Designation: F594 – 09

Standard Specification for Stainless Steel Nuts[1]

This standard is issued under the fixed designation F594; 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 specification covers the requirements for stainless steel nuts 0.25 to 1.50 in., inclusive, in nominal diameter in a number of alloys in common use and intended for service applications requiring general corrosion resistance.

1.2 Seven groups of stainless steel alloys are covered, including ten austenitic, two ferritic, four martensitic, and one precipitation hardening.

Group	Alloys[A]		Condition[B]
1	304, 305, 304L 384, 18–9LW, 302HQ[C]	(CW)	cold worked[D]
2	316, 316L	(CW)	cold worked[D]
3	321, 347	(CW)	cold worked[D]
4	430[E]	(CW)	cold worked[D]
5	410[F]	(H)	hardened and tempered
6	431	(H)	hardened and tempered
7	630	(AH)	aged hardened

[A] Unless otherwise specified on the inquiry and order, the choice of an alloy from within a group shall be at the discretion of the fastener manufacturer (see 6.1).
[B] See 4.2 for options.
[C] When approved by the purchaser, alloys 303, 303Se, or XM1 may be furnished.
[D] Sizes 0.75 in. and larger may be hot worked and solution annealed.
[E] When approved by the purchaser, alloy 430F may be furnished.
[F] When approved by the purchaser, alloy 416 or 416Se may be furnished.

1.3 Supplementary requirements of an optional nature are provided, applicable only when agreed upon by the manufacturer and the purchaser at the time of the inquiry and order.

1.4 Suitable bolts, hex cap screws, and studs for use with nuts included in this specification are covered by Specification F593. Unless otherwise specified, all bolts, hex cap screws, and studs used with these nuts shall conform to the requirements of Specification F593 and shall be of the same alloy group.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
A342/A342M Test Methods for Permeability of Feebly Magnetic Materials
A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
A493 Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
A555/A555M Specification for General Requirements for Stainless Steel Wire and Wire Rods
A564/A564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
A582/A582M Specification for Free-Machining Stainless Steel Bars
A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
D3951 Practice for Commercial Packaging
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
F593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
E1470 Test Method for Characterization of Proteins by Electrophoretic Mobility

2.2 *ASME Standards:*[3]

B1.1 Unified Inch Screw Threads
B18.2.2 Square and Hex Nuts

NOTE 1—The following ASTM standards are noted for information only as suitable sources of material for the manufacture of nuts to this

[1] This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.04 on Nonferrous Fasteners.

Current edition approved Nov. 1, 2009. Published January 2010. Originally approved in 1978. Last previous edition approved in 2008 as F594 – 08. DOI: 10.1520/F0594-09.

[2] 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.

[3] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, http://www.global.ihs.com..

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

specification:

Specifications A493, A564/A564M, and A582/A582M.

3. Ordering Information

3.1 Orders for nuts under this specification shall include the following:

3.1.1 Quantity (number of pieces of each item and size),

3.1.2 Name of item,

3.1.3 Size (diameter and threads per inch),

3.1.4 Alloy group number (see 6.2.1), and

3.1.5 Condition (see 4.2).

3.1.6 Orders for nuts under this specification may include the following optional requirements:

3.1.6.1 Forming (see 4.1.1),

3.1.6.2 Composition (see 6.2),

3.1.6.3 Corrosion resistance (see 8.1),

3.1.6.4 Thread class (see 9.2),

3.1.6.5 Finish (see 10.3),

3.1.6.6 Test report (see 17.2),

3.1.6.7 Rejection (see 16.1),

3.1.6.8 Test rejection (see 16.1), and

3.1.6.9 Special packaging (see 19.2).

3.1.7 Supplementary requirements, if any, to be specified on the order (see S1 through S8), and

3.1.8 ASTM specification and date of issue. When date of issue is not specified, fasteners shall be furnished to the latest issue.

NOTE 2—*Example:* 10 000 pieces, Hex Nut, 0.250 in. –20, Alloy Group 1, Condition CW, Furnish Test Report, Supplementary Requirement S3.

4. Manufacture

4.1 *Manufacture*:

4.1.1 *Forming*—Unless otherwise specified, the nuts shall be hot formed, cold formed, or machined from suitable material, at the option of the manufacturer.

