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Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal[1]

This standard is issued under the fixed designation A 928/A 928M; 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.

1. Scope*

1.1 This specification covers electric-fusion-welded steel pipe suitable for corrosive service.

NOTE 1—The dimensionless designator NPS (nominal pipe size) has been substituted in this specification for traditional terms such as nominal diameter, size, and nominal size.

1.2 This specification covers grades of ferritic/austenitic steel as indicated in Table 1. The selection of the proper alloy 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 using filler metal in all passes and shall be radiographed completely.

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

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

1.3.4 *Class 4*—Same as Class 3, except that the weld pass exposed to the inside pipe surface is permitted to 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 using 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 S4 are included as options to be specified in the purchase order 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 the specification is specified in the order.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 240/A 240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

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

E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

2.2 *ASME Boiler and Pressure Vessel Code:*[3]

Section III, Nuclear Vessels

Section VIII, Unfired Pressure Vessels

Section IX, Welding Qualifications

2.3 *AWS Specifications:*[4]

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

A 5.22 Flux Cored Corrosion-Resisting Chromium and Chromium-Nickel Steel Electrodes

[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 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.

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

[4] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

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

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TABLE 1 Pipe and Filler Metal Specifications

UNS Designation	Grade[A]	ASTM Plate Specification No. and Grade	A 5.4		A 5.9		A 5.11		A 5.14		A 5.22		A 5.30	
			Class	UNS	Class	UNS	Class	UNS	Class	UNS	Class	UNS	Class	UNS
S31200	...	A 240 S31200	...	...	...	...	...	...	...	...	...	...	...	...
S31260	...	A 240 S31260	...	...	...	...	...	...	...	...	...	...	...	...
S31500	...	A 240 S31500	...	...	...	...	...	...	...	...	...	...	...	...
S31803	...	A 240 S31803	...	...	...	...	...	...	...	...	...	...	...	...
S32003	...	A 240 S32003	...	...	...	...	...	...	...	...	...	...	...	...
S32205	2205	A 240 S32205	...	...	...	...	...	...	...	...	...	...	...	...
S32304	2304	A 240 S32304	...	...	...	...	...	...	...	...	...	...	...	...
S32506	...	A 240 S32506	...	...	...	...	...	...	...	...	...	...	...	...
S32550	255	A 240 S32550	...	...	...	...	...	...	...	...	...	...	...	...
S32750	2507	A 240 S32750	...	...	...	...	...	...	...	...	...	...	...	...
S32900	329[B]	A 240 type 329	...	...	...	...	...	...	...	...	...	...	...	...
S32950	...	A 240 S32950	...	...	...	...	...	...	...	...	...	...	...	...
S32760	...	A 240 S32760	...	...	...	...	...	...	...	...	...	...	...	...
S32520	...	A 240 S32520	...	...	...	...	...	...	...	...	...	...	...	...

[A] Except as indicated, common name, not a trademark, widely used, not associated with any one producer.
[B] A grade designation originally assigned by the American Iron and Steel Institute (AISI).

A 5.30 Consumable Weld Inserts for Gas Tungsten Arc Welding

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions in Specification A 999/A 999M and Terminology A 941 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 (see 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 999M),

4.1.8 Authorization for repair of plate defects by welding and subsequent heat treatment without prior approval, if such is intended (see 13.3),

4.1.9 Specification designation,

4.1.10 Special requirements,

4.1.11 Statement invoking requirements of 13.4, if such is intended,

4.1.12 Circumferential weld permissibility (see Section 17),

4.1.13 Supplementary Requirements (S1 through S4),

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 999M).

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 999M unless otherwise provided herein.

6. Materials and Manufacture

6.1 *Materials*—The steel plate material shall conform to the requirements of one of the grades of Specification A 240/A 240M, listed in Table 1.

6.2 *Welding*:

6.2.1 The joints shall be full penetration double-welded or single-welded butt joints using 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 used (single or double) in making the weld. Where backing rings or strips are used, 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 removed completely 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 using backing strips or rings that remain in place are prohibited. Welding procedures and welding operators shall be qualified in accordance with the 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 using multiple passes, it is permitted to make the root-pass without the addition of filler metal.

6.2.2.2 For Class 4 pipe, it is permitted that the weld surface exposed inside the pipe be the 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 radiographed completely.

