Designation: A 826/A 826M – 95 (Reapproved 2001)

Standard Specification for Seamless Austenitic and Martensitic Stainless Steel Duct Tubes for Liquid Metal-Cooled Reactor Core Components[1]

This standard is issued under the fixed designation A 826/A 826M; 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 covers seamless, annealed or cold worked, austenitic or martensitic stainless steel duct tubes of 2 to 7-in. [51 to 178 mm] outside dimensions with wall thickness of 0.250 in. [6.35 mm] or less for use at high temperature in liquid metal-cooled reactor plants.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.3 This specification and the applicable material specifications are expressed in both inch-pound and SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished in inch-pound units. [2]

2. Referenced Documents

2.1 *ASTM Standards:*

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[3]

A 380 Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems[4]

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes[5]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[3]

D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)[6]

D 808 Test Method for Chlorine in New and Used Petroleum Products (Bomb Method)[6]

E 3 Methods of Preparation of Metallographic Specimens[7]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[8]

E 45 Practice for Determining the Inclusion Content of Steel[7]

E 112 Test Methods for Determining the Average Grain Size[7]

E 165 Test Method for Liquid Penetrant Examination[9]

E 384 Test Method for Microhardness of Materials[7]

E 407 Test Methods for Microetching Metals and Alloys[7]

2.2 *ANSI Standard:*

B46.1 Surface Texture[10]

2.3 *ASME Standard:*

NQA-1 Quality Assurance Program Requirements for Nuclear Facilities[10]

2.4 *ASNT Standard:*

SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel Qualification and Certification[10]

3. Ordering Information

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

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Name of material (seamless duct tubes),

3.1.3 Grade (Table 1),

3.1.4 Melting process (5.1),

3.1.5 Approval of procedures for conversion of ingot to bar (5.2),

3.1.6 Thermomechanical treatment requirements (5.4),

3.1.7 Annealing and tempering requirements for martensitic grades (5.4),

3.1.8 Condition (annealed, cold-worked, or thermomechanical treatment) (5.6),

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[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

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[2] Available from the American Society for Nondestructive Testing, 3200 Riverside Drive, Columbus, OH 43221.

[3] *Annual Book of ASTM Standards,* Vol 01.03.

[4] *Annual Book of ASTM Standards,* Vol 01.03.

[5] *Annual Book of ASTM Standards,* Vol 01.01.

[6] *Annual Book of ASTM Standards,* Vol 05.01.

[7] *Annual Book of ASTM Standards,* Vol 03.01.

[8] *Annual Book of ASTM Standards,* Vol 14.02.

[9] *Annual Book of ASTM Standards*, Vol 03.03.

[10] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

TABLE 1 Chemical Requirements of Duct Tubes

Grade UNS Designation	TP 316 S 31600	. . . S38660	. . . S42100
Carbon	0.040–0.060	0.030–0.050	0.17–0.23
Manganese	1.00–2.00	1.65–2.35	0.40–0.70
Phosphorus, max	0.040	0.040	0.040
Sulfur, max	0.010	0.010	0.010
Silicon	0.50–0.75	0.50–1.00	0.20–0.30
Nickel	13.0–14.0	14.5–16.5	0.30–0.80
Chromium	17.0–18.0	12.5–14.5	11.0–12.5
Molybdenum	2.00–3.00	1.50–2.50	0.80–1.20
Titanium	. . .	0.10–0.40[A]	. . .
Columbium	0.050 max	0.050 max	0.050 max
Tantalum, max	0.020	0.020	. . .
Tungsten	. . .	. . .	0.40–0.60
Nitrogen	0.010 max	0.005 max	. . .
Aluminum, max	0.050	0.050	0.050
Arsenic, max	0.030	0.030	. . .
Boron, max	0.0020	0.0020	. . .
Cobalt, max	0.050	0.050	. . .
Copper, max	0.04	0.04	. . .
Vanadium	0.05 max	0.05 max	0.25–0.35

