Designation: B 462 – 06

Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service[1]

This standard is issued under the fixed designation B 462; 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.

1. Scope

1.1 This specification[2] covers forged or rolled UNS N06030, UNS N06035, UNS N06022, UNS N06200, UNS N06059, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033* pipe flanges, forged fittings, and valves and parts intended for corrosive high-temperature service.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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 Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [3]

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
B 166 Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, and N06045)* and Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617) Rod, Bar, and Wire
B 335 Specification for Nickel-Molybdenum Alloy Rod
B 408 Specification for Nickel-Iron-Chromium Alloy Rod and Bar
B 472 Specification for Nickel Alloy Billets and Bars for Reforging
B 473 Specification for UNS N08020, UNS N08024, and UNS N08026 Nickel Alloy Bar and Wire
B 574 Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Molybdenum-Chromium-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod
B 581 Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Rod
B 649 Specification for Ni-Fe-Cr-Mo-Cu-N Low-Carbon Alloys (UNS N08925, UNS N08031, UNS N08354, and UNS N08926), and Cr-Ni-Fe-N Low-Carbon Alloy (UNS R20033) Bar and Wire, and Ni-Cr-Fe-Mo-N Alloy (UNS N08936) Wire
B 691 Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire
B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys
E 8 Test Methods for Tension Testing of Metallic Materials
E 527 Practice for Numbering Metals and Alloys (UNS)
E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

[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-462 in Section II of that Code.

* New designation established in accordance with Practice E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

[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.

E 1916 Guide for Identification and/or Segregation of Mixed Lots of Metals

2.2 *ANSI Standard:*

B16.5 Steel Pipe Flanges and Flanged Fittings (for applicable alloy UNS N08020)[4]

2.3 *Manufacturers' Standardization Society of the Valve and Fittings Industry Standard:*

SP-25 Standard Marking System for Valves, Fittings, Flanges, and Unions[5]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *forgings*, *n*—the term forgings as used in this specification shall be understood to cover one or all of the products mentioned in 1.1, either forged or rolled.

4. Ordering Information

4.1 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:

4.1.1 Quantity (weight or number of pieces),

4.1.2 Name of material or UNS number,

4.1.3 Forging sketch when required (5.2.4),

4.1.4 Forging sectioning, if required (5.2.3),

4.1.5 ASTM designation and year of issue,

4.1.6 Inspection (14.1),

4.1.7 Supplementary requirements, if any, and

4.1.8 If possible, the intended end use.

NOTE 1—A typical ordering description is as follows: 200 forgings, UNS N08020, in accordance with the attached drawing and Specification B 462.

5. Materials and Manufacture

5.1 *Discard*—A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation. The material shall have a homogeneous structure as shown by the macroetch test in 7.3.

5.2 *Manufacturing Practice*:

5.2.1 Material for forging shall consist of a billet, bar, or forging produced in accordance with Specifications B 166, B 335, B 408, B 462, B 472, B 473, B 574, B 581, B 649, or B 691.

5.2.2 The material shall be forged by hammering, pressing, rolling, extruding, or upsetting; it shall be brought as nearly as practicable to the finished shape and size by hot working; and shall be so processed as to cause metal flow during the hot-working operation in the direction most favorable for resisting the stresses encountered in service.

5.2.3 When specified in the order, a sample forging may be sectioned and etched to show flow lines and the condition as regards internal imperfections. In such cases, the question of acceptable and unacceptable character of metal flow shall be a subject for agreement between the manufacturer and the purchaser.

5.2.4 When specified in the order, the manufacturer shall submit for approval of the purchaser a sketch showing the shape of the rough forging before machining.

5.3 *Heat Treatment*:

5.3.1 The product of UNS N08020 alloy shall be furnished in the stabilized-annealed condition. The product of UNS N08024 shall be furnished in the annealed condition. The product of UNS N06022, UNS N06035, UNS N08026, UNS N06030, UNS N06200, UNS N10276, UNS N10665, UNS N10675, and UNS R20033 alloys shall be furnished in the solution annealed condition.

