



Designation: B444 – 16<sup>ε</sup><sup>1</sup>

# Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloys (UNS N06625 and UNS N06852) and Nickel-Chromium- Molybdenum-Silicon Alloy (UNS N06219) Pipe and Tube<sup>1</sup>

This standard is issued under the fixed designation B444; 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 ( $\epsilon$ ) 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.*

<sup>ε</sup>1 NOTE—Table 2 was editorially corrected in August 2016.

## 1. Scope\*

1.1 This specification<sup>2</sup> covers nickel-chromium-molybdenum-columbium alloys (UNS N06625 and UNS N06852) and nickel-chromium-molybdenum-silicon alloy (UNS N06219)<sup>3</sup> in the form of cold-worked seamless pipe and tube. The general requirements for pipe and tube are covered by Specification B829.

1.1.1 UNS N06625 products are furnished in two grades of different heat-treated conditions:

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

1.1.1.2 *Grade 2 (solution annealed)*—Material is normally employed in service temperatures above 1100°F (593°C) when resistance to creep and rupture is required.

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

1.1.2 Alloys UNS N06219 and UNS N06852 are supplied in the solution annealed condition only.

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 The following precautionary caveat pertains only to the test methods portion, Section 9, of this specification: *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 and health practices, and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 ASTM Standards:<sup>4</sup>

B829 Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube

E112 Test Methods for Determining Average Grain Size

G28 Test Methods for Detecting Susceptibility to Intergranular Corrosion in Wrought, Nickel-Rich, Chromium-Bearing Alloys

G48 Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

## 3. General Requirement

3.1 Material furnished under this specification shall conform to the applicable requirements of Specification B829 unless otherwise provided herein.

## 4. Ordering Information

4.1 Orders for material to this specification shall include information with respect to the following:

4.1.1 Alloy name or UNS number,

4.1.2 ASTM designation,

4.1.3 Condition (temper) (see 1.1.1, 1.1.2, Section 6, and Appendix X1 and Appendix X2),

4.1.3.1 If neither grade of N06625 is specified, Grade 1 will be supplied.

4.1.4 Finish (See Appendix X2),

4.1.5 Dimensions:

<sup>1</sup> 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.

Current edition approved June 1, 2016. Published June 2016. Originally approved in 1966. Last previous edition approved in 2011 as B444 – 06 (2011). DOI: 10.1520/B0444-16E01.

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-444 in Section II of that Code.

<sup>3</sup> New designation established in accordance with Practice E527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

<sup>4</sup> 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

4.1.5.1 *Tube*—Specify outside diameter and nominal or minimum wall,

4.1.5.2 *Pipe*—Specify standard pipe size and schedule,

4.1.5.3 *Length*—Cut to length or random,

4.1.6 *Quantity*—Feet (or metres) or number of pieces,

4.1.7 *Hydrostatic Test or Nondestructive Electric Test*—Specify type of test (see 6.2),

4.1.8 *Hydrostatic Pressure Requirements*—Specify test pressure if other than required by 9.1.1,

4.1.9 *Certification*—State if certification is required,

4.1.10 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis should be furnished (see 5.2),

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

4.1.12 *Small-Diameter and Light-Wall Tube (Converter Sizes)*—See Appendix X1 and Table 1.

4.1.13 *Supplementary Ordering Requirements*: Grain Size Test (S1); Intergranular Corrosion Test (S2); Pitting and Crevice Corrosion Test (S3) may be ordered as an option by the purchaser in the purchase order indicating which tests are to be included.

## 5. Chemical Composition

5.1 The material shall conform to the composition limits specified in Table 2. One test is required for each lot as defined in Specification B829.

5.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Table 2 of Specification B829.

## 6. Mechanical Properties and Other Requirements

6.1 *Tension Test*—The material shall conform to the tensile properties specified in Table 1. The sampling and specimen preparation are as covered in Specification B829.

