



## Standard Specification for General Requirements for Alloy and Stainless Steel Pipe<sup>1</sup>

This standard is issued under the fixed designation A 999/A 999M; 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.

### 1. Scope

1.1 This specification<sup>2</sup> covers a group of general requirements that, unless otherwise specified in an individual specification, shall apply to the ASTM product specifications noted below.

1.2 In the case of conflict between a requirement of a product specification and a requirement of this specification, the product specification shall prevail. In the case of conflict between a requirement of the product specification or a requirement of this specification and a more stringent requirement of the purchase order, the purchase order shall prevail.

Title of Specification	ASTM Designation <sup>3</sup>
Seamless and Welded Austenitic Stainless Steel Pipe	A 312/A 312M
Seamless and Welded Steel Pipe for Low-Temperature Service	A 333/A 333M
Seamless Ferritic Alloy-Steel Pipe for High Temperature Service	A 335/A 335M
Electric-Fusion-Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service	A 358/A 358M
Carbon and Ferritic Alloy Steel Forged and Bored Pipe for High-Temperature Service	A 369/A 369M
Seamless Austenitic Steel Pipe for Use With High Temperature Central-Station Service	A 376/A 376M
Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service	A 409/A 409M
Welded, Unannealed Austenitic Stainless Steel Tubular Products	A 778
Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe	A 790/A 790M
Single- or Double-Welded Austenitic Stainless Steel Pipe	A 813/A 813M
Cold-Worked Welded Austenitic Stainless Steel Pipe	A 814/A 814M
Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal	A 928
Spray-Formed Seamless Austenitic Stainless Steel Pipe	A 943
Spray-Formed Seamless Ferritic/Austenitic Stainless Steel Pipe	A 949
Austenitic Chromium-Nickel-Silicon Alloy Steel Seamless and Welded Pipe	A 954

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. With 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. The inch-pound units shall apply unless the “M” designation (SI) of the product specification is specified in the order.

NOTE 1—The dimensionless designator NPS (nominal pipe size) is used in this standard for such traditional terms as “nominal diameter,” “size,” “nominal bore,” and “nominal size”.

1.4 The following precautionary statement pertains only to the test method portion, Section 21, 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:

- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>4</sup>
- A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment<sup>4</sup>
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>5</sup>
- D 3951 Practice for Commercial Packaging<sup>6</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>7</sup>
- E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing<sup>8</sup>
- E 273 Practice for Ultrasonic Examination of Longitudinal Welded Pipe and Tubing<sup>8</sup>
- E 309 Practice for Eddy-Current Testing of Steel Tubular Products Using Magnetic Saturation<sup>8</sup>
- E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys<sup>8</sup>
- E 570 Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products<sup>8</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Alloy Steel Tubular Products.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA 999 in Section II of that Code.

<sup>3</sup> These designations refer to the latest issue of the respective specifications. See *Annual Book of ASTM Standards*, Vol 01.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 01.05.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 15.09.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>8</sup> *Annual Book of ASTM Standards*, Vol 03.03.

## 2.2 *ANSI Standards:*

B36.10 Welded and Seamless Wrought Steel Pipe<sup>9</sup>

B36.19 Stainless Steel Pipe<sup>9</sup>

## 2.3 *Military Standards:*

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage<sup>10</sup>

MIL-STD-271 Nondestructive Testing Requirements for Metals<sup>10</sup>

MIL-STD-792 Identification Marking Requirements for Special Purpose Equipment<sup>10</sup>

## 2.4 *Federal Standard:*

Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products<sup>10</sup>

## 2.5 *Steel Structures Painting Council:*

SSPC-SP6 Surface Preparation Specification No. 6 Commercial Blast Cleaning<sup>11</sup>

## 2.6 *ASNT Standards:*

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing<sup>12</sup>

4.1.11 Specification designation and date of issue, and

4.1.12 Special requirement or any supplementary requirements, or both.

## 5. Chemical Composition

5.1 *Chemical Analysis*—Samples for chemical analysis and method of analysis shall be in accordance with Test Methods, Practices, and Terminology A 751.

5.2 *Heat Analysis*—An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the specified elements. If secondary melting processes are employed, the heat analysis shall be obtained from one remelted ingot or the product of one remelted ingot of each primary melt. The chemical composition thus determined, or that determined from a product analysis made by the tubular product manufacturer shall conform to the requirements specified.

5.3 *Product Analysis*—Product analysis requirements and options, if any, are contained in the product specification.

