Designation: F 468 – 03

Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use[1]

This standard is issued under the fixed designation F 468; 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 commercial wrought nonferrous bolts, hex cap screws, and studs 0.250 to 1.500 in. inclusive in diameter manufactured from a number of alloys in common use and intended for general service applications.

1.2 Applicable nuts for use with bolts, cap screws, and studs covered by this specification are covered by Specification F 467.

NOTE 1—A complete metric companion to Specification F 468 has been developed—F 468M; therefore no metric equivalents are presented in this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

B 154 Test Method for Mercurous Nitrate Test for Copper and Copper Alloys[2]

B 193 Test Method for Resistivity of Electrical Conductor Materials[3]

B 211 Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire[4]

B 446 Specification for Nickel-Chromium-Molybdenum-Columbium-Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and Bar[5]

B 565 Test Method for Shear Testing of Aluminum and Aluminum-Alloy Rivets and Cold-Heading Wire and Rods[4]

D 3951 Practice for Commercial Packaging[6]

E 8 Test Methods for Tension Testing of Metallic Materials[7]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[7]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[8]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys[9]

E 38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys[10]

E 53 Test Methods for Determination of Copper in Unalloyed Copper by Gravimetry[9]

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes[11]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[9]

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)[9]

E 75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys[9]

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys[9]

E 92 Test Method for Vickers Hardness of Metallic Materials[7]

E 101 Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[12]

E 120 Test Methods for Chemical Analysis of Titanium and Titanium Alloys[9]

E 165 Practice for Liquid Penetrant Examination[13]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[11]

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys[9]

E 478 Test Methods for Chemical Analysis of Copper Alloys[9]

[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 May 10, 2003. Published June 2003. Originally approved in 1976. Last previous edition approved in 2001 as F 468 – 01a.

[2] *Annual Book of ASTM Standards,* Vol 02.01.

[3] *Annual Book of ASTM Standards,* Vol 02.03.

[4] *Annual Book of ASTM Standards,* Vol 02.02.

[5] *Annual Book of ASTM Standards,* Vol 02.04.

[6] *Annual Book of ASTM Standards,* Vol 15.09.

[7] *Annual Book of ASTM Standards,* Vol 03.01.

[8] *Annual Book of ASTM Standards,* Vol 14.02.

[9] *Annual Book of ASTM Standards,* Vol 03.05.

[10] Discontinued; see *1988 Annual Book of ASTM Standards,* Vol 03.05.

[11] Discontinued; see *2001 Annual Book of ASTM Standards,* Vol 03.05.

[12] Discontinued; see *1995 Annual Book of ASTM Standards,* Vol 03.05.

[13] *Annual Book of ASTM Standards,* Vol 03.03.

E 1409 Test Method for Determination of Oxygen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique[9]
F 467 Specification for Nonferrous Nuts for General Use[14]
F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets[14]
F 1470 Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection[14]
2.2 *ASME Standards:*
ASME B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)[15]
ASME B18.2.1 Square and Hex Bolts and Screws, Including Hex Cap Screws[15]
ASME H35.1 Alloy and Temper Designation Systems for Aluminum[15]

3. Ordering Information

3.1 Orders for fasteners under this specification shall include the following information:
3.1.1 Quantity (number of pieces of each item and size),
3.1.2 Name of item. For silicon bronze alloy 651, state if hex cap screw dimensions or roll thread body diameter are required (see 7.1.2);
3.1.3 Size (diameter, threads per inch, length);
3.1.4 Alloy number (Table 1). For Ti5, state Class A or Class B (Table 1, 6.5, and 6.5.1);
3.1.5 Stress relieving, if required (see 4.2.3);
3.1.6 Shipment lot testing, as required (see Section 10);
3.1.7 Source inspection, if required (see Section 14);
3.1.8 Certificate of compliance or test report, if required (see Section 16);
3.1.9 Additional requirements, if any, to be specified on the purchase order (see 4.2.1, 4.2.4, 7.3.1, 8.2, 11.1, and 12.1);
3.1.10 Supplementary Requirements, if any; and
3.1.11 ASTM designation and date of issue.

NOTE 2— *Example*
10 000 pieces, Hex Cap Screw, 0.250 in.-20 × 3.00 in., Alloy 270. Furnish Certificate of Compliance, Supplementary Requirement S1, ASTM F 468-XX.

4. Materials and Manufacture

4.1 *Materials*:
4.1.1 The bolts, cap screws, and studs shall be manufactured from material having a chemical composition conforming to the requirements in Table 1 and capable of developing the required mechanical properties for the specified alloy in the finished fastener.

