ASTM - A358/A358M

Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications

This specification covers electric-fusion-welded austenitic chromium-nickel stainless steel pipe suitable for corrosive or high-temperature service, or both, or for general applications.

This specification covers Five classes of pipe as follows:

Class 1—Pipe shall be double welded by processes employing filler metal in all passes and shall be completely radiographed.
Class 2—Pipe shall be double welded by processes employing filler metal in all passes. No radiography is required.
Class 3—Pipe shall be single welded by processes employing filler metal in all passes and shall be completely radiographed.
Class 4—Same as Class 3 except that the weld pass exposed to the inside pipe surface may be made without the addition of filler metal. Class 5—Pipe shall be double welded by processes employing filler metal in all passes and shall be spot radiographed.

❖ **Heat Treatment :-**

1. Unless otherwise stated in the order, all pipe shall be furnished in the heat-treated condition in accordance with the requirements of Table 1.
2. The purchase order shall specify following condition if the heat-treated condition specified in 'point 1' is not desired by the purchaser :-
   i. 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."
3. A solution annealing temperature above 1950 °F [1065 °C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in Grades 321, 321H, 347, 347H, and 348. When specified by the purchaser, a lower temperature stabilization or resolution anneal shall be used subsequent to the initial high temperature solution anneal.

Table 1

Grade or UNS Designation[A]	Heat Treating Temperature[B]	Cooling/Testing Requirements
All grades not individually listed below	1900 °F [1040 °C]	[C]

304H, 309S, 309Cb, 310S, 310Cb, 321H, 347H, S22100, S28300	1900 °F [1040 °C]	D
N08020	1800-1850 °F [980-1010 °C]	D
N08367	2025 °F [1110 °C]	D
N08700	2000 °F [1095 °C]	D
N08810	2050 °F [1120 °C]	D
N08811	2100 °F [1150 °C]	D
N08904	2000 °F [1095 °C]	D
N08926	2010 °F [1100 °C]	D
S30600	2100 °F [1150 °C]	D
S30815	1920 °F [1050 °C]	D
S31254	2100 °F [1150 °C]	D
S31266	2100 °F [1150 °C]	D
S31727	1975–2175 °F [1080 to 1180 °C]	D
S32050	2100 °F [1150 °C]	D
S32053	1975–2175 °F [1080 to 1180 °C]	D
S32654	2100 °F [1150 °C]	D
S34565	2050 °F [1120 °C]	D

[A] *New designation established in accordance with Practice E527 and SAE J1086.*

[B] *Minimum, unless otherwise stated.*

[C] *Quenched in water or rapidly cooled by other means, at a rate sufficient to prevent reprecipitation of carbides, as demonstrable by the capability of passing Practices A262, Practice E. The manufacturer is not required to run the test unless it is specified on the purchase order. Note that Practices A262 requires the test to be performed on sensitized specimens in the low-carbon and stabilized types and on specimens representative of the as-shipped condition for other types. In the case of low-carbon types containing 3 % or more molybdenum, the applicability of the sensitizing treatment prior to testing shall be a matter for negotiation between the seller and the purchaser.* [D] *Quenched in water or rapidly cooled by other means.*

❖ **Chemical Composition :-**

The steel shall conform to the requirements as to chemical composition specified in Table 2.

Table 2[A]

UNS Designation[B]	Type[C]	Carbon[D]	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Copper	Other Elements[E, F]
N08020	. . .	0.07	2	0.045	0.035	1	19.0–21.0	32.0–38.0	2.00–3.00	. . .	3.00–4.00	Cb [8×C min, 1 max]
N08367	. . .	0.03	2	0.04	0.03	1	20.0–22.0	23.5–25.5	6.0–7.0	0.18–0.25	0.75	. . .
N08700	. . .	0.04	2	0.04	0.03	1	19.0–23.0	24.0–26.0	4.3–5.0	. . .	0.5	Cb [8×C min, 0.4 max]
N08800	800[G]	0.1	1.5	0.045	0.015	1	19.0–23.0	30.0–35.0	. . .	. . .	0.75	Fe[H] [39.5 min], Al [0.15–0.60], Ti [0.15–0.60]
N08810	800H[G]	0.05–0.10	1.5	0.045	0.015	1	19.0–23.0	30.0–35.0	. . .	. . .	0.75	Fe[H] [39.5 min], Al [0.15–0.60], Ti [0.15–0.60]
N08811	. . .	0.06–0.10	1.5	0.04	0.015	1	19.0–23.0	30.0–35.0	. . .	. . .	0.75	Fe[H] [39.5 min], Ti[I] [0.25–0.60], Al[I] [0.25–0.60]
N08904	904L[G]	0.02	2	0.045	0.035	1	19.0–23.0	23.0–28.0	4.00–5.00	0.1	1.00–2.00	. . .
N08926	. . .	0.02	2	0.03	0.01	0.5	19.0–21.0	24.0–26.0	6.00–7.00	0.15–0.25	0.50–1.50	. . .
S20100	201	0.15	5.50–7.50	0.06	0.03	1	16.0–18.0	3.5–5.5	. . .	0.25	. . .	. . .
S20153	. . .	0.03	6.40–7.50	0.045	0.015	0.75	16.0–17.5	4.0–5.0	. . .	0.10–0.25	1	. . .

