Designation: F467 – 13ε2

Standard Specification for Nonferrous Nuts for General Use[1]

This standard is issued under the fixed designation F467; 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.

ε[1] NOTE—Table 2 was editorially corrected in February 2014.
ε[2] NOTE—17.1 was editorially corrected in May 2014.

1. Scope*

1.1 This specification covers the requirements for commercial wrought nonferrous nuts 0.250 to 1.500 in. inclusive in diameter in a number of alloys in common use and intended for general service applications.

1.2 Applicable bolts, cap screws, and studs for use with nuts covered by this specification are covered by Specification F468.

1.3 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—This specification is the inch-pound companion to Specification F467M; therefore, no SI equivalents are presented in the specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B154 Test Method for Mercurous Nitrate Test for Copper Alloys

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

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E38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys (Withdrawn 1989)[3]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E54 Test Methods for Chemical Analysis of Special Brasses and Bronzes (Withdrawn 2002)[3]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E62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods) (Withdrawn 2010)[3]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 Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

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

F468 Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use

[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**

F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric) F0606_F0606M

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

2.2 *ASME Standards:*[4]

B 1.1 Unified Inch Screw Threads (UN and UNR Thread Form)

B 18.2.2 Square and Hex Nuts

3. Ordering Information

3.1 Orders for nuts 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;

3.1.3 Size (diameter and threads per inch);

3.1.4 Alloy number (Table 1);

3.1.5 Stress relieving, if required (4.2.3);

3.1.6 "Shipment lot" testing, as required (Section 9);

3.1.7 Source inspection, if required (Section 14);

3.1.8 Certificate of compliance or test report, if required (Section 16);

3.1.9 Additional requirements, if any, to be specified on the purchase order (4.2.1, 7.2, 8.2, 12.1, and 13.1),

3.1.10 Supplementary requirements, if any; and

3.1.11 ASTM designation (including year or published date).

NOTE 2—A typical ordering description is as follows: 10 000 pieces, Hex Nut, 0.250" -20, Alloy 270, Furnish Certificate of Compliance, Supplementary Requirement S 1, ASTM Specification F 467-XX

4. Materials and Manufacture

4.1 *Materials:*

4.1.1 The nuts shall be manufactured from material having a chemical composition conforming to the requirements in Table 2 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 the specified requirements.

4.2 *Manufacture:*

4.2.1 *Forming*—Unless otherwise specified, the nuts shall be hot pressed, cold formed, or machined from suitable material at the option of the manufacturer.

4.2.2 *Condition*—Except as provided in 4.2.3, the nuts shall be furnished in the condition specified below:

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
Nickel alloy 500	Solution annealed and aged
Aluminum alloys:	
2024-T4	Solution treated and naturally aged
6061-T6	Solution treated and artificially aged
6262-T9	Solution treated, artificially aged, and cold worked
Titanium	As formed
625	Annealed

4.2.3 *Stress Relieving*—When required, stress relieving shall be specified by the purchaser for all copper alloys and nickel alloys 400 and 405.

5. Chemical Composition

5.1 *Chemical Composition*—The nuts shall conform to the chemical composition specified in Table 1 for the specified alloy.

5.2 *Manufacturer's Analysis:*

5.2.1 Except as provided in 5.2.2, when test reports are required on the inquiry or purchase order (3.1.8), the manufacturer shall make individual analyses of randomly selected finished nuts from the product to be shipped and report the results to the purchaser. Alternatively, if heat and lot identities have been maintained, the analysis of the raw material from which the nuts have been manufactured may be reported instead of product analysis.

5.2.2 For aluminum nuts, instead of 5.2.1, the manufacturer may furnish 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 12.1 and 13.1.

6. Mechanical Properties

6.1 The nuts shall be tested in accordance with the mechanical testing requirements for the applicable type and shall meet the mechanical requirements in Table 2 for the specified alloy.

6.2 Where both proof load and hardness tests are performed, the proof load test results shall take precedence for acceptance purposes.

7. Dimensions

7.1 *Nuts*—Unless otherwise specified, the dimensions of nuts shall be in accordance with the requirements of ASME B18.2.2.

7.2 *Threads*—Unless otherwise specified, the nuts shall have Class 2B threads in accordance with ASME B1.1.

[4] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, http://global.ihs.com.

