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Designation: ~~A671/A671M – 13~~ A671/A671M – 13$^{\varepsilon 1}$

Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures[1]

This standard is issued under the fixed designation A671/A671M; 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.

ε[1] NOTE—Editorially corrected reference in 8.3 in February 2014.

1. Scope*

1.1 This specification[2] 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. [400 mm] in outside diameter or larger and of ¼ in. [6 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
70	quenched and precipitation heat treated	none	none
71	quenched and precipitation heat treated	9	none
72	quenched and precipitation heat treated	9	8.3
73	quenched and precipitation heat treated	none	8.3

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[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**

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NOTE 1—Selection of materials should be made with attention to temperature of service. For such guidance, Specification A20/A20M may be consulted.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. 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]

A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates
A530/A530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
A577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates
A578/A578M Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
E110 Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers
E165 Practice for Liquid Penetrant Examination for General Industry
E709 Guide for Magnetic Particle Testing

2.2 *Plate Steels:*

A203/A203M Specification for Pressure Vessel Plates, Alloy Steel, Nickel
A285/A285M Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength
A299/A299M Specification for Pressure Vessel Plates, Carbon Steel, Manganese-Silicon
A353/A353M Specification for Pressure Vessel Plates, Alloy Steel, Double-Normalized and Tempered 9 % Nickel
A515/A515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
A516/A516M Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
A517/A517M Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered
A537/A537M Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel
A553/A553M Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 % Nickel
A736/A736M Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-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

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3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—a lot shall consist of 200 ft [60 m] or fraction thereof of pipe from the same heat of steel.

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 or type, or both, 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 A530/A530M),
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.

[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.

TABLE 1 Plate Specifications

Pipe Grade	Type of Steel	ASTM Specification	
		No.	Grade / Class / Type
CA 55	plain carbon	A285/A285M	Gr C
CB 60	plain carbon, killed	A515/A515M	Gr 60
CB 65	plain carbon, killed	A515/A515M	Gr 65
CB 70	plain carbon, killed	A515/A515M	Gr 70
CC 60	plain carbon, killed, fine grain	A516/A516M	Gr 60
CC 65	plain carbon, killed, fine grain	A516/A516M	Gr 65
CC 70	plain carbon, killed, fine grain	A516/A516M	Gr 70
CD 70	manganese-silicon, normalized	A537/A537M	Cl 1
CD 80	manganese-silicon, quenched and tempered	A537/A537M	Cl 2
CF 65	nickel steel	A203/A203M	Gr A
CF 70	nickel steel	A203/A203M	Gr B
CF 65	nickel steel	A203/A203M	Gr D
CF 70	nickel steel	A203/A203M	Gr E
CG 100	9 % nickel	A353/A353M	
CH 115	9 % nickel	A553/A553M	Type 1
CJ 115	alloy steel, quenched and tempered	A517/A517M	Gr A
CJ 115	alloy steel, quenched and tempered	A517/A517M	Gr B
CJ 115	alloy steel, quenched and tempered	A517/A517M	Gr E
CJ 115	alloy steel, quenched and tempered	A517/A517M	Gr F
CJ 115	alloy steel, quenched and tempered	A517/A517M	Gr H
CJ 115	alloy steel, quenched and tempered	A517/A517M	Gr P
CK 75	carbon-manganese-silicon	A299/A299M	Gr A
CP85	alloy steel, age hardening, quenched and precipitation heat treated	A736/A736M	Gr A, Class 3

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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 ⅛ in. [3 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.

5.3 *Heat Treatment*—All classes other than 10, 11, 12, and 13 shall be heat treated in furnace controlled to ± 25 °F [± 15 °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. [0.4 h/cm] 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 ½ h/in. [0.2 h/cm] of thickness or for ½ 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 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. [0.2 h/cm] of thickness or for ½ h, whichever is greater, and air cooled.

5.3.5 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

6.1 Material furnished to this specification shall conform to the applicable requirements of the current edition of Specification A530/A530M 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.