NOTE 2—The recommended annealing temperatures all followed by water quenching or rapidly cooling by other means are: UNS N06030–2125 to 2175°F (1163 to 1191°C), UNS N06022–2025 to 2075°F (1107 to 1135°C), UNS N06035–2025–2075°F (1107–1135°C), UNS N06200–2075 to 2125°F (1135 to 1163°C), UNS N06059–2025 to 2125°F (1107 to 1163°C), UNS N06686–2125 to 2225°F (1163 to 1218°C), UNS N08020–1700 to 1850°F (927 to 1010°C), UNS N08024–1925 to 1975°F (1052 to 1079°C), UNS N08026–2050 to 2200°F (1121 to 1204°C), UNS N10276–2025 to 2075°F (1107 to 1135°C), UNS N10665–1925 to 2000°F (1052 to 1093°C), UNS N10675–1925 to 2000°F (1052 to 1093°C), UNS N10629–1925 to 2000°F (1052 to 1093°C), UNS N08031–2050 to 2160°F (1121 to 1182°C) UNS N06045–2125 to 2190°F (1163 to 1199°C), UNS N06025–2175 to 2240°F (1191 to 1227°C), and UNS R20033–2010 to 2150°F (1100 to 1180°C).

5.3.2 Alloy N08367 shall be furnished in the solution annealed condition.

5.3.2.1 The recommended heat treatment shall consist of heating to a minimum temperature of 2025°F (1105°C) and quenching in water, or rapidly cooling, by other means.

5.3.3 Heat treatment may be performed before machining.

6. Chemical Composition

6.1 The material shall conform to the requirements as to chemical composition prescribed in Table 1.

6.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the requirements specified in Table 1 subject to the permissible tolerances in Specification B 880.

7. Mechanical Properties and Other Requirements

7.1 *Mechanical Properties*—The material shall conform to the requirements as to mechanical properties prescribed in Table 2 at room temperature.

7.2 *Hydrostatic Tests*—After machining, valve bodies, fittings, and other pressure-containing parts shall be tested to the hydrostatic shell-test pressures prescribed in ANSI B16.5 for the applicable alloy steel rating for which the forging is designed and shall show no leaks. Forgings ordered under these specifications for working pressures other than those listed in the American National Standard ratings shall be tested to such pressures as may be agreed upon between the manufacturer and the purchaser.

7.2.1 No hydrostatic test is required for welding neck or other flanges.

7.2.2 The forging manufacturer is not required to perform pressure tests on rough forgings that are to be finally machined

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[5] Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602.

TABLE 1 Chemical Requirements

Element	Composition, %				
	UNS N08026	UNS N08020	UNS N08024	UNS N08367	UNS R20033
Carbon, max	0.03	0.07	0.03	0.030	0.015
Manganese, max	1.00	2.00	1.00	2.00	2.0
Phosphorus, max	0.03	0.045	0.035	0.040	0.02
Sulfur, max	0.03	0.035	0.035	0.030	0.01
Silicon, max	0.50	1.00	0.50	1.00	0.50
Nickel	33.00–37.20	32.00–38.00	35.00–40.00	23.50 to 25.50	30.0–33.0
Chromium	22.00–26.00	19.00–21.00	22.50–25.00	20.00 to 22.00	31.0–35.0
Molybdenum	5.00–6.70	2.00–3.00	3.50–5.00	6.00 to 7.00	0.50–2.0
Copper	2.00–4.00	3.00–4.00	0.50–1.50	0.75 max	0.30–1.20
Columbium (Nb) + tantalum	...	8 × carbon–1.00	0.15–0.35	...	...
Nitrogen	0.10–0.16	...	...	0.18 to 0.25	0.35–0.60
Iron	Remainder[A]	Remainder[A]	Remainder[A]	Remainder[A]	Remainder[A]