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]	Phosphous, 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).
† Editorially corrected in January 2008.

TABLE 1 *Continued*

UNS Designation Number	Alloy	General Name	Aluminum[A]	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[B]	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
A96262	6262	Aluminum 6262	balance	0.04–0.14	0.15–0.40	0.7	0.15	0.40–0.8	0.15	0.25	0.8–1.2	[C]	

[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] Titanium + zirconium 0.20 %, max.

[C] Lead 0.4–0.7 %; bismuth 0.4–0.7 %.

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	Titanium Gr 5	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[A]	7.5–8.5	5.5–6.5	3.5–4.5	3.5–4.5			0.10[C]	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] 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 negotiated.

TABLE 2 Mechanical Property Requirements

Alloy	Mechanical Property Marking	Hardness, min[A]	Proof Stress, Hex Nut min, ksi	Proof Stress, Heavy Hex Nut min, ksi[B]
Cu 110	F 467A	65 HRF	30	32
Cu 260	F 467AB	55 HRF	60	65
Cu 270	F 467B	55 HRF	60	65
Cu 462	F 467C	65 HRB	50	54
Cu 464	F 467D	55 HRB	50	54
Cu 510	F 467E	60 HRB	60	65
Cu 613	F 467F	70 HRB	80	86
Cu 614	F 467G	70 HRB	75	81
Cu 630	F 467H	85 HRB	100	108
Cu 642	F 467J	75 HRB	75	81
Cu 651	F 467K	75 HRB	70	76
Cu 655	F 467L	60 HRB	50	54
Cu 661	F467M	75 HRB	70	76
Cu 675	F 467N	60 HRB	55	59
Cu 710	F 467P	50 HRB	45	49
Cu 715	F 467R	60 HRB	55	59
Ni 59 Grade 1	F 467FN	21HRC	120	130
Ni 59 Grade 2	F 467GN	23HRC	135	146
Ni 59 Grade 3	F 467HN	25HRC	160	173
Ni 59 Grade 4	F 467JN	80HRB	100	108
Ni 335	F 467S	20 HRC	115	124
Ni 276	F 467T	20 HRC	110	119
Ni 400	F 467U	75 HRB	80	86
Ni 405	F 467V	60 HRB	70	76
Ni 500	F 467W	24 HRC	130	140
Ni 625 Grade 1‡	F 467AC†	85 HRB-35 HRC	60	65
Ni 625 Grade 2‡	F 467AD	85 HRB-35 HRC	120	130
Ni 686 Grade 1	F 467BN	21 HRC	120	130
Ni 686 Grade 2	F 467CN	23 HRC	135	146
Ni 686 Grade 3	F 467DN	25 HRC	160	173
Ni 686 Grade 4	F 467EN	65 HRB-25HRC	100	108
Al 2024-T4[C]	F 467X	70 HRB	55	59
Al 6061-T6	F 467Y	40 HRB	40	43
Al 6262-T9	F 467Z	60 HRB	52	56
Ti 1	F 467AT	140 HV	40	43
Ti 2	F 467BT	150 HV	55	59
Ti 4	F 467CT	200 HV	85	92
Ti 5	F 467DT	30 HRC	135	146
Ti 7	F 467ET	160 HV	55	59
Ti-19	F 467FT	24 HRC	120	130
Ti 23	F 467GT	25 HRC	125	135
Ti-5-1-1-1	F 467HT	24 HRC	105	113

[A] For aluminum and titanium alloys hardness values are for information only.
[B] Proof stress values for heavy hex nuts are based on 1.08 times the value for corresponding regular hex nuts.
[C] Aluminum alloy 2024-T4 shall be supplied in naturally aged condition. This material is not recommended for nuts in sizes greater than ¼ (0.250) in.
†Editorially corrected in January 2008. Typographical error— should be F467AC; both F467AC or 647AC are acceptable Mechanical Property Mark.
‡Editorially corrected in February 2014.

8. Workmanship, Finish, and Appearance

8.1 *Workmanship*—Nuts shall have a workmanlike finish free of injurious burrs, seams, laps, irregular surfaces, and other imperfections affecting serviceability.

8.2 *Finish*—Unless otherwise specified, the nuts shall be furnished without any additive chemical or metallic finish.

