



Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications¹

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1. Scope*

1.1 This specification² covers electric-fusion-welded austenitic chromium-nickel stainless steel pipe suitable for corrosive or high-temperature service, or both, or for general applications.

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.”

1.2 This specification covers the grades of alloy and stainless steel listed in Table 1. The selection of the proper grade and requirements for heat treatment shall be at the discretion of the purchaser, dependent on the service conditions to be encountered.

1.3 Five classes of pipe are covered as follows:

1.3.1 *Class 1*—Pipe shall be double welded by processes employing filler metal in all passes and shall be completely radiographed.

1.3.2 *Class 2*—Pipe shall be double welded by processes employing filler metal in all passes. No radiography is required.

1.3.3 *Class 3*—Pipe shall be single welded by processes employing filler metal in all passes and shall be completely radiographed.

1.3.4 *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 (see 6.2.2.1 and 6.2.2.2).

1.3.5 *Class 5*—Pipe shall be double welded by processes employing filler metal in all passes and shall be spot radiographed.

1.4 Supplementary requirements covering provisions ranging from additional testing to formalized procedures for manufacturing practice are provided. Supplementary Requirements S1 through S6 are included as options to be specified when desired.

1.5 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.

2. Referenced Documents

2.1 ASTM Standards:³

A240/A240M [Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications](#)

A262 [Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels](#)

A480/A480M [Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip](#)

A941 [Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys](#) ~~A994 Guide for Editorial Procedures and Form of Product Specifications for Steel, Stainless Steel, and Related Alloys~~

A999/A999M [Specification for General Requirements for Alloy and Stainless Steel Pipe](#)

E527 ~~[Practice for Numbering Metals and Alloys \(UNS\)](#)~~ [Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

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 Specifications SA-358 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.

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

2.2 ASME Boiler and Pressure Vessel Code:⁴

Section II, Materials

Section III, Rules for Construction of Nuclear Facility Components

Section VIII, Pressure Vessels

Section IX, Welding and Brazing Qualifications

2.3 AWS Specifications:⁵

A 5.22 Flux Cored Arc Welding

A 5.30 Consumable Weld Inserts for Gas Tungsten Arc Welding

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

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

A 5.11 Nickel and Nickel-Alloy Covered Welding Electrodes

A 5.14 Nickel and Nickel-Alloy Bare Welding Rods and Electrodes

2.4 Other Standard:⁶

SAE J1086 Practice for Numbering Metals and Alloys (UNS)

3. Terminology

3.1 Definitions:

3.1.1 The definitions in Specification A 999/A 999MA999/A999M and Terminology A 941A941 are applicable to this specification.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for product under this specification. Such requirements to be considered include, but are not limited to, the following:

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

4.1.2 Name of material (electric-fusion-welded pipe),

4.1.3 Grade (Table 1),

4.1.4 Class (see 1.3),

4.1.5 Size (outside diameter and nominal wall thickness),

4.1.6 Length (specific or random),

4.1.7 End finish (Section on Ends of Specification A 999/A 999MA999/A999M),

4.1.8 Authorization for repair of plate defects by welding and subsequent heat treatment without prior approval if such is intended (see 9.3),

4.1.9 Specification designation,

4.1.10 Special requirements,

4.1.11 Statement invoking requirements of 16.4 if such is intended.

4.1.12 Circumferential weld permissibility (see Section 16),

4.1.13 Supplementary Requirements (S1 through S6),

4.1.14 Applicable ASME Code if known,

4.1.15 For ASME Code Section III applications, the service classification intended, and

4.1.16 Certification requirements (see Section on Certification of Specification A 999/A 999MA999/A999M).

5. General Requirements

5.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A 999/A 999MA999/A999M unless otherwise provided herein.

6. Materials and Manufacture

6.1 Materials:

6.1.1 The steel plate material shall conform to the requirements of one of the grades of Specification A 240/A 240MA240/A240M, listed in Table 1, except as provided in 6.3.2.3.

6.2 Welding:

6.2.1 The joints shall be full penetration double-welded or single-welded butt joints employing fusion welding processes as defined under “Definitions,” ASME Boiler and Pressure Vessel Code, Section IX. This specification makes no provision for any difference in weld quality requirements regardless of the weld joint type employed (single or double) in making the weld. Where

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁵ Available from The American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.

⁶ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.



