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 13 of the 16 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 Specification F738M. Unless otherwise specified, all bolts, hex cap screws, and studs used with these nuts shall conform to the requirements of Specification F738M and shall be of the same alloy group.

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

2. Referenced Documents

2.1 ASTM Standards:

- A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- A342/A342M Test Methods for Permeability of Feebly Magnetic Materials
- A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
- A493 Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
- A555/A555M Specification for General Requirements for Stainless Steel Wire and Wire Rods
- A564/A564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
- A582/A582M Specification for Free-Machining Stainless Steel Bars
- A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- D3951 Practice for Commercial Packaging
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric)
- F738M Specification for Stainless Steel Metric Bolts, Screws, and Studs
- F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

2.2 ISO Standard:

- ISO 3506 Corrosion-Resistant Stainless Steel Fasteners

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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.


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.

2.3 ASME Standards:
   ASME B1.13M Metric Screw Threads—M Profile
   ASME B18.2.4.1M Metric Hex Nuts, Style 1

   NOTE 1—The following ASTM standards are noted for information only as suitable sources of material for the manufacture of nuts to this specification: Specifications A493, A564/A564M, and A582/A582M.

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 (see Table 1).

   3.1.1 The letter indicates the general composition type of stainless steel:
       3.1.1.1 A for austenitic steels,
       3.1.1.2 F for ferritic steels,
       3.1.1.3 C for martensitic steels, and
       3.1.1.4 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% 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 six 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:

   4.1.1 Quantity (number of pieces of each item);
   4.1.2 Name of item (specific type and style, and references 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 Orders for nuts under this specification may include the following optional requirements:
       4.1.6.1 Forming (5.1);
       4.1.6.2 Alloy condition (5.2);
       4.1.6.3 Alloy selection (7.2.1 and S2);
       4.1.6.4 Test report (15.2);
       4.1.6.5 Additional testing (11.3);
       4.1.6.6 Corrosion resistance testing (11.2);
       4.1.6.7 Inspection (13.1);
       4.1.6.8 Heat number (11.1.1);
       4.1.6.9 Certification (15.1);
       4.1.6.10 Proof load testing (9.2).

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

   NOTE 2—Example: 10 000 pieces, hex nut, ASME B18.2.4.1M, M6 × 1, Class A2-70, furnish test report, ASTM F836M – XX.

5. Materials and 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 2. 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 Practice A380.

6. Heat Treatment

6.1 Austenitic Alloys, Grades A1, A2, and A4:
   6.1.1 When Condition A is specified, the nuts shall be machined from annealed or solution annealed stock, thus retaining the properties of the original material, or hot formed and solution annealed.

   6.1.2 When Condition AF is specified, the nuts shall be solution annealed stock, thus retaining the properties of the original material, or hot formed and solution annealed.

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 2.

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 2.

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 austenitization, holding for at least 1 h and then air-cooling to provide the properties specified in Table 2.

6.3.2 When Condition HT is specified, the nuts shall be hardened and tempered by heating to 1010 ± 30°C sufficient for austenitization, 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 2.

6.4 Precipitation-Hardening Alloy, Grade P1—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 2.

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 identified clearly on any certification required in the purchase order and shall have a chemical composition conforming to the limits specified in Table 3.

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 3.

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 3 for the specific alloy within the product analysis tolerances specified in Specification A555/A555M.

7.3.1 In the event of discrepancy, a referee analysis of samples for each lot shall be made in accordance with 12.1.
8. Corrosion Resistance

8.1 Carbide Precipitation:

8.1.1 Rod, bar, and wire in the austenitic Alloy Groups A1, A2, and A4, except the free-machining grades, 303 and 303Se, used to make nuts in accordance with this specification, shall be capable of passing the test for susceptibility to intergranular corrosion as specified in Practice E of Practices A262.

8.1.2 As stated in Practices A262, samples may be subjected to the faster and more severe screening test in accordance with Practice A. Failing Practice A, specimens may be tested in accordance with Practice E and be considered satisfactory if passing Practice E.

9. Mechanical Properties

9.1 The hardness of nuts of each class shall not exceed the maximum hardness specified for the class in Table 2. 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, shall be furnished on the basis of having a hardness not less than the minimum hardness specified in Table 2.

10. Dimensions

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

10.2 Unless otherwise specified, threads shall be metric coarse threads with class 6H tolerances as specified in ASME B1.13M.
11. Number of Tests and Retests

11.1 The mechanical and chemical composition requirements of this specification shall be met in continuous mass production for stock, and the manufacturer shall make sample inspections to ensure that the product conforms to the specified requirements. Additional tests of individual shipments of material are not ordinarily necessary.

11.1.1 Individual heats of steel are not identified in the finished product. When specified in the purchase order that the heat number shall be identified for the products in an individual shipment, the manufacturer shall control the product by heat analysis and additionally shall conduct the testing program specified in 11.1.

