



Designation: A 409/A 409M – 95a<sup>ε01</sup>

An American National Standard

## Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service<sup>1</sup>

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.

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<sup>ε1</sup> NOTE ~~The Celsius conversion in 5.3.1 was corrected editorially in May 1996.~~

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<sup>1</sup> 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 ~~Stainless and Alloy Steel Tubing~~ Tubular Products.

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## 1. Scope

1.1 This specification<sup>2</sup> 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:*

~~A 240 Specification 262 Practices for Heat-Resisting Chromium and Chromium-Nickel Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel Plate, Sheet, and Strip for Pressure Vessels Steels<sup>3</sup>~~

~~A 262 Practices 480/A 480M Specification for Detecting Susceptibility to Intergranular Attack in Austenitic General Requirements for Flat-Rolled Stainless and Heat-Resisting Steels Plate, Sheet, and Strip<sup>3</sup>~~

~~A 530999/A 530 999M Specification for General Requirements for Specialized Carbon and Alloy and Stainless Steel Pipe<sup>4</sup>~~

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

### 2.2 *ASME Boiler and Pressure Vessel Code:*

Section IX Welding Qualifications.<sup>5</sup>

### 2.3 *AWS Standards:*

A 5.22 Flux Cored Arc Welding<sup>6</sup>

A 5.30 Consumable Weld Inserts for Gas Tungsten Arc Welding<sup>6</sup>

A 5.4 Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes<sup>6</sup>

A 5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Bare Electrodes<sup>6</sup>

A 5.11 Nickel and Nickel-Alloy Covered Welding Electrodes<sup>6</sup>

A 5.14 Nickel and Nickel-Alloy Bare Welding Rods and Electrodes<sup>6</sup>

### 2.4 *Other Standard:*

~~SAE J1086 Practice for Numbering Metals and Alloys (UNS)<sup>7</sup>~~

## 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 ~~A 530/A 530M~~, ~~A 999/A 999M~~),

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

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-409 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> Available from American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

<sup>6</sup> Available from American Welding Society, 550 Le Jeune Road, P.O. Box 351040, Miami, FL 33135.

<sup>7</sup> Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.



TABLE 1 Chemical Requirements

Grade	UNS Designations	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	10.0–14.0	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	11.0–15.0	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	...	...	...	...	...
TP321	S32100	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–20.0	...	...	...	...	...
TP347	S34700	0.08	2.00	0.045	0.030	0.75 max	9.00–13.0	17.0–20.0	...	...	...	...	...
TP347	S34700	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	...	...	...	...	...
TP348	S34800	0.08	2.00	0.045	0.030	0.75 max	9.00–13.0	17.0–20.0	...	...	...	...	...
TP348	S34800	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	...	...	...	...	...
...	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 0.180–0.220
...	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 0.18–0.22
...	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	0.040	1.00 max	16.0–18.0	23.0–25.0	4.0–5.0	...	0.1	...	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

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

<sup>B</sup> The titanium content shall be not less than 5 times the carbon content and not more than 0.70 %.

<sup>C</sup> The columbium plus tantalum content shall be not less than 10 times the carbon content and not more than 1.10 %.

<sup>D</sup> 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.

A 530/A 530M, A 999/A 999M, 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 IX<sup>r00001</sup>. 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  $\pm 6\frac{1}{16}$  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

~~6.1 Each type of stainless~~

~~6.1 The steel or alloy shall conform to the requirements as to chemical composition prescribed in Table 1.~~

~~6.2 When specified on the purchase order, a product analysis shall be supplied from one tube or coil of steel per heat. The product analysis tolerance of Specification A 480/A 480M shall apply.~~

6.3 Unless 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 Table 2. Grades with no filler metal classification indicated shall be welded with filler metals producing deposited weld metal having a composition in accordance with the chemical composition specified in Table 1. The method of analysis for nitrogen and cerium shall be a matter of agreement between the purchaser and manufacturer. The purchaser may choose a higher-alloy filler metal when needed for corrosion resistance.

## 7. Tensile Requirements

7.1 The tensile properties of the plate or sheet used in making the pipe shall conform to the requirements prescribed in Table 3. Certified mill test reports shall be submitted to the pipe manufacturer.

7.2 A transverse tension test taken across the welded joint of the finished pipe shall meet the same minimum tensile strength requirements as the sheet or plate. The weld section on the tension specimen shall be in the same condition as the finished pipe (with or without bead as specified).

## 8. Mechanical Tests Required

8.1 *Tension Test*—One transverse tension test of the weld shall be made on each lot (Note 2) of finished pipe.

