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Standard Specification for Nickel Alloy Forgings¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification² covers forgings of:

| Alloy Type | UNS Number(s) |
|---------------------------|--------------------------------|
| Fe-Ni-Cr-Mo-N | N08367 |
| Low-carbon Cr-Ni-Fe-N | R20033 |
| Low-carbon Ni-Cr-Mo | N06035, N06058, N06059, N06044 |
| Low-carbon Ni-Cr-Mo-Cu | N06200 |
| Low-carbon Ni-Cr-Mo-W | N06686 |
| Low-carbon Ni-Fe-Cr-Mo-Cu | N08031, N08034 |
| Low-carbon Ni-Mo-Cr | N10276, N06022, N10362 |
| Low-carbon Ni-Mo-Cr-Ta | N06210 |
| Ni | N02200 |
| Ni-Co-Cr-Si | N12160 |
| Ni-Cr-Al | N06699 |
| Ni-Cr-Co-Mo | N06617 |
| Ni-Cr-Fe | N06600, N06603, N06690 |
| Ni-Cr-Fe-Al | N06025 |
| Ni-Cr-Fe-Si | N06045 |
| Ni-Cr-Mo-Nb | N06625 |
| Ni-Cr-Mo-Si | N06219 |
| Ni-Cr-Mo-W | N06110 |
| Ni-Cr-W-Mo | N06230 |
| Ni-Cu | N04400 |
| Ni-Fe-Cr | N08120, N08800, N08810, N08811 |
| Ni-Fe-Cr-Mo-Cu | N08825, N08827 |
| Ni-Fe-Cr-W | N06674 |
| Ni-Mo | N10665, N10675, N10629 |
| Ni-Mo-Cr-Fe | N10242, N10624 |

1.1.1 The nickel-iron-chromium alloys are UNS N08120, UNS N08800, UNS N08810, and UNS N08811. Alloy UNS N08800 is normally employed in service temperatures up to and including ~~1100°F (593°C)~~ 1100 °F (593 °C). Alloys UNS N08810, N08120, and UNS N08811 are normally employed in service temperatures above ~~1100°F (593°C)~~ 1100 °F (593 °C) where resistance to creep and rupture is required, and are annealed to develop controlled grain size for optimum properties in this temperature range.

¹ This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SB-564 in Section II of that Code.

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

1.1.2 Nickel-iron-chromium-tungsten alloy UNS N06674 is normally employed in service temperatures above 1100°F (593°C) where resistance to creep and rupture is required, and is annealed to develop optimum properties in this temperature range.

1.1.3 Nickel-chromium-molybdenum-columbium (UNS N06625) products are furnished in two grades of different heat-treated conditions:

1.1.3.1 Grade 1 (Annealed)—Material is normally employed in service temperatures up to 1100°F (593°C).

1.1.3.2 Grade 2 (Solution annealed)—Material is normally employed in service temperatures above 1100°F (593°C) where resistance to creep and rupture are required.

NOTE 1—Hot-working or reannealing may change properties significantly, depending on working history and temperatures.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety, health, and environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.4 *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:³

[B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E76 Test Methods for Chemical Analysis of Nickel-Copper Alloys \(Withdrawn 2003\)⁴](#)

[E112 Test Methods for Determining Average Grain Size](#)

[E350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron](#)

[E1473 Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys](#)

2.2 Military Standards:⁵

[MIL-STD-129 Marking for Shipment and Storage](#)

[MIL-STD-271 Nondestructive Testing Requirements for Metals](#)

3. Ordering Information

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Examples of such requirements include, but are not limited to, the following:

3.1.1 Alloy ([Table 1](#)).

3.1.2 Condition ([Table 2](#)).

3.1.2.1 Unless otherwise specified, UNS N06625 Grade 1 will be supplied.

3.1.3 Quantity (mass or number of pieces).

³ 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.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