TABLE 1 Plate and Filler Metal Specifications

Grade	UNS Designation	Material Type	ASTM Plate Specification No. and Grade	Filler Metal Classification and UNS Designation ^A for Applicable ^B 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
201	S20100	201	A 240 Type 201	...	...	...	...	...	...	...	...	...	...	...	...
201LN	S20153	201LN	A 240 Type 201LN	...	...	...	...	...	...	...	...	...	...	...	...
304	S30400	304	A 240 Type 304	E308	W30810	ER308	S30880 W30840	...	...	...	...	E308T	W30831	IN308	S30880
304L	S30403	304L	A 240 Type 304	E308L	W30813	ER308L	S30883 W30843	...	...	...	...	E308LT	W30835	IN308L	S30883
304N	S30451	304N	A 240 Type 304N	E308	W30810	ER308	S30880 W30840	...	...	...	...	E308T	W30831	IN308	S30880
304LN	S30453	304LN	A 240 Type 304LN	E308L	W30813	ER308L	S30883 W30843	...	...	...	...	W308LT	W30835	IN308L	S30883
304H	S30409	304H	A 240 Type 304H	E308H	W30810	ER308	S30880 W30840	...	...	...	...	E308T	W30831	IN308	S30880
309Cb	S30940	309Cb	A 240, Type 309Cb	E309Cb	...	...	...	...	...	...	...	...	...	...	...
309S	S30908	309S	A 240, Type 309S	...	...	...	...	...	...	...	...	...	...	...	...
310Cb	S31040	310Cb	A 240, Type 310Cb	E310Cb	...	...	...	...	...	...	...	...	...	...	...
310S	S31008	310S	A 240, Type 310S	...	...	...	...	...	...	...	...	...	...	...	...
316	S31600	316	A 240 Type 316	E316	W31610	ER316	S31680 W31640	...	...	...	...	E316T	W31631	IN316	S31680
316L	S31603	316L	A 240 Type 316L	E316L	W31613	ER316L	S31683 W31643	...	...	...	...	E316LT	W31635	IN316L	S31683
316N	S31651	316N	A 240 Type 316N	E316	W31610	ER316	S31680 W31640	...	...	...	...	E316T	W31631	IN316	S31680
316LN	S31653	316LN	A 240 Type 316LN	E316L	W31613	ER316L	S31683 W31643	...	...	...	...	E316LT	W31635	IN316L	S31683
316H	S31609	316H	A 240 Type 316H	E316H	W31610	ER316H	S31680 W31640	...	...	...	...	E316T	W31631	IN316	S31680
317	S31700	317	A 240 Type 317	E317	W31710	ER 317	S31780 W31740	...	...	...	...	E317LT	W31735	...	...
317L	S31703	317L	A 240 Type 317L	E317L	W34713	ER317L	S31783 W31743	...	...	...	...	E317LT	W31735	...	...
321	S32100	321	A 240 Type 321	E347	W34710	ER321 W34710 ER347	S32180 W32140 S34780	...	...	...	...	E347T	W34733	IN348	S34780
321	S32100	321	A 240 Type 321	E347	W34710	ER321 W34710 ER347	S32180 W32140 S34780	...	...	...	...	E347T	W34733	IN348	S34780
321H ^C	S32109 ^C	321H ^C	A 240 Type 321H ^C	E321H	W34710	ER321 ER347	S32180 W32140 S34780	...	...	...	...	E347T	W34731	IN348	S34780
347	S34700	347	A 240 Type 347	E347	W34710	ER347	S34780 W34740	...	...	...	...	E347T	W34733	IN348	S34780
347H ^C	S34709 ^C	347H ^C	A 240 Type 347H ^C	E347H	E347H	W34710	ER347	S34780 W34740	...	...	...	E347T	W34731	IN348	S34780
348	S34800	348	A 240 Type 348	E347	W34710	ER347	S34780 W34740	...	...	...	...	E347T	W34733	IN348	S34780
XM-19	S22100	XM-19	A 240 Type XM-19	E209	W32210	ER209	S20980 W32240	...	...	...	...	...	...	...	...
XM-29	S28300	XM-29	A 240 Type XM-29	E240	W32410	ER240	S23980 W32440	...	...	...	...	...	...	...	...
...	S31254	...	A 240 S31254	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	N06625	...	...	...	...
...	S30815	...	A 240 S30815	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	N06625	...	...	...	...
...	S31725	...	A 240 S31725	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	N06625	...	...	...	...
...	S31726	...	A 240 S31726	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	N06625	...	...	...	...
...	S30600 ^D	...	A 240 S30600 ^D	...	...	...	...	...	...	...	...	...	...	...	...
...	S24565	...	A 240 S24565	...	...	...	...	...	...	...	...	...	...	...	...
...	S34565	...	A 240 S34565	...	...	...	...	...	...	...	...	...	...	...	...
...	S30415	...	A 240 S30415	...	...	...	...	...	...	...	...	...	...	...	...
...	S32654	...	A 240 S32654	...	...	...	...	...	...	...	...	...	...	...	...
...	S31266	...	A 240 S31266	...	...	...	...	ENiCrMo-13	W86059	ERNiCrMo-13	N06059	...	...	...	...
...	S31266	...	A 240 S31266	...	...	...	...	ENiCrMo-10	W86022	ERNiCrMo-10	N06022	...	...	...	...
...	S32050	...	A 240 S32050	...	...	...	...	...	...	...	...	...	...	...	...
...	N08367	...	A 240 N08367	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	N06625	...	...	...	...
...	N08904	...	A 240 N08904	...	...	...	...	...	...	...	...	...	...	...	...
...	N08926	...	A 240 N08926	...	...	...	...	ENiCrMo-3	W86112	ERNiCrMo-3	N06625	...	...	...	...
...	N08800	...	A 240 N08800	...	...	...	...	...	...	...	...	...	...	...	...
...	N08810	...	A 240 N08810	...	...	...	...	...	...	...	...	...	...	...	...
...	N08020	...	A 240 N08020	...	...	...	...	...	...	...	...	...	...	...	...
...	S20400	...	A 240 S20400	E 209	W32210	ER209	S20980 W32240	...	...	...	...	...	...	...	...
...	S20400	...	A 240 S20400	E 209	W32210	ER209	S20980 W32240	...	...	...	...	...	...	...	...

