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**Designation: F 468M – 01**

**METRIC**

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

This standard is issued under the fixed designation F 468M; 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 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 F 467M. 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.

NOTE 1—This specification is the metric companion of Specification F 468.

## 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 211M Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire [Metric][4]

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[5]

E 8M Test Methods of Tension Testing of Metallic Materials [Metric][6]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[6]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[7]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys[8]

E 38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys[9]

E 53 Test Methods for Chemical Analysis of Copper[8]

E 54 Test Methods for Chemical Analysis of Special Brasses and Bronzes[8]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[8]

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)[8]

E 75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys[8]

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys[8]

E 92 Test Method for Vickers Hardness of Metallic Materials[6]

E 101 Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[10]

E 120 Test Methods for Chemical Analysis of Titanium and Titanium Alloys[8]

E 165 Test Method for Liquid Penetrant Examination[11]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[8]

[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] *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 15.09.

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

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

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

[9] Discontinued 1989;*Replaced by E 350.*

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

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

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E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys[8]

E 478 Test Methods for Chemical Analysis of Copper Alloys[8]

E 1409 Test Method for Determination of Oxygen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique[8]

F 467M Specification for Nonferrous Nuts for General Use [Metric][12]

F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets[12]

F 1470 Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection[12]

2.2 *ANSI Standards:*

B 1.13M Metric Screw Threads[13]

B 18.2.3.1M Metric Hex Cap Screws[13]

B 18.2.3.5M Metric Hex Bolts[13]

H 35.1 Alloy and Temper Designation Systems for Aluminum[13]

## 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 – _____ .

## 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.

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 |
| 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.

[12] *Annual Book of ASTM Standards,* Vol 01.08.

[13] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.



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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 | | | | | | | | | |
| 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 %.



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**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | |
| 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.



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