MATERIALS

STAINLESS STEEL METRIC NUTS

IFI
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IFI Note:

IFI-517 is a specification developed through the procedures of Industrial Fasteners Institute. Originally issued in 1976, it was revised in 1981 to be in conformance with ISO 3506. In 1982 it was submitted to ASTM Committee F-16 on Fasteners for its consideration as the basis of an ASTM specification. The version published in this book is an abstract of the submittal to Committee F-16. It omits those requirements dealing with applicable documents, quality assurance and inspection. This information will be included in the ASTM specification. When the ASTM specification is published, IFI will withdraw IFI-517 and support the ASTM document.

1. Scope.

1.1 This specification covers the chemical and mechanical requirements for stainless steel metric nuts with nominal thread diameters M1.6 through M36, and intended for use in engineering applications requiring general corrosion resistance.

1.2 Eight groups of stainless steel alloys are covered, including three austenitic (Grades A1, A2, and A4), one ferritic (Grade F1), three martensitic (Grades C1, C3, and C4), and one precipitation hardening (Grade P1).

1.3 Seventeen property classes are covered, including nine austenitic, one ferritic, six martensitic, and one precipitation hardening. The property classes with the permissible alloys for each are listed in Table 1.

1.4 This specification is based in concept and content on ISO 3506. The chemical and mechanical requirements specified for all property classes, except as given in 1.4.1, are essentially identical with classes of the same designation in ISO 3506.

1.4.1 This specification includes thirteen of the sixteen property classes covered in ISO 3506. Additionally, it includes property classes A1-70, A2-70, A4-70, A1-80, A2-80, and A4-80 for products with nominal thread diameters larger than M20; and four non-ISO property classes, C1-110, C4-110, C3-120, and P1-90.

1.5 Supplementary requirements of an optional nature are provided, applicable only when agreed upon between the manufacturer and the purchaser at the time of the inquiry and order.

1.6 Suitable bolts, hex cap screws, and studs for use with nuts included in this specification are covered by ASTM Specification F738, page B—19. Unless otherwise specified, all bolts, hex cap screws, and studs used with these nuts shall conform to the requirements of Specification F738 and shall be of the same alloy group.

Table 1 Property Classes of Stainless Steel Nuts

Property Class	Permissible Alloys
A1-50 A1-70 A1-80	304, 305[A] 384, XM7
A2-50 A2-70 A2-80	321, 347
A4-50 A4-70 A4-80	316
F1-45	430[B]
C1-70 C1-110	410
C3-80 C3-120	431
C4-70 C4-110	416, 416Se
P1-90	630

[A]When approved by the purchaser, Alloys 303, 303Se, or XM1 may be furnished.

[B]When approved by the purchaser, Alloy 430F may be furnished.

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2. Applicable Documents.

(Refer to ASTM specification when published; see page J—48.)

3. Classification.

3.1 The designation of each property class is comprised of three parts — a letter followed by a single digit, followed by either two or three digits.

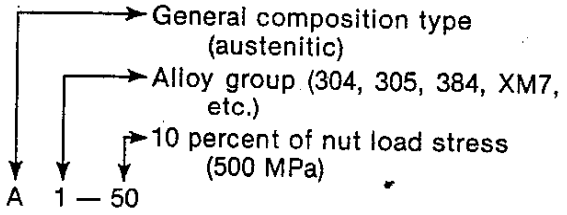
3.1.1 The letter indicates the general composition type of stainless steel as follows:

A for austenitic steels,
F for ferritic steels,
C for martensitic steels, and
P for precipitation-hardening steel.

3.1.2 The first digit (1, 2, 3, or 4) indicates the alloy group. The permissible alloys within each group are given in Table 1.

3.1.3 The last two or three digits (50, 70, 110, etc.) indicate 10 percent of the specified nut proof load stress of the property class.

3.1.4 For example, Class A1-50 is an austenitic steel of any one of seven permitted alloys, and the manufactured nut has a proof load stress of 500 MPa.



