Designation: B564 – 22

Standard Specification for Nickel Alloy Forgings[1]

This standard is issued under the fixed designation B564; 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[2] 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). Alloys UNS N08810, N08120, and UNS N08811 are normally employed in service temperatures above 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.

1.1.2 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

[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.

[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.

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

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).

3.1.4 Forging, sketch or drawing.

3.1.5 *Certification*—State if certification or a report of test results is required (14.1).

3.1.6 *Samples for Product (Check) Analysis*—Whether samples for product (check) analysis should be furnished (see 4.2).

3.1.7 *Purchaser Inspection*—If the purchaser wishes to witness tests or inspection of material at the place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (12.1).

4. Chemical Composition

4.1 The material shall conform to the composition limits specified in Table 1.

4.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in accordance with Specification B880.

5. Mechanical Properties and Other Requirements

5.1 *Mechanical Properties*—The material shall conform to the mechanical properties specified in Table 2.

5.2 *Grain Size*—Annealed alloys UNS N08810, N08120, and UNS N08811 shall conform to an average grain size of ASTM No. 5 or coarser. Annealed alloy UNS N06674 shall conform to an average grain size of ASTM No. 7 or coarser.

6. Dimensions and Permissible Variations

6.1 Dimensions and tolerances shall be as specified on the applicable forging sketch or drawing.

7. Workmanship, Finish, and Appearance

7.1 The material shall be uniform in quality and condition, sound, and free of injurious imperfections.

8. Sampling

8.1 *Lot Definition:*

8.1.1 A lot for chemical analysis shall consist of one heat.

8.1.2 A lot for mechanical properties and grain size testing shall consist of all material from the same heat, size, finish, condition, and processed at one time.

8.2 *Test Material Selection:*

8.2.1 *Chemical Analysis*—Representative samples shall be taken during pouring or subsequent processing.

8.2.1.1 Product (check) analysis shall be wholly the responsibility of the purchaser.

8.2.2 *Mechanical Properties and Grain Size*—Samples of the material to provide test specimens for mechanical properties and grain size shall be taken from such locations in each lot as to be representative of that lot.

9. Number of Tests

9.1 *Chemical Analysis*—One test per lot.

9.2 *Mechanical Properties*—One test per lot.

9.3 *Grain Size*—For alloys N08810, N08120, UNS N08811, and N06674, one test per lot.

10. Specimen Preparation

10.1 The tension test specimen representing each lot shall be taken from a forging or from a test prolongation.

10.2 The axis of the specimen shall be located at any point midway between the center and the surface of solid forgings and at any point midway between the inner and outer surfaces of the wall of hollow forgings, and shall be parallel to the direction of greatest metal flow. Specimens transverse to the direction of flow may be used provided all other requirements of this standard are satisfied.

10.3 The specimens shall be the largest possible round type shown in Test Methods E8/E8M.

11. Test Methods

11.1 The chemical composition, mechanical, and other properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following methods:

Test	ASTM Designation
Chemical Analysis	E76, E350, E1473
Tension	E8/E8M
Rounding Procedure	E29
Grain Size	E112

11.2 The measurement of average grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Test Methods E112. In case of dispute, the "referee" method for determining average grain size shall be the planimetric method.

11.3 For purposes of determining compliance with the specified limits for requirements of the properties listed in the

[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-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	0.3 max	21.0-25.0	1.5	1.5	1.0
Manganese	0.35	2.0	0.50	0.15	0.50	0.07-0.30	1.0	0.50	0.5	1.0
Carbon	0.15	0.3	0.015	0.15-0.25	0.050	0.02 max	0.05-0.12	0.010	0.010	0.15
Silicon	0.35	0.5	0.08	0.5	0.60	0.20 max	2.5-3.0	0.10	0.10	1.0
Sulfur	0.01	0.024	0.02	0.01	0.015	0.020 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 (Nb) + Tantalum	...	...	...	...	...	...	...	...	...	1.0
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	0.3	...
Vanadium	...	...	0.35	...	0.20	...	...	...	...	...
Nitrogen	...	...	...	...	...	...	...	0.02 - 0.15	...	...
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.