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Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength¹

This standard is issued under the fixed designation A 307; 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.

^ε~~NOTE~~ Sections 2.2 and 3.1.12 were editorially revised in October 2006.

1. Scope*

~~1.1 This specification~~

1.1 This specification² covers the chemical and mechanical requirements of three grades of carbon steel bolts and studs in sizes $\frac{1}{4}$ in. (6.35 mm) through 4 in. (104 mm). The fasteners are designated by “Grade” denoting tensile strength and intended use, as follows:

| Grade | Description |
|----------------|---|
| Grade A | Bolts and studs having a minimum tensile strength of 60 ksi (414 MPa) and intended for general applications; |
| <u>Grade A</u> | <u>Bolts and studs having a minimum tensile strength of 60 ksi and intended for general applications;</u> |
| Grade B | Bolts and studs having a tensile strength of 60 to 100 ksi (414 to 690 MPa) and intended for flanged joints in piping systems with cast iron flanges; and |
| <u>Grade B</u> | <u>Bolts and studs having a tensile strength of 60 to 100 ksi and intended for flanged joints in piping systems with cast iron flanges; and</u> |
| Grade C | Nonheaded anchor bolts, either bent or straight, having properties conforming to Specification A 36/A 36M (tensile strength of 58 to 80 ksi (400 to 550 MPa)) and intended for structural anchorage purposes. Replaced by Specification F 1554 Gr.36 |
| <u>Grade C</u> | <u>Nonheaded anchor bolts, either bent or straight, having properties conforming to Specification A 36/A 36M (tensile strength of 58 to 80 ksi (400 to 550 MPa)) and intended for structural anchorage purposes. Replaced by Specification F 1554 Gr.36</u> |

1.1.1 The term *studs* includes stud stock, sometimes referred to as *threaded rod*.

1.2 This specification does not cover requirements for machine screws, thread cutting/forming screws, mechanical expansion anchors or similar externally threaded fasteners.

1.3 Suitable nuts are covered in Specification A 563. Unless otherwise specified, the grade and style of nut for each grade of fastener, of all surface finishes, shall be as follows:

| Fastener Grade and Size | Nut Grade and Style ^A |
|--|----------------------------------|
| <u>_____ A, C, $\frac{1}{4}$ to $1\frac{1}{2}$ in.</u> | <u>_____ A, hex</u> |
| <u>_____ A $\frac{1}{4}$ to $1\frac{1}{2}$ in.</u> | <u>_____ A, hex</u> |

¹ This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets, Rivets and Washers.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-307 in Section II of that Code.

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

~~_____ A, C, over 1½ to 4 in.~~
~~_____ A over 1½ to 4 in.~~
~~_____ B, ¼ to 4 in.~~

~~_____ A, heavy hex~~
~~_____ A, heavy hex~~
~~_____ A, heavy hex~~

^A Nuts of other grades and styles having specified proof load stresses (Specification A 563, Table 3) greater than the specified grade and style of nut are also suitable.

~~1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.~~

~~1.4 The values stated in inch-pound units are to be regarded as the standard.~~

1.5 Supplementary Requirement S1 of an optional nature is provided, which describes additional restrictions to be applied when bolts are to be welded. It shall apply only when specified in the inquiry, order, and contract.

1.6 Terms used in this specification are defined in Terminology F 1789 unless otherwise defined herein.

2. Referenced Documents

2.1 ~~ASTM Standards:~~³ ~~A36/A36M Specification for Carbon Structural Steel~~

A 153/A 153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

~~A370~~ Test 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 563 Specification for Carbon and Alloy Steel Nuts

A 706/A 706M Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

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

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

D 3951 Practice for Commercial Packaging

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F 1470 Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

F 1554 Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

F 1789 Terminology for F16 Mechanical Fasteners

2.2 ~~ASME Standards:~~

B 1.1 Unified Screw Threads⁴

B 18.2.1 Square and Hex Bolts and Screws⁴

~~B18.24~~ Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

2.3 ~~Military Standard:~~

~~MIL-STD105~~ Single Sampling Plan for Normal Inspection

~~B 18.24~~ Part Identifying Number (PIN) Code System⁵

3. Ordering Information

3.1 Orders for externally threaded fasteners (including nuts and accessories) under this specification shall include the following:

3.1.1 ASTM designation and year of issue,

3.1.2 Name of product, bolts or studs; and bolt head style, that is, hex or heavy hex,

3.1.3 Grade, that is, A, or ~~B~~, or ~~C~~. B. If no grade is specified, Grade A is furnished.

3.1.4 Quantities (number of pieces by size including nuts),

3.1.5 Fastener size and length,

3.1.6 *Washers*—Quantity and size (separate from bolts),

3.1.7 *Zinc Coating*—Specify the zinc-coating process required, for example, hot-dip, mechanically deposited, or no preference (see 4.5).