9. Sampling

9.1 A lot, for the purposes of selecting test specimens, shall consist of not more than 100 000 pieces offered for inspection at one time having the following common characteristics:

9.1.1 One type of item,

9.1.2 Same alloy and temper, and

9.1.3 One nominal diameter and thread series.

10. Number of Tests and Retests

10.1 *Normal Testing*—The requirements of this specification shall be met in continuous mass production for stock (see Table 3). The manufacturer shall make sample inspections as specified below to ensure that the product conforms to the

TABLE 3 Mechanical Test Requirements for Nuts

Product	Proof Stress, ksi	Tests Conducted Using Full-size Product	
		Hardness	Proof Load
Jam, slotted, and castle nuts	all	[A]	. . .
All other nuts	up to 120	. . .	[A]
	over 120	[A]	. . .
Tests in accordance with section		11.2.2	12.2.1

[A] Mandatory tests.

specified requirements. When tests of individual shipments are required, Supplementary Requirement S2 shall be specified.

Number of Pieces in Lot	Acceptance Criteria		
	No. of Tests	Acceptance No.	Rejection No.
50 and under	2	0	1
51 to 500	3	0	1
501 to 35 000	5	0	1
35 001 to 100 000	8	0	1

10.2 *Retests:*

10.2.1 When tested in accordance with the required sampling plan, a lot shall be subject to rejection if any of the test specimens fails to meet the applicable test requirements.

10.2.2 If the failure of a test specimen is due to improper preparation of the specimen or to incorrect testing technique, the specimen shall be discarded and another specimen substituted.

11. Significance of Numerical Limits

11.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in this specification, an observed value or calculated value shall be rounded in accordance with Practice E29.

12. Test Specimens

12.1 *Chemical Tests*—When required, samples for chemical analysis shall be taken in accordance with Practice E55 by drilling, sawing, milling, turning, clipping, or such other methods capable of producing representative samples.

12.2 *Mechanical Tests:*

12.2.1 Nuts shall be tested in full section.

12.2.2 The hardness shall be determined on the top or bottom face of the nut.

13. Test Methods

13.1 *Chemical Analysis*—When required, the chemical composition shall be determined by any recognized commercial test method. In the event of disagreement, the following test methods shall be used for referee purposes.

Alloy	Test Method
Copper	E53, E54, E62, E75, E478
Aluminum	E34, E101, E227
Nickel	E38, E76, E354
Titanium	E120, E1409

13.2 *Mechanical:*

13.2.1 The proof load or proof stress tests shall be determined in accordance with the appropriate methods of Test Methods F606. Loads to be determined using Table 2 and Table 4.

13.2.2 The hardness shall be determined in accordance with Test Methods E18 and E92. For sizes ¼ (0.250) to 7⁄16 (0.4375) in. one reading shall be taken. For sizes ½ (0.500) in. and larger the hardness shall be the average of four readings located 90° to one another.

14. Inspection

14.1 When specified on the inquiry or purchase order, the product shall be subject to inspection by the purchaser at the place of manufacture prior to shipment. The inspector representing the purchaser shall have controlled entry only to those parts of the manufacturer's operations that concern the manufacture of the ordered product and only when and where work on the contract of the purchaser is being performed. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the product is being furnished in accordance with this specification. All inspections and tests shall be conducted so as not to interfere unnecessarily with the operations of the manufacturer.

15. Rejection and Rehearing

15.1 Unless otherwise specified, any rejection based on tests specified herein and made by the purchaser shall be reported to

TABLE 4 Tensile Stress Areas and Threads per Inch

Nominal Size, in.	Coarse Threads-UNC		Fine Threads-UNF		8 Thread Series-8UN	
	Threads/in.	Stress Area[A], in.^{2}	Threads/in.	Stress Area[A], in.^{2}	Threads/in.	Stress Area[A], in.^{2}
¼	20	0.0318	28	0.0364	. . .	. . .
5⁄16	18	0.0524	24	0.0580	. . .	. . .
3⁄8	16	0.0775	24	0.0878	. . .	. . .
7⁄16	14	0.1063	20	0.1187	. . .	. . .
½	13	0.1419	20	0.1599	. . .	. . .
9⁄16	12	0.1820	18	0.2030	. . .	. . .
5⁄8	11	0.2260	18	0.2560	. . .	. . .
¾	10	0.3340	16	0.3730	. . .	. . .
7⁄8	9	0.4620	14	0.5090	. . .	. . .
1	8	0.6060	12	0.6630	. . .	. . .
1⅛	7	0.7630	12	0.8560	8	0.790
1¼	7	0.9690	12	1.0730	8	1.000
1⅜	6	1.1550	12	1.3150	8	1.233
1½	6	1.4050	12	1.5810	8	1.492