[A] Aim for 0.25

3.1.9 Percent of cold-work (5.7),
3.1.10 Sublotting requirements (5.8),
3.1.11 Duct identification requirements (5.9),
3.1.12 Archive samples requirements (5.11),
3.1.13 Other chemical requirements (6.1),
3.1.14 Tensile property requirements and number of tests (7.1),
3.1.15 Microhardness measurement acceptance criteria, locations, and number of samples (7.2),
3.1.16 Dimensional data or applicable drawings (8.1),
3.1.17 Surface roughness limits (9.2),
3.1.18 Surface marring limits (9.3),
3.1.19 Cleaning procedures (9.4),
3.1.20 Grain size requirements for martensitic grades (10.1),
3.1.21 Carbide and carbonitride inclusion rating requirements (10.2),
3.1.22 Inclusion rating requirements for martensitic grades (10.2),
3.1.23 Penetrant examination requirements (11.1),
3.1.24 Lot qualification sampling levels (12.1),
3.1.25 Packaging (15.1), and
3.1.26 Quality assurance documentation (see Supplementary Requirements).

4. General Requirements for Delivery

4.1 Material supplied under this specification shall conform to the applicable requirements of Specification A 450/A 450M unless otherwise specified herein.

5. Manufacture

5.1 *Melting*—Unless an alternative melting process has been specified in the order, the process for austenitic grades shall consist of a vacuum induction melt followed by a consumable electrode vacuum-arc remelt. Additions of rare earths during melting are prohibited unless approved by the purchaser. The melting process for martensitic grades shall be as specified in the order.

5.2 *Ingot Processing*—Procedures for converting ingots to bars shall be approved by the purchaser prior to use if specified in the order. The parameters for the conversion of austenitic grades shall be selected to minimize the formation of complex carbides and carbonitrides.

5.3 *Tubemaking*—Duct tube fabrication shall be made by a seamless process that has been previously qualified as acceptable.

5.4 *Heat Treating*:

5.4.1 *Austenitic Grades*—Annealing times and temperatures shall be selected to ensure full carbide solution. Cooling shall be performed at a rate rapid enough to prevent carbide precipitation, unless a specific thermomechanical treatment is specified in the order.

5.4.2 *Martensitic Grades*—Martensitic grades shall be annealed and tempered as specified in the order.

5.5 *Cleanliness During Manufacture*—Before each heat treatment and after each cutting operation prior to any reduction, duct tubes shall be cleaned in accordance with the procedures of Recommended Practice A 380, and shall be visually inspected after cleaning in accordance with 7.2.1 of Recommended Practice A 380.

5.6 *Condition*—Duct tubes shall be furnished in the annealed, cold-worked, or thermomechanical condition as specified in the order.

5.7 *Cold Work*—Percent cold work shall be as specified in the order and shall be based upon the reduction in transverse area. Cold-worked duct tubes shall be cold worked to finished size and delivered without further heat treatment. The cold-working procedure shall be submitted to the purchaser for review and approval prior to use.

5.7.1 *Cold Work Determination*—Calculate percent cold work as follows:

$$CW = [A_1 - A_2/A_1] \times 100$$

where:

CW = percent cold work,
A_1 = duct tube cross-sectional area prior to final cold-work, and
A_2 = duct tube cross-sectional area after final cold-work.

5.8 *Lot Size*—Duct tubes shall be grouped into rational inspection lots that can be characterized by lot qualification sampling. This shall be done on the basis of items of the same nominal dimensions produced from the same heat, processed consecutively, and annealed under identical parameters. Any sublotting shall be as specified in the order.

5.9 *Identification*—Duct tubes shall be marked and processed in a manner that will ensure individual duct tube identity and traceability to both heat and lot numbers. Each duct tube shall be identified with the supplier code, lot code, heat number, alloy, purchase order number, and a sequential identification number as specified in the order. Duct tubes shall be marked using an electrolytic etching procedure approved by the purchaser.

5.10 *Repair and Rework*—Reworked duct tubes shall meet the requirements of this specification. Repair shall be permitted only after prior approval by the purchaser.