Element	Composition, %					
	UNS N06030	UNS N06022	UNS N06200	UNS N10276	UNS N10665	UNS N10675
Carbon, max	0.03	0.015	0.010	0.010	0.02	0.01
Manganese, max	1.5	0.50	0.50	1.0	1.0	3.0
Phosphorous, max	0.04	0.02	0.025	0.04	0.04	0.030
Sulfur, max	0.02	0.02	0.010	0.03	0.03	0.010
Silicon, max	0.8	0.08	0.08	0.08	0.10	0.10
Nickel	Remainder[A]	Remainder[A]	Remainder[A]	Remainder[A]	Remainder[A]	Remainder[A]
Chromium	28.0-31.5	20.0-22.5	22.0-24.0	14.5-16.5	1.0 max	1.0-3.0
Molybdenum	4.0-6.0	12.5-14.5	15.0-17.0	15.0-17.0	26.0-30.0	27.0-32.0
Copper	1.0-2.4	...	1.3-1.9	...	...	0.20
Columbium (Nb) + tantalum	0.30-1.50	...	...	...	...	...
Nitrogen	...	...	...	...	...	...
Iron	13.0-17.0	2.0-6.0	3.0 max	4.0-7.0	2.0 max	1.0-3.0
Cobalt, max	5.0	2.5	2.0	2.5	1.0	3.0
Tungsten	1.5-4.0	2.5-3.5	...	3.0-4.5	...	3.0 max
Vanadium, max	...	0.35	...	0.35	...	0.20
Titanium, max	...	...	...	...	...	0.2
Zirconium, max	...	...	...	...	...	0.10
Columbium (Nb)	...	...	...	...	...	0.20 max
Tantalum	...	...	...	...	...	0.20 max
Nickel + Molybdenum	...	...	...	...	...	94.0-98.0
Aluminum, max	...	...	0.50	...	...	0.50

Element	Composition, %						
	UNS N06059	UNS N06686	UNS N08031	UNS N06045	UNS N06025	UNS N10629	UNS N06035
Carbon, max	0.010	0.010	0.015	0.05-0.12	0.15-0.25	0.01	0.050
Manganese, max	0.5	0.75	2.0	1.0	0.15	1.5	0.50
Phosphorous, max	0.015	0.04	0.020	0.02	0.02	0.040	0.030
Sulfur, max	0.010	0.02	0.010	0.010	0.010	0.010	0.015
Silicon, max	0.10	0.08	0.3	2.5-3.0	0.5	0.05	0.60
Nickel	Remainder[A]	Remainder[A]	30.0-32.0	45.0 min	Remainder[A]	Remainder[A]	Remainder[A]
Chromium	22.0-24.0	19.0-23.0	26.0-28.0	26.0-29.0	24.0-26.0	0.5-1.5	32.25–34.25
Molybdenum	15.0-16.5	15.0-17.0	6.0-7.0	...	...	26.0-30.0	7.60–9.00
Copper	0.50 max	...	1.0-1.4	0.3 max	0.1 max	0.5	0.30 max
Yttrium	...	...	...	...	0.05-0.12	...	...
Nitrogen	...		0.15-0.25	...		...	...
Iron	1.5 max	5.0 max	Remainder[A]	21.0–25.0	8.0–11.0	1.0-6.0	2.00 max
Cobalt, max	0.3	...	...	...	...	2.5	1.00
Tungsten	...	3.0–4.4	...	...	...	...	0.60 max
Vanadium, max	...	...	...	...	...	...	0.20
Titanium, max	...	0.02–0.25	...	...	0.1-0.2	...	...
Zirconium, max	...	...	...	...	0.01-0.10	...	...
Columbium (Nb)	...	...	...	...	...	...	...
Tantalum	...	...	...	...	...	...	...
Cerium	...	...	...	0.03-0.09	...	...	...
Aluminum, max	0.1-0.4	...	...	...	1.8-2.4	0.1–0.5	0.40

[A] Shall be determined arithmetically by difference.

by others. The fabricator of finished forged parts is not required to pressure-test forgings that are designed to be pressure containing only after assembly by welding into a larger structure. However, the manufacturer of such forgings is responsible as required in accordance with 15.1 for the satisfactory performance of the forgings under the final test required in 7.2.

TABLE 2 Mechanical Property Requirements

Alloy	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %
	ksi	MPa	ksi	MPa		
UNS N08020, UNS N08024, and UNS N08026	80	551	35	241	30.0	50.0
UNS N08367	95	655	45	310	30.0	50.0
UNS R20033	109	750	55	380	40.0	...
UNS N06030	85	586	35	241	30	...
UNS N06022	100	690	45	310	45	...
UNS N06035	85	586	35	241	30	...
UNS N06200	100	690	45	310	45	...
UNS N10276	100	690	41	283	40	...
UNS N10665	110	760	51	350	40	...
UNS N10675	110	760	51	350	40	...
UNS N06059	100	690	45	310	45	...
UNS N06686	100	690	45	310	45	...
UNS N08031	94	650	40	276	40.0	...
UNS N06045	90	620	35	241	35	...
UNS N06025	98	680	39	270	30	...
UNS N10629	110	760	51	350	40	...