6.2.3 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 ⅛ in. [3 mm]. It is permitted to remove any weld reinforcement, at the option of the manufacturer or by agreement between the manufacturer and purchaser. The contour of the reinforcement shall be reasonably smooth and free of irregularities. The deposited metal shall be fused uniformly into the plate surface. No concavity of contour is permitted

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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, heat treatment shall be performed after welding and in accordance with the requirements of Table 2.

6.3.2 If the purchaser desires pipe without heat treatment subsequent to welding, the purchase order shall specify the following condition:

6.3.2.1 *No final heat treatment of pipe fabricated of plate that has been heat treated as required by Table 2 for the particular grade*. Each pipe supplied under this requirement shall be stenciled with the suffix "HT-O."

7. Chemical Composition

7.1 The chemical composition of the plate shall conform to the requirements of the applicable specification and grade listed in Table 1.

7.2 Unless otherwise specified in the purchase order, the chemical composition of the welding material shall conform to the requirements of the applicable AWS specification for the corresponding grade given in Table 1 or shall conform to the chemical composition specified for the plate, 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 shall be reported and the filler metal identified on the certificate of tests. When nitrogen is a specified element for the ordered grade, the method of analysis shall be a matter of agreement between the purchaser and the manufacturer.

8. Heat Analysis

8.1 The chemical analysis of the steel shall be determined by the plate manufacturer and shall conform to the requirements for the particular grade as prescribed in Specification A 240/A 240M.

9. Product Analysis

9.1 At the request of the purchaser's inspector, an analysis of one length of flat-rolled stock from each heat, or from base metal and weld deposit from two pipes from each lot, shall be made by the manufacturer. A lot of pipe shall consist of the following number of lengths of the same size and wall thickness from any one heat of steel:

NPS Designator	Lengths of Pipe in Lot
Under 2	400 or fraction thereof
2 to 5, incl	200 or fraction thereof
6 and over	100 or fraction thereof

9.2 The results of these analyses shall be reported to the purchaser or the purchaser's representative and shall conform to the requirements specified in Section 7, subject to the product analysis tolerances of Table 1 in Specification A 480/A 480M.

9.3 If the analysis of one of the tests specified in 8.1 or 9.1 does not conform to the requirements specified in Section 7, it is permitted to obtain an analysis of the base metal and weld deposit of each pipe from the same heat or lot, and all pipe conforming to the requirements shall be accepted.

10. Tensile Requirements

10.1 The plate used in making the pipe shall conform to the requirements as to tensile properties of the applicable specifications listed in Table 1. Tension tests made by the plate manufacturer shall qualify the plate material.

10.2 The transverse tension test taken across the welded joint specimen shall have a tensile strength not less than the specified minimum tensile strength of the plate.

11. Permissible Variations of Dimensions for Thin-Wall Pipe

11.1 For thin-wall pipe, defined as pipe having a wall thickness of 3 % or less of the specified outside diameter, the diameter tolerance, as listed in Specification A 999/A 999M, shall apply only to the mean of the extreme (maximum and minimum) outside diameter readings in any one cross section.

11.2 For thin-wall pipe, the difference in extreme outside readings (called the ovality) in any one section shall not exceed

TABLE 2 Heat Treatment

UNS Designation	Grade[A]	Temperature, °F [°C]	Quench
S31200	. . .	1920–2010 [1050–1100]	rapid cooling in water
S31260	. . .	1870–2010 [1020–1100]	rapid cooling in water
S31500	. . .	1800–1900 [980–1040]	rapid cooling in air or water
S31803	. . .	1870–2010 [1020–1100]	rapid cooling in air or water
S32003	. . .	1850–2010 [1010–1100]	rapid cooling in air or water
S32205	2205	1870–2010 [1020–1100]	rapid cooling in air or water
S32304	2304	1700–1920 [925–1050]	rapid cooling in air or water
S32506	. . .	1870–2050 [1020–1120]	rapid cooling in air or water
S32550	255	1900 [1040], min	rapid cooling in air or water
S32750	2507	1880–2060 [1025–1125]	rapid cooling in air or water
S32900	329[B]	1700–1750 [925–955]	rapid cooling in air or water
S32950	. . .	1820–1880 [990–1025]	rapid cooling in air or water
S32760	. . .	2010–2085 [1100–1140]	rapid cooling in air or water
S32520	. . .	1975–2050 [1080–1120]	rapid cooling in air or water

[A] Except as indicated, common name, not a trademark, widely used, not associated with any one producer.
[B] A grade designation originally assigned by the American Iron and Steel Institute (AISI).