3.1.8 *Other Finishes*—Specify other protective finish, if required.

3.1.9 Specify if inspection at point of manufacture is required,

3.1.10 Specify if certified test report is required (see 8.2), and

3.1.11 Specify additional testing (8.3) or special requirements.

~~3.1.12~~ For 3.1.12 For establishment of a part identifying system, see ASME B18.24.

4. Materials and Manufacture

4.1 Steel for bolts and studs shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

4.2 Bolts shall be produced by hot or cold forging of the heads or machining from bar stock.

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 American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

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

⁵ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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

4.3 Heat Treatment:

4.3.1 Cold headed fasteners with head configurations other than hex shall be stress relief annealed.

4.3.2 Stress relieving of hex head fasteners shall be at the manufacturer's option.

4.4 Bolt and stud threads shall be rolled or cut.

4.5 Zinc Coatings, Hot-Dip and Mechanically Deposited:

4.5.1 When zinc-coated fasteners are required, the purchaser shall specify the zinc-coating process, for example hot dip, mechanically deposited, or no preference.

4.5.2 When hot-dip is specified, the fasteners shall be zinc-coated by the hot-dip process in accordance with the requirements of Class C of Specification A 153/A 153M.

4.5.3 When mechanically deposited is specified, the fasteners shall be zinc-coated by the mechanical-deposition process in accordance with the requirements of Class 50 of Specification B 695.

4.5.4 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification A 153/A 153M, Class C or a mechanically deposited zinc coating in accordance with Specification B 695, Class 50. Threaded components (bolts and nuts) shall be coated by the same zinc-coating process and the supplier's option is limited to one process per item with no mixed processes in a lot.

5. Chemical Composition

5.1 Grade A and B bolts and studs shall have a heat analysis conforming to the requirements specified in Table 1 based on the steel producer's heat analysis.

5.2 The purchaser shall have the option of conducting product analyses on finished bolts in each lot, which shall conform to the product analysis specified in Table 1.

5.3 In case of conflict or for referee purposes, the product analysis shall take precedence.

5.4 Bolts and studs are customarily furnished from stock, in which case individual heats of steel cannot be identified.

5.5 Application of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted for Grade B bolts and studs.

5.6 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology A 751.

6. Mechanical Properties

6.1 Grades A and B bolts and studs shall conform to the hardness specified in Table 2.

6.2 Grade A and B bolts and studs 1½ in. in diameter or less, other than those excepted in 6.4, shall be tested full size and shall conform to the requirements for tensile strength specified in Table 3.

6.3 Grade A and B bolts and studs larger than 1½ in. in diameter, other than those excepted in 6.4, shall preferably be tested full size and when equipment of sufficient capacity is available and shall conform to the requirements for tensile strength specified in Table 3. When equipment of sufficient capacity for full-size bolt testing is not available, or when the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements specified in Table 4.

6.4 Grades A and B bolts and studs less than three diameters in length or bolts with drilled or undersize heads are not subject to tensile tests.

~~6.5 Grade C nonheaded anchor bolts shall be tested using machined specimens and shall conform to the tensile properties specified for bars in Specification A36/A36M. Properties are shown in Table 4 for information. In the event of conflict Specification A36/A36M shall control.~~

~~6.6 In the event that bolts are tested by both full size and by machine test specimen methods, the full-size test shall govern if a controversy between the two methods exists.~~

~~6.7 For bolts and studs on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event that there is controversy over low readings of hardness tests.~~

6.5 In the event that bolts are tested by both full size and by machine test specimen methods, the full-size test shall govern if a controversy between the two methods exists.

6.6 For bolts and studs on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event that there is controversy over low readings of hardness tests.

TABLE 1 Chemical Requirements for Grades A and B Bolts and Studs

| | Heat Analysis | Product Analysis |
|-----------------|---------------|------------------|
| Carbon, max | 0.29 | 0.33 |
| Manganese, max | 1.20 | 1.25 |
| Phosphorus, max | 0.04 | 0.041 |
| Sulfur, max | | |
| Grade A | 0.15 | ^A |
| Grade B | 0.05 | 0.051 |

^A Resulfurized steel is not subject to rejection based on product analysis for sulfur.