## 3. Process

3.1 The steel shall be made by a suitable process.

3.2 If secondary melting, such as electroslag remelting or vacuum remelting, is used, the heat shall be defined as all of the ingots remelted from a single primary heat.

3.3 When steels of different are sequentially strand cast, the resultant transition material shall be removed using an established procedure that positively separates the grades.

3.4 If a specific type of melting is required by the purchaser, it shall be specified on the purchase order.

## 4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under the product specification and this specification. Such requirements to be considered include, but are not limited to, the following:

4.1.1 Quantity (feet, metres, or number of pieces),

4.1.2 Name of material (stainless steel pipe),

4.1.3 Process, when applicable (seamless or welded),

4.1.4 Grade or UNS number,

4.1.5 Size (NPS and outside diameter and schedule number, average (nominal) wall thickness (see 8.1 and 9.1), or minimum wall thickness (see 8.2 and 9.1.1), or minimum inside diameter (see 10.1)),

4.1.6 Length (specific or random),

4.1.7 End finish,

4.1.8 Optional requirements,

4.1.9 Specific type of melting, if required (see 3.4),

4.1.10 Certified test report requirements,

## 6. Mechanical Properties

6.1 *Method of Mechanical Tests*—The specimens and the mechanical tests required shall be in accordance with Test Methods and Definitions A 370, especially Annex A2 thereof.

6.2 Specimens shall be tested at room temperature.

6.3 Small or subsize specimens as described in Test Methods and Definitions A 370 may be used only when there is insufficient material to prepare one of the standard specimens. When using small or subsize specimens, the largest one possible shall be used.

## 7. Tensile Requirements

7.1 The material shall conform to the requirements as to tensile properties in the individual product specification.

7.2 The yield strength, when specified, shall be determined corresponding to a permanent offset of 0.2 % of the gage length or to a total extension of 0.5 % of the gage length under load.

7.3 If the percentage of elongation of any test specimen is less than that specified and any part of the fracture is more than  $\frac{3}{4}$  in. [19.0 mm] from the center of the gage length, as indicated by scribe marks on the specimen before testing, a retest shall be allowed.

## 8. Permissible Variation in Weight for Seamless Pipe

8.1 Except as noted in 8.2, the weight of any length of seamless pipe NPS 12 and under shall not vary more than 10 % over the 3.5 % under that specified. For sizes over NPS 12, the weight of any length of pipe shall not vary more than 10 % over and 5 % under that specified. Unless otherwise specified, pipe of NPS 4 and smaller may be weighed in convenient lots; pipe in sizes larger than NPS 4 shall be weighed separately.

8.2 *Minimum Wall*—When the wall thickness of the pipe is specified as minimum wall in the purchase order, the weight of any length of seamless pipe shall not vary more than 16 % over that calculated in accordance with 13.3. Unless otherwise specified, pipe of NPS 4 and smaller may be weighed in convenient lots; pipe in sizes larger than NPS 4 shall be weighed separately.

<sup>9</sup> Portions of these standards appear in *ASTM Book of Standards*, Vol 01.01. Full text of these standards is available from American National Standards Institute, 11 West 42nd St., 13th floor, New York, NY 10036.

<sup>10</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>11</sup> Available from Steel Structures Painting Council, 4400 Fifth Ave., Pittsburgh, PA 15213.

<sup>12</sup> Available from American Society for Nondestructive Testing, 1711 Arlington Plaza, P.O. Box 28518, Columbus, OH 43228-0518.

## 9. Permissible Variations in Wall Thickness

9.1 *Seamless and Welded*—Except as noted in 9.1.1, the minimum wall thickness at any point shall not be more than 12.5 % under the nominal wall thickness specified. The minimum wall thickness on inspection is shown in Table X1.1.

9.1.1 *Minimum Wall*—When the wall thickness of the pipe is specified as minimum wall in the purchase order, there shall be no variation under the specified wall thickness.

9.2 *Forged and Bored*—The wall thickness shall not vary over that specified by more than 1/8 in. [3.2 mm]. There shall be no variation under the specified wall thickness.

9.3 *Cast*—The wall thickness shall not vary over that specified by more than 1/16 in. [1.6 mm]. There shall be no variation under the specified wall thickness.

## 10. Permissible Variations in Inside Diameter

10.1 *Forged and Bored, and Cast*—The inside diameter shall not vary under that specified by more than 1/16 in. [1.6 mm]. There shall be no variation over the specified inside diameter.

## 11. Permissible Variation in Outside Diameter

11.1 Variations in outside diameter, unless otherwise agreed upon, shall not exceed the limits prescribed in Table 1. The tolerances on outside diameter include ovality except as provided for in 11.2 and 11.2.1. (See Note 2.)