S20400	. . .	0.03	7.00–9.00	0.04	0.03	1	15.0–17.0	1.50–3.00	. . .	0.15–0.30	. . .	. . .
S20910	XM-19[J]	0.06	4.00–6.00	0.04	0.03	0.75	20.5–23.5	11.5–13.5	1.50–3.00	0.20–0.40	. . .	Cb [0.10–0.30], V [0.10–0.30]
S24000	XM-29[J]	0.08	11.50–14.50	0.06	0.03	0.75	17.0–19.0	2.3–3.7	. . .	0.20–0.40	. . .	. . .
S30400	304	0.07	2	0.045	0.03	0.75	17.5–19.5	8.0–10.5	. . .	0.1	. . .	. . .

S30403	304L	0.03	2	0.045	0.03	0.75	17.5–19.5	8.0–12.0	. . .	0.1	. . .	. . .
S30409	304H	0.04–0.10	2	0.045	0.03	0.75	18.0–20.0	8.0–10.5	. . .	. . .	. . .	. . .
S30415	. . .	0.04–0.06	0.8	0.045	0.03	1.00–2.00	18.0–19.0	9.0–10.0	. . .	0.12–0.18	. . .	Ce [0.03–0.08]
S30451	304N	0.08	2	0.045	0.03	0.75	18.0–20.0	8.0–10.5	. . .	0.10–0.16	. . .	. . .
S30453	304LN	0.03	2	0.045	0.03	0.75	18.0–20.0	8.0–12.0	. . .	0.10–0.16	. . .	. . .
S30600	. . .	0.018	2	0.02	0.02	3.7–4.3	17.0–18.5	14.0–15.5	0.2	. . .	0.5	. . .
S30815	. . .	0.05–0.10	0.8	0.04	0.03	1.4–2.0	20.0–22.0	10.0–12.0	. . .	0.14–0.20	. . .	Ce [0.03–0.08]
S30908	309S	0.08	2	0.045	0.03	0.75	22.0–24.0	12.0–15.0	. . .	. . .	. . .	. . .
S30940	309Cb[G]	0.08	2	0.045	0.03	0.75	22.0–24.0	12.0–16.0	. . .	. . .	. . .	Cb [10×Cmin,1.1 max]
S31008	310S	0.08	2	0.045	0.03	1.5	24.0–26.0	19.0–22.0	. . .	. . .	. . .	. . .
S31040	310Cb[G]	0.08	2	0.045	0.03	1.5	24.0–26.0	19.0–22.0	. . .	. . .	. . .	Cb [10×Cmin,1.1 max]
S31254	. . .	0.02	1	0.03	0.01	0.8	19.5–20.5	17.5–18.5	6.0–6.5	0.18–0.25	0.50–1.00	. . .
S31266	. . .	0.03	2.00–4.00	0.035	0.02	1	23.0–25.0	21.0–24.0	5.2–6.2	0.35–0.60	1.00–2.50	W [1.50–2.50]
S31600	316	0.08	2	0.045	0.03	0.75	16.0–18.0	10.0–14.0	2.00–3.00	0.1	. . .	. . .
S31603	316L	0.03	2	0.045	0.03	0.75	16.0–18.0	10.0–14.0	2.00–3.00	0.1	. . .	. . .
S31609	316H	0.04–0.10	2	0.045	0.03	0.75	16.0–18.0	10.0–14.0	2.00–3.00	. . .	. . .	. . .
S31651	316N	0.08	2	0.045	0.03	0.75	16.0–18.0	10.0–14.0	2.00–3.00	0.10–0.16	. . .	. . .
S31653	316LN	0.03	2	0.045	0.03	0.75	16.0–18.0	10.0–14.0	2.00–3.00	0.10–0.16	. . .	. . .
S31700	317	0.08	2	0.045	0.03	0.75	18.0–20.0	11.0–15.0	3.0–4.0	0.1	. . .	. . .
S31703	317L	0.03	2	0.045	0.03	0.75	18.0–20.0	11.0–15.0	3.0–4.0	0.1	. . .	. . .
S31725	317LM[G]	0.03	2	0.045	0.03	0.75	18.0–20.0	13.5–17.5	4.0–5.0	0.2	. . .	. . .

