



Designation: A671/A671M – 20

# Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures<sup>1</sup>

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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification<sup>2</sup> 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 1/4 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

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-671 in Section II of that Code.

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

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.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

- 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

<sup>3</sup> 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

- [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 Rockwell and Brinell Hardness of Metallic Materials by Portable Hardness Testers
- [E165/E165M](#) Practice for Liquid Penetrant Testing 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 7, 8, and 9 % Nickel
- [A736/A736M](#) Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium (Niobium) Alloy Steel

2.3 *ASME Boiler and Pressure Vessel Code:*<sup>4</sup>

- Section II
- Section III
- Section VIII
- Section IX

**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 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](#).

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 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:

**TABLE 1 Plate Specifications**

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

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

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<sup>A</sup>**

Pipe Grade <sup>B</sup>	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] <sup>C</sup>	1700 [925]	1700 [925]	1100 [590] <sup>D</sup>	...
CC 65	A516/A516M (65)	1100–1200 [590–650] <sup>C</sup>	1700 [925]	1700 [920]	1100 [590] <sup>D</sup>	...
CC 70	A516/A516M (70)	1100–1200 [590–650] <sup>C</sup>	1700 [925]	1700 [925]	1100 [590] <sup>D</sup>	...
CD 70	A537/A537M (Cl 1)	1100–1250 [590–680]	1700 [925]	...	...	...
CD 80	A537/A537M (Cl 2)	1100–1250 [590–680] <sup>C</sup>	...	1650 [900]	1100 [590]	...
CFA 65	A203/A203M (A)	1100–1175 [590–635]	1750 [950]	...	...	...
CFB 70	A203/A203M (B)	1100–1175 [590–635]	1750 [950]	...	...	...
CFD 65	A203/A203M (D)	1100–1175 [590–635]	1750 [950]	...	...	...
CFE 70	A203/A203M (E)	1100–1175 [590–635]	1750 [950]	...	...	...
CG 100	A353/A353M	1025–1085 [550–580]	1650 ± 25 [900 ± 15] plus <sup>E</sup> 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] <sup>F</sup>	...
CJA 115	A517/A517M (A)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJB 115	A517/A517M (B)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJE 115	A517/A517M (E)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJF 115	A517/A517M (F)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJH 115	A517/A517M (H)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CJP 115	A517/A517M (P)	1000–1100 [540–590]	...	1650–1725 [900–940]	1150 [620]	...
CK 75	A299/A299M (A)	1100–1250 [590–680]	1700 [925]	...	...	...
CP85	A736/A736M (A, Class 3)	1000–1175 [540–635]	...	1725 [940]	...	1000–1225 [540–665]

<sup>A</sup>Where ellipses (...) appear in this table, there is no requirement.

<sup>B</sup>Numbers indicate minimum tensile strength in ksi.

<sup>C</sup>In no case shall the post-weld heat-treatment temperature exceed the mill tempering temperature.

<sup>D</sup>Tempering range 1100 to 1300 [590 to 705], if accelerated cooling utilized per Specification **A516/A516M**.

<sup>E</sup>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.

<sup>F</sup>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.