NOTE 2—The term "lot" applies to each 200 ft [60 m] or less of pipe of the same NPS and wall thickness (or schedule number) which is produced from the same heat of steel and subjected to the same finishing treatment in a continuous furnace. When final heat treatment is in a batch-type furnace, the lot shall include only that pipe which is heat treated in the same furnace charge. When no heat treatment is performed following final forming operations, the lot shall include each 200 ft [60 m] or less of pipe of the same NPS and wall thickness (or schedule number) which is produced from the same heat of steel.

8.2 *Transverse Guided-Bend Weld Test*— One test (two specimens) of the weld shall be made on each lot (Note 2) of finished pipe.

8.3 *Pressure or Nondestructive Electric Test*—Each length of pipe shall be subjected to a pressure test or a nondestructive electric test as prescribed in Section 5.



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**TABLE 2 Filler Metal Specifications**

Grade	UNS Designation	Filler Metal Classification and UNS Designation <sup>A</sup> for Applicable <sup>B</sup> AWS Specification											
		A5.4		A5.9		A5.11		A5.14		A5.22		A5.30	
		Class.	UNS	Class.	UNS	Class.	UNS	Class.	UNS	Class.	UNS	Class.	UNS
TP304	S30400	E308	W30810	ER308	S30880 W30840	...	...	...	...	E308T	W30831	IN308	S30880
TP304L	S30403	E308L	W30813	ER308L	S30883 W30843	...	...	...	...	E308T	W30835	IN308L	S30883
TP309Cb	S30940	E309Cb	W30917	...	...	...	...	...	...	...	...	...	...
TP310Cb	S31040	E310Cb	W31017	...	...	...	...	...	...	...	...	...	...
TP316	S31600	E316	W31610	ER316	S31680 W31640	...	...	...	...	E316T	W31631	IN316	S31680
TP316L	S31603	E316L	W31603	ER316L	S31683 W31643	...	...	...	...	E316LT	W31635	IN316L	S31683
TP317	S31700	E317	W31700	ER317	S31783 W31743	...	...	...	...	E317T	W31731	IN317	S31780
TP321	S32100	E347	W34710	ER321 ER347	S32180 W32140 S34780 W34740	...	...	...	...	E347T	W34733	IN348	S34780
TP347	S34700	E347	W34710	ER347	S34780 W34740	...	...	...	...	E347T	W34733	IN348	S34780
TP348	S34800	E347	W34710	ER347	S34780 W34740	...	...	...	...	E347T	W34733	IN348	S34780
...	S31254	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	NO6625	...	...	...	...
...	S31725	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	NO6625	...	...	...	...
...	S31726	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	NO6625	...	...	...	...
...	S24565	...	...	...	...	...	...	...	...	...	...	...	...
...	N08367	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	NO6625	...	...	...	...
...	S20400	E209	W32210	ER209	W32240	...	...	...	...	...	...	...	...

<sup>A</sup>New designation established in accordance with Practice E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).  
<sup>B</sup>Choice of American Welding Society specification depends on the welding process used.

**TABLE 3 Tensile Requirements**

Grade	UNS Designation	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]
TP304	S30400	75 [515]	30 [205]
TP304L	S30403	70 [485]	25 [170]
TP309Cb	S30940	75 [515]	30 [205]
TP309S	S30908	75 [515]	30 [205]
TP310Cb	S31040	75 [515]	30 [205]
TP310S	S31008	75 [515]	30 [205]
TP316	S31600	75 [515]	30 [205]
TP316L	S31603	70 [485]	25 [170]
TP317	S31700	75 [515]	30 [205]
TP321	S32100	75 [515]	30 [205]
TP347	S34700	75 [515]	30 [205]
TP348	S34800	75 [515]	30 [205]
...	S31254	94 [650]	44 [300]
...	S30815	87 [600]	45 [310]
...	S31725	75 [515]	30 [205]
...	S31726	80 [550]	35 [240]
...	S24565	115 [795]	60 [415]
...	S20400	95 [655]	48 [330]
...	N08367	...	...
...	t ≤ 0.187	100 [690]	45 [310]
...	t > 0.187	95 [655]	45 [310]

## 9. Permissible Variations in Wall Thickness

9.1 The minimum wall thickness at any point shall not be more than 0.018 in. [0.46 mm] under the specified wall thickness. (This tolerance is slightly more than commercial tolerances on sheet and plate to allow for possible loss of thickness caused by manufacturing operations.)