**TABLE 1 Room Temperature Tensile Properties and Heat Treatment Including Small Diameter and Light-Wall Tubing (Converter Sizes)<sup>A,B</sup>**

Condition	Tensile Strength, min, ksi (MPa) <sup>C</sup>	Yield Strength (0.2 % offset), min, ksi (MPa) <sup>C</sup>	Elongation
			in 2 in. or 50.8 mm (or 4 D), min, %
Alloy N06625			
Grade 1 (annealed) <sup>D</sup>	120 (827)	60 (414)	30
Grade 2 (solution annealed) <sup>E</sup>	100 (690)	40 (276)	30
Alloy N06219			
All (solution annealed)	96 (660)	39 (270)	30
Alloy N06852			
All (solution annealed)	85 (586)	35 (241)	30

<sup>A</sup> Not applicable to outside diameters under 1/8 in. (3.2 mm) and to wall thicknesses under 0.015 in. (0.38 mm).

<sup>B</sup> Hot forming quality pipe and tubing is furnished to chemical requirements and surface inspection only. No tensile properties are required.

<sup>C</sup> The minimum strength values apply only to tubing in straight lengths.

<sup>D</sup> Annealed at 1600°F (871°C) minimum.

<sup>E</sup> Solution annealed at 2000°F (1093°C) minimum, with or without subsequent stabilization anneal at 1800°F (982°C) minimum to increase resistance to sensitization.

**TABLE 2 Chemical Requirements**

Element	Composition Limits, %		
	N06852	N06625	N06219
Carbon	0.05 max	0.10 max	0.05 max
Manganese	0.50 max	0.50 max	0.50 max
Silicon	0.50 max	0.50 max	0.70-1.10
Phosphorus	0.015 max	0.015 max	0.020 max
Sulfur	0.015 max	0.015 max	0.010 max
Chromium	20.0-23.0	20.0 min	18.0-22.0
	...	23.0 max	...
Columbium + tantalum	...	3.15 min	...
	...	4.15 max	...
Columbium	0.51-1.00	...	...
Cobalt (if determined)	...	1.0 max	1.0 max
Molybdenum	8.0-10.0	8.0 min	7.0-9.0
		10.0 max	...
Iron	15.0-20.0	5.0 max	2.0-4.0
Aluminum	0.40 max	0.40 max	0.50 max
Titanium	0.40 max	0.40 max	0.50 max
Copper	...	...	0.50 max
Nickel <sup>A</sup>	Bal.	58.0 min	Bal.

<sup>A</sup> Element shall be determined arithmetically by difference.

6.2 *Hydrostatic or Nondestructive Electric Test*—Each pipe or tube shall be subjected to either the hydrostatic test or to the nondestructive electric test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

## 7. Dimensions and Permissible Variations

7.1 Permissible variations for material specified as small-diameter and light-wall tube (converter size) shall conform to the permissible variations prescribed in Table X1.1 and Table X1.2.

## 8. Number of Tests

8.1 *Chemical Analysis*—One test per lot.

8.2 *Tension*—One test per lot.

8.3 *Hydrostatic or Nondestructive Electric Test*—Each piece in each lot.

## 9. Test Methods

9.1 *Hydrostatic Test*—Each pipe or tube with an outside diameter 1/8 in. (3 mm) and larger and with wall thickness of 0.015 in. (0.38 mm) and over shall be tested in accordance with Specification B829. The allowable fiber stress for material in the condition furnished, is as follows:

UNS N06625:

Grade 1—30 000 psi (207 MPa)

Grade 2—25 000 psi (172 MPa)

UNS N06219:

All—24 000 psi (165 MPa)

UNS N06852:

All—21 000 psi (145 MPa)

9.1.1 When so agreed upon by the manufacturer and purchaser, pipe or tube may be tested to 1½ times the allowable fiber stress given above.

9.1.2 If any pipe or tube shows leak during hydrostatic testing, it shall be rejected.