S31726	317LMN[G]	0.03	2	0.045	0.03	0.75	17.0–20.0	13.5–17.5	4.0–5.0	0.10–0.20	. . .	. . .
S31727	. . .	0.03	1	0.03	0.03	1	17.5–19.0	14.5–16.5	3.8–4.5	0.15–0.21	2.80–4.00	. . .
S32050	. . .	0.03	1.5	0.035	0.02	1	22.0–24.0	20.0–23.0	6.0–6.8	0.21–0.32	0.4	. . .
S32053	. . .	0.03	1	0.03	0.01	1	22.0–24.0	24.0–26.0	5.0–6.0	0.17–0.22	. . .	. . .
S32100	321	0.08	2	0.045	0.03	0.75	17.0–19.0	9.0–12.0	. . .	0.1	. . .	Ti [5×(C+N) min, 0.7 max]
S32109	321H	0.04–0.10	2	0.045	0.03	0.75	17.0–19.0	9.0–12.0	. . .	. . .	. . .	Ti [4×(C+N) min, 0.7 max]
S32654	. . .	0.02	2.00–4.00	0.03	0.005	0.5	24.0–25.0	21.0–23.0	7.0–8.0	0.45–0.55	0.30–0.60	. . .
S34565	. . .	0.03	5.00–7.00	0.03	0.01	1	23.0–25.0	16.0–18.0	4.0–5.0	0.40–0.60	. . .	Cb [0.1]
S34700	347	0.08	2	0.045	0.03	0.75	17.0–19.0	9.0–13.0	. . .	. . .	. . .	Cb [10×Cmin,1 max]
S34709	347H	0.04–0.10	2	0.045	0.03	0.75	17.0–19.0	9.0–13.0	. . .	. . .	. . .	Cb [8×Cmin,1 max]
S34751	347LN	0.005–0.020	2	0.045	0.03	1	17.0–19.0	9.0–13.0	. . .	0.06–0.10	. . .	Cb [0.2-0.5]
S34800	348	0.08	2	0.045	0.03	0.75	17.0–19.0	9.0–13.0	. . .	. . .	. . .	(Cb + Ta) [10×C min, 1.00 max], Ta [0.10], Co [0.20]

[A] *Maximum, unless range or minimum is indicated.*

[B] *Designation established in accordance with Practice E527 and SAE J 1086.*

[C] *Unless otherwise indicated, a grade designation originally assigned by the American Iron and Steel Institute (AISI).*

[D] *Carbon analysis shall be reported to nearest 0.01 % except for the low-carbon types, which shall be reported to nearest 0.001 %.*

[E] *The terms Columbium (Cb) and Niobium (Nb) both relate to the same element.*

[F] *When two minimums or two maximums are listed for a single type, as in the case of both a value from a formula and an absolute value, the higher minimum or lower maximum shall apply.*

[G] *Common name, not a trademark, widely used, not associated with any one producer.*

[H] *Iron shall be determined arithmetically by difference of 100 minus the sum of the other specified elements.* [I] *(Al + Ti) 0.85–1.20.*

❖ **Tensile Requirements :-**

The material shall conform to the Tensile properties specified in Table 3.