TABLE 1 Chemical Requirements^A

| Element | Composition, % | | | | | | | | | |
|---------------------|-------------------------------|--------------------------------------|---|--|--|--|---|--|--|--|
| | Nickel Alloy UNS N02200 | Nickel-Copper Alloy UNS N04400 | Low-Carbon Nickel-Chromium-Molybdenum-Chromium Alloy UNS N06022 | Nickel-Chromium-Iron-Aluminum Alloy UNS N06025 | Low-Carbon Nickel-Chromium-Molybdenum Alloy UNS N06035 | Low-Carbon Nickel-Chromium-Molybdenum Alloy UNS N06044 | Nickel-Chromium-Iron-Silicon Alloy UNS N06045 | Low-Carbon Nickel-Chromium-Molybdenum Alloy UNS N06058 | Low-Carbon Nickel-Chromium-Molybdenum Alloy UNS N06059 | Nickel-Chromium-Molybdenum-Tungsten Alloy UNS N06110 |
| Nickel | 99.0 ^B min | 63.0 ^B min | balance ^B | balance | balance ^B | balance | 45 min | balance | balance ^B | 51.0 ^B min |
| Copper | 0.25 | 28.0-34.0 | ... | 0.10 | 0.30 | ... | 0.3 | 0.50 | 0.50 | 0.50 |
| Iron | 0.40 | 2.5 | 2.0-6.0 | 8.0-11.0 | 2.00 | ... | 21.0-25.0 | 1.5 | 1.5 | 1.0 |
| Manganese | 0.35 | 2.0 | 0.50 | 0.15 | 0.50 | 0.3 max | 1.0 | 0.50 | 0.5 | 1.0 |
| Carbon | 0.15 | 0.3 | 0.015 | 0.15-0.25 | 0.050 | 0.07-0.30 | 0.05-0.12 | 0.010 | 0.010 | 0.15 |
| Silicon | 0.35 | 0.5 | 0.08 | 0.5 | 0.60 | 0.02 max | 2.5-3.0 | 0.10 | 0.10 | 1.0 |
| Sulfur | 0.01 | 0.024 | 0.02 | 0.01 | 0.015 | 0.20 max | 0.010 | 0.010 | 0.010 | 0.015 |
| Chromium | ... | ... | 20.0-22.5 | 24.0-26.0 | 32.25-34.25 | 43.5-45.3 | 26.0-29.0 | 20.0-23.0 | 22.0-24.0 | 28.0-33.0 |
| Aluminum | ... | ... | ... | 1.8-2.4 | 0.40 | 0.30 max | ... | 0.40 | 0.1-0.4 | 1.0 |
| Titanium | ... | ... | ... | 0.1-0.2 | ... | 0.10-0.30 | ... | ... | ... | 1.0 |
| Columbium | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1.0 |
| (Nb) + Tantalum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Molybdenum | ... | ... | 12.5-14.5 | ... | 7.60-9.00 | 0.80-1.20 | ... | 18.5-21.0 | 15.0-16.5 | 9.0-12.0 |
| Phosphorus | ... | ... | 0.02 | 0.02 | 0.030 | 0.020 max | 0.02 | 0.015 | 0.015 | 0.50 |
| Tungsten | ... | ... | 2.5-3.5 | ... | 0.60 | ... | ... | 0.3 | ... | 1.0-4.0 |
| Cobalt | ... | ... | 2.5 | ... | 1.00 | ... | ... | 0.3 | ... | ... |
| Vanadium | ... | ... | 0.35 | ... | 0.20 | ... | ... | ... | 0.3 | ... |
| Nitrogen | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Boron | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Lanthanum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Aluminum + Titanium | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Nickel + Molybdenum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Columbium (Nb) | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Tantalum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Zirconium | ... | ... | ... | 0.01-0.10 | ... | ... | ... | ... | ... | ... |
| Cerium | ... | ... | ... | ... | ... | ... | 0.03-0.09 | ... | ... | ... |
| Yttrium | ... | ... | ... | 0.05-0.12 | ... | ... | ... | ... | ... | ... |

^A Maximum unless range or minimum is given. Where ellipses (...) appear in this table there is no requirement and the element need neither be analyzed for nor reported.

^B Element shall be determined arithmetically by difference.

TABLE 1 Chemical Requirements^A (continued)

