



# Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe<sup>1</sup>

This standard is issued under the fixed designation A 790/A 790M; 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 seamless and straight-seam welded ferritic/austenitic steel pipe intended for general corrosive service, with particular emphasis on resistance to stress corrosion cracking. These steels are susceptible to embrittlement if used for prolonged periods at elevated temperatures.

1.2 Optional supplementary requirements are provided for pipe when a greater degree of testing is desired. These supplementary requirements call for additional tests to be made and, when desired, one or more of these may be specified in the order.

1.3 Appendix X1 of this specification lists the dimensions of welded and seamless stainless steel pipe as shown in ANSI B36.19. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

1.4 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. The inch-pound units shall apply unless the *M* designation of this specification is specified in the order.

NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as nominal diameter, size, and nominal size.

## 2. Referenced Documents

### 2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>3</sup>

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys and Ferroalloys<sup>4</sup>

A 999/A 999M Specification for General Requirements for Alloy and Stainless Steel Pipe<sup>4</sup>

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing<sup>5</sup>

E 309 Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation<sup>5</sup>

E 381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings<sup>6</sup>

E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys<sup>5</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>4</sup>

### 2.2 ANSI Standards:<sup>7</sup>

B1.20.1 Pipe Threads, General Purpose

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

### 2.3 SAE Standard:<sup>8</sup>

SAE J 1086

### 2.4 Other Standard:<sup>9</sup>

SNT-TC-1A Personal Qualification and Certification in Nondestructive Testing

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification refer to Terminology A 941.

## 4. Ordering Information

4.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

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

4.1.2 Name of material (ferritic/austenitic steel pipe),

4.1.3 Process (seamless or welded),

4.1.4 Grade (see Table 1),

4.1.5 Size (NPS designator or outside diameter and schedule number of average wall thickness),

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-790 in Section II of that Code.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.03.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>7</sup> Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

<sup>8</sup> Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

<sup>9</sup> Available from Society for Nondestructive Testing, 711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228-0518.

\*A Summary of Changes section appears at the end of this standard.

**TABLE 1 Heat Treatment**

UNS Designation	Temperature	Quench
S31803	1870–2010°F [1020–1100°C]	Rapid cooling in air or water
S32205	1870–2010°F [1020–1100°C]	Rapid cooling in air or water
S31500	1800–1900°F [980–1040°C]	Rapid cooling in air or water
S31200	1920–2010°F [1050–1100°C]	Rapid cooling in water
S32550	1900°F [1040°C] min	Rapid cooling in air or water
S31260	1870–2010°F [1020–1100°C]	Rapid cooling in water
S32304	1700–1920°F [925–1050°C]	Rapid cooling in air or water
S39274	1920–2060°F [1025–1125°C]	Rapid cooling in air or water
S32750	1880–2060°F [1025–1125°C]	Rapid cooling in air or water
S32760	2010–2085°F [1100–1140°C]	Rapid cooling in air or water
S32900	1700–1750°F [925–955°C]	Rapid cooling in air or water
S32950	1820–1880°F [990–1025°C]	Air cool
S39277	1975–2155°F [1080–1180°C]	Rapid cooling in air or water
S32520	1975–2050°F [1080–1120°C]	Rapid cooling in air or water
S32906	1900–1980°F [1040–1080°C]	Rapid cooling in air or water
S32003	1850–2050°F [1010–1120°C]	Rapid cooling in air or water

4.1.6 Length (specific or random) (see Section 11),

4.1.7 End finish (section on ends of Specification A 999/A 999M),

4.1.8 Optional requirements (product analysis, Section 9; hydrostatic test or nondestructive electric test, Section 14),

4.1.9 Test report required (section on certification of Specification A 999/A 999M),

4.1.10 Specification designation, and

4.1.11 Special requirements and any supplementary requirements selected.

## 5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 999/A 999M unless otherwise provided herein.

## 6. Materials and Manufacture

### 6.1 Manufacture:

6.1.1 The pipe shall be made by the seamless or an automatic welding process, with no addition of filler metal in the welding operation.

6.1.2 At the manufacturer's option, pipe may be either hot-finished or cold-finished.

6.1.3 The pipe shall be pickled free of scale. When bright annealing is used, pickling is not necessary.

6.2 *Discard*—A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

6.3 All pipe shall be furnished in the heat-treated condition as shown in Table 1. For seamless pipe, as an alternate to final heat treatment in a continuous furnace or batch-type furnace, immediately following hot forming while the temperature of the pipes is not less than the specified minimum solution treatment temperature, pipes may be individually quenched in water or rapidly cooled by other means.

