



Designation: **A789/A789M—20 A789/A789M – 22**

Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service¹

This standard is issued under the fixed designation A789/A789M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification² covers grades of average wall thickness, or, if specified on the order, minimum wall thickness, of stainless steel tubing for services requiring general corrosion resistance, 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 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. Within the text, the SI units are shown in brackets. The inch-pound units shall apply unless the *M* designation of this specification is specified in the order.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:³

[A480/A480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip](#)
[A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes](#)
[E527 Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

2.2 SAE Standard:⁴

[SAE J 1086 Practice for Numbering Metals and Alloys \(UNS\)](#)

3. Ordering Information

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

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

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 For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-789 in Section II of that Code.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

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

- 3.1.2 Name of product (seamless or welded tubes),
- 3.1.3 Grade (see [Table 1](#)),
- 3.1.4 Size (outside diameter and average wall thickness, unless minimum wall thickness is specified),
- 3.1.5 Length (specific or random),
- 3.1.6 Optional requirements (for product analysis, see [Section 8](#); for hydrostatic or nondestructive electric test, see [Section 10](#)),
- 3.1.7 Test report required (see the Inspection section of Specification [A1016/A1016M](#)),
- 3.1.8 Specification designation, and
- 3.1.9 Special requirements.

4. General Requirements

4.1 Product furnished under this specification shall conform to the applicable requirements of Specification [A1016/A1016M](#), unless otherwise provided herein.

5. Manufacture

5.1 The tubes shall be made by the seamless or welded process with no filler metal added.

6. Heat Treatment

6.1 All tubes shall be furnished in the heat-treated condition in accordance with the procedures shown in [Table 2](#). For seamless

TABLE 1 Chemical Requirements^A

UNS Designation ^B	C	Mn	P	S	Si	Ni	Cr	Mo	N	Cu	Others
S31200	0.030	2.00	0.045	0.030	1.00	5.5–6.5	24.0–26.0	1.20–2.00	0.14–0.20	...	...
S31260	0.030	1.00	0.030	0.030	0.75	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
S31500	0.030	1.20–2.00	0.030	0.030	1.40–2.00	4.3–5.2	18.0–19.0	2.50–3.00	0.05–0.1	...	...
S31803	0.030	2.00	0.030	0.020	1.00	4.5–6.5	21.0–23.0	2.5–3.5	0.08–0.20	...	...
S32001	0.030	4.00–6.00	0.040	0.030	1.00	1.0–3.0	19.5–21.5	0.60	0.05–0.17	1.00	...
S32003	0.030	2.00	0.030	0.020	1.00	3.0–4.0	19.5–22.5	1.50–2.00	0.14–0.20	...	...
S32101	0.040	4.0–6.0	0.040	0.030	1.00	1.35–1.70	21.0–22.0	0.10–0.80	0.20–0.25	0.10–0.80	...
S32202	0.030	2.00	0.040	0.010	1.00	1.00–2.80	21.5–24.0	0.45	0.18–0.26	...	...
S32205	0.030	2.00	0.030	0.020	1.00	4.5–6.5	22.0–23.0	3.0–3.5	0.14–0.20	...	...
S32304	0.030	2.50	0.040	0.040	1.00	3.0–5.5	21.5–24.5	0.05–0.60	0.05–0.20	0.05–0.60	...
S32506	0.030	1.00	0.040	0.015	0.90	5.5–7.2	24.0–26.0	3.0–3.5	0.08–0.20	...	W 0.05–0.30
S32520	0.030	1.50	0.035	0.020	0.80	5.5–8.0	23.0–25.0	3.–5.	0.20–0.35	0.50–3.00	...
S32550	0.04	1.50	0.040	0.030	1.00	4.5–6.5	24.0–27.0	2.9–3.9	0.10–0.25	1.50–2.50	...
S32707	0.030	1.50	0.035	0.010	0.50	5.5–9.5	26.0–29.0	4.0–5.0	0.30–0.50	1.0 max	Co 0.5–2.0
S32750 ^C	0.030	1.20	0.035	0.020	0.80	6.0–8.0	24.0–26.0	3.0–5.0	0.24–0.32	0.50	...
S32760 ^D	0.030	1.00	0.030	0.010	1.00	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
S32808	0.030	1.10	0.030	0.010	0.50	7.0–8.2	27.0–27.9	0.80–1.20	0.30–0.40	...	W 2.10–2.50
S32900	0.08	1.00	0.040	0.030	0.75	2.5–5.0	23.0–28.0	1.00–2.00	...	...	...
S32906	0.030	0.80–1.50	0.030	0.030	0.80	5.8–7.5	28.0–30.0	1.50–2.60	0.30–0.40	0.80	...
S32950	0.030	2.00	0.035	0.010	0.60	3.5–5.2	26.0–29.0	1.00–2.50	0.15–0.35	...	...
S33207	0.030	1.50	0.035	0.010	0.80	6.0–9.0	29.0–33.0	3.0–5.0	0.40–0.60	1.0	...
S39274	0.030	1.00	0.030	0.020	0.80	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
S39277	0.025	0.80	0.025	0.002	0.80	6.5–8.0	24.0–26.0	3.00–4.00	0.23–0.33	1.20–2.00	W 0.80–1.21
S82011	0.030	2.0–3.0	0.040	0.020	1.00	1.00–2.00	20.5–23.5	0.10–1.00	0.15–0.27	0.50	...
S82031	0.05	2.50	0.040	0.005	0.80	2.0–4.0	19.0–22.0	0.60–1.40	0.14–0.24	1.00	...
S82441	0.030	2.50–4.00	0.035	0.005	0.70	3.0–4.5	23.0–25.0	1.00–2.00	0.20–0.30	0.10–0.80	...
S83071	0.030	0.50–1.50	0.030	0.020	0.50	6.0–8.0	29.0–31.0	3.0–4.0	0.28–0.40	0.80	...

