~~Designation:A 409/A409M–95a$^{\varepsilon 1}$~~

~~An American National Standard~~ Designation: A 409/A 409M – 01

Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service[1]

This standard is issued under the fixed designation A 409/A 409M; 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. ~~ε[1]NOTE—The Celsius conversion in 5.3.1 was corrected editorially in May 1996.~~

1. Scope

1.1 This specification[2] covers straight seam or spiral seam electric-fusion-welded, light-wall, austenitic chromium-nickel alloy steel pipe for corrosive or high-temperature service. The sizes covered are NPS 14 to 30 with extra light (Schedule 5S) and light (Schedule 10S) wall thicknesses. Table X1.1 shows the wall thickness of Schedule 5S and 10S pipe. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

1.2 Several grades of alloy steel are covered as indicated in Table 1.

1.3 Optional supplementary requirements are provided. These call for additional tests to be made, and when desired shall be stated in the order, together with the number of such tests required.

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:*

~~A240Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels~~

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels[3]

~~A530/A530MSpecification for General Requirements for Specialized Carbon and Alloy Steel Pipe~~ 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip[3]

A 999/A 999M Specification for General Requirements for Alloy and Stainless Steel Pipe[4]

E 527 Practice for Numbering Metals and Alloys (UNS)[4]

2.2 *ASME Boiler and Pressure Vessel Code:*

~~Section IX Welding Qualifications.~~

Section IX Welding Qualifications. [5]

2.3 *AWS Standards:*

A 5.22 Flux Cored Arc Welding[6]

A 5.30 Consumable Weld Inserts for Gas Tungsten Arc Welding[6]

A 5.4 Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes[6]

A 5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes[6]

A 5.11 Nickel and Nickel-Alloy Covered Welding Electrodes[6]

A 5.14 Nickel and Nickel-Alloy Bare Welding Rods and Electrodes[6]

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[1] This specification is under the jurisdiction of ASTM Committee ~~A-1~~ A01 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.10 ~~on Steel Tubing.~~

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-409 in Section II of that Code.

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

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

[5] Available from American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

[6] Available from American Welding Society, 550 Le Jeune Road, P.O. Box 351040, Miami, FL 33135.