11.2 For thin-wall pipe, defined as pipe having a wall thickness of 3 % or less of the outside diameter, the diameter tolerance of Table 1 is applicable only to the mean of the extreme (maximum and minimum) outside diameter readings in any one cross-section.

11.2.1 For thin-wall pipe the difference in extreme outside readings (ovality) in any one cross-section shall not exceed 1.5 % of the specified outside diameter.

NOTE 2—Thin-wall pipe usually develops significant ovality (out-of-roundness) during final annealing, straightening, or both. The diameter tolerances of Table 1 are usually not sufficient to provide for additional ovality expected in thin-wall pipe.

## 12. Permissible Variations in Length

12.1 *Seamless and Welded (No Filler Metal Added)*—If specific cut lengths of 24 ft [7.3 m] or less are ordered, no length of pipe shall be under the length specified or more than 1/4 in. [6 mm] over that specified.

12.1.1 Permissible variations in length for lengths greater than 24 ft [7.3 m] shall be subject to agreement between the manufacturer and purchaser.

12.2 *Forged and Bored, Cast, and Cast Cold-Wrought*—If specific cut lengths are ordered, no length of pipe shall be under the length specified or more than 1/8 in. [3 mm] over that specified.

12.3 For pipe ordered to random lengths, the lengths and variations shall be agreed upon between the manufacturer and purchaser.

12.4 No girth welds are permitted unless agreed upon by the manufacturer and purchaser.

## 13. Standard Weight (Weight per Unit Length)

13.1 A system of standard pipe sizes has been approved by the American National Standards Institute as ANSI B36.10 and B36.19. The standard sizes do not prohibit the production and use of other sizes of pipe produced to the various product specifications referenced in 1.1. (See Note 3.)

13.2 For nonstandard sizes of pipe, the calculated weight per foot shall be determined from the following equation:

$$W = C(D-t)t \quad (1)$$

where:

$C$  = 10.69 [0.02466],

$W$  = weight, lb/ft [kg/m],

$D$  = specified or calculated (from specified inside diameter and wall thickness) outside diameter, in. [mm], and

$t$  = specified wall thickness, in. (to 3 decimal places) [mm to 2 decimal places].

13.3 When minimum wall thickness is specified on the purchase order, the calculated weight per foot shall be determined using Eq 1, obtaining from Table X1.1 the nominal wall thickness,  $t$ , corresponding to that minimum wall.

NOTE 3—The weights given in the American National Standards and the calculated weights given by Eq 1 are based on the weights for carbon steel pipe. The weight of pipe made of ferritic stainless steels may be up to about 5 % less, and that made of austenitic stainless steel up to about 2 % greater than the values given.

## 14. Ends

14.1 Unless otherwise specified, the pipe shall be furnished with plain ends. All burrs at the ends of the pipe shall be removed.

## 15. Straightness

15.1 The finished pipe shall be reasonably straight.

15.2 For metal-arc welded pipe, the maximum deviation from a 10-ft [3.0-m] straightedge placed so that both ends are in contact with the pipe shall be 1/8 in. [3.2 mm]. For metal-arc welded pipe with lengths shorter than 10 ft [3.0 m], this maximum deviation shall be prorated with respect to the ratio of the actual length to 10 ft [3.0 m].

## 16. Repair by Welding

16.1 Repair by welding of defects in seamless pipe (including centrifugally cast pipe and forged and bored pipe) and of plate defects in welded pipe and, when specifically stated by the product specification, weld seam defects in welded pipe shall be permitted subject to the approval of the purchaser and with the further understanding that the composition of the deposited filler metal shall be suitable for the composition

**TABLE 1 Permissible Variations in Outside Diameter**

NPS Designator	Permissible Variations in Outside Diameter			
	Over		Under	
	in.	mm	in.	mm
1/8-1 1/2, incl	1/64 (0.015)	0.4	1/32 (0.031)	0.8
Over 1 1/2 to 4, incl	1/32 (0.031)	0.8	1/32 (0.031)	0.8
Over 4 to 8, incl	1/16 (0.062)	1.6	1/32 (0.031)	0.8
Over 8 to 18, incl	3/32 (0.093)	2.4	1/32 (0.031)	0.8
Over 18 to 26, incl	1/8 (0.125)	3.2	1/32 (0.031)	0.8
Over 26 to 34, incl	5/32 (0.156)	4.0	1/32 (0.031)	0.8
Over 34 to 48, incl	3/16 (0.187)	4.8	1/32 (0.031)	0.8

being welded. Defects shall be thoroughly chipped or ground out before welding and each repaired length shall be reheat treated or stress relieved as required by the applicable specification. Each length of repaired pipe shall be nondestructively tested as required by the product specification.