^A New designation established in accordance with Practice E 527E527 and SAE J1086.
^B Choice of American Welding Society specification depends on the welding process used.
^C Minimum carbon content of the filler metal shall be 0.040 mass %.
^D In previous editions, S30600 was incorrectly shown as S01815.

backing rings or strips are employed, the ring or strip material shall be of the same P-Number (Table QW-422 of Section IX) as the plate being joined. Backing rings or strips shall be completely removed after welding, prior to any required radiography, and the exposed weld surface shall be examined visually for conformance to the requirements of 6.2.3. Welds made by procedures employing backing strips or rings that remain in place are prohibited. Welding procedures, and welding operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

6.2.2 Except as provided in 6.2.2.1 and 6.2.2.2, welds shall be made in their entirety by processes involving the deposition of filler metal.

6.2.2.1 For Class 4 pipe employing multiple passes, the root-pass may be without the addition of filler metal.

6.2.2.2 For Class 4 pipe, the weld surface exposed inside the pipe may result from a single pass made from the inside of the pipe without the addition of filler metal.

6.2.2.3 All single-welded pipe shall be completely radiographed.

6.2.3 The weld surface on either side of the weld is permitted to be flush with the base plate or to have a reasonably uniform crown, not to exceed $\frac{1}{8}$ in. [3 mm]. It is permitted at the option of the manufacturer or by agreement between the manufacturer and purchaser to remove any weld reinforcement. The contour of the reinforcement should be reasonably smooth and free from irregularities. The deposited 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.

6.2.4 Weld defects shall be repaired by removal to sound metal and rewelding. Subsequent heat treatment and examination (that is, visual, radiographic, and dye penetrant) shall be as required on the original welds.

6.3 *Heat Treatment:*

6.3.1 Unless otherwise stated in the order, all pipe shall be furnished in the heat-treated condition in accordance with the requirements of Table 2.

6.3.2 The purchase order shall specify one of the following conditions if the heat-treated condition specified in 6.3.1 is not desired by the purchaser:

6.3.2.1 *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.

6.3.2.2 *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”.

6.3.2.3 *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”.

6.4 *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 re-solution anneal shall be used subsequent to the initial high temperature solution anneal (see Supplementary Requirement S5).*

7. Chemical Composition

7.1 The chemical composition of the plate shall conform to the requirements of the applicable specification and grade listed in Specification A 240/A 240MA240/A240M.

7.2 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 1, or shall conform to the chemical composition specified for the plate in Specification A 240/A 240MA240/A240M, or shall, subject to purchaser approval, be a filler metal more highly alloyed than the base metal when needed for corrosion resistance or other properties. Use of a filler metal other than that listed in Table 1 or conforming to the chemical composition specified for the plate in Specification A 240/A 240MA240/A240M shall be reported and the filler metal identified on the certificate of tests. When nitrogen and cerium are specified elements for the ordered grade, the method of analysis for these elements shall be a matter of agreement between the purchaser and the manufacturer.

8. Permissible Variations in Dimensions

8.1 *Permissible Variations*—The dimensions at any point in a length of pipe shall not exceed the following:

8.1.1 *Outside Diameter*—Based on circumferential measurement, $\pm 0.5\%$ of the specified outside diameter.

8.1.2 *Out-of-Roundness*—Difference between major and minor outside diameters, 1 %.

8.1.3 *Alignment*—Using a 10-ft [3-m] straightedge placed so that both ends are in contact with the pipe, $\frac{1}{8}$ in. [3 mm] deviation from contact with the pipe.

8.1.4 *Thickness*—The minimum wall thickness at any point in the pipe shall not be more than 0.01 in. [0.3 mm] under the nominal thickness.

9. Workmanship, Finish, and Appearance

9.1 The finished pipe shall have a workmanlike finish.

9.2 *Repair of Plate Defects by Machining or Grinding*—It is permitted to repair pipes showing slivers, or other surface defects, by machining or grinding inside or outside to a depth that ensures the removal of all included scale and slivers, provided that