



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

This standard is issued under the fixed designation A307; 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 the chemical and mechanical requirements of two grades of carbon steel bolts and studs in sizes 1/4 in. through 4 in. The fasteners are designated by “Grade” denoting tensile strength and intended use, as follows:

Grade	Description
Grade A	Bolts, studs, and threaded rod having a minimum tensile strength of 60 ksi and intended for general applications,
Grade B	Bolts, studs, and threaded rod ⁴ having a tensile strength of 60 to 100 ksi and intended for flanged joints in piping systems with cast iron flanges, and
Grade C	Replaced by Specification F1554 Gr.36

⁴ Threaded rod is not usually produced to Grade B, but can be when specified by the purchaser.

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 **A563**. 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 ⁴
A 1/4 to 1 1/2 in.	A, hex
A over 1 1/2 to 4 in.	A, heavy hex
B, 1/4 to 4 in.	A, heavy hex

⁴ Nuts of other grades and styles having specified proof load stresses (Specification **A563**, 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.

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 and Washers.

Current edition approved Dec. 1, 2012. Published January 2013. Originally approved in 1947. Last previous edition approved in 2010 as A307–10. DOI: 10.1520/A0307-12.

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

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 **F1789** unless otherwise defined herein.

2. Referenced Documents

2.1 ASTM Standards:³

- A563** Specification for Carbon and Alloy Steel Nuts
- A706/A706M** Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- A751** Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- B695** Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
- F606** Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
- F1470** Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
- F1554** Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
- F1789** Terminology for F16 Mechanical Fasteners
- 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:

- B 1.1** Unified Screw Threads⁴
- B 18.2.1** Square and Hex Bolts and Screws⁴
- B 18.24** Part Identifying Number (PIN) Code System⁵
- B18.31.3** Threaded Rods (Inch Series)⁴

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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.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>.

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

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, or threaded rod,
- 3.1.3 Grade, that is, A, or 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 establishment of a part identifying system, see ASME B18.24.

4. Materials and Manufacture

- 4.1 Steel for bolts, studs, and threaded rod 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.
- 4.3 *Heat Treatment:*
 - 4.3.1 Cold headed fasteners with head configurations other than hex having a minimum head height less than or equal to .5 D (D is nominal diameter) shall be stress relief annealed at a minimum temperature of 875°F.
 - 4.3.2 Stress relieving of hex head fasteners and those with minimum head heights greater than .5 D 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 Specification F2329.
 - 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 55 of Specification B695.
 - 4.5.4 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification F2329, or a mechanically deposited zinc coating in accordance with Specification B695, Class 55. 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, studs, and threaded rod 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 A751.

6. Mechanical Properties

- 6.1 Grades A and B bolts, studs, and threaded rod shall conform to the hardness specified in Table 2.
- 6.2 Grade A and B bolts, studs, and threaded rod 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. Threaded rod is permitted to be cut to a length suitable for tensile testing and shall be treated using the same method specified for studs.
- 6.3 Grade A and B bolts, studs, and threaded rod 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 testing is not available, or when the length of the bolt or stud 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 In the event that bolts, studs, and threaded rod 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.

TABLE 1 Chemical Requirements for Grades A and B Bolts, Studs, and Threaded Rod

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

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

TABLE 2 Hardness Requirements for Bolts, Studs, and Threaded Rod

Grade	Length, in.	Hardness ^A			
		Brinell		Rockwell B	
		min	max	min	max
A	Less than 3 × dia ^B	121	241	69	100
	3 × dia and longer	...	241	...	100
B	Less than 3 × dia ^B	121	212	69	95
	3 × dia and longer	...	212	...	95

^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, Studs, and Threaded Rod

Bolt Size, in.	Threads per inch	Stress Area, in. ² ^A	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).

6.6 For bolts, studs, and threaded rod 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 4 Tensile Requirements for Machined Specimens

	Grade A	Grade B
Tensile strength, ksi	60 min	60–100
Yield point, min ksi
Elongation in 2 in., min, %	18	18

7. Dimensions

7.1 Unless otherwise specified, threads on bolts and studs shall be the Coarse Thread Series as specified in the latest issue of ASME B1.1, and shall have a Class 2A tolerance. Unless otherwise specified, threads on threaded rod shall be per the requirements of the latest issue of ASME B18.31.3.

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. Unless otherwise specified, threads on threaded rod shall be per the requirements of the latest issue of ASME B18.31.3.