4.2 *Condition*—The fasteners shall be furnished in the following conditions, unless specified to be furnished in one of the optional conditions:

Alloy Group	Condition Furnished Unless Otherwise Specified	Optional Conditions (must be specified)
1, 2, 3	CW	AF, A, SH
4	CW	A
5	H	HT
6	H	HT
7	AH	none

A— Machined from annealed or solution annealed stock thus retaining the properties of the original material; or hot formed and solution annealed.
AF— Annealed after all threading is completed.
AH— Solution annealed and age hardened after forming.
CW— Annealed and cold worked. Sizes 0.75 in. and larger may be hot worked and solution annealed.
H— Hardened and tempered at 1050°F (565°C) minimum.
HT— Hardened and tempered at 525°F (274°C) minimum.
SH— Machined from strain hardened stock.

5. Heat Treatment

5.1 *Alloy Groups 1, 2, and 3 (Austenitic Alloys 303, 303Se, 304, 304L, 305, 316, 316L, 321, 347, 384, XM1, 18–9LW, and 302HQ)* :

5.1.1 *Condition A*—When Condition A is specified, the austenitic alloys shall be heated to 1900 ± 50°F (1038 ± 28°C), at which time the chromium carbide will go into the solution, be held for a sufficient time, and then be cooled at a rate sufficient to prevent precipitation of the carbide and to provide the specified properties.

5.1.2 *Condition CW*—When Condition CW is specified, the austenitic alloys shall be annealed as specified in 5.1.1 and then cold worked to develop the specified properties.

5.1.3 *Condition AF*—When Condition AF is specified, the austenitic alloys shall be annealed as specified in 5.1.1 after all cold working, including forming and threading.

5.2 *Alloy Group 4 (Ferritic Alloys 430 and 430F)*:

5.2.1 *Condition A*—The ferritic alloys shall be heated to a temperature of 1450 ± 50°F (788 ± 28°C), held for an appropriate time, and then air cooled to provide the specified properties.

5.2.2 *Condition CW*—When Condition CW is specified, the ferritic alloys shall be annealed in accordance with 5.2.1, generally by the raw material manufacturer, and then cold worked to develop the specified properties.

5.3 *Alloy Group 5 (Martensitic Alloys 410, 416, and 416Se)*:

5.3.1 *Condition H*—When Condition H is specified, the martensitic alloys 410, 416, and 416Se shall be hardened and tempered by heating to 1850 ± 50°F (1010 ± 28°C) sufficient for austenitization, held for at least ½ h and rapid air- or oil-quenched, then reheating to 1050°F (565°C) minimum for at least 1 h and air cooled to provide the specified properties.

5.3.2 *Condition HT*—When Condition HT is specified, the martensitic alloys 410, 416, and 416Se shall be hardened and tempered by heating to 1850 ± 50°F (1010 ± 28°C) sufficient for austenitization, held for at least ½ h and rapid air- or oil-quenched, then reheating to 525°F (274°C) minimum for at least 1 h and air cooled to provide the specified properties.

5.4 *Alloy Group 6 (Martensitic Alloy 431)*:

5.4.1 *Conditions H and HT*—The martensitic alloy 431 shall be hardened and tempered as specified in 5.3.1 and 5.3.2 as applicable.

5.5 *Alloy Group 7 (Precipitation Hardening Alloy 630)*:

5.5.1 *Condition AH*—The precipitation hardening alloy 630 shall be solution annealed and aged by heating to 1900 ± 25°F (1038 ± 14°C) for at least ½ h and rapid air or oil quenched to 80°F (27°C) maximum, then reheating to a temperature of 1150 ± 15°F (621 ± 8°C) for 4 h and air cooled to provide the specified properties.

6. Chemical Composition

6.1 *Alloy Groups*—It is the intent of this specification that fasteners shall be ordered by alloy group numbers that include alloys considered to be chemically equivalent for general purpose use. The alloy groupings are as shown below. When required, however, a specific alloy may be specified as permitted by 6.2.2.

Alloy Group	Alloys
1	304, 305, 304L
	384, 18–9LW, 302HQ[A]
2	316, 316L

3	321, 347
4	430[B]
5	410[C]
6	431
7	630

[A] When approved by the purchaser, alloys 303, 303Se, or XM1 may be furnished.

[B] When approved by the purchaser, alloy 430F may be furnished.

[C] When approved by the purchaser, alloys 416 or 416Se may be furnished.

6.2 *Chemical Composition Limits*:

6.2.1 *Ordering by Alloy Group*—Unless otherwise specified on the inquiry and order (see Supplementary Requirement S4), the choice of an alloy from within a group shall be at the discretion of the fastener manufacturer as required by his method of fastener fabrication and material availability. The specific alloy used by the fastener manufacturer shall be clearly identified on any certification required by the order and shall have a chemical composition conforming to the requirements of Table 1 for the specific alloy.

