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Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures¹

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1. Scope*

1.1 This specification² covers electric-fusion-welded steel pipe with filler metal added, fabricated from pressure vessel quality plate of several analyses and strength levels and suitable for high-pressure service at atmospheric and lower temperatures. Heat treatment may or may not be required to attain the desired properties or to comply with applicable code requirements. Supplementary requirements are provided for use when additional testing or examination is desired.

1.2 The specification nominally covers pipe 16 in. (405 mm) in outside diameter or larger and of 1/4 in. (6.4 mm) wall thickness or greater. Pipe having other dimensions may be furnished provided it complies with all other requirements of this specification.

1.3 Several grades and classes of pipe are provided.

1.3.1 Grade designates the type of plate used as listed in 5.1.

1.3.2 Class designates the type of heat treatment performed during manufacture of the pipe, whether the weld is radiographically examined, and whether the pipe has been pressure tested as listed in 1.3.3.

1.3.3 Class designations are as follows (Note 1):

Class	Heat Treatment on Pipe	Radiography, see Section	Pressure Test, see:
10	none	none	none
11	none	9	none
12	none	9	8.3
13	none	none	8.3
20	stress relieved, see 5.3.1	none	none
21	stress relieved, see 5.3.1	9	none
22	stress relieved, see 5.3.1	9	8.3
23	stress relieved, see 5.3.1	none	8.3
30	normalized, see 5.3.2	none	none
31	normalized, see 5.3.2	9	none
32	normalized, see 5.3.2	9	8.3
33	normalized, see 5.3.2	none	8.3
40	normalized and tempered, see 5.3.3	none	none
41	normalized and tempered, see 5.3.3	9	none
42	normalized and tempered, see 5.3.3	9	8.3
43	normalized and tempered, see 5.3.3	none	8.3
50	quenched and tempered, see 5.3.4	none	none
51	quenched and tempered, see 5.3.4	9	none
52	quenched and tempered, see 5.3.4	9	8.3
53	quenched and tempered, see 5.3.4	none	8.3
60	normalized and precipitation heat treated	none	none
61	normalized and precipitation heat treated	9	none
62	normalized and precipitation heat treated	9	8.3
63	normalized and precipitation heat treated	none	8.3
70	quenched and precipitation heat treated	none	none
71	quenched and precipitation heat treated	9	none

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 A01.09 on Carbon Steel Tubular Products.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-671 in Section II of that Code.

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

72	quenched and precipitation heat treated	9	8.3
73	quenched and precipitation heat treated	none	8.3

NOTE 1—Selection of materials should be made with attention to temperature of service. For such guidance, Specification A 20/A 20M may be consulted.

~~1.4 The values stated in inch-pound units are to be regarded as the standard.~~

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 ASTM Standards:³

- A 20/A 20M Specification for General Requirements for Steel Plates for Pressure Vessels
- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A 435/A 435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates
- A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
- A 577/A 577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates
- A 578/A 578M Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
- E 110 Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers
- E 165 Practice for Liquid Penetrant Examination for General Industry
- E 709 Guide for Magnetic Particle Testing

2.2 Plate Steels:

- A 203/A 203M Specification for Pressure Vessel Plates, Alloy Steel, Nickel
- A 285/A 285M Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
- A 299/A 299M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Silicon
- A 353/A 353M Specification for Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered
- A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
- A 516/A 516M Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
- A 517/A 517M Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered
- A 537/A 537M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel
- A 553/A 553M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 % Nickel
- A 736/A 736M Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium and Nickel-Copper-Manganese-Molybdenum-Columbium Alloy Steel

2.3 ASME Boiler and Pressure Vessel Code:⁴

- Section II, Material Specifications
- Section III, Nuclear Vessels
- Section VIII, Unfired Pressure Vessels
- Section IX, Welding Qualifications

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

- 3.1.1 *lot*—a lot shall consist of 200 ft (61 m) or fraction thereof of pipe from the same heat of steel.
- 3.1.2 The description of a lot may be further restricted by the use of Supplementary Requirement S14.

4. Ordering Information

- 4.1 The inquiry and order for material under this specification should include the following information:
 - 4.1.1 Quantity (feet, metres, or number of lengths),
 - 4.1.2 Name of material (steel pipe, electric-fusionwelded),
 - 4.1.3 Specification number,
 - 4.1.4 Grade and class designations (see 1.3),
 - 4.1.5 Size (inside or outside diameter, nominal or minimum wall thickness),
 - 4.1.6 Length (specific or random),
 - 4.1.7 End finish (11.4),
 - 4.1.8 Purchase options, if any (see 5.2.3 and 11.3 of this specification. See also Specification A 530/A 530M),

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.

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

4.1.9 Supplementary requirements, if any.

5. Materials and Manufacture

5.1 *Materials*—The steel plate material shall conform to the requirement of the applicable plate specification for the pipe grade ordered as listed in Table 1.