7.3 Unless otherwise specified, bolts, studs, and threaded rod to be used with nuts or tapped holes which have been tapped oversize, in accordance with Specification A563, shall have threads as specified in 7.1 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:

Diameter, in.	Oversize Limit, in. (mm) ^A
1/4	0.016
5/16, 3/8	0.017
7/16, 1/2	0.018
9/16 to 3/4, incl	0.020
7/8	0.022
1.0 to 1 1/4, incl	0.024
1 3/8, 1 1/2	0.027
1 3/4 to 4.0, incl	0.050

^A These values are the same as the overtapping required for zinc-coated nuts in Specification A563.

7.4 The gaging limit for bolts and studs, and threaded rod shall be verified during manufacture or use by assembly of a nut tapped as nearly as practical to the amount oversize shown above. In case of dispute, a calibrated thread ring gage of that same size (Class X tolerance, gage tolerance plus) shall be used. Assembly of the gage, or the nut described above, must be possible with hand effort following application of light machine oil to prevent galling and damage to the gage. These inspections, when performed to resolve disputes, shall be performed at the frequency and quality described in Table 5.

8. Number of Tests and Retests

8.1 The requirements of this specification shall be met in continuous mass production for stock, and the manufacturer shall make sample inspections to ensure that the product conforms to the specified requirements. Additional tests of individual shipments of material are not ordinarily contemplated. Individual heats of steel are not identified in the finished product.

TABLE 5 Sample Sizes and Acceptance Numbers for Inspection of Hot-Dip or Mechanically Deposited Zinc-Coated Threads

Lot Size	Sample Size ^A	Acceptance Number
2 to 90	13	1
91 to 150	20	2
151 to 280	32	3
281 to 500	50	5
501 to 1 200	80	7
1 201 to 3 200	125	10
3 201 to 10 000	200	14
10 001 and over	315	21

^A Inspect all bolts in the lot if the lot size is less than the sample size.

8.2 When specified in the order, the manufacturer shall furnish a test report certified to be the last completed set of mechanical tests for each stock size in each shipment.

8.3 When additional tests are specified on the purchase order, a lot, for purposes of selecting test samples, shall consist of all material offered for inspection at one time that has the following common characteristics:

8.3.1 One type of item,

8.3.2 One nominal size, and

8.3.3 One nominal length of bolts and studs.

8.4 From each lot, the number of tests for each requirement shall be as follows:

Number of Pieces in Lot	Number of Samples
800 and under	1
801 to 8 000	2
8 001 to 22 000	3
Over 22 000	5

8.5 If any machined test specimen shows defective machining it shall be discarded and another specimen substituted.

8.6 Should any sample fail to meet the requirements of a specified test, double the number of samples from the same lot shall be tested, in which case all of the additional samples shall meet the specification.

9. Test Methods

9.1 Grades A and B bolts and studs shall be tested in accordance with Test Methods **F606**.

9.2 Standard square and hex head bolts only shall be tested by the wedge tension method except as noted in **6.4**. Fracture shall be in the body or threads of the bolt without any fracture at the junction of the head and body. Other headed bolts shall be tested by the axial tension method.

10. Inspection

10.1 If the inspection described in **10.2** is required by the purchaser it shall be specified in the inquiry, order, or contract.

10.2 The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser's representative shall

be made before shipment, and shall be conducted as not to interfere unnecessarily with the operation of the works.

11. Responsibility

11.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser.

12. Rejection and Rehearing

12.1 Disposition of nonconforming lots shall be in accordance with Guide **F1470**, specifically sections on disposition of nonconforming lots, suppliers option, and purchasers option.

13. Product Marking

13.1 *Grades A and B Bolts and Studs:*

13.1.1 Bolt heads and one end of studs shall be marked with a unique identifier by the manufacturer to identify the manufacturer or private label distributor, as appropriate. Additional marking required by the manufacturer shall be at the option of the manufacturer.

13.1.2 In addition to the requirements of **13.1**, all bolt heads, one end of studs $\frac{3}{8}$ in. and larger, and whenever feasible studs less than $\frac{3}{8}$ in. shall be marked with a grade marking as follows:

Grade	Marking
A	307A
B	307B

13.1.3 All markings shall be located on the top of the bolt head or stud end and shall be raised or depressed at the option of the manufacturer.