^A Maximum, unless a range or minimum is indicated. Where ellipses (...) appear in this table, there is no minimum and analysis for the element need not be determined or reported.

^B Designation established in accordance with Practice [E527](#) and SAE J1086.

^C % Cr + 3.3 × % Mo + 16 × % N ≥ 41.

^D % Cr + 3.3 × (% Mo + 1/2 %W) + 16 × % N ≥ 41.



TABLE 2 Heat Treatment

UNS Designation	Temperature °F [°C]	Quench
S31200	1920–2010	rapid cooling in water
S31260	[1050–1100]	rapid cooling in air or water
	1870–2010	
S31260	[1020–1100]	rapid cooling in water or by other means
	1870–2010	
S31500	1800–1900	rapid cooling in air or water
	[980–1040]	
S31500	1800–1900	rapid cooling in water or by other means
	[980–1040]	
S31803	1870–2010	rapid cooling in air or water
	[1020–1100]	
S31803	1870–2010	rapid cooling in water or by other means
	[1020–1100]	
S32001	1800–1950	rapid cooling in air or water
	[982–1066]	
S32001	1800–1950	rapid cooling in water or by other means
	[982–1066]	
S32003	1850–2050	rapid cooling in air or water
	[1010–1120]	
S32101	1870 [1020] min	quenched in water or rapidly cooled by other means
S32101	1870 [1020] min	rapid cooling in water or by other means
S32202	1870–1975	rapid cooling in air or water
	[1020–1080]	
S32202	1870–1975	rapid cooling in water or by other means
	[1020–1080]	
S32205	1870–2010	rapid cooling in air or water
	[1020–1100]	
S32205	1870–2010	rapid cooling in water or by other means
	[1020–1100]	
S32304	1700–1920	rapid cooling in air or water
	[925–1050]	
S32304	1700–1920	rapid cooling in water or by other means
	[925–1050]	
S32506	1870–2050	rapid cooling in air or water
	[1020–1120]	
S32506	1870–2050	rapid cooling in water or by other means
	[1020–1120]	
S32520	1975–2050	rapid cooling in air or water
	[1080–1120]	
S32520	1975–2050	rapid cooling in water or by other means
	[1080–1120]	
S32550	1900	rapid cooling in air or water
	[1040] min	
S32550	1900	rapid cooling in water or by other means
	[1040] min	
S32707	1975–2050	rapid cooling in air or water
	[1080–1120]	
S32707	1975–2050	rapid cooling in water or by other means
	[1080–1120]	
S32750	1880–2060	rapid cooling in air or water
	[1025–1125]	
S32750	1880–2060	rapid cooling in water or by other means
	[1025–1125]	
S32760	1960–2085	rapid cooling in air or water
	[1070–1140]	
S32760	1960–2085	rapid cooling in water or by other means
	[1070–1140]	
S32808	1920–2100	rapid cooling in air or water
	[1050–1150]	
S32808	1920–2100	rapid cooling in water or by other means
	[1050–1150]	
S32900	1700–1750	rapid cooling in air or water
	[925–955]	
S32900	1700–1750	rapid cooling in water or by other means
	[925–955]	
S32906	1870–2100	rapid cooling in air or water
	[1020–1150]	
S32906	1870–2100	rapid cooling in water or by other means
	[1020–1150]	
S32950	1820–1880	air cool
	[990–1025]	



S33207	1905–2085 [1040–1140]	rapid cooling in water or by other means
S39274	1920–2060 [1050–1125]	rapid cooling in air or water
S39274	1920–2060 [1050–1125]	rapid cooling in water or by other means
S39277	1975–2155 [1080–1180]	rapid cooling in air or water
S39277	1975–2155 [1080–1180]	rapid cooling in water or by other means
S82011	1850–2050 [1010–1120]	rapid cooling in air or water
S82011	1850–2050 [1010–1120]	rapid cooling in water or by other means
S82031	1830 [1000] min	rapid cooling in water or by other means
S82441	1830 [1000] min	rapid cooling in air or water
S82441	1830 [1000] min	rapid cooling in water or by other means
S83071	1830–2100 [1000–1150]	rapid cooling in water or by other means

tubes, as an alternate to final heat treatment in a continuous furnace or batch-type furnace, immediately following hot forming while the temperature of the tubes is not less than the specified minimum solution treatment temperature, tubes 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 prescribed in [Table 1](#).