TABLE 2 Hardness Requirements for Bolts and Studs

| Grade | Length, in. θ | Hardness ^A | | | |
|-------|-----------------------------------|-----------------------|-----|------------|-----|
| | | Brinell | | Rockwell B | |
| | | min | max | min | max |
| A | Less than $3 \times \text{dia}^B$ | 121 | 241 | 69 | 100 |
| | $3 \times \text{dia}$ and longer | ... | 241 | ... | 100 |
| B | Less than $3 \times \text{dia}^B$ | 121 | 212 | 69 | 95 |
| | $3 \times \text{dia}$ and longer | ... | 212 | ... | 95 |
| C | All | No hardness required | | | |

^A As measured anywhere on the surface or through the cross section.

^B Also bolts with drilled or undersize heads. These sizes and bolts with modified heads shall meet the minimum and maximum hardness as hardness is the only requirement.

TABLE 3 Tensile Requirements for Full-Size Bolts and Studs

| Bolt Size, in. | Threads per inch | Stress Area, ^A in. ² | Tensile Strength, lbf ^B | | |
|----------------|------------------|--|------------------------------------|------------------|------------------|
| | | | Grade A, min ^C | Grade B | |
| | | | | min ^D | max ^D |
| 1/4 | 20 | 0.0318 | 1 900 | 1 900 | 3 180 |
| 5/16 | 18 | 0.0524 | 3 100 | 3 100 | 5 240 |
| 3/8 | 16 | 0.0775 | 4 650 | 4 650 | 7 750 |
| 7/16 | 14 | 0.1063 | 6 350 | 6 350 | 10 630 |
| 1/2 | 13 | 0.1419 | 8 500 | 8 500 | 14 190 |
| 9/16 | 12 | 0.182 | 11 000 | 11 000 | 18 200 |
| 5/8 | 11 | 0.226 | 13 550 | 13 550 | 22 600 |
| 3/4 | 10 | 0.334 | 20 050 | 20 050 | 33 400 |
| 7/8 | 9 | 0.462 | 27 700 | 27 700 | 46 200 |
| 1 | 8 | 0.606 | 36 350 | 36 350 | 60 600 |
| 1 1/8 | 7 | 0.763 | 45 800 | 45 800 | 76 300 |
| 1 1/4 | 7 | 0.969 | 58 150 | 58 150 | 96 900 |
| 1 3/8 | 6 | 1.155 | 69 300 | 69 300 | 115 500 |
| 1 1/2 | 6 | 1.405 | 84 300 | 84 300 | 140 500 |
| 1 3/4 | 5 | 1.90 | 114 000 | 114 000 | 190 000 |
| 2 | 4 1/2 | 2.50 | 150 000 | 150 000 | 250 000 |
| 2 1/4 | 4 1/2 | 3.25 | 195 000 | 195 000 | 325 000 |
| 2 1/2 | 4 | 4.00 | 240 000 | 240 000 | 400 000 |
| 2 3/4 | 4 | 4.93 | 295 800 | 295 800 | 493 000 |
| 3 | 4 | 5.97 | 358 200 | 358 200 | 597 000 |
| 3 1/4 | 4 | 7.10 | 426 000 | 426 000 | 710 000 |
| 3 1/2 | 4 | 8.33 | 499 800 | 499 800 | 833 000 |
| 3 3/4 | 4 | 9.66 | 579 600 | 579 600 | 966 000 |
| 4 | 4 | 11.08 | 664 800 | 664 800 | 1 108 000 |

^A Area calculated from the equation:

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

where:

 A_s = stress area,
 D = nominal diameter of bolt, and
 n = threads per inch.

^B 1 lbf = 4.448 N.

^C Based on 60 ksi (414 MPa).

^D Based on 60–100 ksi (414–690 MPa).

7. Dimensions

7.1 Unless otherwise specified, threads shall be the Coarse Thread Series as specified in the latest issue of ASME B1.1, and shall have a Class 2A tolerance.

7.2 Unless otherwise specified, Grade A bolts shall be hex bolts with dimensions as given in the latest issue of ASME B18.2.1. Unless otherwise specified, Grade B bolts shall be heavy hex bolts with dimensions as given in the latest issue of ASME B18.2.1.

7.3 Unless otherwise specified, bolts and studs to be used with nuts or tapped holes which have been tapped oversize, in accordance with Specification A 563, shall have Class 2A threads before hot-dip or mechanically deposited zinc coating. After zinc coating the maximum limit of pitch and major diameter shall not exceed the Class 2A maximum limit by more than the following amounts: