SPECIFICATION FOR SEAMLESS AND WELDED FERRITIC/AUSTENITIC STAINLESS STEEL PIPE

SA-790/SA-790M

(Identical with ASTM Specification A 790/A 790M-95.)

1. Scope

1.1 This specification 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 where 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 Table X1.1 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 dimensions 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

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

A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe

E 381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 *ANSI Standards:*

B1.20.1 Pipe Threads, General Purpose

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

2.3 *SAE Standard:*

SAE J1086

3. General Requirements

3.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 530/A 530M unless otherwise provided herein.

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 (Table 1),

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

4.1.6 Length (specific or random) (Section 10),

4.1.7 End finish (section on ends of Specification A 530/A 530M),

4.1.8 Optional requirements (Section 8), Supplementary Requirements S1 to S4),

4.1.9 Test report required (section on Certification of Specification A 530/A 530M),

4.1.10 Specification designation, and

4.1.11 Special requirements or exception to the specification.

5. Materials and Manufacture

5.1 *Manufacture:*

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

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

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

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

5.3 All pipe shall be furnished in the heat-treated condition as shown in Table 1.

6. Chemical Composition

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

7. Heat Analysis

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

8. Product Analysis

8.1 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

8.2 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 6.

8.3 If the analysis of one of the tests specified in 7.1 or 8.1 does not conform to the requirements specified in Section 6, 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.

9. Tensile and Hardness Properties

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

10. Lengths

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

10.1.1 Unless otherwise agreed upon, all sizes from NPS $\frac{1}{8}$ to and including NPS 8 are available in a length up to 24 ft (Note 2) with the permissible range of 15 to 24 ft (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.

10.1.2 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 $\frac{1}{4}$ in. [6 mm] over it.

10.1.3 No jointers are permitted unless otherwise specified.

11. Workmanship, Finish, and Appearance

11.1 The finished pipes shall be reasonably straight and shall have a workmanlike finish. Imperfections may be removed by grinding, provided the wall thickness are not decreased to less than that permitted, in the Permissible Variations in Wall Thickness Section of Specification A 530/A 530M.

12. Mechanical Tests Required

12.1 *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 two 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.

12.2 *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.

12.2.1 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.

12.3 *Hydrostatic Test* — Each length of finished pipe shall be subjected to the hydrostatic test.

12.3.1 The hydrostatic test shall be in accordance with Specification A 530/A 530M. When making the calculations in the Hydrostatic Test Requirements Section of Specification A 530/A 530M, an *S* value 50% of the specified minimum yield strength shall be used.

12.3.2 When specified by the purchaser, a nondestructive electric test in accordance with Specification A 450/A 450M may be used instead of, or in addition to, the hydrostatic test.

13. Product Marking

13.1 In addition to the marking prescribed in Specification A 530/A 530M, the marking shall include the manufacturer's private identifying mark and whether the pipe is seamless or welded. If specified in the purchase order, the marking for pipe larger than NPS 4 shall include the weight.

14. Keywords

14.1 duplex stainless steel: ferritic/austenitic stainless steel; seamless steel pipe; stainless steel pipe; steel pipe; welded steel pipe

TABLE 1
HEAT TREATMENT

UNS Designation	Temperature	Quench
S31803	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

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TABLE 2
CHEMICAL REQUIREMENTS