TABLE 2 Heat Treatment Parameters[A]

Pipe Grade[B]	ASTM Specification and Grade / Class / Type	Post-Weld Heat-Treatment Temperature Range °F [°C]	Normalizing Temperature, max, unless otherwise noted °F [°C]	Quenching Temperature, max, unless otherwise noted °F [°C]	Tempering Temperature, min, °F [°C]	Precipitation Heat Treatment Temperature Range °F [°C]
CA 55	A285/A285M (C)	1100–1250 [590–680]	1700 [925]	...	...	...
CB 60	A515/A515M (60)	1100–1250 [590–680]	1750 [950]	...	...	...
CB 65	A515/A515M (65)	1100–1250 [590–680]	1750 [950]	...	...	...
CB 70	A515/A515M (70)	1100–1250 [590–680]	1750 [950]	...	...	...
CC 60	A516/A516M (60)	1100–1200 [590–650][C]	1700 [925]	1700 [925]	1100 [590][D]	...
CC 65	A516/A516M (65)	1100–1200 [590–650][C]	1700 [925]	1650 [900]	1100 [590][D]	...
CC 70	A516/A516M (70)	1100–1200 [590–650][C]	1700 [925]	1700 [925]	1100 [590][D]	...
CD 70	A537/A537M (Cl 1)	1100–1250 [590–680]	1700 [925]	...	...	...
CD 80	A537/A537M (Cl 2)	1100–1250 [590–680][C]	...	1650 [900]	1100 [590]	...
CF 65	A203/A203M (A)	1100–1175 [590–635]	1750 [950]	...	...	...
CF 70	A203/A203M (B)	1100–1175 [590–635]	1750 [950]	...	...	...
CF 65	A203/A203M (D)	1100–1175 [590–635]	1750 [950]	...	...	...
CF 70	A203/A203M (E)	1100–1175 [590–635]	1750 [950]	...	...	...
CG 100	A353/A353M	1025–1085 [550–580]	1650 ± 25 [900 ± 15] plus[E] 1450 ± 25 [790 ± 15]	...	1050–1125 [560–605]	...
CH 100	A553/A553M (Type 1)	1025–1085 [550–580]		1475–1700 [800–925]	1050–1175 [560–635][F]	...
CJ 115	A517/A517M (A)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJ 115	A517/A517M (B)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJ 115	A517/A517M (E)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJ 115	A517/A517M (F)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJ 115	A517/A517M (H)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJ 115	A517/A517M (P)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CK 75	A299/A299M	1100–1250 [590–680]	1700 [925]	...	...	...
CP85	A736/A736M (A, Class 3)	1000–1175 [540–635]	...	1725 [940]	...	1000–1225 [540–665]

[A] Where ellipses (...) appear in this table, there is no requirement.
[B] Numbers indicate minimum tensile strength in ksi.
[C] In no case shall the post-weld heat-treatment temperature exceed the mill tempering temperature.
[D] Tempering range 1100 to 1300 [590 to 705], if accelerated cooling utilized per Specification A516/A516M.
[E] If hot forming is performed after heating to a temperature in the range from 1650 to 1750°F [900 to 955°C], the first normalize may be omitted.
[F] Prior to the tempering treatment, the plates may be subjected to an intermediate heat treatment consisting of heating to a temperature in the range from 1165 to 1290°F [630 to 700°C] and either air-cooled or water quenched. See Specification A553/A553M for hold times and cooling instructions.

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7.2 *Product Analyses of Weld*—The pipe manufacturer shall make an analysis of finished deposited weld material from each 200 ft [60 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 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.

8.1.2 *Number of Tests*—One test specimen of weld metal and one specimen of base metal, if required by 8.1.1, shall be made and tested to represent each lot of finished pipe.

8.1.3 *Test Specimen Location and Orientation*—The test specimens shall be taken transverse to the weld at the end of the finished pipe and may be flattened cold before final machining to size.

8.1.4 *Test Method*—The test specimen shall be made in accordance with QW-150 in Section IX of the ASME Boiler and Pressure Vessel Code. The test specimen shall be tested at room temperature in accordance with Test Methods and Definitions A370.

8.2 *Transverse Guided Weld Bend Test:*

8.2.1 *Requirements*—The bend test shall be acceptable if no cracks or other defects exceeding ⅛ in. [3 mm] in any direction are present in the weld metal or between the weld and the base metal after bending. Cracks that originate along the edges of the specimen during testing, and that are less than ¼ in. [6 mm] measured in any direction shall not be considered.