| Element | Composition, % | | | | | | | | | |
|---------------------|---|---|---|--|--|--|---|---------------------------------------|--|--|
| | Low-Carbon Nickel-Chromium-Molybdenum-Copper Alloy UNS N06200 | Low-Carbon Nickel-Chromium-Molybdenum-Tantalum Alloy UNS N06210 | Nickel-Chromium-Molybdenum-Silicon Alloy UNS N06219 | Nickel-Chromium-Tungsten-Molybdenum Alloy UNS N06230 | Nickel-Chromium-Iron-Aluminum Alloy UNS N06603 | Nickel-Chromium-Cobalt-Molybdenum Alloy UNS N06617 | Nickel-Chromium-Molybdenum-Columbium Alloy UNS N06625 | Nickel-Chromium-Iron Alloy UNS N06600 | Nickel-Iron-Chromium-Tungsten Alloy UNS N06674 | |
| Nickel | balance ^B | balance ^B | balance ^B | balance ^B | balance ^B | balance ^B | balance ^B | balance ^B | balance ^B | |
| Copper | 1.3–1.9 | ... | 0.50 | ... | 0.5 | 0.5 | ... | ... | ... | |
| Iron | 3.0 | 1.0 | 2.0–4.0 | ... | 8.0–11.0 | 3.0 | 5.0 | 72.0 ^B min | 20.0–27.0 | |
| Manganese | 0.50 | 0.5 | 0.50 | 0.30–1.00 | 0.15 | 1.0 | 0.5 | 6.0–10.0 | 1.50 | |
| Carbon | 0.010 | 0.015 | 0.05 | 0.05–0.15 | 0.20–0.40 | 0.05–0.15 | 0.10 | 1.0 | 0.10 | |
| Silicon | 0.08 | 0.08 | 0.70–1.10 | 0.25–0.75 | 0.5 | 1.0 | 0.5 | 0.5 | 1.0 | |
| Sulfur | 0.010 | 0.02 | 0.010 | 0.015 | 0.010 | 0.015 | 0.015 | 0.015 | 0.015 | |
| Chromium | 22.0–24.0 | 18.0–20.0 | 18.0–22.0 | 20.0–24.0 | 24.0–26.0 | 20.0–24.0 | 20.0–23.0 | 14.0–17.0 | 21.5–24.5 | |
| Aluminum | 0.50 | ... | 0.50 | 0.50 | 2.4–3.0 | 0.8–1.5 | 0.4 | ... | ... | |
| Titanium | ... | ... | 0.50 | ... | 0.01–0.25 | 0.6 | 0.4 | ... | 0.05–0.20 | |
| Columbium | ... | ... | ... | ... | ... | ... | 3.15–4.15 | ... | ... | |
| (Nb) + Tantalum | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Molybdenum | 15.0–17.0 | 18.0–20.0 | 7.0–9.0 | 1.0–3.0 | ... | 8.0–10.0 | 8.0–10.0 | ... | ... | |
| Phosphorus | 0.025 | 0.02 | 0.020 | 0.030 | 0.02 | ... | 0.015 | ... | 0.030 | |
| Tungsten | ... | ... | ... | 13.0–15.0 | ... | ... | ... | ... | 6.0–8.0 | |
| Cobalt | 2.0 | 1.0 | 1.0 | 5.0 | ... | 10.0 min–15.0 | ... | ... | ... | |
| Vanadium | ... | 0.35 | ... | ... | ... | ... | ... | ... | ... | |
| Nitrogen | ... | ... | ... | ... | ... | ... | ... | ... | 0.02 | |
| Boron | ... | ... | ... | 0.015 | ... | 0.006 | ... | ... | 0.0005–0.006 | |
| Lanthanum | ... | ... | ... | 0.005–0.050 | ... | ... | ... | ... | ... | |
| Aluminum + Titanium | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Nickel + Molybdenum | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Columbium | ... | ... | ... | ... | ... | ... | ... | ... | 0.10–0.35 | |
| (Nb) | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Tantalum | ... | 1.5–2.2 | ... | ... | ... | ... | ... | ... | ... | |
| Zirconium | ... | ... | ... | ... | 0.01–0.10 | ... | ... | ... | ... | |
| Cerium | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Yttrium | ... | ... | ... | ... | 0.01–0.15 | ... | ... | ... | ... | |

^A Maximum unless range or minimum is given. Where ellipses (...) appear in this table there is no requirement and the element need neither be analyzed for nor reported.

^B Element shall be determined arithmetically by difference.

