



Designation: F468 – 23

# Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use<sup>1</sup>

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 U.S. 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., 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. and low head socket cap screws with nominal thread 0.112 (size 4) through 0.625 (5/8) 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.

1.2.1 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

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

1.3 *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:<sup>2</sup>

**B154 Test Method for Mercurous Nitrate Test for Copper Alloys**

**B193 Test Method for Resistivity of Electrical Conductor Materials**

**B211/B211M 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 and Bar**

**D3951 Practice for Commercial Packaging**

**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 (Withdrawn 2017)<sup>3</sup>**

**E38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys (Withdrawn 1989)<sup>3</sup>**

**E53 Test Method for Determination of Copper in Unalloyed Copper by Gravimetry (Withdrawn 2022)<sup>3</sup>**

**E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)<sup>3</sup>**

**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)<sup>3</sup>**

**E75 Test Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys (Withdrawn 2010)<sup>3</sup>**

**E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys (Withdrawn 2003)<sup>3</sup>**

**E92 Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials**

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

- E101** Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique (Withdrawn 1996)<sup>3</sup>
- E120** Test Methods for Chemical Analysis of Titanium and Titanium Alloys (Withdrawn 2003)<sup>3</sup>
- E165/E165M** Practice for Liquid Penetrant Testing for General Industry
- E227** Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique (Withdrawn 2002)<sup>3</sup>
- 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
- F467** Specification for Nonferrous Nuts for General Use
- F606/F606M** 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, Studs, and Rivets, Inch and Metric Series
- F1470** Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

## 2.2 ASME Standards:<sup>4</sup>

- 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:<sup>5</sup>

- 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 (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);

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

<sup>5</sup> DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 <http://quicksearch.dla.mil/>

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 year 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 4.1.3 and Supplementary Requirement S5, but shall be such that the finished products conform to all of the specified requirements.

4.1.3 Alloy 625 material shall be refined using the electroslag remelting process (ESR), or the vacuum arc remelting process (VAR).

### 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:      |                                                       |
| 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.

4.2.4.1 Bolts, cap screws and studs shall be rolled or cut at the option of the manufacturer.

4.2.4.2 Socket head cap screws and flat countersunk head cap screws in sizes up to 1.00 in. inclusive and product lengths up to 6.00 in. inclusive shall have threads formed by rolling, except by special arrangement with the purchaser. Larger products may be rolled or cut at the option of the manufacturer.

