

ASTM - A409/A409M
Standard Specification for
Welded Large Diameter Austenitic Steel Pipe for Corrosive or
High-Temperature Service

This specification 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 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.

A. Heat Treatment :-

1. Except as provided in ‘point A.2’, all pipe shall be furnished in the heat-treated condition. For H grades and S30815, separate solution heat treatments are required for solution annealing; in-process heat treatments are not permitted as a substitute for the separate solution heat treatments. The heat-treatment procedure shall consist of heating the material to a minimum temperature of 1900 °F [1040 °C], except for S31254, S31266, and S30815 which shall be heat treated to 2100 °F [1150 °C] and 1920 °F [1050 °C] respectively, S31727 and S32053 which shall be heat treated in the range 1975 to 2155 °F [1080 to 1180 °C], S34565 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.
2. The purchase order shall specify 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.
3. 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.

B. Grain Size :-

1. The grain size for all H grades and S30815 shall be No. 7 or coarser, when determined according to ASTM E112 Test Methods.

C. Chemical Composition :-

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

Table 1

	UNS Designations ^A	C, max	Mn, max	P, max	S, max	Si	Ni	Cr	Mo	Ti	Cb	Ce	Other Elements
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TP201	S20100	0.15	5.5–7.5	0.06	0.03	1.0	3.5–5.5	16.0–18.0	N 0.25
TP201LN	S20153	0.03	6.4–7.5	0.045	0.015	0.75	4.0–5.0	16.0–17.5	N 0.10–0.25, Cu 1.00
TP304	S30400	0.08	2.0	0.045	0.03	1.00 max	8.0–11.0	18.0–20.0	...	...	...	...	...
TP304L	S30403	0.035	2.0	0.045	0.03	1.00 max	8.0–12.0	18.0–20.0	...	...	...	...	...
TP309Cb	S30940	0.08	2.0	0.045	0.03	1.00 max	12.0–16.0	22.0–24.0	...	...	...	...	Cb 10×C min, 1.10 max
TP309S	S30908	0.08	2.0	0.045	0.03	1.00 max	12.0–15.0	22.0–24.0	...	...	...	...	...
TP310Cb	S31040	0.08	2.0	0.045	0.03	1.00 max	19.0–22.0	24.0–26.0	...	...	...	...	Cb 10×C min, 1.10 max
TP310S	S31008	0.08	2.0	0.045	0.03	1.00 max	19.0–22.0	24.0–26.0	...	...	...	...	...
TP316	S31600	0.08	2.0	0.045	0.03	1.00 max	10.0–14.0	16.0–18.0	2.0–3.0	...	...	...	...
TP316L	S31603	0.035	2.0	0.045	0.03	1.00 max	10.0–14.0	16.0–18.0	2.0–3.0	...	...	...	...
TP317	S31700	0.08	2.0	0.045	0.03	1.00 max	11.0–15.0	18.0–20.0	3.0–4.0	...	...	...	...
...	S31727	0.03	1.0	0.03	0.03	1.00 max	14.5–16.5	17.5–19.0	3.8–4.5	...	...	...	N 0.15–0.21 Cu 2.8–4.0
...	S32053	0.03	1.0	0.03	0.01	1.00 max	24.0–26.0	22.0–24.0	5.0–6.0	...	...	...	N 0.17–0.22
TP321	S32100	0.08	2.0	0.045	0.03	1.00 max	9.00–12.0	17.0–20.0	...	B	...	...	...
TP347	S34700	0.08	2.0	0.045	0.03	1.00 max	9.00–12.0	17.0–19.0	...	...	C	...	...
TP348	S34800	0.08	2.0	0.045	0.03	1.00 max	9.00–12.0	17.0–19.0	...	...	D	...	...
...	S31254	0.02	1.0	0.03	0.01	0.80 max	17.5–18.5	19.5–19.5	6.0–6.5	...	...	...	Cu 0.50–1.00 N 0.18–0.25
...	S30815	0.05–0.10	0.8	0.04	0.03	1.40–2.00	10.0–12.0	20.0–22.0	...	...	...	0.03–0.08	N 0.14–0.20
...	S31725	0.03	2.0	0.045	0.03	1.00 max	13.5–17.5	18.0–20.0	4.0–5.0	...	...	...	N 0.020 max
...	S31726	0.03	2.0	0.045	0.03	1.00 max	14.5–17.5	17.0–20.0	4.0–5.0	...	...	...	N 0.10–0.20
...	S34565	0.03	5.0–7.0	0.03	0.01	1.00 max	16.0–18.0	23.0–25.0	4.0–5.0	...	0.1 max	...	N 0.40–0.60

...	N08367	0.03	2.0	0.04	0.03	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	0.03	7.0–9.0	0.45	0.03	1.00 max	1.50–3.00	15.0–17.0	...	...	...	...	N 0.15–0.30
...	S31266	0.03	2.0–4.0	0.035	0.02	1.00 max	21.0–24.0	23.0–25.0	5.2–6.2	...	...	...	Cu 1.00–2.50 W 1.50–2.50 N 0.35–0.60

^A New designation established in accordance with ASTM E527 and SAE J1086.

^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.

D. Tensile Requirements :-

The tensile properties of the plate or sheet used in making the pipe shall conform to the requirements prescribed in Table 2.

Table 2

Grade	UNS Designation	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]
TP201	S20100	75 [515]	38 [260]
TP201LN	S20153	95 [655]	45 [310]
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]

...	S31727	80 [550]	36 [245]
...	S32053	93 [640]	43 [295]
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]
...	S34565	115 [795]	60 [415]
...	S20400	95 [655]	48 [330]
...	N08367		
	$t \leq 0.187$	100 [690]	44 [310]
	$t > 0.187$	95 [655]	45 [310]
...	S31266	109 [750]	61 [420]

E. Mechanical Tests :- 1.

- Tension Test.
- 2. Transverse Guided-Bend Weld Test.
- 3. Pressure Tests :- 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.
- 4. Non-destructive Electric Test :- 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 non-destructive testing methods. These methods shall be capable of detecting both surface and subsurface defects.

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

F. Lengths :-

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

NOTE —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.

G. Supplementary Test :-

- Radiographic Examination.
- Intergranular Corrosion Test.

Table X1

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	0.25	6.35
30	0.25	6.35	0.312	7.92

Keyword

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