UNS Designation [Note (1)]	C	Mn	P	S	Si	Ni	Cr	Mo	N	Cu	Others
S31803	0.030 max	2.0 max	0.030 max	0.020 max	1.0 max	4.50–6.50	21.0–23.0	2.50–3.50	0.08–0.20	...	
S31500	0.030 max	1.20–2.00	0.030 max	0.030 max	1.40–2.00	4.25–5.25	18.0–19.0	2.50–3.00	0.05–0.10	...	
S32550	0.040 max	1.5 max	0.040 max	0.030 max	1.0 max	4.50–6.50	24.0–27.0	2.90–3.90	0.10–0.25	1.5–2.5	
S31200	0.030 max	2.0 max	0.045 max	0.030 max	1.0 max	5.50–6.50	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	5.50–7.50	24.0–26.0	2.50–3.50	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	1.0 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	1.0 max	0.030 max	0.020 max	0.80 max	6.0–8.0	24.0–26.0	2.50–3.50	0.24–0.32	0.20–0.80	W 1.50–2.50
S32750	0.030 max	1.2 max	0.035 max	0.020 max	0.8 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	6.00–8.00	24.00–26.00	3.00–4.00	0.20–0.30	0.50–1.00	W 0.50–1.00 40 min [Note (2)]
S32900	0.08 max	1.00 max	0.040 max	0.030 max	0.75 max	2.50–5.00	23.00–28.00	1.00–2.00	...	...	...
S32950	0.03 max	2.00 max	0.035 max	0.010 max	0.60 max	3.50–5.20	26.00–29.00	1.00–2.50	0.15–0.35	...	
S39277	0.025 max	0.80 max	0.025 max	0.002 max	0.80 max	6.5–8.00	24.00–26.00	3.00–4.00	0.23–0.33	1.2–2.0	W 0.8–1.2

NOTES:
(1) New designation established in accordance with Practice E 527 and SAE J1086.
(2) % Cr + 3.3 × % Mo + 16 × % N.

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
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 [Note (1)]	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 [Note (2)]	100 [690]	70 [480]	20	290	30.5
S39277	120 [825]	90 [620]	25	290	30

NOTES:
(1) Prior to A 790/A 790M - 87, the values for S31260 were: 92 ksi tensile strength, 54 ksi yield strength, and 30% elongation.
(2) Prior to A 790/A 790M - 89, the tensile strength value was 90 ksi for UNS S32950.

SUPPLEMENTARY REQUIREMENTS FOR PIPE REQUIRING SPECIAL CONSIDERATION

One or more of the following supplementary requirements shall apply only when specified in the purchase order. The purchaser may specify a different frequency of test or analysis than is provided in the supplementary requirement. Subject to agreement between the purchaser and manufacturer, retest and retreatment provisions of these supplementary requirements may also be modified.

S1. Product Analysis

S1.1 For all pipe over NPS 5 there shall be one product analysis made of a representative sample from one piece for each ten lengths or fraction thereof from each heat of steel.

S1.2 For pipe smaller than NPS 5 there shall be one product analysis made from ten lengths per heat of steel or from 10% of the number of lengths per heat of steel, whichever number is smaller.

S1.3 Individual lengths failing to conform to the chemical requirements specified in Section 6 shall be rejected.

S2. Transverse Tension Tests

S2.1 There shall be one transverse tension test made from one end of 10% of the lengths furnished per heat of steel. This applies only to pipe over NPS 8.

S2.2 If a specimen from any length fails to conform to the tensile properties specified that length shall be rejected.

S3. Flattening Test

S3.1 The flattening test of Specification A 530/A 530M shall be made on a specimen from one end or both ends of each pipe. Crops end may be used. If this supplementary requirement is specified, the number of tests per pipe shall also be specified. If a specimen from any length fails because of lack of ductility prior to satisfactory completion of the first step of the flattening test requirement, that pipe shall be rejected subject to retreatment in accordance with Specification A 530/A 530M and satisfactory retest. If a specimen from any length of pipe fails because of a lack of soundness that length shall be rejected, unless subsequent retesting indicates that the remaining length is sound.

S4. Etching Tests

S4.1 The steel shall be homogeneous as shown by etching tests conducted in accordance with the appropriate portions of Method E 381. Etching tests shall be made on a cross section from one end or both ends of each pipe and shall show sound and reasonably uniform material free of injurious laminations, cracks and similar objectionable defects. If this supplementary requirement is specified, the number of tests per pipe required shall also be specified. If a specimen from any length shows objectionable defects, the length shall be rejected, subject to removal of the defective end and subsequent retests indicating the remainder of the length to be sound and reasonably uniform material.