11.2 Unless otherwise specified, tests for corrosion resistance shall be in accordance with the manufacturer’s standard quality control practices. A specific number of tests is not required but the nuts shall be produced by manufacturing practices and subjected to tests and inspection to assure compliance with the specified requirements.

11.2.1 When specified on the purchase order, not less than one corrosion test to determine freedom from precipitated carbides shall be made to represent each lot.

11.3 When the purchaser requires that additional tests be performed by the manufacturer to determine that the properties of nuts in an individual shipment are within specified limits, the purchaser shall specify Supplementary Requirement S1 in the inquiry and purchase order.

11.3.1 When the purchaser does not specify the sampling plan and basis of acceptance the following shall apply:

11.3.1.1 The lot, for purposes of selecting samples, shall consist of all nuts offered for inspection and testing, at one time, that are the same type, style, nominal diameter, thread pitch, material (alloy), property class, and surface finish.

11.3.1.2 From each lot, samples shall be selected at random and tested for each requirement in accordance with the following plan:

<table>
<thead>
<tr>
<th>Number of Pieces in Lot</th>
<th>Number of Tests</th>
<th>Acceptance Criteria</th>
<th>Rejection Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 and less</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>801 to 8000</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>8001 to 22 000</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Over 22 000</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

11.3.1.3 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 test specimen substituted.

12. Test Methods

12.1 Chemical Analysis—Chemical analysis shall be performed in accordance with Test Methods, Practices and Terminology A751.

12.2 Mechanical Tests:

12.2.1 Hardness and proof load tests of nuts shall be performed in accordance with requirements of Test Methods F606M.

12.2.2 For nut proof load testing, the speed of testing as determined with a free-running crosshead 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 Practice A262, Practices A or E, as applicable.

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**TABLE 4 Nut Proof Load Values, kN**

<table>
<thead>
<tr>
<th>Nominal Size and Thread Pitch</th>
<th>Stress Area, mm²</th>
<th>450</th>
<th>500</th>
<th>550</th>
<th>600</th>
<th>650</th>
<th>700</th>
<th>800</th>
<th>900</th>
<th>1100</th>
<th>1200</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1.6 x 0.35</td>
<td>1.27</td>
<td>0.57</td>
<td>0.64</td>
<td>...</td>
<td>0.76</td>
<td>...</td>
<td>0.89</td>
<td>1.02</td>
<td>1.14</td>
<td>1.40</td>
<td>1.52</td>
</tr>
<tr>
<td>M2 x 0.4</td>
<td>2.07</td>
<td>0.93</td>
<td>1.04</td>
<td>...</td>
<td>1.24</td>
<td>...</td>
<td>1.45</td>
<td>1.66</td>
<td>1.86</td>
<td>2.28</td>
<td>2.48</td>
</tr>
<tr>
<td>M2.5 x 0.45</td>
<td>3.39</td>
<td>1.52</td>
<td>1.70</td>
<td>...</td>
<td>2.03</td>
<td>...</td>
<td>2.37</td>
<td>2.71</td>
<td>3.05</td>
<td>3.73</td>
<td>4.07</td>
</tr>
<tr>
<td>M3 x 0.5</td>
<td>5.03</td>
<td>2.26</td>
<td>2.52</td>
<td>...</td>
<td>3.02</td>
<td>...</td>
<td>3.52</td>
<td>4.02</td>
<td>4.53</td>
<td>5.53</td>
<td>6.04</td>
</tr>
<tr>
<td>M3.5 x 0.6</td>
<td>6.78</td>
<td>3.05</td>
<td>3.39</td>
<td>...</td>
<td>4.07</td>
<td>...</td>
<td>4.75</td>
<td>5.42</td>
<td>6.10</td>
<td>7.46</td>
<td>8.14</td>
</tr>
<tr>
<td>M4 x 0.7</td>
<td>8.78</td>
<td>3.95</td>
<td>4.39</td>
<td>...</td>
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<td>...</td>
<td>6.15</td>
<td>7.02</td>
<td>7.90</td>
<td>9.66</td>
<td>10.5</td>
</tr>
<tr>
<td>M5 x 0.8</td>
<td>14.2</td>
<td>6.39</td>
<td>7.10</td>
<td>...</td>
<td>8.52</td>
<td>...</td>
<td>9.94</td>
<td>11.4</td>
<td>12.8</td>
<td>15.6</td>
<td>17.0</td>
</tr>
<tr>
<td>M6 x 1</td>
<td>20.1</td>
<td>9.05</td>
<td>10.1</td>
<td>...</td>
<td>12.1</td>
<td>...</td>
<td>14.1</td>
<td>16.1</td>
<td>18.1</td>
<td>22.1</td>
<td>24.1</td>
</tr>
<tr>
<td>M8 x 1.25</td>
<td>36.6</td>
<td>16.5</td>
<td>18.3</td>
<td>...</td>
<td>22.0</td>
<td>...</td>
<td>25.6</td>
<td>29.3</td>
<td>32.9</td>
<td>40.3</td>
<td>43.9</td>
</tr>
<tr>
<td>M10 x 1.5</td>
<td>58.0</td>
<td>26.1</td>
<td>29.0</td>
<td>...</td>
<td>34.8</td>
<td>...</td>
<td>40.6</td>
<td>46.4</td>
<td>52.2</td>
<td>63.8</td>
<td>69.6</td>
</tr>
<tr>
<td>M12 x 1.75</td>
<td>84.3</td>
<td>37.9</td>
<td>42.2</td>
<td>...</td>
<td>50.6</td>
<td>...</td>
<td>59.0</td>
<td>67.4</td>
<td>75.9</td>
<td>92.7</td>
<td>101</td>
</tr>
<tr>
<td>M14 x 2</td>
<td>115</td>
<td>51.7</td>
<td>57.5</td>
<td>...</td>
<td>69.0</td>
<td>...</td>
<td>80.5</td>
<td>92.0</td>
<td>104</td>
<td>127</td>
<td>138</td>
</tr>
<tr>
<td>M16 x 2</td>
<td>157</td>
<td>70.7</td>
<td>78.5</td>
<td>...</td>
<td>94.2</td>
<td>...</td>
<td>110</td>
<td>126</td>
<td>141</td>
<td>173</td>
<td>188</td>
</tr>
<tr>
<td>M20 x 2.5</td>
<td>245</td>
<td>110</td>
<td>123</td>
<td>135</td>
<td>147</td>
<td>172</td>
<td>196</td>
<td>221</td>
<td>270</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>M24 x 3</td>
<td>353</td>
<td>159</td>
<td>177</td>
<td>194</td>
<td>212</td>
<td>247</td>
<td>282</td>
<td>318</td>
<td>388</td>
<td>424</td>
<td></td>
</tr>
<tr>
<td>M30 x 3.5</td>
<td>561</td>
<td>282</td>
<td>312</td>
<td>347</td>
<td>387</td>
<td>427</td>
<td>465</td>
<td>505</td>
<td>570</td>
<td>617</td>
<td>673</td>
</tr>
<tr>
<td>M36 x 4</td>
<td>817</td>
<td>368</td>
<td>409</td>
<td>449</td>
<td>490</td>
<td>572</td>
<td>654</td>
<td>735</td>
<td>899</td>
<td>980</td>
<td></td>
</tr>
</tbody>
</table>