## 7. Chemical Composition

7.1 The steel shall conform to the chemical requirements as prescribed in Table 2.

## 8. Heat Analysis

8.1 An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified.

**TABLE 2 Chemical Requirements**

UNS Designation <sup>A</sup>	C	Mn	P	S	Si	Ni	Cr	Mo	N	Cu	Others
S31803	0.030 max	2.00 max	0.030 max	0.020 max	1.00 max	4.5–6.5	21.0–23.0	2.5–3.5	0.08–0.20	...	...
S32205	0.030 max	2.00 max	0.030 max	0.020 max	1.00 max	4.5–6.5	22.0–23.0	3.0–3.5	0.14–0.20	...	...
S31500	0.030 max	1.20–2.00	0.030 max	0.030 max	1.40–2.00	4.2–5.2	18.0–19.0	2.50–3.00	0.05–0.10	...	...
S32550	0.04 max	1.50 max	0.040 max	0.030 max	1.00 max	4.5–6.5	24.0–27.0	2.9–3.9	0.10–0.25	1.50–2.50	...
S31200	0.030 max	2.00 max	0.045 max	0.030 max	1.00 max	5.5–6.5	24.0–26.0	1.20–2.00	0.14–0.20	...	...
S31260	0.030 max	1.00 max	0.030 max	0.030 max	0.75 max	5.5–7.5	24.0–26.0	2.5–3.5	0.10–0.30	0.20–0.80	W 0.10–0.50
S32304	0.030 max	2.50 max	0.040 max	0.040 max	1.00 max	3.0–5.5	21.5–24.5	0.05–0.60	0.05–0.20	0.05–0.60	...
S39274	0.030 max	1.00 max	0.030 max	0.020 max	0.80 max	6.0–8.0	24.0–26.0	2.5–3.5	0.24–0.32	0.20–0.80	W 1.50–2.50
S32750	0.030 max	1.20 max	0.035 max	0.020 max	0.80 max	6.0–8.0	24.0–26.0	3.0–5.0	0.24–0.32	0.5 max	...
S32760	0.05 max	1.00 max	0.030 max	0.010 max	1.00 max	6.0–8.0	24.0–26.0	3.0–4.0	0.20–0.30	0.50–1.00	W 0.50–1.00 40 min <sup>B</sup>
S32900	0.08 max	1.00 max	0.040 max	0.030 max	0.75 max	2.5–5.0	23.0–28.0	1.00–2.00	...	...	...
S32950	0.030 max	2.00 max	0.035 max	0.010 max	0.60 max	3.5–5.2	26.0–29.0	1.00–2.50	0.15–0.35	...	...
S39277	0.025 max	0.80 max	0.025 max	0.002 max	0.80 max	6.5–8.0	24.0–26.0	3.0–4.0	0.23–0.33	1.20–2.00	W 0.8–1.2
S32520	0.030 max	1.5 max	0.035 max	0.020 max	0.80 max	5.5–8.0	24.0–26.0	3.0–5.0	0.20–0.35	0.5–3.00	...
S32906	0.030 max	1.50 max 0.80 min	0.030 max	0.030 max	0.050 max	7.5 max 5.8 min	30.0 max 28.0 min	2.60 max 1.50 min	0.40 max 0.30 min	0.80 max	...
S32003	0.030 max	2.00 max	0.030 max	0.020 max	1.00 max	3.0–4.0	19.5–22.5	1.50–2.00	0.14–0.20	...	...

<sup>A</sup> New designation established in accordance with Practice E 527 and SAE J1086.

<sup>B</sup> % Cr + 3.3 × % Mo + 16 × % N.

## 9. Product Analysis

9.1 At the request of the purchaser's inspector, an analysis of one billet or one length of flat-rolled stock from each heat, or two pipes from each lot, shall be made by the manufacturer. A lot of pipe shall consist of the following number of lengths of the same size and wall thickness from any one heat of steel:

NPS Designator	Lengths of Pipe in Lot
Under 2	400 or fraction thereof
2 to 5, incl	200 or fraction thereof
6 and over	100 or fraction thereof

9.2 The results of these analyses shall be reported to the purchaser or the purchaser's representative and shall conform to the requirements specified in Section 7.

9.3 If the analysis of one of the tests specified in 8.1 or 9.1 does not conform to the requirements specified in Section 7, an analysis of each billet or pipe from the same heat or lot may be made, and all billets or pipe conforming to the requirements shall be accepted.