[14] *Annual Book of ASTM Standards*, Vol 01.08.
[15] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112

4.1.2 The starting condition of the raw material shall be at the discretion of the fastener manufacturer but shall be such that the finished products conform to all of the specified requirements.
4.2 *Manufacture*:
4.2.1 *Forming*—Unless otherwise specified, the fasteners shall be cold formed, hot formed, or machined from suitable material, at the option of the manufacturer.
4.2.2 *Condition*—Except as provided in 4.2.3, the fasteners shall be furnished in the following conditions:

Alloy	Condition
Copper (all alloys)	As formed or stress relieved at manufacturer's option
Nickel alloys:	
400 and 405	As formed or stress relieved at manufacturer's option
500	Solution annealed and aged
625	Annealed
Aluminum alloys:	
2024-T4	Solution treated and naturally aged
6061-T6	Solution treated and artificially aged
7075-T73	Solution treated and stabilized
Titanium	As formed

4.2.3 *Stress Relieving*—When required, stress relieving shall be specified by the purchaser for nickel alloys 400 and 405 and all copper alloys.
4.2.4 *Threads*—Unless otherwise specified, the threads shall be rolled or cut at the option of the manufacturer.

5. Chemical Composition

5.1 *Chemical Composition*—The fasteners shall conform to the requirements as to chemical composition prescribed in Table 1 for the specified alloy.
5.2 *Manufacturer's Analysis*:
5.2.1 When test reports are required on the inquiry or purchase order (see 3.1.8), the manufacturer shall make individual analyses of randomly selected finished fasteners from the product to be shipped and report the results to the purchaser, except as provided in 5.2.2. Alternatively, if heat and lot identities have been maintained, the analysis of the raw material from which the fasteners have been manufactured may be reported instead of product analysis.
5.2.2 For aluminum fasteners, the manufacturer may furnish instead a certificate of conformance certifying compliance with the chemical composition specified in Table 1.
5.3 *Product Analysis*:
5.3.1 Product analyses may be made by the purchaser from finished products representing each lot. The chemical composition thus determined shall conform to the requirements in Table 1.
5.3.2 In the event of disagreement, a referee chemical analysis of samples from each lot shall be made in accordance with 11.1 and 12.1.

TABLE 1 Chemical Requirements

UNS Designation Number	Composition, %												
	Copper and Copper-Base Alloys												
	Alloy	General Name	Aluminum	Copper, min	Iron, max	Manganese, max	Nickel, max	Phosphorus	Silicon	Zinc, max[A]	Lead, max	Tin	Arsenic, max
C11000	110	ETP copper		99.9									
C27000	270	brass		63.0–68.5	0.07					balance	0.10		
C46200	462	naval brass		62.0–65.0	0.10					balance	0.20	0.5–1.0	
C46400	464	naval brass		59.0–62.0	0.10					balance	0.20	0.5–1.0	
C51000	510	phosphor bronze		balance[A]	0.10			0.03–0.35		0.30	0.05	4.2–5.8	
C61300	613	aluminum bronze	6.0–7.5	[B]	2.0–3.0	0.10	0.15[C]	0.015	0.10	0.05	0.01	0.20–0.50	
C61400	614	aluminum bronze	6.0–8.0	88.0[D]	1.5–3.5	1.0							
C63000	630	aluminum bronze	9.0–11.0	78.0[D]	2.0–4.0	1.5	4.0–5.5		0.25 max			0.20 max	
C64200	642	aluminum silicon bronze	6.3–7.6	88.65[D]	0.30	0.10	0.25		1.5–2.2[E]	0.50	0.05	0.20 max	0.15
C65100	651	silicon bronze		96.0[D]	0.8	0.7			0.8–2.0	1.5	0.05		
C65500	655	silicon bronze		94.8[D]	0.8	1.5	0.6		2.8–3.8	1.5	0.05		
C66100	661	silicon bronze	0.25 max	94.0[D]	0.25	1.5			2.8–3.5	1.5	0.20–0.8		
C67500	675	manganese bronze		57.0–60.0	0.8–2.0	0.05–0.5				balance	0.20	0.5–1.5	
C71000	710	cupro-nickel		74.0[D]	0.60	1.00	19.0–23.0[C]			1.00	0.05		
C71500	715	cupro-nickel		65.0[D]	0.40–0.7	1.00	29.0–33.0[C]			1.00	0.05		

[A] Elements shown as balance shall be arithmetically computed by deducting the sum of the other named elements from 100.
[B] Copper plus specified elements = 99.8 min; copper plus silver = 88.5–91.5.
[C] Cobalt is to be counted as nickel.
[D] Minimum content of copper plus all other elements with specified limits shall be 99.5 %.
[E] An alloy containing as high as 2.6 % silicon is acceptable provided the sum of all the elements other than copper, silicon, and iron does not exceed 0.30 %.

