1 at room temperature after heat treatment.

8.2 The longitudinal axis of the test specimen shall be parallel to the direction of rolling.

TABLE 2 Chemical Requirements[A]

Element	Grades B4B, B4C[B]		Grade B4D	
	Range, %	Product Variation, %, Over or Under	Range, %	Product Variation, %, Over or Under
Carbon	0.20–0.25	0.02	0.36–0.44	0.02
Manganese	0.50–1.00	0.03	0.45–0.70	0.03
Phosphorus, max	0.025	0.005 over	0.04	0.005 over
Sulfur, max	0.025	0.005 over	0.04	0.005 over
Silicon	0.20–0.50	0.05	0.20–0.35	0.02
Nickel	0.50–1.00	0.03	...	...
Chromium	11.0–12.5	0.15	0.80–1.15	0.05
Molybdenum	0.90–1.25	0.05	0.50–0.65	0.03
Vanadium	0.20–0.30	0.03	0.25–0.35	0.03
Tungsten	0.90–1.25	0.05	...	...
Aluminum, max[C]	0.05	...	0.015	...
Titanium, max	0.05	...	...	...
Tin, max	0.04	...	...	...

[A] Steel to which lead has been added shall not be used.
[B] UNS S42200.
[C] Total, Soluble + Insoluble

9. Impact Requirements

9.1 The material Grades B4B, B4C, and B4D shall conform to the requirements as to impact properties prescribed in Table 3 at room temperature after heat treatment.

10. Hardness Tests

10.1 The material Grades B4B, B4C, and B4D shall conform to the requirements as to hardness as prescribed in Table 4 and Table 5 at room temperature after heat treatment.

11. Workmanship, Finish, and Appearance

11.1 Standard permissible variations of bars shall be as set forth in Table 6.

12. Nuts and Washers

12.1 When specified by the purchaser, the nuts shall be subject to the impact and tension requirements of this specification. The tests shall be made on test specimens taken from the bar or plate used in the manufacture of the nuts.

13. Threads

13.1 All threads shall be formed after heat treatment.

14. Nondestructive Inspection

14.1 Each bar or forged blank of starting material shall be subjected to NDE following final heat treatment. The method used shall be either the Eddy Current (EC), the Magnetic Particle (MPI) (wet or dry), the Liquid Penetrant (LPI), the Ultrasonic (UT), or the Visual Testing (VT), at the option of the producer. For LPI or MPI, linear indications (those indications longer than 1/16 in. [1.5 mm] with a length greater than three

TABLE 3 Impact Requirements

Grade	Minimum Impact Value, ft·lbf [J]
B4B	10 [14]
B4C	25 [34]
B4D[A]	25 [34]

[A] For bars over 5-in. [127-mm] diameter only.

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TABLE 4 Hardness Requirements for Bolts and Studs

Grade	Brinell Hardness Number, max
B4B	331
B4C	277
B4D	302

TABLE 5 Hardness Requirements for Nuts and Washers

Grade	Brinell Hardness Number	Rockwell Hardness Number
B4B	293–341	C 31–37
B4C	229–277	C 21–29
B4D	263–311	C 27–33

times their width) are unacceptable. For UT or ET, reject levels for linear indications shall be based on the alarm response from a surface notch with a maximum depth of 0.012 in. [.30 mm] in a calibration bar. Product being subjected to VT shall be pickled prior to inspection. VT indications longer than ⅛ in. are prohibited.

TABLE 6 Permissible Variations in Size of Hot-Rolled Bars

Specified Size, in. [mm]	Permissible Variations from Specified Size, in. [mm]		Out of Round, in. [mm]
	Over	Under	
5⁄16 [8] and under	0.005 [0.13]	0.005 [0.13]	0.008 [0.20]
Over 5⁄16 to 7⁄16 [8 to 11] incl	0.006 [0.15]	0.006 [0.15]	0.009 [0.23]
Over 7⁄16 to 5⁄8 [11 to 16] incl	0.007 [0.18]	0.007 [0.18]	0.010 [0.25]
Over 5⁄8 to 7⁄8 [16 to 22] incl	0.008 [0.20]	0.008 [0.20]	0.012 [0.30]
Over 7⁄8 to 1 [22 to 25] incl	0.009 [0.23]	0.009 [0.23]	0.013 [0.33]
Over 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 [2.0]	0	0.058 [1.47]
Over 5½ to 6½ [140 to 165], incl	⅛ [3.2]	0	0.070 [1.78]
Over 6½ to 7½ [165 to 190], incl	5⁄32 [4.0]	0	0.085 [2.16]

15. Keywords

15.1 bolts—steel; chromium alloy steel; fasteners—steel; marking on fasteners; nuts—steel; steel bars—alloy; steel bolting material; temperature service applications—high; turbine materials

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall be applied only when specified by the purchaser in the inquiry, contract, or order; in which event the specified tests shall be made before shipment of the product.

S1. Non-Destructive Examination

S1.1 NDE is required following all machining and threading. The acceptance criteria of 14.1 shall apply.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 437/A 437M – 04, that may impact the use of this specification. (Approved March 1, 2006)

(*1*) Revised paragraph 3.1.

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