8. Product Analysis

8.1 An analysis of either one billet or one length of flat-rolled stock or one tube shall be made from each heat. The chemical composition thus determined shall conform to the requirements specified.

8.2 A product analysis tolerance (see the annex table on Chemical Requirements (Product Analysis Tolerances) in Specification [A480/A480M](#)) shall apply. The product analysis tolerance is not applicable to the carbon content for material with a specified maximum carbon of 0.04 % or less.

8.3 If the original test for product analysis fails, retests of two additional billets, lengths of flat-rolled stock, or tubes shall be made. Both retests for the elements in question shall meet the requirements of this specification; otherwise, all remaining material in the heat shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets, lengths of flat-rolled stock, or tubes that do not meet the requirements of this specification shall be rejected.

NOTE 1—For flange and flaring requirements, the term *lot* applies to all tubes prior to cutting of the same nominal size and wall thickness that are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and from the same heat that are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, or when heat treated condition is obtained directly by quenching after hot forming, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubes as prescribed in [Table 3](#).

NOTE 2—For tension and hardness test requirements, the term *lot* applies to all tubes prior to cutting, of the same nominal diameter and wall thickness

TABLE 3 Number of Tubes in a Lot Heat Treated by the Continuous Process or by Direct Quench after Hot Forming

Size of Tube	Size of Lot
2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness	not more than 50 tubes
Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter or over 1 in. [25.4 mm] in outside diameter and under 0.200 in. [5.1 mm] in wall thickness	not more than 75 tubes
1 in. [25.4 mm] or less in outside diameter	not more than 125 tubes



that are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and the same heat that are heat treated in the same furnace charge. When the final heat treatment is in a continuous furnace, or when heat treated condition is obtained directly by quenching after hot forming, a lot shall include all tubes of the same size and heat, heat treated in the same furnace at the same temperature, time at heat, and furnace speed, or all tubes of the same size and heat, hot formed and quenched in the same production run.

9. Mechanical Tests Required

9.1 *Tension Tests*—One tension test shall be made on a specimen for lots of not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes (see [Note 2](#)).

9.2 *Flaring Test (for Seamless Tubes)*—One test shall be made on specimens from one end of one tube from each lot (see [Note 1](#)) of finished tubes. The minimum expansion of the inside diameter shall be 10 %.

9.3 *Flange Test (for Welded Tubes)*—One test shall be made on specimens from one end of one tube from each lot (see [Note 1](#)) of finished tubes.

9.4 *Hardness Test:*

9.4.1 Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot (see [Note 2](#)).

9.4.2 For tubing less than 0.354 in. [9.00 mm] in inside diameter and for tubing less than 0.065 in. [1.65 mm] in wall thickness, it is permissible to use the Vickers hardness test in lieu of the Brinell or Rockwell methods.

9.5 When more than one heat is involved, the tension, flaring, flanging, and hardness test requirements shall apply to each heat.

9.6 *Reverse Flattening Test*—For welded tubes, one reverse flattening test shall be made on a specimen from each 1500 ft [450 m] of finished tubing.

10. Hydrostatic or Nondestructive Electric Test

10.1 Each tube 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.

10.2 The hydrostatic test shall be in accordance with Specification [A1016/A1016M](#), except that in the calculation of the hydrostatic test pressure $64000(441.2)$ shall be substituted for $32000(220.6)$.

11. Tensile and Hardness Properties

11.1 The material shall conform to the tensile and hardness properties prescribed in [Table 4](#).

12. Permissible Variations in Dimensions

12.1 Variations in outside diameter, wall thickness, and length from those specified shall not exceed the amounts prescribed in [Table 5](#).

12.2 The permissible variations in outside diameter given in [Table 5](#) are not sufficient to provide for ovality in thin-walled tubes, as defined in the table. In such tubes, the maximum and minimum diameters at any cross section shall deviate from the nominal diameter by no more than twice the permissible variation in outside diameter given in [Table 5](#); however, the mean diameter at that cross section must still be within the given permissible variation.

13. Surface Condition

13.1 All tubes shall be free of excessive mill scale, suitable for inspection. A slight amount of oxidation will not be considered as scale. Any special finish requirements shall be subject to agreement between the manufacturer and the purchaser.