## 10. Tensile and Hardness Properties

10.1 The material shall conform to the tensile and hardness properties prescribed in Table 3.

## 11. Lengths

11.1 Pipe lengths shall be in accordance with the following regular practice:

11.1.1 Unless otherwise agreed upon, all sizes from NPS 1/8 to and including NPS 8 are available in a length up to 24 ft (see Note 2) with the permissible range of 15 to 24 ft (see Note 2). Short lengths are acceptable and the number and minimum length shall be agreed upon between the manufacturer and the purchaser.

NOTE 2—This value applies when the inch-pound designation of this specification is the basis of purchase. When the *M* designation of this specification is the basis of purchase, the corresponding metric value(s) shall be agreed upon between the manufacturer and purchaser.

11.1.2 If definite cut lengths are desired, the lengths required shall be specified in the order. No pipe shall be less than the specified length and no more than 1/4 in. [6 mm] over it.

11.1.3 No jointers are permitted unless otherwise specified.

## 12. Workmanship, Finish, and Appearance

12.1 The finished pipes shall be reasonably straight and shall have a workmanlike finish. Imperfections may be removed by grinding, provided the wall thicknesses are not decreased to less than that permitted, in the Permissible Variations in Wall Thickness Section of Specification A 999/A 999M.

## 13. Mechanical Tests Required

13.1 *Transverse or Longitudinal Tension Test*—One tension test shall be made on a specimen for lots of not more than 100 pipes. Tension tests shall be made on specimens from 2 pipes for lots of more than 100 pipes.

NOTE 3—The term *lot* for mechanical tests applies to all pipe of the same nominal size and wall thickness (or schedule) that is produced from the same heat of steel and subjected to the same finishing treatment (1) in a continuous heat treatment furnace, or (2) in a batch-type heat-treatment furnace equipped with recording pyrometers and automatically controlled within a 50°F [30°C] range, the larger of (a) each 200 ft [60 m] or fraction thereof or (b) that pipe heat treated in the same batch furnace charge.

13.2 *Flattening Test*—For material heat treated in a batch-type furnace, flattening tests shall be made on 5 % of the pipe from each heat-treated lot. For material heat treated by the continuous process, this test shall be made on a sufficient number of pipes to constitute 5 % of the lot, but in no case less than two lengths of pipe.

13.2.1 For welded pipe with a diameter equal to or exceeding NPS 10, a transverse guided face bend test of the weld may be conducted instead of a flattening test in accordance with the method outlined in the steel tubular product supplement of Test Methods and Definitions A 370. The ductility of the weld shall be considered acceptable when there is no evidence of cracks in the weld or between the weld and the base metal after bending. Test specimens from 5 % of the lot shall be taken from the pipes or test plates of the same material as the pipe, the test plates being attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam.

## 14. Hydrostatic or Nondestructive Electric Test

14.1 Each pipe shall be subjected to the nondestructive electric test or the hydrostatic test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

14.2 The hydrostatic test shall be in accordance with Specification A 999/A 999M, except that the value for *S* to be used in the calculation of the hydrostatic test pressure shall be equal to 50 % of the specified minimum yield strength of the pipe.

### 14.3 *Nondestructive Electric Test:*

Nondestructive electric tests shall be in accordance with Practice E 213 or E 309.

**TABLE 3 Tensile and Hardness Requirements**

UNS Designation	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]	Elongation in 2 in. or 50 mm, min, %	Hardness, max	
				Brinell	Rockwell C
S31803	90 [620]	65 [450]	25	290	30.5
S32205	90 [620]	65 [450]	25	290	30.5
S31500	92 [630]	64 [440]	30	290	30.5
S32550	110 [760]	80 [550]	15	297	31.5
S31200	100 [690]	65 [450]	25	280	...
S31260 <sup>A</sup>	100 [690]	65 [450]	25	...	...
S32304	87 [600]	58 [400]	25	290	30.5
S39274	116 [800]	80 [550]	15	310	...
S32750	116 [800]	80 [550]	15	310	32
S32760	109–130 [750–895]	80 [550]	25	270	...
S32900	90 [620]	70 [485]	20	271	28
S32950 <sup>B</sup>	100 [690]	70 [480]	20	290	30.5
S39277	120 [825]	90 [620]	25	290	30
S32520	112 [770]	80 [550]	25	310	...
S32906					
Wall below 0.40 in. (10 mm)	116 [800]	94 [650]	25	310	32
Wall 0.40 in. (10 mm) and above	109 [750]	80 [550]	25	310	32
S32003	90 [620]	65 [450]	25	290	30

<sup>A</sup> Prior to A 790/A 790M – 87, the values for S31260 were: 92 ksi tensile strength, 54 ksi yield strength, and 30 % elongation.

<sup>B</sup> Prior to A 790/A 790M – 89, the tensile strength value was 90 ksi for UNS S32950.