TABLE 1 Chemical Requirements^A (continued)

| Element | Composition, % | | | | | | | | | | |
|--------------------------------------|---|--|--------------------------------|----------------------------|-----------------------|---|----------------------------|----------------------------|----------------------------|--|--|
| | Low-Carbon Nickel-Chromium-Tungsten Alloy | Low-Carbon Nickel-Chromium-Molybdenum-Copper Alloy | Nickel-Chromium-Aluminum Alloy | Nickel-Chromium-Iron Alloy | Nickel-Chromium-Alloy | Nickel-Chromium-Molybdenum-Nitrogen Alloy | Nickel-Iron-Chromium Alloy | Nickel-Iron-Chromium Alloy | Nickel-Iron-Chromium Alloy | Nickel-Iron-Chromium-Molybdenum-Copper Alloy | Nickel-Iron-Chromium-Molybdenum-Copper Alloy |
| | UNS N06686 | UNS N06699 | UNS N08031 | UNS N08034 | UNS N08120 | UNS N08367 | UNS N08810 | UNS N08811 | UNS N08825 | UNS N08827 | |
| Nickel | remainder | remainder | 30.0–32.0 | 33.5–35.0 | 35.0–39.0 | 23.50–25.50 | 30.0–35.0 | 30.0–35.0 | 38.0–46.0 | 39.0–43.0 | |
| Copper | ... | 0.50 | 1.0–1.4 | 0.5–1.5 | 0.50 | 0.75 | 0.75 | 0.75 | 1.5–3.0 | 1.6–2.3 | |
| Iron | 5.0 | 2.5 | balance ^B | balance ^B | balance | balance ^B | 39.5 ^B min | 39.5 ^B min | 22.0 ^B min | balance ^B | |
| Manganese | 0.75 | 0.50 | 2.0 | 1.0–4.0 | 1.5 | 2.00 | 1.5 | 1.5 | 1.0 | 0.5–0.9 | |
| Carbon | 0.010 | 0.005–0.10 | 0.015 | 0.01 | 0.02–0.10 | 0.030 | 0.05–0.10 | 0.06–0.10 | 0.05 | 0.015 | |
| Silicon | 0.08 | 0.50 | 0.3 | 0.1 | 1.0 | 1.00 | 1.0 | 1.0 | 0.5 | 0.2–0.5 | |
| Sulfur | 0.02 | 0.015 | 0.010 | 0.010 | 0.03 | 0.030 | 0.015 | 0.015 | 0.03 | 0.005 | |
| Chromium | 19.0–23.0 | 26.0–30.0 | 26.0–28.0 | 26.0–27.0 | 23.0–27.0 | 20.0–22.0 | 19.0–23.0 | 19.0–23.0 | 19.5–23.5 | 21.0–23.0 | |
| Aluminum | ... | 1.9–3.0 | ... | 0.3 | 0.40 | ... | 0.15–0.60 | 0.15–0.60 | 0.2 | 0.06–0.25 | |
| Titanium | 0.02–0.25 | 0.60 | ... | ... | 0.20 | ... | 0.15–0.60 | 0.15–0.60 | 0.6–1.2 | ... | |
| Columbium | ... | ... | ... | ... | 0.4–0.9 | ... | ... | ... | ... | ... | |
| (Nb) + Tantalum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Molybdenum | 15.0–17.0 | ... | 6.0–7.0 | 6.0–7.0 | 2.50 | 6.00–7.00 | ... | ... | 2.5–3.5 | 4.5–6.5 | |
| Phosphorus | 0.04 | 0.02 | 0.020 | 0.020 | 0.040 | 0.040 | ... | ... | ... | ... | |
| Tungsten | 3.0–4.4 | ... | ... | ... | 2.50 | ... | ... | ... | ... | ... | |
| Cobalt | ... | ... | ... | ... | 3.0 | ... | ... | ... | ... | 0.5 | |
| Vanadium | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Nitrogen | ... | 0.05 | 0.15–0.25 | 0.10–0.25 | ... | 0.18–0.25 | ... | ... | ... | 0.03 | |
| Boron | ... | 0.008 | ... | ... | 0.010 | ... | ... | ... | ... | 0.002–0.004 | |
| Lanthanum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Aluminum + Titanium | ... | ... | ... | ... | ... | ... | ... | 0.85–1.20 | ... | ... | |
| Nickel + Molybdenum + Columbium (Nb) | ... | 0.50 | ... | ... | ... | ... | ... | ... | ... | 0.15 | |
| Tantalum | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Zirconium | ... | 0.10 | ... | ... | ... | ... | ... | ... | ... | ... | |
| Cerium | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Yttrium | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Magnesium | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.006–0.015 | |

^A Maximum unless range or minimum is given. Where ellipses (...) appear in this table there is no requirement and the element need neither be analyzed for nor reported.

^B Element shall be determined arithmetically by difference.