Table 3

UNS Designation	Type[A]	Tensile Strength, min		Yield Strength[B] min		Elongation in 2 in. or 50 mm, min, %
		ksi	MPa	ksi	MPa	
N08020	. . .	80	550	35	240	30 [H]
N08367		95	655	45	310	30
N08700	. . .	80	550	35	240	30
N08800	800[C]	75	520	30[D]	205[D]	30[E]
N08810	800H[C]	65	450	25[D]	170[D]	30
N08811	. . .	65	450	25	170	30
N08904	904L[C]	71	490	31	220	35
N08926	. . .	94	650	43	295	35
S20100	201-1[F]	75	515	38	260	40
S20100	201-2[F]	95	655	45	310	40
S20153	201LN[F]	95	655	45	310	45
S20400	. . .	95	655	48	330	35

S20910	XM-19[G]	100	690	55	380	35
S24000	XM-29[G]	100	690	55	380	40
S30400	304	75	515	30	205	40
S30403	304L	70	485	25	170	40
S30409	304H	75	515	30	205	40
S30415	. . .	87	600	42	290	40
S30451	304N	80	550	35	240	30
S30453	304LN	75	515	30	205	40
S30600	. . .	78	540	35	240	40

S30815	. . .	87	600	45	310	40
S30908	309S	75	515	30	205	40
S30940	309Cb[C]	75	515	30	205	40
S31008	310S	75	515	30	205	40
S31040	310Cb[C]	75	515	30	205	40
S31254		95	655	45	310	35
S31266	. . .	109	750	61	420	35
S31600	. . .	75	515	30	205	40
S31603	316L	70	485	25	170	40
S31609	316H	75	515	30	205	40
S31651	316N	80	550	35	240	35
S31653	316LN	75	515	30	205	40
S31700	317	75	515	30	205	35
S31703	317L	75	515	30	205	40
S31725	317LM[C]	75	515	30	205	40
S31726	317LMN[C]	80	550	35	240	40
S31727	. . .	80	550	36	245	35
S32050	. . .	98	675	48	330	40
S32053	. . .	93	640	43	295	40
S32100	321	75	515	30	205	40
S32109	321H	75	515	30	205	40
S32654	. . .	109	750	62	430	40
S34565	. . .	115	795	60	415	35

S34700	347	75	515	30	205	40
S34709	347H	75	515	30	205	40
S34751	347LN	75	515	30	205	40
S34800	348	75	515	30	205	40

[A] *Unless otherwise indicated, a grade designation originally assigned by the American Iron and Steel Institute (AISI).*

[B] *Yield strength shall be determined by the offset method at 0.2 % in accordance with Test Methods and Definitions A370. Unless otherwise specified (see Specification A480/A480M, paragraph 4.1.11, Ordering Information), an alternative method of determining yield strength may be based on total extension under load of 0.5 %.* [C] *Common name, not a trademark, widely used, not associated with any one producer.*

[D] *Yield strength requirements shall not apply to material under 0.020 in [0.50 mm] in thickness.*

[E] *Not applicable for thicknesses under 0.010 in. [0.25 mm].*

[F] *Type 201 is generally produced with a chemical composition balanced for rich side (Type 201-1) or lean side (Type 201-2) austenite stability depending on the properties required for specific applications.*

[G] *Naming system developed and applied by ASTM.*

[H] *Elongation for thickness, less than 0.015 in. [0.38 mm] shall be 20 % minimum, in 1 in. [25.4 mm].*

❖ **Mechanical Tests :-**

1. Transverse Tension Test :-
    i. Tension test specimens shall be made in accordance with Section IX, Part QW, Paragraph QW-150 of the ASME Boiler and Pressure Vessel Code and shall be one of the types shown in QW-462.1 of that code.
2. Transverse Guided-Bend Weld Test :-
    i. For wall thicknesses over 3⁄8 in. [9.5 mm] but less than 3⁄4 in. [19 mm] side-bend tests may be made instead of the face and rootbend tests.
    ii. For specified wall thicknesses 3⁄4 in. [19 mm] and over, both specimens shall be subjected to the side-bend tests.
3. Hydrostatic Test :-
    i. Each length of pipe shall be subjected to a hydrostatic test in accordance with Specification A999/A999M, unless specifically exempted as follow:
    ii. The purchaser, with the agreement of the manufacturer, is permitted to complete the hydrostatic test requirement with the system pressure test, performed at a pressure either lower or higher than the specification test pressure, but in no case shall the test pressure be lower than the system design pressure.

❖ **Radiographic Examination :-**

1. For Classes 1, 3, and 4 pipe, all welded joints shall be completely examined by radiographic examination in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, latest edition, Paragraph UW-51.
2. For Class 5 pipe, the welded joints shall be spot radiographed to the extent of not less than 12 in. [300 mm] of radiograph per 50 ft [15 m] of weld. Radiographic examination shall be in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition, Paragraph UW-52.

❖ **Supplementary Tests :-** A. Tension and Bend Tests.

B. Penetrant Oil and Powder Examination.

C. Intergranular Corrosion Test.

Keyword

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