[A] Tensile stress areas are computed using the following formula:

$$A_s = 0.7854\left[D - \frac{0.9743}{n}\right]$$

where:

A_s = tensile stress area, in.^{2},
D = nominal size (basic major diameter), in., and
n = number of threads per inch.

the manufacturer as soon as practical after receipt of the product by the purchaser.

16. Certification and Test Reports

16.1 *Certificate of Compliance*—When specified in the contract or purchase order, the manufacturer shall furnish certification that the product was manufactured and tested in accordance with this specification and conforms to all specified requirements.

16.2 *Test Reports*—When "Shipment Lot Testing" in accordance with Supplementary Requirement S2 is specified in the contract or purchase order, the manufacturer shall furnish a test report showing the results of the mechanical tests for each lot shipped.

17. Product, Packaging and Package Marking

17.1 *Individual Nuts*—All products shall be marked with a symbol identifying the manufacturer. In addition, they shall be marked with the alloy/mechanical property marking specified in Table 2. The marking shall be raised or depressed at the option of the manufacturer.

17.2 *Packaging:*

17.2.1 Unless otherwise specified, packaging shall be in accordance with Practice D3951.

17.2.2 When special packaging requirements are required by the purchaser, they shall be defined at the time of inquiry and order.

17.3 *Package Marking*—Each shipping unit shall include or be plainly marked with the following:

17.3.1 ASTM designation,

17.3.2 Alloy number,

17.3.3 Alloy/mechanical property marking,

17.3.4 Size,

17.3.5 Name and brand or trademark of the manufacturer,

17.3.6 Number of pieces,

17.3.7 Country of origin, and

17.3.8 Purchase order number.

18. Keywords

18.1 general use; nonferrous; nuts

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall be applied only when specified by the purchaser in the inquiry, contract, or order. Supplementary requirements shall in no way negate any requirement of the specification itself.

S1. Stress Corrosion Requirements, Copper Alloys

S1.1 Copper alloy fasteners shall exhibit no evidence of cracking after immersion for 30 min in an aqueous solution of mercurous nitrate when tested in accordance with Test Method B154.

S1.1.1 **Warning—**Mercury is a definite health hazard and equipment for the detection and removal of mercury vapor produced in volatilization is recommended. The use of rubber gloves in testing is advisable.

S2. Shipment Lot Testing

S2.1 When Supplementary Requirement S2 is specified on the order (3.1.6), the manufacturer shall make sample tests on the individual lots for shipment to ensure that the product conforms to the specified requirements.

S2.2 The manufacturer shall make an analysis of a randomly selected finished nut from each lot of product to be shipped. Heat or lot control shall be maintained. The analysis of the starting material from which the nuts have been manufactured may be reported in place of the product analysis.

S2.3 The manufacturer shall perform mechanical property tests in accordance with this specification and Guide F1470 on the individual lots for shipment.

S2.4 The manufacturer shall furnish a test report for each lot in the shipment showing the actual results of the chemical analysis and mechanical property tests performed in accordance with Supplementary Requirement S2.

S3. Dye Penetrant Inspection

S3.1 When dye penetrant inspection is specified on the purchase order, the nuts shall be tested in accordance with Practice E165 or other mutually acceptable procedures and shall conform to acceptance criteria as mutually agreed upon between the purchaser and the manufacturer.

S4. Heat Control (Alloys 400, 405, and 500 Only)

S4.1 When Supplementary Requirement S4 is specified on the inquiry or order, the manufacturer shall control the product by heat analysis and identify the finished product in each shipment by the actual heat number.

S4.2 When Supplementary Requirement S4 is specified on the inquiry and order, Supplementary Requirement S2 shall be considered automatically invoked with the addition that the heat analysis shall be reported to the purchaser on the test reports.

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (F467–08ε1) that may impact the use of this standard.