6.2.2 *Ordering by Specific Alloy*—When ordered by a specific alloy number, the fasteners shall conform to the chemical composition limits of Table 1 for the specific alloy.

6.3 *Product Analysis*:

6.3.1 Product analysis may be made by the purchaser from finished nuts representing each lot. The chemical composition thus determined shall conform to the requirements of Table 1

TABLE 1 Chemical Requirements

Alloy Group	UNS Designation	Alloy	Composition, % maximum except as shown									
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Copper	Molybdenum	Others
						Austenitic Alloys						
1	S30300	303	0.15	2.00	0.20	0.15 min	1.00	17.0 to 19.0	8.0 to 10.0	. . .	0.60 max[A]	. . .
1	S30323	303Se	0.15	2.00	0.20	0.060	1.00	17.0 to 19.0	8.0 to 10.0	. . .	. . .	Se 0.15 min
1	S30400	304	0.08	2.00	0.045	0.030	1.00	18.0 to 20.0	8.0 to 10.5	1.00	. . .	. . .
1	S30403	304L	0.03	2.00	0.045	0.030	1.00	18.0 to 20.0	8.0 to 12.0	1.00	. . .	. . .
1	S30500	305	0.12	2.00	0.045	0.030	1.00	17.0 to 19.0	10.5 to 13.0	1.00	. . .	. . .
1	S38400	384	0.08	2.00	0.045	0.030	1.00	15.0 to 17.0	17.0 to 19.0	. . .	. . .	. . .
1	S20300	XM1	0.08	5.0 to 6.5	0.040	0.18 to 0.35	1.00	16.0 to 18.0	5.0 to 6.5	1.75 to 2.25	0.50 max[A]	. . .
1	S30430	18–9LW	0.10	2.00	0.045	0.030	1.00	17.0 to 19.0	8.0 to 10.0	3.0 to 4.0	. . .	. . .
1	S30433	302HQ	0.03	2.00	0.045	0.030	1.00	17.0 to 19.0	8.0 to 10.0	3.0 to 4.0	. . .	. . .
2	S31603	316L	0.03	2.00	0.045	0.030	1.00	16.0 to 18.0	10.0 to 14.0	. . .	2.00–3.00†	. . .
2	S31600	316	0.08	2.00	0.045	0.030	1.00	16.0 to 18.0	10.0 to 14.0	. . .	2.00–3.00	. . .
3	S32100	321	0.08	2.00	0.045	0.030	1.00	17.0 to 19.0	9.0 to 12.0	. . .	. . .	Ti 5 × C min
3	S34700	347	0.08	2.00	0.045	0.030	1.00	17.0 to 19.0	9.0 to 13.0	. . .	. . .	Cb + Ta 10 × C min
						Ferritic Alloys						
4	S43000	430	0.12	1.00	0.040	0.030	1.00	16.0 to 18.0	. . .	. . .		. . .
	S43020	430F	0.12	1.25	0.060	0.15 min	1.00	16.0 to 18.0			0.60 max[A]	
						Martensitic Alloys						
5	S41000	410	0.15	1.00	0.040	0.030	1.00	11.5 to 13.5	. . .	. . .	. . .	. . .
5	S41600	416	0.15	1.25	0.060	0.15 min	1.00	12.0 to 14.0	. . .	. . .	0.60 max[A]	. . .
5	S41623	416Se	0.15	1.25	0.060	0.060	1.00	12.0 to 14.0	. . .	. . .	. . .	Se 0.15 min
6	S43100	431	0.20	1.00	0.040	0.030	1.00	15.0 to 17.0	1.25 to 2.50	. . .	. . .	. . .
						Precipitation Hardening Alloy						
7	S17400	630	0.07	1.00	0.040	0.030	1.00	15.0 to 17.5	3.0 to 5.0	3.0 to 5.0	. . .	Cb + Ta 0.15–0.45

[A] At manufacturer's option, determined only when intentionally added.

†Editorially corrected.

for the specific alloy subject to the Product Analysis Tolerance in Specification A555/A555M.

6.3.2 In the event of discrepancy, a referee chemical analysis of samples from each lot shall be made in accordance with 14.1.

7. Mechanical Properties

7.1 The finished fasteners shall meet the applicable mechanical properties of Table 2 for the specified alloy group and condition when tested in accordance with the mechanical property requirements as specified herein (see also Table 3).

