This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F468M – 06 (Reapproved 2018)

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

This standard is issued under the fixed designation F468M; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers the requirements for commercial wrought nonferrous bolts, hex cap screws, and studs in nominal thread diameters M6 to M36 inclusive manufactured from a number of alloys in common use and intended for general service applications.

1.2 Unless otherwise specified, nuts used on these bolts, cap screws, and studs shall conform to the requirements of Specification F467M. Nuts shall be of the same alloy group as the fastener on which they are used and shall have a specified minimum proof stress equal to or greater than the specified minimum tensile strength stress of the fastener on which they are used.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

NOTE 1—This specification is the metric companion of Specification F468.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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

B211M Specification for Aluminum and Aluminum-Alloy Rolled or Cold-Finished Bar, Rod, and Wire (Metric)

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

E8M Test Methods for Tension Testing of Metallic Materials [Metric] (Withdrawn 2008)[3]

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 (Withdrawn 2017)[3]

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 Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

[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

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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
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 Inert Gas Fusion
F467M Specification for Nonferrous Nuts for General Use (Metric)
F606/F606M 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

2.2 *ASME Standards:*[4]
B 1.13M Metric Screw Threads
B 18.2.3.1M Metric Hex Cap Screws
B 18.2.3.5M Metric Hex Bolts
H 35.1 Alloy and Temper Designation Systems for Aluminum

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 Dimensions including nominal diameter, thread pitch, and length;
3.1.4 Alloy number (Table 1). For Ti5, state Class A or Class B (Table 2, 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 specification and year of issue.

NOTE 2—A typical ordering description is as follows: 10 000 pieces, Hex Cap Screw, M6 × 1 × 80, Alloy 270. Furnish Certificate of Compliance, Supplementary Requirement S1, ASTM F 468M-XX.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

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. 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 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.

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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	...	...	...	...	...	...	...	...	...
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	...	...	...	...	...	...	...
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	...	94.0[D]	0.25	1.5	...	...	2.8–3.5	1.5	0.20–0.8	...	...
C67500	675	manganese bronze	0.25 max	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 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	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	. . .	. . .
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	. . .	. . .	. . .
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
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).

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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	
Composition, %													
Aluminum-Base Alloys[A]													
												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] Lead 0.4–0.7 %; bismuth 0.4–0.7 %.

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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	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	0.6–1.4	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.

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