**TABLE 1 Chemical Requirements**

| Composition, % maximum except as shown, ellipses indicate no requirement for listed element |       |                                  |          |                          |           |           |                     |            |                      |         |          |           |         |
|---------------------------------------------------------------------------------------------|-------|----------------------------------|----------|--------------------------|-----------|-----------|---------------------|------------|----------------------|---------|----------|-----------|---------|
| Copper and Copper-Base Alloys <sup>A</sup>                                                  |       |                                  |          |                          |           |           |                     |            |                      |         |          |           |         |
| UNS Designation Number                                                                      | Alloy | General Name                     | Aluminum | Copper                   | Iron      | Manganese | Nickel <sup>B</sup> | Phosphorus | Silicon              | Zinc    | Lead     | Tin       | Arsenic |
| C11000                                                                                      | 110   | ETP copper                       | ...      | 99.9 min <sup>C</sup>    | ...       | ...       | ...                 | ...        | ...                  | ...     | ...      | ...       | ...     |
| C26000                                                                                      | 260   | cartridge brass 70 %             | ...      | 68.5–71.5 <sup>D</sup>   | 0.05      | ...       | ...                 | ...        | ...                  | balance | 0.07     | ...       | ...     |
| C27000                                                                                      | 270   | yellow brass 65 %                | ...      | 63.0–68.5 <sup>D</sup>   | 0.07      | ...       | ...                 | ...        | ...                  | balance | 0.09     | ...       | ...     |
| C46200                                                                                      | 462   | naval brass 63 – 1/2 %           | ...      | 62.0–65.0 <sup>E</sup>   | 0.10      | ...       | ...                 | ...        | ...                  | balance | 0.20     | 0.5–1.0   | ...     |
| C46400                                                                                      | 464   | naval brass                      | ...      | 59.0–62.0 <sup>E</sup>   | 0.10      | ...       | ...                 | ...        | ...                  | balance | 0.20     | 0.5–1.0   | ...     |
| C51000                                                                                      | 510   | phosphor bronze 5 % <sup>A</sup> | ...      | balance <sup>F</sup>     | 0.10      | ...       | ...                 | 0.03–0.35  | ...                  | 0.30    | 0.05     | 4.2–5.8   | ...     |
| C61300                                                                                      | 613   | aluminum bronze                  | 6.0–7.5  | balance <sup>G</sup>     | 2.00–3.00 | 0.20      | 0.15                | 0.015      | 0.10                 | 0.10    | 0.01     | 0.20–0.50 | ...     |
| C61400                                                                                      | 614   | aluminum bronze <sup>D</sup>     | 6.0–8.0  | balance <sup>C,F</sup>   | 1.50–3.50 | 1.00      | ...                 | 0.015      | ...                  | 0.20    | 0.01     | ...       | ...     |
| C63000                                                                                      | 630   | aluminum bronze                  | 9.0–11.0 | balance <sup>C,F</sup>   | 2.00–4.00 | 1.50      | 4.0–5.5             | ...        | 0.25                 | 0.30    | ...      | 0.20      | ...     |
| C64200                                                                                      | 642   | aluminum bronze                  | 6.3–7.6  | balance <sup>C,F</sup>   | 0.30      | 0.10      | 0.25                | ...        | 1.5–2.2 <sup>H</sup> | 0.50    | 0.05     | 0.20      | 0.09    |
| C65100                                                                                      | 651   | silicon bronze low <sup>B</sup>  | ...      | balance <sup>C,F</sup>   | 0.80      | 0.70      | ...                 | ...        | 0.8–2.0              | 1.5     | 0.05     | ...       | ...     |
| C65500                                                                                      | 655   | silicon bronze high <sup>A</sup> | ...      | balance <sup>C,F</sup>   | 0.80      | 0.05–1.30 | 0.6                 | ...        | 2.8–3.8              | 1.5     | 0.05     | ...       | ...     |
| C66100                                                                                      | 661   | silicon bronze                   | ...      | balance <sup>C,F</sup>   | 0.25      | 1.50      | ...                 | ...        | 2.8–3.5              | 1.5     | 0.20–0.8 | ...       | ...     |
| C67500                                                                                      | 675   | manganese bronze <sup>A</sup>    | 0.25 max | 57.0–60.0 <sup>C,F</sup> | 0.80–2.0  | 0.05–0.50 | ...                 | ...        | ...                  | balance | 0.20     | 0.5–1.5   | ...     |
| C71000                                                                                      | 710   | copper-nickel 20 %               | ...      | balance <sup>C,F</sup>   | 1.0       | 1.00      | 19.0–23.0           | ...        | ...                  | 1.00    | 0.05     | ...       | ...     |
| C71500                                                                                      | 715   | copper-nickel 30 %               | ...      | balance <sup>C,F</sup>   | 0.40–1.0  | 1.00      | 29.0–33.0           | ...        | ...                  | 1.00    | 0.05     | ...       | ...     |

<sup>A</sup>Elements shown as balance shall be arithmetically computed by deducting the sum of the other named elements from 100.

<sup>B</sup>Cobalt is to be counted as nickel.

<sup>C</sup>Silver is to be counted as copper.

<sup>D</sup>Minimum content of copper plus all other elements with specified limits shall be 99.7 %.

<sup>E</sup>Minimum content of copper plus all other elements with specified limits shall be 99.6 %.

<sup>F</sup>Minimum content of copper plus all other elements with specified limits shall be 99.5 %.

<sup>G</sup>per UNS C61300: copper (including silver) plus specified elements = 99.8 min; this standard requires copper plus silver = 88.5–91.5