4. Ordering Information.

4.1 Orders for nuts under this specification shall include the following information:

4.1.1 Quantity (number of pieces of each item).

4.1.2 Name of item (specific type and style, and reference to dimensional standard when appropriate).

4.1.3 Size (nominal diameter, thread pitch).

4.1.4 Property class.

4.1.5 Supplementary requirements, if any (S1 through S3).

4.1.6 Additional requirements, if any, to be specified on the purchase order:

4.1.6.1 Forming (5.1).

4.1.6.2 Alloy condition (5.2).

4.1.6.3 Protective finish (5.4).

4.1.6.4 Alloy selection (7.2.1 and S2).

4.1.6.5 Test report (11.2).

4.1.6.6 Additional testing (11.4).

4.1.6.7 Corrosion resistance testing (11.3).

4.1.6.8 Inspection (13.1).

4.1.6.9 Heat number (11.1.1).

4.1.6.10 Certification (15.1).

4.1.6.11 Proof load testing (9.2).

4.1.7 ASTM Designation and date of issue. When date of issue is not specified, nuts shall be furnished to the latest issue.

NOTE — *Examples:*

10,000 pieces, Hex Nut, ANSI B18.2.4.1M, M6 × 1, class A2-70, furnish test report, ASTM F ____, dated _____.

15,000 pieces, Hex Flange Nuts, ANSI B18.2.4.4M, M8 × 1.25, class A4-50, Supplementary Requirement S3, ASTM F ____, dated _____.

5. Manufacture.

5.1 **Forming.** Unless otherwise specified, nuts shall be cold-formed, hot-formed, or machined, at the option of the manufacturer.

5.2 **Condition.** Nuts shall be furnished in the condition specified for the property class in Table 3. If other conditions are required, the condition and resultant mechanical properties shall be as agreed upon between the manufacturer and the purchaser.

5.3 **Surface Finish.** Unless otherwise specified, nuts shall be cleaned and descaled in accordance with Recommended Practice A380.

6. Heat Treatment.

6.1 **Austenitic Alloys, Grades A1, A2, and A4:**

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Table 3 Mechanical Property Requirements

Property Class	Condition[A]	Nom Thread Dia	Proof Load Stress MPa	Hardness			
				Vickers		Rockwell	
				min	max	min	max
A1-50 A2-50 A4-50	A or AF	M1.6 - M36	500	155	220	B81	B95
A1-70 A2-70 A4-70	CW	M1.6 - M20 over M20 - M36	700 550	220 160	330 310	B96 B83	C33 C31
A1-80 A2-80 A4-80	SH	M1.6 - M20 over M20 - M24 over M24 - M30 over M30 - M36	800 700 650 600	240 220 200 180	350 330 310 285	C23 B96 B93 B89	C36 C33 C30 C28
F1-45	A or AF	M1.6 - M36	450	135	220	B74	B96
C1-70 C4-70	H	M1.6 - M36	700	220	330	B96	C34
C1-110 C4-110	HT	M1.6 - M36	1100	350	440	C36	C45
C3-80	H	M1.6 - M36	800	240	340	C23	C35
C3-120	HT	M1.6 - M36	1200	380	480	C39	C48
P1-90	AH	M1.6 - M36	900	285	370	C28	C38

[A] **Legend of Conditions:**

AF — formed and annealed.
CW — formed from annealed stock, thus acquiring a degree of cold work.
SW — machined from strain hardened stock.
A — machined from annealed or solution annealed stock, thus retaining the properties of the original material. Alternatively, may be hot formed and solution annealed.
H — hardened and tempered at 565 °C minimum.
HT — hardened and tempered at 275 °C minimum.
AH — solution annealed and age hardened after forming.

6.1.1 When Condition A is specified, the nuts shall be machined from annealed or solution annealed stock. Alternatively, nuts may be hot formed and solution annealed.

6.1.2 When Condition AF is specified, the nuts, following manufacture, shall be annealed by heating to 1040 ± 30 °C, at which time the chromium carbide will go into solution. The nuts shall be held for a sufficient time and then cooled at a rate sufficient to prevent precipitation of the carbide and to provide the properties specified in Table 3.

6.1.3 When Condition CW is specified, the austenitic alloy shall be annealed as specified in 6.1.1, and then cold-worked to develop the properties specified in Table 3.

6.1.4 When Condition SH is specified, nuts shall be machined from strain hardened stock.

6.2 Ferritic Alloys, Grade F1:

6.2.1 When Condition A is specified, the ferritic alloy shall be heated to a temperature of 790 ± 30 °C, held for an appropriate time, and then air-cooled to provide the properties specified in Table 3.