13.2 *Grades A and B Threaded Rod:*

13.2.1 Refer to ASME B18.31.3 for marking of Grade A and B threaded rod.

13.2.2 If markings are required, they shall be located on the ends of the threaded rod and shall be raised or depressed at the option of the manufacturer.

14. Packaging and Package Marking

14.1 *Packaging:*

14.1.1 Unless otherwise specified, packaging shall be in accordance the manufacturer's practice to prevent damage before and during shipment.

14.1.2 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

14.2 *Package Marking:*

14.2.1 Each shipping unit shall include or be plainly marked with the following information:

14.2.1.1 ASTM designation and grade,

14.2.1.2 Size,

14.2.1.3 Name and brand or trademark of the manufacturer,

14.2.1.4 Number of pieces,

14.2.1.5 Purchase order number (when specified in the order),

14.2.1.6 Country of origin.

15. Keywords

15.1 all thread rod; bolts; carbon steel; steel; studs; threaded rod

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement shall apply only when specified in the purchase order or contract:

S1. Bolts Suitable for Welding

S1.1 The material described in this section is intended for welding. This supplemental section, by additional chemical composition restrictions and by a carbon equivalent formula, provides assurance of weldability by chemical composition control.

S1.2 Welding technique is of fundamental importance when bolts produced to this supplementary section are welded. It is presupposed that suitable welding procedures for the steel being welded and the intended service will be selected.

S1.3 All of the requirements of this supplemental section apply in addition to all of the chemical, mechanical, and other requirements of the base specification, Specification A307 for Grade B.

S1.4 Because of the embrittling effects of welding temperatures on cold-forged steel, this supplemental section is limited to hot-forged bolts, or, if not forged, then to bolts produced from hot-rolled bars without forging or threaded bars, bars studs, or stud bolts produced from hot-rolled bars without forging. Cold-forged bolts, or cold-drawn threaded bars, if they are given a thermal treatment by heating to a temperature of not less than 1500°F (815°C) and air-cooled are also suitable.

S1.5 Chemical Requirements:

S1.5.1 *Heat Chemical Analysis*—Material conforming to the following additional analysis limitations shall be used to manufacture the product described in this supplementary requirement.

Carbon	0.30 %, max
Manganese	1.00 %, max
Phosphorus	0.04 %, max
Sulfur	0.05 %, max
Silicon	0.50 %, max

S1.5.2 *Carbon Equivalent (Source—Specification A706/A706M)*—In addition to the heat chemical analysis requirements in S1.5.1, the heat analysis shall be such as to provide a carbon equivalent (CE) not exceeding 0.55 when calculated as follows:

$$CE = \% C + \frac{\% Mn}{6} + \frac{\% Cu}{40} + \frac{\% Ni}{20} + \frac{\% Cr}{10} - \frac{\% Mo}{50} - \frac{\% V}{10}$$

S1.6 *Analysis Reports*—If requested on the order or contract, the chemical composition of each heat of steel used and the calculated carbon equivalent for each heat shall be reported to the purchaser.

S1.7 *Product (Check) Verification Analysis*—Chemical analyses when made by the purchaser or a representative on bolts from each heat of steel, shall not exceed the values specified in S1.5.2 by more than the following amounts:

	%
Carbon	+0.03
Manganese	+0.06
Phosphorus	+0.008
Sulfur	+0.008
Silicon	+0.05

S2. Permanent Manufacturer's Identification

S2.1 Replaced by Specification **F1554**.

S3. Permanent Grade Identification

S3.1 Replaced by Specification **F1554**.

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (A307–10) that may impact the use of this standard.

- | | |
|---|---|
| (1) Revised title to include threaded rod. | (4) Removed reference to Practice D3951 in section 2.1 . |
| (2) Added reference to threaded rod to sections, 1.1 , 3.1.2 , 4.1 , 5.1 , 6.1 , 6.2 , 6.3 , 6.5 , 6.6 , 7.1 , 7.2 , 7.3 , 7.4 , and in Table 1 , Table 2 , and Table 3 . | (5) Added ASME B18.31.3 in 2.2 . |
| (3) Removed section 9.3 as it is specified in Test Methods F606 . | (6) Added 13.2 . |
| | (7) Revised 14.1.1 and 14.2.1.5 . |
| | (8) Added additional key words to Section 15 . |

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the ASTM website (www.astm.org/COPYRIGHT/).