5.2 *Welding*:

5.2.1 The joints shall be double-welded, full-penetration welds made in accordance with procedures and by welders or welding operators qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

5.2.2 The welds shall be made either manually or automatically by an electric process involving the deposition of filler metal.

5.2.3 As welded, the welded joint shall have positive reinforcement at the center of each side of the weld, but no more than 1/8 in. (3.2 mm). This reinforcement may be removed at the manufacturer's option or by agreement between the manufacturer and purchaser. The contour of the reinforcement shall be smooth and the deposited metal shall be fused smoothly and uniformly into the plate surface.

5.2.4 When radiographic examination in accordance with 9.1 is to be used, the weld reinforcements shall be governed by the more restrictive provision UW-51 of Section VIII of the ASME Boiler and Pressure Vessel Code instead of 5.2.3 of this specification.

5.3 *Heat Treatment*—All classes other than 10, 11, 12, and 13 shall be heat treated in furnace controlled to ± 25 °F (± 14 °C) and equipped with a recording pyrometer so that heating records are available. Heat treating after forming and welding shall be to one of the following:

5.3.1 Classes 20, 21, 22, and 23 pipe shall be uniformly heated within the post-weld heat-treatment temperature range indicated in Table 2 for a minimum of 1 h/in. of thickness or for 1 h, whichever is greater.

5.3.2 Classes 30, 31, 32, and 33, pipe shall be uniformly heated to a temperature in the austenitizing range and not exceeding the maximum normalizing temperature indicated in Table 2 and subsequently cooled in air at room temperature.

5.3.3 Classes 40, 41, 42, and 43 pipe shall be normalized in accordance with 5.3.2. After normalizing, the pipe shall be reheated to the tempering temperature indicated in Table 2 as a minimum and held at temperature for a minimum of 1/2 h/in. of thickness or for 1/2 h, whichever is greater, and air cooled.

5.3.4 Classes 50, 51, 52, and 53 pipe shall be uniformly heated to a temperature in the austenitizing range, and not exceeding the maximum quenching temperature indicated in Table 2 and subsequently quenched in water or oil. After quenching, the pipe

TABLE 1 Plate Specifications

Pipe Grade	Type of Steel	ASTM Specification	
		No.	Grade
CA 55	plain carbon	A 285/A 285M	C
CB 60	plain carbon, killed	A 515/A 515M	60
CB 65	plain carbon, killed	A 515/A 515M	65
CB 70	plain carbon, killed	A 515/A 515M	70
CC 60	plain carbon, killed, fine grain	A 516/A 516M	60
CC 65	plain carbon, killed, fine grain	A 516/A 516M	65
CC 70	plain carbon, killed, fine grain	A 516/A 516M	70
CD 70	manganese-silicon, normalized	A 537/A 537M	1
CD 80	manganese-silicon, quenched and tempered	A 537/A 537M	2
CF 65	nickel steel	A 203/A 203M	A
CF 70	nickel steel	A 203/A 203M	B
CF 66	nickel steel	A 203/A 203M	D
CF 71	nickel steel	A 203/A 203M	E
CG 100	9 % nickel	A 353/A 353M	
CH 100	9 % nickel	A 553/A 553M	1
CJ 101	alloy steel, quenched and tempered	A 517/A 517M	A
CJ 102	alloy steel, quenched and tempered	A 517/A 517M	B
CJ 103	alloy steel, quenched and tempered	A 517/A 517M	C
CJ 104	alloy steel, quenched and tempered	A 517/A 517M	D
CJ 105	alloy steel, quenched and tempered	A 517/A 517M	E
CJ 106	alloy steel, quenched and tempered	A 517/A 517M	F
CJ 107	alloy steel, quenched and tempered	A 517/A 517M	G
CJ 108	alloy steel, quenched and tempered	A 517/A 517M	H
CJ 109	alloy steel, quenched and tempered	A 517/A 517M	J
CJ 110	alloy steel, quenched and tempered	A 517/A 517M	K
CJ 111	alloy steel, quenched and tempered	A 517/A 517M	L
CJ 112	alloy steel, quenched and tempered	A 517/A 517M	M
CJ 113	alloy steel, quenched and tempered	A 517/A 517M	P
CK 75	carbon-manganese-silicon	A 299/A 299M	
CP65	alloy steel, age hardening, normalized and precipitation heat treated	A 736/A 736M	2
CP75	alloy steel, age hardening, quenched and precipitation heat treated	A 736/A 736M	3

