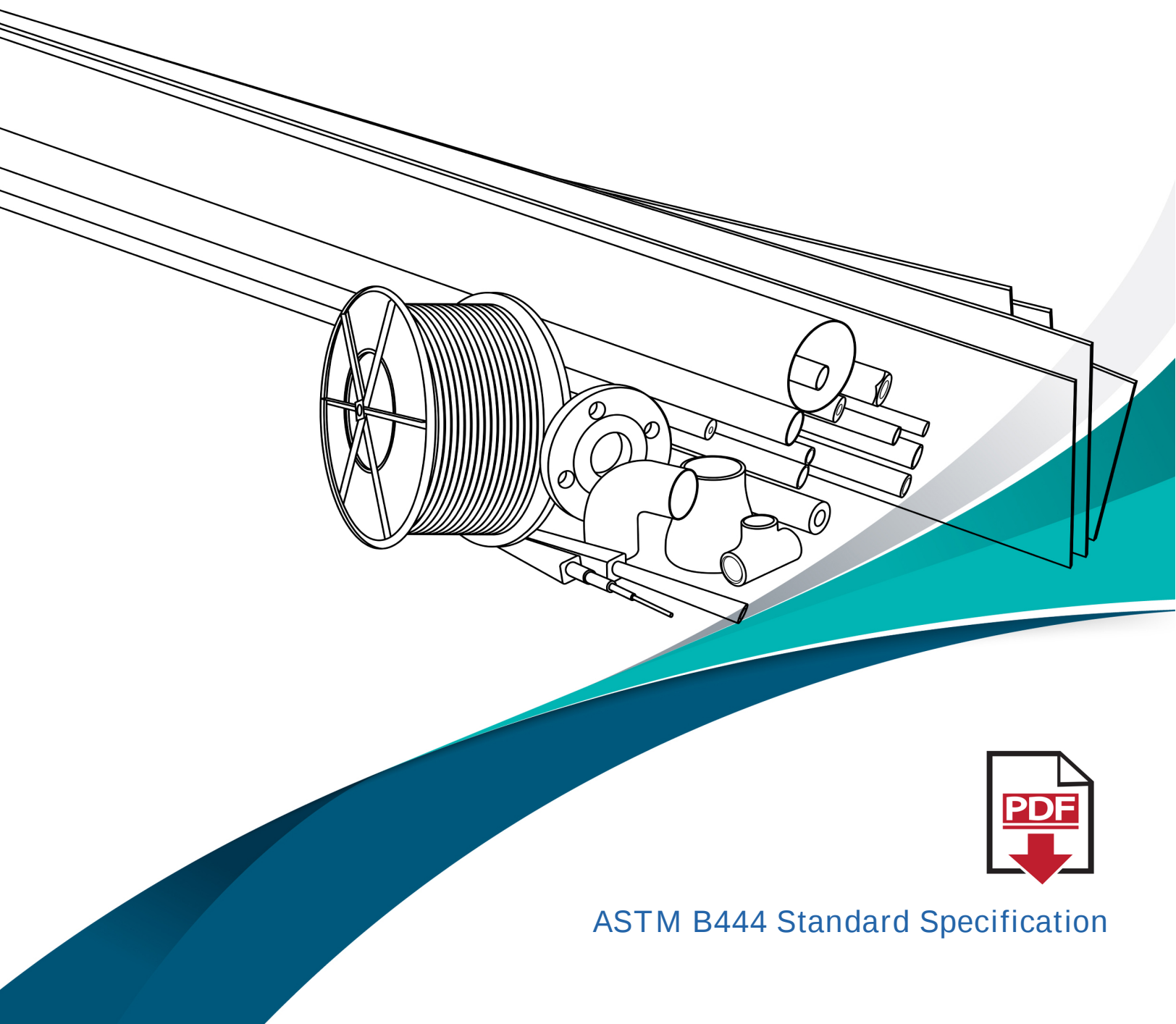




ASTM B444 Standard Specification

Designation: B 444 – 00<sup>e1</sup>

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

This standard is issued under the fixed designation B 444; 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 (e) indicates an editorial change since the last revision or reapproval.

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

<sup>e1</sup> NOTE—Sections 1.1.2, 4.1.3.1, and 9.1 were editorially altered in January 2001.

### 1. Scope

1.1 This specification<sup>2</sup> covers nickel-chromium-molybdenum-columbium alloy (UNS N06625) and nickel-chromium-molybdenum-silicon alloy (UNS N06219)\* in the form of cold-worked seamless pipe and tube. The general requirements for pipe and tube are covered by Specification B 829.

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 Alloy UNS N06219 is supplied in solution annealed condition only.

1.2 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 establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

~~B 829~~ Specification for General Requirements for Nickel and Nickel Alloy Seamless Pipe and Tube<sup>3</sup>

<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.

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\* New designation established in accordance with Practice E 527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

<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> *Annual Book of ASTM Standards*, Vol 02.04.

### 3. General Requirement

3.1 Material furnished under this specification shall conform to the applicable requirements of Specification B 829 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*:

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

4.1.8 *Certification*—State if certification is required,

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

4.1.10 *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

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

### 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 B 829.

5.2 If a product (check) analysis is performed by the

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**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 4D), 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                                             |

<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.

purchaser, the material shall conform to the product (check) analysis variations in Table 2 of Specification B 829.

## 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 B 829.

6.2 *Hydrostatic Test*— If any pipe or tube shows leaks during hydrostatic testing, it shall be rejected.

## 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*— 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 based on allowable fiber stress for material in the condition furnished, as follows:

N06625:

Grade 1—30 000 psi (207 MPa)

Grade 2—25 000 psi (172 MPa)

N06219:

All—24 000 psi (165 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.