TABLE 1 Chemical Requirements

Grade	UNS Designations[A]	Composition, %											
		Carbon, max	Manganese, max	Phosphorus, max	Sulfur, max	Silicon	Nickel	Chromium	Molybdenum	Titanium	Columbium	Cerium	Other Elements
TP304	S30400	0.08	2.00	0.045	0.030	0.75 max	8.00–11.0	18.0–20.0	...	...	...	...	...
TP304	S30400	0.08	2.00	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	...	...	...	...	...
TP304L	S30403	0.035	2.00	0.045	0.030	0.75 max	8.00–13.0	18.0–20.0	...	...	...	...	...
TP304L	S30403	0.035	2.00	0.045	0.030	1.00 max	8.0–12.0	18.0–20.0	...	...	...	...	...
TP309Cb	S30940	0.08	2.00	0.045	0.030	0.75 max	12.0–16.0	22.0–24.0	0.75 max	...	...	...	Cu 0.75 max; Cb + Ta 10 × C min, 1.10 max
TP309Cb	S30940	0.08	2.00	0.045	0.030	1.00 max	12.0–16.0	22.0–24.0		...	...	...	Cb 10 × C min, 1.10 max
–	–	–	–	–	–	–	–	–	–	–	–	–	Cu 0.75 max
–	–	–	–	–	–	–	–	–	–	–	–	–	Cu 0.75 max; Cb + Ta 10 × C min, 1.10 max
TP309S	S30908	0.08	2.00	0.045	0.030	0.75 max	12.0–15.0	22.0–24.0	0.75 max	...	...	...	Cu 0.75 max
TP309S	S30908	0.08	2.00	0.045	0.030	1.00 max	12.0–15.0	22.0–24.0		...	...	...	
TP310Cb	S31040	0.08	2.00	0.045	0.030	0.75 max	19.0–22.0	24.0–26.0	0.75 max	...	...	...	...
TP310Cb	S31040	0.08	2.00	0.045	0.030	1.00 max	19.0–22.0	24.0–26.0		...	...	...	Cb 10 × C min, 1.10 max
TP310S	S31008	0.08	2.00	0.045	0.030	0.75 max	19.0–22.0	24.0–26.0	0.75 max	...	...	...	
TP310S	S31008	0.08	2.00	0.045	0.030	1.00 max	19.0–22.0	24.0–26.0		...	...	...	
TP316	S31600	0.08	2.00	0.045	0.030	0.75 max	10.0–14.0	16.0–18.0	2.0–3.0	...	...	...	
TP316	S31600	0.08	2.00	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	...	...	...	
TP316L	S31603	0.035	2.00	0.045	0.030	0.75 max	10.0–15.0	16.0–18.0	2.0–3.0	...	...	...	...
TP316L	S31603	0.035	2.00	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	...	...	...	...
TP317	S31700	0.08	2.00	0.045	0.030	0.75 max	11.0–14.0	18.0–20.0	3.0–4.0	...	...	...	...
TP317	S31700	0.08	2.00	0.045	0.030	1.00 max	11.0–15.0	18.0–20.0	3.0–4.0	...	...	...	...
TP321	S32100	0.08	2.00	0.045	0.030	0.75 max	9.00–13.0	17.0–20.0	...	B	...	...	...
TP321	S32100	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–20.0	...	B	...	...	...
TP347	S34700	0.08	2.00	0.045	0.030	0.75 max	9.00–13.0	17.0–20.0	...	–	C	...	...
TP347	S34700	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	...	–	C	...	...
TP348	S34800	0.08	2.00	0.045	0.030	0.75 max	9.00–13.0	17.0–20.0	...	–	D	...	...
TP348	S34800	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	...	–	D	...	...
...	S31254	0.020	1.00	0.030	0.010	0.80 max	17.5–18.5	19.5–20.5	6.00–6.50	...	...	...	Cu 0.50–1.00 N 0.180–0.220
...	S31254	0.020	1.00	0.030	0.010	0.80 max	17.5–18.5	19.5–19.5	6.0–6.5	...	...	...	Cu 0.50–1.00 N 0.18–0.22
...	S30815	0.05–0.10	0.80	0.040	0.030	1.40–2.00	10.0–12.0	20.0–22.0	...	...	...	0.03–0.08	N 0.14–0.20
...	S31725	0.03	2.00	0.045	0.030	0.75 max	13.5–17.5	18.0–20.0	4.0–5.0	...	...	...	Cu 0.75 max N 0.10 max
...	S31725	0.030	2.00	0.045	0.030	1.00 max	13.5–17.5	18.0–20.0	4.0–5.0	...	...	...	N 0.020 max
...	S31726	0.03	2.00	0.045	0.030	0.75 max	13.5–17.5	17.0–20.0	4.0–5.0	...	...	...	Cu 0.75 max N 0.10–0.20
...	S31726	0.030	2.00	0.045	0.030	1.00 max	14.5–17.5	17.0–20.0	4.0–5.0	...	...	...	N 0.10–0.20
...	S24565	0.03	5.0–7.0	0.030	0.010	1.00 max	16.0–18.0	23.0–25.0	4.0–5.0	...	0.1 max	...	N 0.4–0.6
...	S34565	0.030	5.0–7.0	0.030	0.010	1.00 max	16.0–18.0	23.0–25.0	4.0–5.0	...	0.10 max	...	N 0.40–0.60
...	N08367	0.03	2.00	0.040	0.030	1.00 max	23.50–25.50	20.00–22.00	6.00–7.00	...	...	...	Cu 0.75 max Ni 0.18–0.25
...	N08367	0.030	2.00	0.040	0.030	1.00 max	23.5–25.5	20.0–22.0	6.0–7.0	...	...	...	Cu 0.75 max Ni 0.18–0.25
...	S20400	0.030	7.0–9.0	0.45	0.030	1.00 max	1.50–3.00	15.0–17.0	...	...	...	...	N 0.15–0.30

[A] New designation established in accordance with ASTM E 527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

[B] The titanium content shall be not less than 5 times the carbon content and not more than 0.70 %.

[C] The columbium plus tantalum content shall be not less than 10 times the carbon content and not more than 1.10 %.

[D] The columbium plus tantalum content shall be not less than 10 times the carbon content and not more than 1.10 %. The tantalum content shall be 0.10 % maximum, CO 0.20 % maximum.