<sup>H</sup>This standard allows for an alloy with max 2.6 % silicon 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<sup>A</sup>

| UNS Designation Number | Alloy            | General Name                            | Aluminum  | Carbon | Chromium  | Copper  | Iron    | Manganese | Nickel    | Phosphorus | Silicon | Titanium  | Cobalt | Molybdenum | Sulfur      | Vanadium | Tungsten | Niobium   |
|------------------------|------------------|-----------------------------------------|-----------|--------|-----------|---------|---------|-----------|-----------|------------|---------|-----------|--------|------------|-------------|----------|----------|-----------|
| N10001                 | 335              | Ni-Mo Alloy Solid Solution Strengthened | ...       | 0.12   | 1.0       | ...     | 6.0     | 1.0       | balance   | 0.040      | 1.00    | ...       | 2.50   | 26.0–33.0  | 0.030       | 0.60     | ...      | ...       |
| N10276                 | 276              | Ni-Mo-Cr Alloy SSS                      | ...       | 0.02   | 14.5–16.5 | ...     | 4.0–7.0 | 1.00      | balance   | 0.030      | 0.08    | ...       | 2.50   | 15.0–17.0  | 0.030       | 0.35     | 3.0–4.5  | ...       |
| N04400                 | 400              | Ni-Cu Alloy SSS                         | ...       | 0.3    | ...       | balance | 2.5     | 2.0       | 63.0–70.0 | ...        | 0.5     | ...       | ...    | ...        | 0.024       | ...      | ...      | ...       |
| N04405                 | 405              | Ni-Cu Alloy SSS                         | ...       | 0.3    | ...       | balance | 2.5     | 2.0       | 63.0–70.0 | ...        | 0.5     | ...       | ...    | ...        | 0.025–0.060 | ...      | ...      | ...       |
| N05500                 | 500              | Ni-Cu Alloy Precipitation Hardenable    | 2.30–3.15 | 0.25   | ...       | balance | 2.0     | 1.5       | 63.0–70.0 | ...        | 0.5     | 0.35–0.85 | ...    | ...        | 0.01        | ...      | ...      | ...       |
| N06059                 | 59               | Low Carbon Ni-Cr-Mo Alloy               | 0.1–0.4   | 0.010  | 22.0–24.0 | 0.5     | 1.5     | 0.5       | balance   | 0.015      | 0.10    | ..        | 0.3    | 15.0–16.5  | 0.010       | ...      | ...      | ...       |
| N06625                 | 625 <sup>B</sup> | Ni-Cr-Mo-Cb (Nb) Alloy SSS              | 0.40      | 0.10   | 20.0–23.0 | ...     | 5.0     | 0.50      | balance   | 0.015      | 0.50    | 0.40      | 1.00   | 8.0–10.0   | 0.015       | ...      | ...      | 3.15–4.15 |
| N06686                 | 686              | Ni-Cr-Mo-W Alloy                        | ...       | 0.010  | 19.0–23.0 | ...     | 5.0     | 0.75      | balance   | 0.04       | 0.08    | 0.02–0.25 | ...    | 15.0–17.0  | 0.02        | ...      | 3.0–4.4  | ...       |

<sup>A</sup> Elements shown as balance shall be arithmetically computed by deducting the sum of the other named elements from 100.

<sup>B</sup> See 4.1.3.

**TABLE 1 Continued**

| Composition, %                      |       |               |          |           |           |      |           |          |                   |         |           |                |       |
|-------------------------------------|-------|---------------|----------|-----------|-----------|------|-----------|----------|-------------------|---------|-----------|----------------|-------|
| Aluminum-Base Alloys <sup>A,B</sup> |       |               |          |           |           |      |           |          |                   |         |           |                |       |
| UNS Designation Number              | Alloy | General Name  | Aluminum | Chromium  | Copper    | Iron | Manganese | Silicon  | Titanium          | Zinc    | Magnesium | Other Elements |       |
|                                     |       |               |          |           |           |      |           |          |                   |         |           | Each           | Total |
| A92024                              | 2024  | Aluminum 2024 | balance  | 0.10 max  | 3.8–4.9   | 0.50 | 0.30–0.9  | 0.50     | 0.15 <sup>C</sup> | 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  | 0.18–0.28 | 1.2–2.0   | 0.50 | 0.30      | 0.40     | 0.20 <sup>D</sup> | 5.1–6.1 | 2.1–2.9   | 0.05           | 0.15  |

<sup>A</sup> 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.

<sup>B</sup> Elements shown as balance shall be arithmetically computed by deducting the sum of the other named elements from 100.

<sup>C</sup> Titanium + zirconium 0.20 %, max for extruded and forged products only, when agreed upon.

<sup>D</sup> Titanium + zirconium 0.25 %, max for extruded and forged products only, when agreed upon.