16.2 Repair welding shall be performed using procedures and welders or welding operators that have been qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

## 17. Retests

17.1 If the results of the certification tests of any lot do not conform to the requirements specified in the individual specification, retests may be made on additional lengths of pipe of double the original number from the same lot, each of which shall conform to the requirements specified. Only one retest of any lot will be permitted. Nonconformance will be cause for the rejection of the lot.

17.2 Any individual length of pipe that meets the test requirements is acceptable. Individual lengths that do not conform to the test requirements may be resubmitted for test provided the reason for nonconformance is established and the nonconforming portion removed.

## 18. Retreatment

18.1 If individual lengths of pipe selected to represent any lot fail to conform to the test requirements, the lot represented may be reheat treated and resubmitted for test. The manufacturer may reheat treat the pipe, but not more than twice, except with the approval of the purchaser.

## 19. Test Specimens

19.1 Test specimens shall be taken from the ends of finished pipe prior to any forming operations, or being cut to length.

19.2 Specimens cut either longitudinally or transversely shall be acceptable for the tension test.

19.3 If any test specimen shows flaws or defective machining, the specimen may be discarded and another substituted.

## 20. Flattening Test Requirements

20.1 *Seamless and Centrifugally Cast Pipe*—A section of pipe not less than 2½ in. [63 mm] in length shall be flattened cold between parallel plates in two steps. During the first step, which is a test for ductility, no cracks or breaks on the inside, outside, or end surfaces, except as provided for in 20.3.4, shall occur until the distance between the plates is less than the value of  $H$  calculated as follows:

$$H = (l+e)t/(e+t/D) \quad (2)$$

where:

$H$  = distance between flattening plates, in. [mm],

$t$  = specified wall thickness, in. [mm],

$D$  = specified outside diameter, outside diameter corresponding to specified ANSI pipe size, or outside diameter calculated by adding  $2t$  (as defined above) to the specified inside diameter in. [mm], and

$e$  = deformation per unit length (constant for a given grade of steel, 0.07 for medium carbon steel (maximum specified carbon 0.19 % or greater), 0.08 for ferritic alloy steel, 0.09 for austenitic steel, and 0.09 for low-carbon steel (maximum specified carbon 0.18 % or less)).

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet.

20.2 *Welded Pipe*—A section of welded pipe not less than 4 in. [100 mm] in length shall be flattened cold between parallel plates in two steps. The weld shall be placed at 90° from the direction of the applied force (at the point of maximum bending). During the first step, which is a test for ductility, no cracks or breaks on the inside or outside surfaces, except as provided for in 20.3.4, shall occur until the distance between the plates is less than the value of  $H$  calculated by Eq 2. During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the pipe meet.

### 20.3 *Seamless, Centrifugally Cast, and Welded Pipe:*

20.3.1 Evidence of laminated or defective material or weld that is revealed at any time during the entire flattening test shall be cause for rejection.

20.3.2 Surface imperfections not evident in the test specimen before flattening, but revealed during the first step of flattening test, shall be judged in accordance with the finish requirements.

20.3.3 Superficial ruptures resulting from surface imperfections shall not be a cause for rejection.

20.3.4 When low  $D$ -to- $t$  ratio tubular products are tested, because the strain imposed due to geometry is unreasonably high on the inside surface at the six and twelve o'clock locations, cracks at these locations shall not be cause for rejection if the  $D$ -to- $t$  ratio is less than 10.

## 21. Nondestructive Test Requirements

21.1 When required by the applicable product specification or the purchase order, the pipe shall be tested by the hydrostatic test (see 21.2) or by the nondestructive electrical test (see 21.3).

### 21.2 *Hydrostatic Test:*

21.2.1 Except as provided in 21.2.2 and 21.2.3, each length of pipe shall be tested by the manufacturer to a hydrostatic pressure which will produce in the pipe wall a stress not less than 60 % of the minimum specified yield strength for ferritic alloy and stainless steel pipe, or 50 % of the specified minimum yield strength for austenitic alloy and stainless steel pipe and for ferritic/austenitic stainless steel pipe. The test pressure or stress shall be determined by the following equation:

$$P = 2St/D \text{ or } S = PD/2t \quad (3)$$

where:

$P$  = hydrostatic test pressure in psi [MPa],

$S$  = pipe wall stress in psi or [MPa],