## 10. Permissible Variations in Dimensions

10.1 Permissible variations in dimensions shall not exceed the following at any point in each length of pipe.

10.1.1 *Specified Diameter*—Where the specified wall thickness is less than 0.188 in. [4.8 mm], the actual outside diameter, based on circumferential measurement, shall not vary more than ±0.20 % from the specified outside diameter. Where the specified wall thickness is 0.188 in. [4.8 mm] and heavier, the actual outside diameter, based on circumferential measurement, may vary a

maximum of  $\pm 0.40\%$  from the specified outside diameter. (Outside diameter tolerances closer than shown above may be obtained by agreement between the pipe manufacturer and purchaser.)

10.1.2 *Out-of-Roundness*—The difference between the major and the minor outside diameter shall not be more than 1.5 % of the specified outside diameter.

10.1.3 *Alignment (Camber)*—Using a 10-ft [3.0-m] straightedge placed so that both ends are in contact with the pipe, the camber shall not be more than  $3\pm 6\frac{3}{16}$  in. [4.8 mm].

## 11. Lengths

11.1 Unless otherwise specified in the purchase order, pipe of NPS 22 or less will be furnished in random lengths of 9 to 12 ft (Note 3). For outside diameters of over NPS 22, the minimum length will be 5 ft (Note 3).

NOTE 3—This value(s) applies when the inch-pound designation of this specification is the basis of purchase. The corresponding metric value(s) shall be agreed upon between the manufacturer and the purchaser.

11.2 When specified by the purchaser, two or more lengths may be circumferentially welded together to produce longer lengths.

11.3 Circumferentially welded joints shall be of the same quality as the longitudinal joints.

## 12. Workmanship, Finish, and Appearance

12.1 The finished pipe shall have a workmanlike finish.

12.2 *Repair of Defects by Machining or Grinding*—Pipe showing moderate slivers or other surface defects may be machined or ground inside or outside to a depth which will ensure the removal of all defects providing the wall thickness is not reduced below the minimum specified in 9.1.

12.3 *Repair of Defects by Welding*—Defects which violate minimum wall thickness may be repaired by welding, but only with the approval of the purchaser. Areas shall be suitably prepared for welding with tightly closed defects removed by grinding. Open, clean defects, such as pits or impressions, may require no preparation. All welders, welding operators, and weld procedures shall be qualified to the ASME Boiler and Pressure Vessel Code, Section IX. Unless the purchaser specifies otherwise, pipe required to be heat treated under the provisions of 5.3 shall be heat treated or reheat treated following repair welding. Repaired lengths, where repair depth is greater than  $\frac{1}{4}$  of the thickness, shall be pressure tested or repressure tested after repair and heat treatment (if any). Repair welds shall also be examined by suitable non-destructive examination techniques, including any techniques specifically required of the primary weld.

12.4 The pipe shall be free of scale and contaminating iron particles. Pickling, blasting, or surface finishing is not mandatory when pipe is bright annealed. The purchaser may request that a passivating treatment be applied.

## 13. Test Specimens

13.1 Transverse tension and bend test specimens may be taken from a test plate of the same material as the pipe, made by attaching a formed cylinder to the end of the pipe and welding the abutting edges as a continuation and duplication of the seam of the pipe (run-off plate). As an alternative to a formed cylinder, the run-off plate may consist of flat plates with reinforcing bars clamped to the underside to prevent distortion. The run-off plate material shall be of the same heat, preferably shear croppings from the same plate.

13.2 When heat treatment is required, test specimens shall be cut from pipe after the heat treating has been completed, or specimens removed from the pipe prior to heat treating shall be heat treated with the pipe.

## 14. Transverse Guided-Bend Weld Tests

14.1 Two bend test specimens shall be taken transversely across the weld. One shall be subject to a face guided-bend test and the second to a root guided-bend test. One specimen shall be bent with the inside surface of the pipe against the plunger, and the other with the outside surface against the plunger.

14.2 The bend test shall be acceptable if no cracks or other defects exceeding  $\frac{1}{8}$  in. [3 mm] in any direction are present in the weld metal or between the weld and the pipe metal after bending. Cracks which originate along the edges of the specimen during testing, and that are less than  $\frac{1}{4}$  in. [6.5 mm] measured in any direction shall not be considered.

## 15. Pressure Tests

15.1 Where hydrostatic test equipment is not available, the pipe may be air or gas pressure tested with an internal pressure of 100 psi [700 kPa]. The weld and weld area shall be inspected with the use of soap solution or any other prepared solution which will detect the leakage of air or gas from the inside.

15.2 Instead of a pressure test, when mutually agreed upon between the purchaser and manufacturer, the entire weld area of each pipe, including circumferential welds, may be tested by nondestructive testing methods. These methods shall be capable of detecting both surface and subsurface defects.