APPENDIX

X1. TABLE X1.1 IS BASED ON TABLE 1 OF THE AMERICAN NATIONAL STANDARD FOR STAINLESS STEEL PIPE (ANSI B36.19-1965)

TABLE X1.1
DIMENSIONS OF WELDED AND SEAMLESS STAINLESS STEEL PIPE

NPS Designator	Outside Diameter		Nominal Wall Thickness							
			Schedule 5S [Note (1)]		Schedule 10S [Note (1)]		Schedule 40S		Schedule 80S	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
1/8	0.405	10.29	...	...	0.049 [Note (2)]	1.24	0.068	1.73	0.095	2.41
1/4	0.540	13.72	...	...	0.065 [Note (2)]	1.65	0.088	2.24	0.119	3.02
3/8	0.675	17.15	...	...	0.065 [Note (2)]	1.65	0.091	2.31	0.126	3.20
1/2	0.840	21.34	0.065 [Note (2)]	1.65	0.083 [Note (2)]	2.11	0.109	2.77	0.147	3.73
3/4	1.050	26.67	0.065 [Note (2)]	1.65	0.083 [Note (2)]	2.11	0.113	2.87	0.154	3.91
1.0	1.315	33.40	0.065 [Note (2)]	1.65	0.109 [Note (2)]	2.77	0.133	3.38	0.179	4.55
1 1/4	1.660	42.16	0.065 [Note (2)]	1.65	0.109 [Note (2)]	2.77	0.140	3.56	0.191	4.85
1 1/2	1.900	48.26	0.065 [Note (2)]	1.65	0.109 [Note (2)]	2.77	0.145	3.68	0.200	5.08
2	2.375	60.33	0.065 [Note (2)]	1.65	0.109 [Note (2)]	2.77	0.154	3.91	0.218	5.54
2 1/2	2.875	73.03	0.083	2.11	0.120 [Note (2)]	3.05	0.203	5.16	0.276	7.01
3	3.500	88.90	0.083	2.11	0.120 [Note (2)]	3.05	0.216	5.49	0.300	7.62
3 1/2	4.000	101.60	0.083	2.11	0.120 [Note (2)]	3.05	0.226	5.74	0.318	8.08
4	4.500	114.30	0.083	2.11	0.120 [Note (2)]	3.05	0.237	6.02	0.337	8.56
5	5.563	141.30	0.109 [Note (2)]	2.77	0.134 [Note (2)]	3.40	0.258	6.55	0.375	9.52
6	6.625	168.28	0.109	2.77	0.134 [Note (2)]	3.40	0.280	7.11	0.432	10.97
8	8.625	219.08	0.109 [Note (2)]	2.77	0.148 [Note (2)]	3.76	0.322	8.18	0.500	12.70
10	10.750	273.05	0.134 [Note (2)]	3.40	0.165 [Note (2)]	4.19	0.365	9.27	0.500 [Note (2)]	12.70 [Note (2)]
12	12.750	323.85	0.156 [Note (2)]	3.96	0.180 [Note (2)]	4.57	0.375 [Note (2)]	9.52 [Note (2)]	0.500 [Note (2)]	12.70 [Note (2)]
14	14.000	355.60	0.156 [Note (2)]	3.96	0.188	4.78	...	...	...	...
16	16.000	406.40	0.165 [Note (2)]	4.19	0.188	4.78	...	...	...	...
18	18.000	457.20	0.165 [Note (2)]	4.19	0.188	4.78	...	...	...	...
20	20.000	508.00	0.188 [Note (2)]	4.78	0.218 [Note (2)]	5.54	...	...	...	...
22	22.000	558.80	0.188 [Note (2)]	4.78	0.218 [Note (2)]	5.54	...	...	...	...
24	24.000	609.60	0.218 [Note (2)]	5.54	0.250	6.35	...	...	...	...
30	30.000	762.00	0.250	6.35	0.312	7.92	...	...	...	...

GENERAL NOTE: The decimal thickness listed for the respective pipe sizes represents their nominal or average wall dimensions.

NOTES:
(1) Schedules 5S and 10S wall thicknesses do not permit threading in accordance with the American National Standard for Pipe Threads (ANSI B1.20.1).
(2) These do not conform to the American National Standard for Welded and Seamless Wrought Steel Pipe (ANSI B36.10-1979).