(1) Table 2—Added property marking designation for Ni alloy 615 with proof stress of 120 ksi for hex nut and 130 ksi for heavy hex nut.

Designation: F467M – 06a (Reapproved 2012)

Standard Specification for Nonferrous Nuts for General Use (Metric)[1]

This standard is issued under the fixed designation F467M; 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 nuts in nominal thread diameters M6 to M36 inclusive in a number of alloys in common use and intended for general service applications.

1.2 Applicable bolts, cap screws, and studs for use with nuts covered by this specification are covered by Specification F468M.

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 F467.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B154 Test Method for Mercurous Nitrate Test for Copper Alloys

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

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 Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

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

F468M Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use (Metric)

F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric)

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

[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 April 1, 2012. Published May 2012. Originally approved in 1979. Last previous edition approved in 2006 as F467M – 06a ε2. DOI: 10.1520/F0467M-06R12.

[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**

2.2 *ASME Standards:*[4]
B 1.13M Metric Screw Threads
B 18.2.4.1M Metric Hex Nuts, Style 1

3. Ordering Information

3.1 Orders for nuts under this specification shall include the following information:
3.1.1 Quantity (numbers of pieces of each item and size);
3.1.2 Name of item;
3.1.3 Nominal thread diameter and thread pitch;
3.1.4 Alloy number (Table 1);
3.1.5 Stress relieving, if required (4.2.3);
3.1.6 "Shipment lot" testing, as required (Section 9);
3.1.7 Source inspection, if required (Section 14);
3.1.8 Certificate of compliance or test report, if required (Section 16);
3.1.9 Additional requirements, if any, to be specified on the purchase order (4.2.1, 7.2, 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 Nut, M8 × 1.25 Alloy 270, Furnish Certificate of Compliance, Supplementary Requirement S1, ASTM Specification F467M – XX.

4. Materials and Manufacture

4.1 *Materials:*
4.1.1 The nuts 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 nut. 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 nuts conform to all the specified requirements.

4.2 *Manufacture:*
4.2.1 *Forming*—Unless otherwise specified, the nuts shall be hot pressed, cold formed, or machined from suitable material at the option of the manufacturer.
4.2.2 *Condition*—Except as provided in 4.2.3, the nuts shall be furnished in the condition specified below:

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
Nickel alloy 500	Solution annealed and aged
Aluminum alloys:	
2024-T4	Solution treated and naturally aged
6061-T6	Solution treated and artificially aged
6262-T9	Solution treated, artificially aged, and cold worked
Titanium	As formed

4.2.3 *Stress Relieving*—When required, stress relieving shall be specified by the purchaser for all copper alloys and nickel alloys 400 and 405.

5. Chemical Composition

5.1 *Chemical Composition*—The nuts shall conform to the chemical composition specified in Table 1 for the specified alloy.

5.2 *Manufacturer's Analysis:*
5.2.1 Except as provided in 5.2.2, when test reports are required on the inquiry or purchase order (3.1.8), the manufacturer shall make individual analyses of randomly selected nuts from the product to be shipped and report the results to the purchaser. Alternatively, if heat and lot identities have been maintained, the analysis of the raw material from which the nuts have been manufactured may be reported instead of product analysis.
5.2.2 For aluminum nuts, instead of 5.2.1, the manufacturer may furnish 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 nuts 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.

6. Mechanical Properties

6.1 The nuts shall be tested in accordance with the mechanical testing requirements for the applicable type and shall meet the mechanical requirements in Table 2 for the specified alloy.

6.2 Where both proof load and hardness tests are performed, the proof load test results shall take precedence for acceptance purposes.

7. Dimensions

7.1 *Nuts*—Unless otherwise specified, the dimensions of nuts shall be in accordance with the requirements of ASME B18.2.4.1M.

7.2 *Threads*—Unless otherwise specified, the nuts shall have threads in accordance with ASME B1.13M, tolerance Class 6H.

8. Workmanship, Finish, and Appearance

8.1 *Workmanship*—Nuts shall have a workmanlike finish free of injurious burrs, seams, laps, irregular surfaces, and other imperfections affecting serviceability.

8.2 *Finish*—Unless otherwise specified, the nuts shall be furnished without any additive chemical or metallic finish.