TABLE 1 Chemical Requirements^A (continued)

| Element | Composition, % | | | | | | | | | |
|---------------------|---|--|--|--|------------------------------------|------------------------------------|------------------------------------|---|---|--|
| | Nickel-Molybdenum-Chromium-Alloy UNS N10242 | Low-Carbon Nickel-Molybdenum-Chromium Alloy UNS N10276 | Low-Carbon Nickel-Molybdenum-Chromium Alloy UNS N10362 | Nickel-Molybdenum-Chromium-Iron Alloy UNS N10624 | Nickel-Molybdenum Alloy UNS N10629 | Nickel-Molybdenum Alloy UNS N10665 | Nickel-Molybdenum Alloy UNS N10675 | Nickel-Cobalt-Chromium-Silicon Alloy UNS N12160 | Chromium-Nickel-Iron-Nitrogen Alloy UNS R200033 | |
| Nickel | balance ^B | balance ^B | balance ^B | balance ^B | balance | balance ^B | 65.0 min | balance ^B | 30.0–33.0 | |
| Copper | ... | ... | ... | 0.5 | 0.5 | ... | 0.20 | ... | 0.30–1.20 | |
| Iron | 2.0 | 4.0–7.0 | 1.25 | 5.0–8.0 | 1.0–6.0 | 2.0 | 1.0–3.0 | 3.5 | balance ^B | |
| Manganese | 0.80 | 1.0 | 0.60 | 1.0 | 1.5 | 1.0 | 3.0 | 1.5 | 2.0 | |
| Carbon | 0.03 | 0.010 | 0.010 | 0.01 | 0.010 | 0.02 | 0.01 | 0.15 | 0.015 | |
| Silicon | 0.80 | 0.08 | 0.08 | 0.10 | 0.05 | 0.10 | 0.10 | 2.4–3.0 | 0.50 | |
| Sulfur | 0.015 | 0.03 | 0.010 | 0.01 | 0.01 | 0.03 | 0.010 | 0.015 | 0.01 | |
| Chromium | 7.0–9.0 | 14.5–16.5 | 13.8–15.6 | 6.0–10.0 | 0.5–1.5 | 1.0 | 1.0–3.0 | 26.0–30.0 | 31.0–35.0 | |
| Aluminum | 0.50 | ... | 0.50 | 0.5 | 0.1–0.5 | ... | 0.50 | ... | ... | |
| Titanium | ... | ... | ... | ... | ... | ... | 0.20 | 0.20–0.80 | ... | |
| Columbium | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| (Nb) + Tantalum | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Molybdenum | 24.0–26.0 | 15.0–17.0 | 21.5–23.0 | 21.0–25.0 | 26.0–30.0 | 26.0–30.0 | 27.0–32.0 | 1.0 | 0.50–2.0 | |
| Phosphorus | 0.030 | 0.04 | 0.025 | 0.025 | 0.04 | 0.04 | 0.030 | 0.030 | 0.02 | |
| Tungsten | ... | 3.0–4.5 | ... | ... | ... | ... | 3.0 | 1.0 | ... | |
| Cobalt | 1.00 | 2.5 | ... | 1.0 | 2.5 | 1.00 | 3.0 | 27.0–33.0 | ... | |
| Vanadium | ... | 0.35 | ... | ... | ... | ... | 0.20 | ... | ... | |
| Nitrogen | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Boron | 0.006 | ... | ... | ... | ... | ... | ... | ... | 0.35–0.60 | |
| Lanthanum | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Aluminum + Titanium | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Nickel + Molybdenum | ... | ... | ... | ... | ... | ... | 94.0–98.0 | ... | ... | |
| Columbium | ... | ... | ... | ... | ... | ... | 0.20 | 1.0 | ... | |
| (Nb) | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Tantalum | ... | ... | ... | ... | ... | ... | 0.20 | ... | ... | |
| Zirconium | ... | ... | ... | ... | ... | ... | 0.10 | ... | ... | |
| Cerium | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Yttrium | ... | ... | ... | ... | ... | ... | ... | ... | ... | |

^A Maximum unless range or minimum is given. Where ellipses (...) appear in this table there is no requirement and the element need neither be analyzed for nor reported.
^B Element shall be determined arithmetically by difference.

