Designation: ~~F468 – 10~~ F468 – 12

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

This standard is issued under the fixed designation F468; 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. and socket head cap screws (including socket head cap, button head and flat countersunk head configurations) with nominal thread 0.06 (size 0) through 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 F467.

NOTE 1—A complete metric companion to Specification F468 has been developed—F468M; therefore no metric equivalents are presented in this specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B154 Test Method for Mercurous Nitrate Test for Copper Alloys
B193 Test Method for Resistivity of Electrical Conductor Materials
B211 Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
B565 Test Method for Shear Testing of Aluminum and Aluminum-Alloy Rivets and Cold-Heading Wire and Rods
B574 Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Molybdenum-Chromium, Low-Carbon Nickel-Molybdenum-Chromium-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod
D3951 Practice for Commercial Packaging
~~E8~~E8/E8M Test Methods for Tension Testing of Metallic Materials
E18 Test Methods for Rockwell Hardness of Metallic Materials
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys
E38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys (Withdrawn 1989)[3]
E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry
E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[3]
E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition
E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]
E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)[3]
E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)[3]
E92 Test Method for Vickers Hardness of Metallic Materials (Withdrawn 2010)[3]
E101 Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique (Withdrawn 1996)[3]
E120 Test Methods for Chemical Analysis of Titanium and Titanium Alloys (Withdrawn 2003)[3]
E165 Practice for Liquid Penetrant Examination for General Industry

[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.
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[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] The last approved version of this historical standard is referenced on www.astm.org.

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

E227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique (Withdrawn 2002)[3]
E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
E478 Test Methods for Chemical Analysis of Copper Alloys
E1409 Test Method for Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
F467 Specification for Nonferrous Nuts for General Use
F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
F788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series
F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

2.2 *ASME Standards:*[4]
ASME B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.3 Screw Thread Gaging System for Dimensional Acceptability – Inch Screw Threads (IN, UNR, and UNJ)
ASME B18.2.1 Square and Hex Bolts and Screws, Including Hex Cap Screws
ASME B18.3 Socket Head Cap, Shoulder, and Set Screws – Inch Series
ASME H35.1 Alloy and Temper Designation Systems for Aluminum

2.3 *Federal Specifications:*
QQ-N-286 Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)

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,~~ (nominal diameter, threads per inch, thread pitch, thread class, and 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 Source inspection, if required (see Section 13);
3.1.7 Certificate of compliance, conformance, or test reports, if required (see Section 15);
3.1.8 Additional requirements, if any, to be specified on the purchase order (see 4.2.1, 4.2.4, 7.3.1, 8.2, 10.1, and 11.1);
3.1.9 Supplementary Requirements, if any; and
3.1.10 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, socket head cap screws and studs shall be manufactured from material having a chemical composition conforming to the requirements in Table 1, except as provided in Supplementary Requirement S5, and capable of developing the required mechanical properties for the specified alloy in the finished fastener. See Specification B574 for nickel alloys.
4.1.2 The starting condition of the raw material shall be at the discretion of the fastener manufacturer except as provided in Supplementary Requirement S5, 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, ~~and~~ Supplementary Requirement S5, 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:	

[4] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704.

TABLE 1 Chemical Requirements

UNS Designation Number	Composition, %												
	Copper and Copper-Base Alloys												
	Alloy	General Name	~~Alumi-~~ Aluminum ~~num~~	Copper, min	Iron, max	~~Man-~~ Manganese, ~~ganese,~~ max	Nickel, max	~~Phos-~~ Phosphorus ~~phorus~~	Silicon	Zinc, max[A]	Lead, max	Tin	Arsenic, max
C11000	110	ETP copper	. . .	99.9	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
C26000	260	brass	. . .	68.5–71.5	0.05	. . .	. . .	. . .	. . .	balance	0.07	. . .	. . .
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~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~
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~~	~~. . .~~
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*

Nickel and Nickel-Base Alloys

UNS Designation Designation Number	Alloy	General Name	Aluminum Aluminum, max	Carbon Carbon, max	Chromium Chromium	Copper[A]	Iron, max	Manganese Manganese, max	Nickel[A]	Phosphorus Phosphorus, max	Silicon Silicon, max	Titanium Titanium	Cobalt Cobalt, max	Molybdenum Molybdenum	Sulfur, max	Vanadium Vanadium	Tungsten Tungsten	Niobium[†]
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	...	...
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	...
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[B]	...	0.5	...	[B]	...	0.024	...	...	...
N04400	400	Ni-Cu Class A	...	0.3	...	balance	2.5	2.0	63.0–70.0[B]	...	0.5	...	[B]	...	0.024	...	...	...
N04405	405	Ni-Cu Class B	...	0.3	...	balance	2.5	2.0	63.0–70.0[B]	...	0.5	...	[B]	...	0.025–0.060	...	...	...
N04405	405	Ni-Cu Class B	...	0.3	...	balance	2.5	2.0	63.0–70.0[B]	...	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[B]	...	0.5	0.35–0.85	[B]	...	0.01	...	...	...
N05500	500	Ni-Cu-Al	2.30–3.15	0.25	...	balance	2.0	1.5	63.0–70.0[B]	...	0.5	0.35–0.85	[B]	...	0.01	...	...	...
N06059	59	Ni-Cr-Mo	0.1–0.4	0.010 max	22.0–24.0	0.5 max	1.5 max	0.5 max	balance	0.015 max	0.10 max	...	0.3 max	15.0–16.5	0.010 max	...	...	...
N06059	59	Ni-Cr-Mo	0.1–0.4	0.010 max	22.0–24.0	0.5 max	1.5 max	0.5 max	balance	0.015 max	0.10 max	..	0.3 max	15.0–16.5	0.010 max	...	...	...
N06625	625[C]	Ni-Cr-Mo-Cb	0.40 max	0.10[†]	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
N06625	625[C]	Ni-Cr-Mo-Cb	0.40 max	0.10[†]	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	...
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).
[†] Editorially corrected in January 2008.

TABLE 1 *Continued*

Composition, %													
Aluminum-Base Alloys[A]													
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
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	~~Alumi-~~ Aluminum, ~~num,~~ Al	~~Car-~~ Carbon, ~~bon,~~ C	Iron, Fe	~~Tita-~~ Titanium, ~~nium,~~ Ti	~~Hydro-~~ Hydrogen, ~~gen,~~ H	~~Nitro-~~ Nitrogen, ~~gen,~~ N	~~Oxy-~~ Oxygen, ~~gen,~~ O	~~Palla-~~ Palladium, ~~dium,~~ Pd	~~Vana-~~ Vanadium, ~~dium,~~ V	~~Chro-~~ Chromium, ~~mium,~~ Cr	~~Molyb-~~ Molybdenum, ~~denum,~~ Mo	~~Zirco-~~ Zirconium, ~~nium,~~ Zr	Tin, Sn	~~Sili~~Silicon, ~~con,~~ Si	~~Ruthe-~~ Ruthenium, ~~nium,~~ 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~~
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~~
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~~
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~~
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~~	~~0.6–1.4~~	~~0.06–0.14~~	~~. . .~~	~~0.1~~	~~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	0.6–1.4	0.06–0.14	. . .	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.