\[ A = \frac{0.7854 (D - 0.9382 P)^2}{\pi} \]

where:

- \( D \) = nominal, mm,
- \( P \) = thread pitch, mm, and
- Proof Load Stress is found in Table 2.
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 Practice E29.

13. Inspection
13.1 If the inspection described in 13.2 is required by the purchaser, it shall be specified in the inquiry, order, or contract.

13.2 The inspector representing the purchaser shall have free entry to all parts of the manufacturer’s works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspection required by the specification that are requested by the purchaser’s representative shall be made prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the work.

14. Rejection and Rehearing
14.1 Unless otherwise specified, any rejection based on tests specified herein and made by the purchaser shall be reported to the manufacturer within 30 working days from the receipt of the product by the purchaser.

15. Certification
15.1 When specified in the purchase order, the manufacturer shall furnish certification that the product was manufactured and tested in accordance with this specification and the purchaser’s order and conforms to all specified requirements.

15.2 When specified in the purchase order, the manufacturer shall furnish a test report certified to be the last complete set of chemical analysis and mechanical tests for each nut size in each shipment.

15.3 All certifications shall indicate the purchase order number and the applicable requirements of Section 4.

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

16.2 All products with a nominal size of M5 and larger 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.

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 shall be raised or depressed at the option of the manufacturer.

17. Packaging and Package Marking
17.1 Packaging:
17.1.1 Unless otherwise specified packaging shall be in accordance with Practice D3951.

17.2 Package Marking—Each shipping unit shall include or be plainly marked with the following:
17.2.1 ASTM specification,
17.2.2 Alloy number,
17.2.3 Alloy/mechanical property marking,
17.2.4 Size,
17.2.5 Name and brand or trademark of the manufacturer,
17.2.6 Number of pieces,
17.2.7 Country of origin, and
17.2.8 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 Methods A342/A342M.

S4. Shipment Lot Testing
S4.1 When Supplementary Requirement S4 is specified on the order, the manufacturer shall make sample tests on the individual lots for shipment to ensure that the product conforms to the specified requirements.
S4.2 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.

S4.3 The manufacturer shall perform mechanical property tests in accordance with this specification and Guide F1470 on the individual lots for shipment.

S4.4 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 S4.

S5. Heat Control

S5.1 When Supplementary Requirement S5 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 or lot number that is heat lot traceable.

S5.2 When Supplementary Requirement S5 is specified on the inquiry or order, Supplementary Requirements S2 and S4 shall be considered automatically invoked with the addition that the heat analysis shall be reported to the purchaser on the test report.