TABLE 2 Mechanical Property Requirements^A

| Material and Condition | Maximum Section Thickness, Thickness or Diameter, in. (mm) | Tensile Strength, min, ksi (MPa) | Yield Strength, 0.2 % Offset, min, ksi (MPa) | Elongation in 2 in. or 50 mm or 4D, min, % |
|---|--|----------------------------------|--|--|
| Iron-nickel-chromium-molybdenum-nitrogen alloy UNS N08367, solution annealed | ... | 95 (655) | 45 (310) | 30 |
| Low-carbon chromium-nickel-iron-nitrogen alloy UNS R20033, solution annealed | ... | 109 (750) | 55 (380) | 40 |
| Low-carbon nickel-chromium-molybdenum alloy UNS N06035, solution annealed | ... | 85 (586) | 35 (241) | 30 |
| alloy UNS N06044, solution annealed | ... | 100 (690) | 45 (310) | 30 |
| alloy UNS N06058, solution annealed | ... | 110 (760) | 52 (360) | 40 |
| alloy UNS N06059, solution annealed | ... | 100 (690) | 45 (310) | 45 |
| Low-carbon nickel-chromium-molybdenum-copper alloy UNS N06200, solution annealed | ... | 100 (690) | 45 (310) | 45 |
| Low-carbon nickel-chromium-molybdenum-tungsten alloy UNS N06686, solution annealed | ... | 100 (690) | 45 (310) | 45 |
| Low-carbon nickel-iron-chromium-molybdenum-copper alloy UNS N08031, solution annealed | ... | 94 (650) | 40 (276) | 40 |
| UNS N08034, solution annealed | ... | 94 (650) | 40 (280) | 40 |
| Low-carbon nickel-chromium-molybdenum alloy UNS N10276, solution annealed | ... | 100 (690) | 41 (283) | 40 |
| Low-carbon nickel-chromium-molybdenum alloy UNS N06022, solution annealed | ... | 100 (690) | 45 (310) | 45 |
| Low-carbon nickel-molybdenum-chromium UNS N10362, solution annealed | ... | 105 (725) | 45 (310) | 40 |
| Low-carbon nickel-molybdenum-chromium-tantalum alloy UNS N06210, solution annealed | ... | 100 (690) | 45 (310) | 45 |
| Nickel alloy UNS N02200, annealed | ... | 55 (380) | 15 (105) | 40 |
| Nickel-cobalt-chromium-silicon alloy UNS N12160, solution annealed | ... | 90 (620) | 35 (240) | 40 |
| Nickel-chromium-aluminum alloy UNS N06699, solution annealed | ... | 89 (610) | 35 (240) | 40 |
| Nickel-chromium-cobalt-molybdenum alloy UNS N06617, annealed | ... | 95 (655) | 35 (241) | 35 |
| Nickel-chromium-iron alloy UNS N06600, annealed | ... | 80 (552) | 35 (241) | 30 |
| Nickel-chromium-iron-aluminum alloy UNS N06603, annealed | ... | 94 (650) | 43 (300) | 25 |
| Nickel-chromium-iron alloy UNS N06690, annealed | ... | 85 (586) | 35 (241) | 30 |
| Nickel-chromium-iron-aluminum alloy UNS N06025, solution annealed | Up to 4 (102) Over 4 (102) to 12 (305) incl | 98 (680) 84 (580) | 39 (270) 39 (270) | 30 15 |
| Nickel-chromium-iron-silicon alloy UNS N06045, solution annealed | ... | 90 (620) | 35 (240) | 35 |
| Nickel-chromium-molybdenum-columbium alloy UNS N06625, annealed | Up to 4 (102), incl Over 4 ^B (102) to 10 (254), incl | 120 (827) 110 (758) | 60 (414) 50 (345) | 30 25 |
| Nickel-chromium-molybdenum-columbium alloy UNS N06625 grade 1, (annealed) ^B | Up to 4 (102), incl Over 4 (102) to 10 (254), incl | 120 (827) 110 (758) | 60 (414) 50 (345) | 30 25 |
| Nickel-chromium-molybdenum-columbium alloy UNS N06625 grade 2, (solution annealed) ^C | All sizes | 100 (690) | 40 (276) | 30 |
| Nickel-chromium-molybdenum-silicon alloy UNS N06219, solution annealed | ... | 96 (660) | 39 (270) | 50 |
| Nickel-chromium-molybdenum-tungsten alloy UNS N06110, annealed | Up to 4 (102), incl Over 4 (102) to 10 (254), incl | 95 (655) 90 (621) | 45 (310) 40 (276) | 60 50 |