TABLE 2 Heat Treatment Parameters

Pipe Grade ^A	ASTM Specification and Grade	Post-Weld Heat-Treatment Temperature Range °F (°C)	Normalizing Temperature, max, °F (°C)	Quenching Temperature, max, °F (°C)	Tempering Temperature, min, °F (°C)	Precipitation Heat Treatment Temperature Range °F (°C)
CA 55	A 285/A 285M (C)	1100–1250 (590–680)	1700 (925)	...	...	...
CB 60	A 515/A 515M (60)	1100–1250 (590–680)	1750 (950)	...	...	...
CB 65	A 515/A 515M (65)	1100–1250 (590–680)	1750 (950)	...	...	...
CB 70	A 515/A 515M	1100–1250 (590–680)	1750 (950)	...	...	...
CC 60	A 516/A 516M (60)	1100–1250 (590–680) ^B	1700 (925)	1650 (900)	1200 (650) ^C	...
CC 65	A 516/A 516M (65)	1100–1250 (590–680) ^B	1700 (925)	1650 (900)	1200 (650)	...
CC 70	A 516/A 516M (70)	1100–1250 (590–680) ^B	1700 (925)	1650 (900)	1200 (650)	...
CD 70	A 537/A 537M (1)	1100–1250 (590–680)	1700 (925)	...	...	...
CD 80	A 537/A 537M (2)	1100–1250 (590–680) ^B	...	1650 (900)	1100 (590)	...
CF 65	A 203/A 203M (A)	1100–1175 (590–635)	1750 (950)	...	...	...
CF 70	A 203/A 203M (B)	1100–1175 (590–635)	1750 (950)	...	...	...
CF 66	A 203/A 203M (D)	1100–1175 (590–635)	1750 (950)	...	...	...
CF 71	A 203/A 203M (E)	1100–1175 (590–635)	1750 (950)	...	...	...
CG 100	A 353/A 353M	1025–1085 (550–580)	1650 (900)	...	1050 (560)	...
CH 400	A 553/A 553M	1025–1085 (550–580)	1650 (900)	...	1050 (560)	...
CH 100	A 553/A 553M	1025–1085 (550–580)	1650 (900)	1700 (925)	1050 (560)	...
CJ 101	A 517/A 517M (A)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 102	A 517/A 517M (B)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 103	A 517/A 517M (C)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 104	A 517/A 517M (D)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 105	A 517/A 517M (E)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 106	A 517/A 517M (F)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 107	A 517/A 517M (G)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 108	A 517/A 517M (H)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 109	A 517/A 517M (J)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 110	A 517/A 517M (K)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 111	A 517/A 517M (L)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 112	A 517/A 517M (M)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CJ 113	A 517/A 517M (P)	1000–1100 (540–590)	...	1725 (940) ^D	1150 (620)	...
CK 75	A 299/A 299M	1100–1250 (590–680)	1700 (925)	...	...	...
CP65	A 736/A 736M (2)	1000–1175 (540–635)	1725 (940)	...	...	1000–1200 (540–650)
CP75	A 736/A 736M (3)	1000–1175 (540–635)	...	1725 (940)	...	1000–1225 (540–665)

^A Numbers indicate minimum tensile strength in ksi.

^B In no case shall the post-weld heat-treatment temperature exceed the mill tempering temperature.

^C Tempering range 1100 to 1300 (590 to 705), if accelerated cooling utilized per Specification A 516/A 516M.

^D Per ASME Section VIII Specification A 517/A 517M specified 1650 (900) minimum quenching temperature.

shall be reheated to the tempering temperature indicated in Table 2 as a minimum and held at that temperature for a minimum of ½ h/in. of thickness or for ½ h, whichever is greater, and air cooled.

5.3.5 Classes 60, 61, 62, and 63 pipe shall be normalized in accordance with 5.3.2. After normalizing, the pipe shall be precipitation heat treated in the range shown in Table 2 for a time to be determined by the manufacturer.

5.3.6 Classes 70, 71, 72, and 73 pipe shall be uniformly heated to a temperature in the austenitizing range, not exceeding the maximum quenching temperature indicated in Table 2, and subsequently quenched in water or oil. After quenching the pipe shall be reheated into the precipitation heat treating range indicated in Table 2 for a time to be determined by the manufacturer.

6. General Requirements for Delivery General Requirements for Delivery

6.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A 530/A 530M unless otherwise provided herein.

7. Chemical Composition

7.1 *Product Analysis of Plate*—The pipe manufacturer shall make an analysis of each mill heat of plate material. The product analysis so determined shall meet the requirements of the plate specification to which the material was ordered.

7.2 *Product Analyses of Weld*—The pipe manufacturer shall make an analysis of finished deposited weld material from each 200 ft (61 m) or fraction thereof. Analyses shall conform to the welding procedure for deposited weld metal.

7.3 Analysis may be taken from the mechanical test specimens. The results of the analyses shall be reported to the purchaser.

8. Mechanical Requirements

8.1 Tension Test:

8.1.1 *Requirements*—Transverse tensile properties of the welded joint shall meet the minimum requirements for ultimate tensile strength of the specified plate material. In addition for Grades CD and CJ, when these are of Class 3x, 4x, or 5x, and Grade CP of Class 6x and 7x, the transverse tensile properties of the base plate shall be determined on specimens cut from the heat-treated pipe. These properties shall meet the mechanical test requirements of the plate specification.