**TABLE 2 Chemical Requirements**

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

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

## APPENDIXES

### (Nonmandatory Information)

#### X1. CONVERTER SIZES

X1.1 Small-diameter and light-wall tube in outside diameters 1¼ in. (31.8 mm) and under may be furnished in a limited range of sizes and the manufacturer should be consulted as to

the various outside diameters and wall thicknesses that may be furnished. Material will have a bright finish. Such material shall conform to the requirements in Tables X1.1 and X1.2.

**TABLE X1.2 Tolerances on Cut Lengths of Light-Wall Tube**

| Length, ft (m)                   | Tube Size, in. (mm)      | Permissible Variations, in. (mm) |       |
|----------------------------------|--------------------------|----------------------------------|-------|
|                                  |                          | Over                             | Under |
| Under 1 (0.30)                   | up to 1.250 (31.8), incl | 1/32 (0.8)                       | 0 (0) |
| 1 to 4 (0.30 to 1.22), incl      | up to 1.250 (31.8), incl | 1/16 (1.6)                       | 0 (0) |
| Over 4 to 10 (1.22 to 3.0), incl | up to 1.250 (31.8), incl | 3/32 (2.4)                       | 0 (0) |
| Over 10 (3.0)                    | up to 1.250 (31.8), incl | 3/16 (4.8)                       | 0 (0) |

TABLE X1.1 Permissible Variations for Small-Diameter and Light-Wall Tube (Converter Sizes)<sup>A,B,C,D,E,F,G</sup>

| Specified Outside Diameter, in. (mm) | Outside Diameter |                 | Inside Diameter |              | Wall Thickness, % |       |
|--------------------------------------|------------------|-----------------|-----------------|--------------|-------------------|-------|
|                                      | Plus             | Minus, in. (mm) | Plus            | Minus        | Plus              | Minus |
| Under 3/32 (2.4)                     | 0.002 (0.05)     | 0               | 0               | 0.002 (0.05) | 10                | 10    |
| 3/32 to 3/16 (2.4 to 4.8), excl      | 0.003 (0.08)     | 0               | 0               | 0.003 (0.08) | 10                | 10    |
| 3/16 to 1/2 (4.8 to 12.7), excl      | 0.004 (0.10)     | 0               | 0               | 0.004 (0.10) | 10                | 10    |
| 1/2 to 1 1/4 (12.7 to 31.8), incl    | 0.005 (0.13)     | 0               | 0               | 0.005 (0.13) | 10                | 10    |

<sup>A</sup>*Ovality, Normal-Wall Tube*—Ovality will be held within 2 % of the theoretical average outside diameter.

<sup>B</sup>*Ovality, Light-Wall Tube*—Ovality will be held within 3 % of the theoretical average outside diameter.

<sup>C</sup>*Wall Tolerances, Light-Wall Tube*—The plus and minus wall tolerance shown in the table shall apply down to and including 0.005 in. (0.13 mm) in wall thickness. For wall thicknesses less than 0.005 in. (0.13 mm), the tolerance shall be 60.0005 in. (0.013 mm).

<sup>D</sup>*Random Lengths:*

Where nominal random lengths on tubing 1/8 in. (3.2 mm) and larger in outside diameter are specified, a length tolerance of 3 1/2 ft (1.07 m) applies to the nominal length. This is a total spread of 7 ft (2.13 m).

Random lengths in sizes 1/8 in. (3.2 mm) and larger in outside diameter shall be subject to a length range of 5 to 24 ft (1.52 to 7.32 m). Long random lengths are subject to a range from 15 to 22 ft (4.57 to 6.71 m).

Random lengths in sizes up to, but not including 1/8 in. (3.2 mm) in outside diameter, and fragile light-wall tubes over this outside diameter are subject to the length range from 1 to 15 ft (0.30 to 4.57 m).

<sup>E</sup>*Cut Lengths*—Tolerances on cut lengths shall be in accordance with Table X1.2.

<sup>F</sup>*Straightness*—Round tubing is subject to a straightness tolerance of 1 part in 600 [equivalent to a depth of arc of 0.030 in. (0.76 mm) in any 3 ft (0.91 m) of length].

<sup>G</sup>When specified, the tolerance spreads of this table may be applied as desired. However, when not specified, the tolerances in this table will apply. It should be noted that inside diameter tolerances are based upon the outside diameter range.

## X2. CONDITIONS AND FINISHES NORMALLY SUPPLIED

### X2.1 Scope

X2.1.1 This appendix lists the conditions and finishes in which pipe and tube (other than converter sizes) are normally supplied. These are subject to change, and the manufacturer should be consulted for the latest information available.

### X2.2 Cold-Worked Tube and Pipe

X2.2.1 *Cold-Drawn, Annealed or Solution Annealed with Ground Outside Diameter*—The inside diameter may have a bright finish when material is annealed or solution annealed in a protective atmosphere; otherwise, the inside diameter is

supplied descaled as necessary. It is available in sizes 1/2 to 4 in. (12.7 to 102 mm), incl, in outside diameter in both normal and heavy-wall tube, and pipe sizes, all schedules, of corresponding outside-diameter dimensions.

X2.2.2 *Cold-Drawn, Annealed or Solution Annealed and Pickled (Not Ground)*—Outside and inside diameter will have dull, matte (pickled) surfaces. Available in sizes 1/2 to 6 5/8 in. (12.7 to 168 mm), incl, in outside diameter in both normal and heavy-wall tube, and pipe sizes, all schedules, of corresponding outside-diameter dimensions.

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