TABLE 1 *Continued*

UNS Designation Number	Alloy	General Name	Aluminum	Carbon, max	Chromium	Copper[A]	Iron, max	Manganese, max	Nickel[A]	Phosphorus, max	Silicon, max	Titanium	Cobalt, max	Molybdenum	Sulfur, max	Vanadium	Tungsten
Nickel and Nickel-Base Alloys																	
N10001	335	Ni-Mo		0.05	1.0 max		4.0–6.0	1.0	balance	0.025	1.00		2.50	26.0–30.0	0.030	0.2–0.4	
N10276	276	Ni-Mo-Cr		0.02	14.5–16.5		4.0–7.0	1.00	balance	0.040	0.08		2.50	15.0–17.0	0.030	0.35 max	3.0–4.5
N04400	400	Ni-Cu Class A		0.3		balance	2.5	2.0	63.0–70.0		0.5		[B]		0.024		
N04405	405	Ni-Cu Class B		0.3		balance	2.5	2.0	63.0–70.0		0.5		[B]		0.025–0.060		
N05500	500	Ni-Cu-Al	2.30–3.15	0.25		balance	2.0	1.5	63.0–70.0		0.5	0.35–0.85	[B]		0.01		
N06625	625[C]	Ni-Cr-Mo-Cb	0.40 max	0.010	20.0–23.0		5.0 max	0.50	58.0 min	0.015	0.50 max	0.40 max	1.00 max	8.0–10.0	0.015		3.2–4.2
N06686	686	Ni-Cr-Mo-W		0.010 max	19.0–23.0		5.0 max	0.75 max	balance	0.04 max	0.08 max	0.02–0.25		15.0–17.0	0.02 max		3.0–4.4

[A] Elements shown as balance shall be arithmetically computed by deducting the sum of the other named elements from 100.
[B] Cobalt is to be counted as nickel.
[C] Alloy 625 material shall be refined using the electroslag remelting process (ESR), or the vacuum arc remelting process (VAR).

TABLE 1 *Continued*

UNS Designation Number	Alloy	General Name	Aluminum[B]	Chromium	Copper	Iron, max	Manganese, max	Silicon, max	Titanium, max	Zinc, max	Magnesium	Other Elements, max	
												Each	Total
Composition, % — Aluminum-Base Alloys[A]													
A92024	2024	Aluminum 2024	balance	0.10 max	3.8–4.9	0.50	0.30–0.9	0.50	0.15[C]	0.25	1.2–1.8	0.05	0.15
A96061	6061	Aluminum 6061	balance	0.04–0.35	0.15–0.40	0.7	0.15	0.40–0.8	0.15	0.25	0.8–1.2	0.05	0.15
A97075	7075	Aluminum 7075	balance	0.18–0.35	1.2–2.0	0.50	0.30	0.40	0.20[D]	5.1–6.1	2.1–2.9	0.05	0.15

[A] Analysis shall regularly be made only for the elements specified in this table. If, however, the presence of other elements is suspected or indicated in amounts greater than the specified limits, further analysis shall be made to determine that these elements are not present in excess of the specified limits.
[B] Elements shown as balance shall be arithmetically computed by deducting the sum of the other named elements from 100.
[C] Titanium + zirconium 0.20 %, max.
[D] Titanium + zirconium 0.25 %, max.

TABLE 1 *Continued*

Titanium and Titanium-Base Alloys[A]

UNS Designation Number	Alloy	General Name	Aluminum, Al	Carbon, C	Iron, Fe	Titanium, Ti	Hydrogen, H	Nitrogen, N	Oxygen, O	Palladium, Pd	Vanadium, V	Chromium, Cr	Molybdenum, Mo	Zirconium, Zr	Tin, Sn	Silicon, Si	Ruthenium, Ru	Residuals[B] each, max	Residuals[B] total, max
R50250	1	Titanium Gr 1		0.10	0.20	balance	0.0125	0.05	0.18									0.1	0.4
R50400	2	Titanium Gr 2		0.10	0.30	balance	0.0125	0.05	0.25									0.1	0.4
R50700	4	Titanium Gr 4		0.10	0.50	balance	0.0125	0.07	0.40									0.1	0.4
R56400	5[C]	Titanium Gr 5[C]	5.5–6.75	0.10	0.40	balance	0.0125	0.05	0.20		3.5–4.5							0.1	0.4
R56401	23	Titanium Ti-6Al-4V ELI	5.5–6.5	0.08	0.25	balance	0.0125	0.05	0.13		3.5–4.5							0.1	0.4
R52400	7	Titanium Gr 7		0.10	0.30	balance	0.0125	0.05	0.25	0.12–0.25								0.1	0.4
R58640	19	Titanium Ti-38-6-44	3.0–4.0	0.05	0.30	balance	0.0200	0.03	0.12	0.10[D]	7.5–8.5	5.5–6.5	3.5–4.5	3.5–4.5			0.10[D]	0.15	0.4
R55111	32	Titanium Ti-5-1-1-1	4.5–5.5	0.08	0.25	balance	0.0125	0.03	0.11		0.6–1.4		0.6–1.2	0.6–1.4	0.6–1.40	06–0.14		0.1	0.4

[A] All reported values are maximums, unless a range is specified.

[B] A residual is an element present in a metal or an alloy in small quantities inherent to the manufacturing process but not added intentionally. Residual elements need not be reported unless a report is specifically required by the purchaser.

[C] Identical chemical requirements apply to both Class A and B as defined in Table 2 and 6.5.

[D] Ruthenium and palladium, or both, may be added to Grade 19 for enhanced corrosion resistance as negotiated between purchaser and vendor. Chemical analysis is not required unless specifically required by the purchaser.