6.2.2 When Condition AF is specified, nuts shall be treated as specified in 6.1.2.

6.3 Martensitic Alloys, Grades C1, C3 and C4.

6.3.1 When Condition H is specified, the nuts shall be hardened and tempered by heating to 1010 ± 30 °C sufficient for austenization, holding for at least ½ h, rapid air- or oil-quenching, reheating to 565 °C minimum, and holding for at least 1 h and then air-cooling to provide the properties specified in Table 3.

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6.3.2 When Condition HT is specified, the nuts shall be hardened and tempered by heating to 1010 ± 30 °C sufficient for austenization, holding for at least ½ h, rapid air- or oil-quenching, reheating to 275 °C minimum, and holding for at least 1 h and then air-cooling to provide the properties specified in Table 3.

6.4 Precipitation-Hardening Alloy, Grade P1.

6.4.1 When Condition AH is specified, the nuts shall be solution-annealed and aged by heating to 1040 ± 15 °C, holding for at least ½ h, rapid air- or oil-quenching to 27 °C maximum, reheating to 620 ± 10 °C minimum, holding for 4 h, and then air-cooling to provide the properties specified in Table 3.

7. Chemical Composition.

7.1 It is the intent of this specification that nuts shall be ordered by property class.

7.2 Unless otherwise specified in the inquiry and purchase order (see Supplementary Requirement S2), when two or more alloys are permitted for nuts of a specified property class, the choice of alloy to be used shall be that of the fastener manufacturer as determined by his nut fabrication methods and material availability. The specific alloy used by the manufacturer shall be clearly identified on any certification required in the purchase order and shall have a chemical composition conforming to the limits specified in Table 2 of ASTM F738, page B—21.

7.2.1 When the purchaser specifies that a specific alloy be used, the alloy shall have a chemical composition conforming to the limits specified in Table 2.

7.3 Product analysis may be made by the purchaser from nuts representing each lot. The chemical composition thus determined shall conform to the limits specified in Table 2 for the specific alloy within the product analysis tolerances specified in ASTM Specification A555.

7.3.1 In the event of discrepancy, a referee analysis of samples for each lot shall be made in accordance with 11.3.1.

8. Corrosion Resistance.

8.1 Carbide Precipitation.

8.1.1 The austenitic alloys in Alloy Groups A1, A2 and A4 shall be free from carbide precipitation as specified in ASTM A262, Practice A, Oxalic Acid Etch Test for Classification of Etch Structures of Stainless Steel.

8.1.2 If the fasteners pass the requirements of Sec. 8.1.1, they shall be considered acceptable. If they fail, they shall be tested in accordance with ASTM A262, Practice C, Nitric Acid Test and shall show a corrosion rate not exceeding 0.05mm (0.002 in.) per month.

9. Mechanical Requirements.

9.1 The hardness of nuts of each class shall not exceed the maximum hardness specified for the class in Table 3. This shall be the only hardness requirement for nuts that are proof load tested.

9.2 Unless proof load testing is specified in the inquiry and purchase order, nuts of all classes in nominal thread diameters M4 and smaller, and nuts of all classes with proof loads greater than 530 kN, as specified in Table 4, may be furnished on the basis of having a hardness not less than the minimum hardness specified in Table 3.

9.3 Nuts of all classes, except those covered in 9.2, shall withstand the proof load stress specified for the diameter and class of nut in Table 3. The proof load of a nut is the axially applied load the nut must withstand without thread stripping or rupture. Proof loads (Table 4) are computed by multiplying proof load stress (Table 3) by the nut thread stress area (Table 4).

10. Dimensions.

10.1 Unless otherwise specified, nuts shall conform to dimensions for hex nuts, Style 1, as given in ANSI B18.2.4.1M, page D—1.