9. Sampling

9.1 A lot, for the purposes of selecting test specimens, shall consist of not more than 100 000 pieces offered for inspection at one time having the following common characteristics:
9.1.1 One type of item,
9.1.2 Same alloy and temper, and
9.1.3 One nominal diameter and thread pitch.

10. Number of Tests and Retests

10.1 *Normal Testing*—The requirements of this specification shall be met in continuous mass production for stock (see Table 3). The manufacturer shall make sample inspections as specified below to ensure that the product conforms to the

[4] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, http://global.ihs.com.

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	
C61400	614	aluminum bronze	6.0–8.0	88.0[B]	1.5–3.5	1.0							
C63000	630	aluminum bronze	9.0–11.0	78.0[B]	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[B]	0.30	0.10	0.25		1.5–2.2[C]	0.50	0.05	0.20 max	0.15
C65100	651	silicon bronze		96.0[B]	0.8	0.7			0.8–2.0	1.5	0.05		
C65500	655	silicon bronze		94.8[B]	0.8	1.5	0.6		2.8–3.8	1.5	0.05		
C66100	661	silicon bronze		94.0[B]	0.25	1.5			2.8–3.5	1.5	0.20–0.8	0.5–1.5	
C67500	675	manganese bronze	0.25 max	57.0–60.0	0.8–2.0	0.05–0.5				balance	0.20		
C71000	710	cupro-nickel		74.0[B]	0.60	1.00	19.0–23.0[A]			1.00	0.05		
C71500	715	cupro-nickel		65.0[B]	0.40–0.7	1.00	29.0–33.0[A]			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] Minimum content of copper plus all other elements with specified limits shall be 99.5 %.
[C] 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	0.010 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).

TABLE 1 *Continued*

Composition, %

Aluminum-Base Alloys[A]

UNS Designation Number	Alloy	General Name	Aluminum[A]	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[B]	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
A96262	6262	Aluminum 6262	balance	0.04–0.14	0.15–0.40	0.7	0.15	0.40–0.8	0.15	0.25	0.8–1.2	[C]	

[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] Titanium + zirconium 0.20 %, max.
[C] Lead 0.4–0.7 %; bismuth 0.4–0.7 %.

TABLE 1 *Continued*

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
Titanium and Titanium-Base Alloys[A]																			
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	Titanium Gr 5	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[C]	7.5–8.5	5.5–6.5	3.5–4.5	3.5–4.5			0.10[B]	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] 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 negotiated.

TABLE 2 Mechanical Property Requirements

Alloy	Mechanical Property Marking	Hardness, min[A]	Proof Stress, MPa
Cu 110	F 467MA	65 HRF	205
Cu 260	F 467MAB	55 HRF	415
Cu 270	F 467MB	55 HRF	415
Cu 462	F 467MC	65 HRB	345
Cu 464	F 467MD	55 HRB	345
Cu 510	F 467ME	60 HRB	415
Cu 614	F 467MG	70 HRB	520
Cu 630	F 467MH	85 HRB	690
Cu 642	F 467MJ	75 HRB	520
Cu 651	F 467MK	75 HRB	485
Cu 655	F 467ML	60 HRB	345
Cu 661	F 467MM	75 HRB	485
Cu 675	F 467MN	60 HRB	380
Cu 710	F 467MP	50 HRB	310
Cu 715	F 467MR	60 HRB	380
Ni 59 Grade 1	F 467FN	21HRC	825
Ni 59 Grade 2	F 467GN	23HRC	930
Ni 59 Grade 3	F 467HN	25HRC	1100
Ni 59 Grade 4	F 467JN	80HRB	690
Ni 335	F 467MS	20 HRC	790
Ni 276	F 467MT	20 HRC	760
Ni 400	F 467MU	75 HRB	550
Ni 405	F 467MV	60 HRB	485
Ni 500	F 467MW	24 HRC	900
Ni 625	F 467AC[†]	85 HRB-35 HRC	415
Ni 686 Grade 1	F 467MBN	21 HRC	825
Ni 686 Grade 2	F 467MCN	23 HRC	930
Ni 686 Grade 3	F 467MDN	25 HRC	1100
Ni 686 Grade 4	F 467MEN	65 HRB-25 HRC	690
Al 2024-T4[B]	F 467MX	70 HRB	380
Al 6061-T6	F 467MY	40 HRB	275
Al 6262-T9	F 467MZ	60 HRB	360
Ti 1	F 467MAT	140 HV	275
Ti 2	F 467MBT	150 HV	380
Ti 4	F 467MCT	200 HV	585
Ti 5	F 467MDT	30 HRC	930
Ti 7	F 467MET	160 HV	380
Ti 19	F 467MFT	24 HRC	825
Ti 23	F 467MGT	25 HRC	860
Ti-5-1-1-1	F 467MHT	24 HRC	725