TABLE 3 Mechanical Test Requirements on Nuts

Product	Proof Stress, psi	Tests Conducted using Full Size Product	
		Hardness	Proof Load
Jam, slotted, castle nuts	all	A	B
All other nuts	up to 120 000	A	A
	Over 120 000	option A[A]	option B

[A] Denotes mandatory tests; where options are given, all the tests under an option shall be performed. Option B tests should be made whenever feasible. Option B is the referee test in case of arbitration.
[B] Tests that are not mandatory.

TABLE 2 Mechanical Property Requirements[A]

Stainless Alloy Group	Condition[B]	Alloy Mechanical Property Marking	Nominal Diameter, in.	Proof Stress, Hex Nuts ksi, min	Proof Stress, Heavy Hex Nuts ksi, min[C]	Rockwell Hardness
			Austenitic Alloys			
1 (303, 304, 304L 305, 384, XM1, 18–9LW, 302HQ, 303Se)	AF	F594A	¼ to 1½ , incl	70	76	B85 max
	A	F594B	¼ to 1½ , incl	75	81	B65 to 95, incl
	CW1	F594C	¼ to ⅝ , incl	100	108	B95 to C35, incl
	CW2	F594D	¾ to 1½ , incl	85	92	B80 to C35, incl
	SH1	F594A	¼ to ⅝ , incl	120	130	C24 to C36, incl
	SH2	F594B	¾ to 1, incl	110	119	C20 to C32, incl
	SH3	F594C	1⅛ to 1¼ , incl	100	108	B95 to C30, incl
	SH4	F594D	1⅜ to 1½ , incl	85	92	B90 to C28, incl
2 (316) 316L	AF	F594E	¼ to 1½ , incl	70	76	B85 max
	A	F594F	¼ to 1½ , incl	75	81	B65 to 95, incl
	CW1	F594G	¼ to ⅝ , incl	100	108	B95 to C35, incl
	CW2	F594H	¾ to 1½ , incl	85	92	B80 to C35, incl
	SH1	F594E	¼ to ⅝ , incl	120	130	C24 to C36, incl
	SH2	F594F	¾ to 1, incl	110	119	C20 to C32, incl
	SH3	F594G	1⅛ to 1¼ , incl	100	108	B95 to C30, incl
	SH4	F594H	1⅜ to 1½ , incl	85	92	B90 to C28, incl
3 (321, 347)	AF	F594J	¼ to 1½ , incl	70	76	B85 max
	A	F594K	¼ to 1½ , incl	75	81	B65 to 95, incl
	CW1	F594L	¼ to ⅝ , incl	100	108	B95 to C35, incl
	CW2	F594M	¾ to 1½ , incl	85	92	B80 to C35, incl
	SH1	F594J	¼ to ⅝ , incl	120	130	C24 to C36, incl
	SH2	F594K	¾ to 1, incl	110	119	C20 to C32, incl
	SH3	F594L	1⅛ to 1¼ , incl	100	108	B95 to C30, incl
	SH4	F594M	1⅜ to 1½ , incl	85	92	B90 to C28, incl
			Ferritic Alloys			
4 (430, 430F)	A	F594N	¼ to 1½ , incl	55	59	85 max
	CW1	F594V	¼ to ⅝ , incl	60	65	B75 to 98, incl
	CW2	F594W	¾ to 1½ , incl	55	59	B65 to 95, incl
			Martensitic Alloys			
5 (410, 416, 416Se)	H	F594P	¼ to 1½ , incl	100	108	C20 to 30, incl
	HT	F594R	¼ to 1½ , incl	160	173	C34 to 45, incl
6 (431)	H	F594S	¼ to 1½ , incl	125	135	C25 to 32, incl
	HT	F594T	¼ to 1½ , incl	180	194	C40 to 48, incl
			Precipitation Hardening Alloys			
7 (630)	AH	F594U	¼ to 1½ , incl	135	146	C28 to 38, incl

[A] Minimum values except where shown as maximum or as a range.
[B] Legend of conditions:
A—Machined from annealed or solution annealed stock thus retaining the properties of the original stock; or hot formed and solution annealed.
AF—Annealed after all threading is completed.
AH—Solution annealed and age hardened after forming.
CW—Annealed and cold worked. Sizes 0.75 in. and larger may be hot worked and solution annealed.
H—Hardened and tempered at 1050°F (566°C) min.
HT—Hardened and tempered at 525°F (274°C) min.
SH—Machined from strain hardened stock.
[C] Proof stress values for heavy hex nuts are based on 1.08 times the value for corresponding hex nuts.