7.3 *Macroetch Tests*— Etching of tests shall show sound and reasonably uniform material, free of injurious laminations, cracks, segregations, and similar objectionable defects. If, on successive tests, 10 % of any heat fails to pass the requirements of the macroetch test, all forgings from that heat shall be rejected.

8. Dimensions and Permissible Variations

8.1 The forgings shall conform to the sizes and shapes specified by the purchaser.

9. Workmanship, Finish, and Appearance

9.1 The forgings shall be uniform in quality and condition, and shall be free of injurious defects.

10. Sampling

10.1 *Lot*—Definition:

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

10.1.2 A lot for mechanical properties shall consist of each heat in each heat-treatment charge.

10.2 *Test Material Selection*:

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

10.2.1.1 *Check analysis*, shall be wholly the responsibility of the purchaser.

10.2.2 *Mechanical Properties*—Samples of the material to provide test specimens shall be taken from such locations in each lot as to be representative of that lot.

11. Number of Tests

11.1 *Chemical Analysis*—One test per lot.

11.2 *Mechanical Properties*—One test per lot.

12. Specimen Preparation

12.1 The tension test specimens taken from the forgings, billets, or bars shall be machined to the form and dimensions of the standard 2-in. (50.8-mm) gage length tension test specimen shown in the figure titled Standard 0.500 in. Round Tension Test Specimen with 2 in. Gage Length and Examples of Small-Size Specimens Proportional to the Standard Specimen of Test Methods E 8, except as specified in 12.2.

12.2 In the case of small sections that will not permit taking the standard test specimen specified in 12.1, the tension test specimen shall be as large as feasible and its dimensions shall be proportional to those shown in the figure titled Standard 0.500 in. Round Tension Test Specimen with 2 in. Gage Length and Examples of Small-Size Specimens Proportional to the Standard Specimen of Test Methods E 8. The gage length for measuring elongation shall be four times the diameter of the specimen.

12.3 For the purpose of tests, the necessary extra forgings or test bars shall be provided. The test specimen, if cut from a flange, shall be cut tangentially from the flange portion approximately midway between the inner and outer surfaces and approximately midway between the front and back faces. When it is impractical to provide forgings for test purposes, test bars may be made from the billet or bar, provided they are given approximately the same reduction and heat treatment as the forgings.

13. Tests Methods

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

Test	ASTM Designations
Chemical analysis	E 1473[A]
Tension	E 8

[A] Iron shall be determined arithmetically by difference.

14. Inspection

14.1 If specified, source inspection of the material by the purchaser at the manufacturer's plant shall be made as agreed upon between the manufacturer and the purchaser as part of the purchase contract.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported

to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

16. Certification

16.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

17. Product Marking

17.1 Identification marks consisting of the manufacturer's symbol or name, designation of service rating, the specification, the grade of material, and the size shall be stamped legibly on each forging in accordance with MSS SP-25 and in such position as not to injure the usefulness of the forging.

18. Keywords

18.1 forgings; UNS N06030; UNS N06022; UNS N06035; UNS N06200; UNS N06059; UNS N06686; UNS N08020; UNS N08024; UNS N08026; UNS N08367; UNS N10276; UNS N10665; UNS N10675; UNS N10629; UNS N08031; UNS N06045; UNS N06025; UNS R20033

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall be applied only when specified by the purchaser in the inquiry, contract, or order.

S1. Corrosion Tests for UNS N08020

S1.1 One intergranular corrosion test per heat shall be performed by the manufacturer on a sensitized specimen and tested in accordance with Practices A 262. When this supplementary requirement is specified, the specific practice (Practice B or Practice E) shall also be specified. If Practice B is specified, the specimen must pass with a rate of less than 0.002 inches per month (ipm).

S1.1.1 In addition to the stabilize anneal, the specimen shall be sensitized for 1 h at 1250°F (677°C) before being subjected to corrosion testing.

S2. Positive Material Identification Examination

S2.1 Product shall receive Positive Material Identification to ensure that the purchaser is receiving product of the correct material grade prior to shipment of the product. This examination is a method to assure that no material grade mix-up has happened during manufacturing and marking of the product.

S2.2 Product shall receive a Positive Material Identification examination by Guide E 1916.

S2.3 The quantity examined shall be 100 % of the product.

S2.4 All product that is not of the correct material grade shall be rejected.

S2.5 The method of product marking after examination shall be agreed upon between the manufacturer and purchaser.