[A] For aluminum and titanium alloys hardness values are for information only.
[B] Aluminum alloy 2024-T4 shall be supplied in naturally aged condition. This material is not recommended for nuts in nominal thread diameter larger than M6.
[†]Editorially corrected in September 2008. Typographical error, should be F467AC both F467AC or 647AC are acceptable Mechanical Property Mark.

TABLE 3 Mechanical Test Requirements on Nuts

Product	Proof Load, kN[A]	Tests Conducted Using Full-Size Product	
		Hardness	Proof Load
Jam, slotted, and castle nuts	all	[B]	. . .
All other nuts	up to 530	. . .	[B]
	over 530	[B]	. . .
Tests in accordance with section		11.2.2	12.2.1

[A] Proof load of nut equals proof stress (MPa) multiplied by stress area (mm^2).
[B] Mandatory tests.

specified requirements. When tests of individual shipments are required, Supplementary Requirement S1 shall be specified.

Number of Pieces in lot	No. of Tests	Acceptance Criteria Acceptance No.	Rejection No.
50 and under	2	0	1
51 to 500	3	0	1
501 to 35 000	5	0	1
35 001 to 100 000	8	0	1

10.2 *Retests:*

10.2.1 When tested in accordance with the required sampling plan, a lot shall be subject to rejection if any of the test specimens fails to meet the applicable test requirements.

10.2.2 If the failure of a test specimen is due to improper preparation of the specimen or to incorrect testing technique, the specimen shall be discarded and another specimen substituted.

11. Significance of Numerical Limits

11.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in this specification, an observed value or calculated value shall be rounded in accordance with Practice E29.

12. Test Specimens

12.1 *Chemical Tests*—When required, samples for chemical analysis shall be taken in accordance with Practice E55 by drilling, sawing, milling, turning, clipping, or such other methods capable of producing representative samples.

12.2 *Mechanical Tests:*

12.2.1 Nuts shall be proof load tested in full section.

12.2.2 The hardness shall be determined on the top or bottom face of the nut.

13. Test Methods

13.1 *Chemical Analysis*—When required, the chemical composition shall be determined by any recognized commercial test method. In the event of disagreement, the following test methods shall be used for referee purposes.

Alloy	Test Method
Copper	E53, E54, E62, E75, E478
Aluminum	E34, E101, E227
Nickel	E38, E76, E354
Titanium	E120, E1409

13.2 *Mechanical:*

13.2.1 The proof load test shall be conducted in accordance with the appropriate methods of Test Methods F606M. Loads to be determined using Table 2 and Table 4.

13.2.2 The hardness shall be determined in accordance with Test Methods E18 and E92. For nominal thread diameters M6 to M10, one reading shall be taken. For diameters M12 and larger, the hardness shall be the average of four readings located 90° to one another.

14. Inspection

14.1 When specified on the inquiry or purchase order, the product shall be subject to inspection by the purchaser at the

TABLE 4 Tensile Stress Areas

Nominal Nut Diameter and Thread Pitch	Stress Area,[A] mm^2	Nominal Nut Diameter and Thread Pitch	Stress Area,[A] mm^2
M6 × 1	20.1	M16 × 2	157
M8 × 1.25	36.6	M20 × 2.5	245
M10 × 1.5	58.0	M24 × 3	353
M12 × 1.75	84.3	M30 × 3.5	561
M14 × 2	115	M36 × 4	817

[A] Tensile stress areas are computed using the following formula:

$$A_s = 0.7854\ (D - 0.9382P)^2$$

where:

A_s = stress area, mm^2,
D = nominal nut diameter (basic major diameter), mm, and
P = thread pitch, mm.

place of manufacture prior to shipment. The inspector representing the purchaser shall have controlled entry only to those parts of the manufacturer's operations that concern the manufacture of the ordered product and only when and where work on the contract of the purchaser is being performed. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the product is being furnished in accordance with this specification. All inspections and tests shall be conducted so as not to interfere unnecessarily with the operations of the manufacturer.