2.4 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[7]

[7] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

3. Ordering Information

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

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

3.1.2 Name of material (straight seam or spiral seam electric-fusion-welded austenitic steel pipe),

3.1.3 Grade (Table 1),

3.1.4 Size (outside diameter and schedule number, or wall thickness).

3.1.5 Length (specific or random) (Section 11),

3.1.6 End finish (Section on Ends of Specification ~~A530~~A 999/A 999M~~/A530M),~~,),

3.1.7 Optional requirements (5.2.1-5.2.3 removal of weld bead; 5.3.2, special heat treatment; 15.2, nondestructive test; 10.1.1, outside diameter tolerance; 11.2, length circumferentially welded; 12.3, repair by welding and heat treatment subsequent to repair welding; 12.4, sand blasted or pickled; 17.1 Certification; Supplementary Requirements S1 to S6).

3.1.8 Specification designation, and

3.1.9 Special requirements.

4. General Requirements

4.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification ~~A530~~A 999/A 999M~~/A530M,~~, unless otherwise provided herein.

5. Materials and Manufacture

5.1 If a specific type of melting is required by the purchaser it shall be stated on the order.

5.2 *Welding*:

5.2.1 The welds shall be made by the manual or automatic electric-welding process. For manual welding, the operator and procedure shall be qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IXr00001. Unless otherwise specified on the purchase order, the pipe may be welded with or without filler metal when the automatic electric-welding process is used.

5.2.2 The weld surface on either side of the weld may be flush with the base plate or may have a reasonably uniform crown, not to exceed ~~1/16~~1/16 in. [2 mm]. Any weld reinforcement may be removed at the manufacturer's option or by agreement between the manufacturer and purchaser. The contour of the reinforcement should be reasonably smooth and free from irregularities. The weld metal shall be fused uniformly into the plate surface. No concavity of contour is permitted unless the resulting thickness of weld metal is equal to or greater than the minimum thickness of the adjacent base metal.

5.2.3 Weld defects, as determined by specified inspection requirements, shall be repaired by removal to sound metal and rewelding.

5.3 *Heat Treatment*:

5.3.1 Except as provided in 5.3.2, all pipe shall be furnished in the heat-treated condition. The heat-treatment procedure shall consist of heating the material to a minimum temperature of 1900°F [1040°C], except for S31254 and S30815 which shall be heat treated to 2100°F [1150°C] and 1920°F [1050°C] respectively, S24565 which shall be heat treated in the range 2050°F [1120°C] to 2140°F [1170°C], and N08367, which shall be heated to a minimum temperature of 2025°F [1107°C], all materials to be followed by quenching in water or rapidly cooling by other means.

5.3.2 The purchase order shall specify one of the following conditions if the heat-treated condition specified in 5.3.1 is not desired by the purchaser:

5.3.2.1 A final heat-treatment temperature under 1900°F [1040°C]. Each pipe supplied under this requirement shall be stenciled with the final heat-treatment temperature in degrees Fahrenheit or degrees Celsius after the suffix "HT". Controlled structural or special service characteristics may be specified as a guide for the most suitable heat treatment.

5.3.2.2 No final heat treatment of pipe fabricated of plate, that has been solution heat treated at temperatures required by this specification. Each pipe supplied under this requirement shall be stenciled with the suffix "HT-O".

5.3.2.3 No final heat treatment of pipe fabricated of plate, that has not been solution heat treated. Each pipe supplied under this requirement shall be stenciled with the suffix "HT-SO".

5.4 A solution annealing temperature above 1950°F [1065°C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in TP321, TP347, and TP348. When specified by the purchaser, a lower temperature stabilization or re-solution anneal shall be used subsequent to the initial high temperature solution anneal (see Supplementary Requirement S5).

6. Chemical Composition

~~6.1Each type of stainless steel or alloy shall conform to the requirements as to chemical composition prescribed in~~

6.1 The steel shall conform to the chemical composition in Table 1.

~~6.2Unless otherwise specified in the purchase order, the chemical composition of the welding filler metal shall conform to the requirements of the applicable AWS specification for the corresponding grade shown in~~

6.2 When specified on the purchase order, a product analysis shall be supplied from one tube or coil of steel per heat. The