10.2 Unless otherwise specified, threads shall be metric coarse threads with class 6H

Table 4 Nut Proof Load Values, kN

Nom Size and Thread Pitch	Stress Area,[A] mm²	Proof Load Stress, MPa									
		450	500	550	600	650	700	800	900	1100	1200
M1.6 × 0.35	1.27	0.57	0.64	...	0.76	...	0.89	1.02	1.14	1.40	1.52
M2 × 0.4	2.07	0.93	1.04	...	1.24	...	1.45	1.66	1.86	2.28	2.48
M2.5 × 0.45	3.39	1.52	1.70	...	2.03	...	2.37	2.71	3.05	3.73	4.07
M3 × 0.5	5.03	2.26	2.52	...	3.02	...	3.52	4.02	4.53	5.53	6.04
M3.5 × 0.6	6.78	3.05	3.39	...	4.07	...	4.75	5.42	6.10	7.46	8.14
M4 × 0.7	8.78	3.95	4.39	...	5.27	...	6.15	7.02	7.90	9.66	10.5
M5 × 0.8	14.2	6.39	7.10	...	8.52	...	9.94	11.4	12.8	15.6	17.0
M6 × 1	20.1	9.05	10.1	...	12.1	...	14.1	16.1	18.1	22.1	24.1
M8 × 1.25	36.6	16.5	18.3	...	22.0	...	25.6	29.3	32.9	40.3	43.9
M10 × 1.5	58.0	26.1	29.0	...	34.8	...	40.6	46.4	52.2	63.8	69.6
M12 × 1.75	84.3	37.9	42.2	...	50.6	...	59.0	67.4	75.9	92.7	101
M14 × 2	115	51.7	57.5	...	69.0	...	80.5	92.0	104	127	138
M16 × 2	157	70.7	78.5	...	94.2	...	110	126	141	173	188
M20 × 2.5	245	110	123	135	147	...	172	196	221	270	294
M24 × 3	353	159	177	194	212	...	247	282	318	388	424
M30 × 3.5	561	252	281	309	337	365	393	449	505	617	673
M36 × 4	817	368	409	449	490	...	572	654	735	899	980

[A] Stress area = $0.7854\,(D - 0.9382P)^2$

where:

D = nominal dia., mm

P = thread pitch, mm

tolerances as specified in ANSI B1.13M, page A—8.

11. Number of Tests and Retests.

(Refer to ASTM specification when published.)

12. Test Methods.

12.1 Chemical Analysis. The chemical composition may be determined by any recognized commercial test method. In the event of discrepancy, Methods E353 shall be used for referee purposes.

12.2 Mechanical Tests.

12.2.1 Hardness and proof load tests of nuts shall be performed in accordance with requirements of Specification F606, page B—59.

12.2.2 For nut proof load testing, the speed of testing as determined with a free-running cross head shall be a maximum of 25 mm/min.

12.3 Corrosion Resistance. Corrosion tests to determine freedom from precipitated carbide shall be performed in accordance with ASTM A262, Practices A or C, as applicable.

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

13. Inspection.

14. Rejection and Rehearing.

15. Certification.

(For Sections 13, 14 and 15 refer to ASTM specification when published.)

16. Product Marking.

16.1 Nuts in nominal thread diameters M4 and smaller need not be marked.

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16.2 Nuts of all classes, in nominal thread diameters M5 and larger, shall be marked with the property class designation (A1-50, F1-45, etc.) and a symbol to identify the manufacturer.

16.3 The manufacturer's symbol shall be of his design.

16.4 The markings shall be on the top of nut, top of flange or on one of the wrenching flats.

16.5 Markings located on one of the wrenching flats shall be depressed. Markings on all other locations may be raised or depressed at the option of the manufacturer.

17. Packaging.

17.1 Each shipping unit shall bear a tag or be plainly marked with the following: ASTM designation number; property class alloy number; size; name and brand or trademark of the manufacturer; number of pieces; and purchase order number.

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified by the purchaser in the inquiry and order (4.1.6). Supplementary requirements shall in no way negate any requirement of the specification itself.

S1. Additional Tests.

S1.1 When tests for additional mechanical properties, corrosion resistance, etc., are desired by the purchaser, the test(s) shall be made as agreed upon between the manufacturer and the purchaser at the time of the inquiry or order.

S2. Alloy Control.

S2.1 When Supplementary Requirement S2 is specified on the inquiry and order, the manufacturer shall supply that alloy specified by the customer on his order with no group substitutions permitted without the written permission of the purchaser.

S3. Permeability.

S3.1 When Supplementary Requirement S3 is specified on the inquiry and order, the permeability of nuts of Grades A1, A2, and A4 in Conditions A or AF shall not exceed 1.5 at 100 oersteds when determined by ASTM Methods A342 or by a go-no-go permeability indicator of the type described in MIL-I-17214. In case of conflict, Methods A342 shall be the referee method.