## 16. Inspection

16.1 When specified in the purchase order, the pipe may be inspected at the manufacturer's plant by an inspector representing the purchaser. The inspector shall have entry at all times. The manufacturer shall afford the inspector, all reasonable facilities to

satisfy him that the material is being furnished in accordance with these specifications.

### **17. Certification**

17.1 Upon request of the purchaser in the contract or order, certification in accordance with the provisions of Specification A 530/A 530M A 999/A 999M shall be furnished. When specified on the purchase order or when a specific type of melting has been specified on the purchase order, the type of melting used shall also be reported to the purchaser or the purchaser's representative.

### **18. Product Marking**

18.1 Each length of pipe manufactured in accordance with this specification shall have the following identifying marking within 12 in. [300 mm] of one end: manufacturer's name or trade-mark, specification number, grade number of the alloy, the manufacturer's heat number, size, and schedule number. Additional marking requirements for heat treatment are described in Supplementary Requirement S2.

18.2 Marking shall be legibly stenciled with a suitable paint or permanent marking compound, except when otherwise specified by the purchaser.

## **SUPPLEMENTARY REQUIREMENTS**

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 At the request of the purchaser a product analysis of one coupon representing finished sheet or plate from each heat shall be made by the pipe manufacturer. The drillings for product analysis may be taken from shear crop or test specimens. The results of product analysis shall conform to the requirements in Table 1 and shall be reported to the purchaser.

### **S2. Radiographic Examination**

S2.1 Weld soundness shall be determined through radiographic examination made in accordance with requirements as agreed upon between the pipe manufacturer and purchaser.

### **S3. Corrosion Requirements**

S3.1 *Boiling Nitric Acid Test*—Except for Grade TP321, coupons representing finished pipe made of nonmolybdenum-bearing material (0.50 % and less molybdenum) shall meet the requirement of the boiling nitric acid test conducted according to Practice C of Practices A 262. The condition of the test specimens and the corrosion rates are as follows: Type 347 and Type 348 shall be tested in the sensitized condition (heated for 1 h at 1240°F [675°C]) and the rate of penetration shall not exceed 0.0020 in. [0.05 mm]/month. All other nonmolybdenum-bearing types, except for Grade TP321, shown in Table 1 shall be tested in the annealed and unsensitized condition and the rate of penetration shall not exceed 0.0015 in. [0.04 mm]/month.

S3.2 *Acidified Copper Sulfate Test*—Coupons representing finished pipe made of molybdenum-bearing material and Type 321 (over 0.50 % molybdenum) shall meet the requirements of the copper-copper sulfate-sulfuric acid test (intergranular corrosion test) conducted in accordance with Practice E of Practices A 262. The condition of the test specimen is as follows: All molybdenum-bearing types shown in Table 1 shall be tested in the annealed and unsensitized condition. Type 321 shall be tested in the sensitized condition (heated for 1 h at 1240°F [675°C]). All specimens shall meet the requirements of the prescribed bend test.

### **S4. Ferrite Control of Weld Deposits**

S4.1 The ferrite content of the deposited weld metal in any length of pipe may be determined. The procedural details pertaining to this subject (that is, welding, plate and weld deposit chemistry, testing equipment and method, number and location of test sites, and ferrite control limits) shall be a matter for agreement between the purchaser and the manufacturer.

### **S5. Stabilizing Heat Treatment**

S5.1 Subsequent to the heat treatment required in 5.3, Grades TP321, TP347, and TP348 shall be given a stabilization heat treatment at a temperature lower than that used for the initial solution annealing heat treatment. The temperature of stabilization heat treatment shall be at a temperature as agreed upon between the purchaser and vendor.

### **S6 Intergranular Corrosion Test**

S6.1 When specified, material shall pass intergranular corrosion tests conducted by the manufacturer in accordance with Practices A 262, Practice E.

NOTE S6.1—Practice E requires testing on the sensitized condition for low carbon or stabilized grades, and on the as-shipped condition for other grades.

S6.2 A stabilization heat treatment in accordance with Supplementary Requirement S5 may be necessary and is permitted in order to meet this requirement for the grades containing titanium or columbium.

## APPENDIX

### (Nonmandatory Information)

#### X1. Wall Thickness of Schedule 5S and Schedule 10S

TABLE—Pipe X1.1 Pipe Dimensions

NPS Designator	Wall Thickness			
	Schedule 5S		Schedule 10S	
	in.	mm	in.	mm
14	0.156	3.96	0.188	4.78
16	0.165	4.19	0.188	4.78
18	0.165	4.19	0.188	4.78
20	0.188	4.78	0.218	5.54
22	0.188	4.78	0.218	5.54
24	0.218	5.54	0.250	6.35
30	0.250	6.35	0.312	7.92

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