15. Rejection and Rehearing

15.1 Unless otherwise specified, any rejection based on tests specified herein and made by the purchaser shall be reported to the manufacturer as soon as practical after receipt of the product by the purchaser.

16. Certification and Test Reports

16.1 *Certificate of Compliance*—When specified in the contract or purchase order, the manufacturer shall furnish certification that the product was manufactured and tested in accordance with this specification and conforms to all specified requirements.

16.2 *Test Reports*—When "Shipment Lot Testing" in accordance with Supplementary Requirement S2 is specified in the contract or purchase order, the manufacturer shall furnish a test report showing the results of the mechanical tests for each lot shipped.

17. Product, Packaging, and Package Marking

17.1 *Individual Nuts*—All products shall be marked with a symbol identifying the manufacturer. In addition, they shall be marked with the alloy/mechanical property marking specified in Table 2. The markings shall be raised or depressed at the option of the manufacturer.

17.2 *Packaging:*

17.2.1 Unless otherwise specified, packaging shall be in accordance with Practice D3951.

17.2.2 When special packaging requirements are required by the purchaser, they shall be defined at the time of inquiry and order.

17.3 *Package Marking*—Each shipping unit shall include or be plainly marked with the following:

17.3.1 ASTM specification,
17.3.2 Alloy number,
17.3.3 Alloy/mechanical property marking,
17.3.4 Size,
17.3.5 Name and brand or trademark of the manufacturer,
17.3.6 Number of pieces,
17.3.7 Country of origin, and
17.3.8 Purchase order number.

18. Keywords

18.1 general use; nonferrous; nuts

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall be applied only when specified by the purchaser in the inquiry, contract, or order. Supplementary requirements shall in no way negate any requirement of the specification itself.

S1. Stress Corrosion Requirements, Copper Alloys

S1.1 Copper alloy nuts shall exhibit no evidence of cracking after immersion for 30 min in an aqueous solution of mercurous nitrate when tested in accordance with Test Method B154.

S1.1.1 **Warning—**Mercury is a definite health hazard and equipment for the detection and removal of mercury vapor produced in volatilization is recommended. The use of rubber gloves in testing is advisable.

S2. Shipment Lot Testing

S2.1 When Supplementary Requirement S2 is specified on the order (3.1.6), the manufacturer shall make sample tests on the individual lots for shipment to ensure that the product conforms to the specified requirements.

S2.2 The manufacturer shall make an analysis of a randomly selected finished nut from each lot of product to be shipped. Heat or lot control shall be maintained. The analysis of the starting material from which the nuts have been manufactured may be reported in place of the product analysis.

S2.3 The manufacturer shall perform mechanical property tests in accordance with this specification and Guide F1470 on the individual lots for shipment.

S2.4 The manufacturer shall furnish a test report for each lot in the shipment showing the actual results of the chemical analysis and mechanical property tests performed in accordance with Supplementary Requirement S2.

S3. Dye Penetrant Inspection

S3.1 When dye penetrant inspection is specified on the purchase order, the nuts shall be tested in accordance with Practice E165 or other mutually acceptable procedures and shall conform to acceptance criteria as mutually agreed upon between the purchaser and the manufacturer.

S4. Heat Control (Alloys 400, 405, and 500 Only)

S4.1 When Supplementary Requirement S4 is specified on the inquiry or order, the manufacturer shall control the product by heat analysis and identify the finished product in each shipment by the actual heat number.

S4.2 When Supplementary Requirement S4 is specified on the inquiry and order, Supplementary Requirement S2 shall be considered automatically invoked with the addition that the heat analysis shall be reported to the purchaser on the test reports.

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (F467M – 06) that may impact the use of this standard. (Approved Aug. 1, 2006.)

(1) Revised proof stress for Ni 686 in Table 2.

Committee F16 has identified the location of selected changes to this standard since the last issue (F467M – 05) that may impact the use of this standard. (Approved May 1, 2006.)

(1) Added new alloys UNS N06059 and UNS C26000 in Table 1.

(2) Added alloys Ni 59 and Cu 260 in Table 2.