



Standard Specification for Centrifugally Cast Ferritic Alloy Steel Pipe for High-Temperature Service¹

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1. Scope

1.1 This specification² covers centrifugally cast alloy steel pipe intended for use in high-temperature, high-pressure service.

1.2 Several grades of ferritic steels are covered. Their compositions are given in Table 1.

1.3 Supplementary Requirements S1 through S12 are provided. The supplementary requirements provide for additional tests of an optional nature and when desired shall be so stated in the order (Section 4).

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

2. Referenced Documents

2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products³

A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe⁴

A 609/A 609M Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof⁵

E 44 Definitions of Terms Relating to Heat Treatment of Metals⁵

E 94 Guide for Radiographic Examination⁶

E 165 Test Method for Liquid Penetrant Examination⁶

E 186 Reference Radiographs for Heavy-Walled (2 to 4½-in. (51 to 114-mm)) Steel Castings^{5,6}

E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels⁷

E 280 Reference Radiographs for Heavy-Walled (4½ to

12-in. (114 to 305-mm)) Steel Castings^{5,6}
E 446 Reference Radiographs for Steel Castings Up to 2 in. (51 mm) in Thickness^{5,6}
E 709 Practice for Magnetic Particle Examination⁶
2.2 *ANSI Standard:*
B46.1 Surface Texture⁸
2.3 *ASME Boiler and Pressure Vessel Code:*
Section IX Welding Qualifications⁹

3. Ordering Information

3.1 Orders for material under this specification shall include the following, as required, to describe the desired material adequately:

- 3.1.1 Quantity (feet, centimetres, or number of lengths),
- 3.1.2 Name of material (centrifugally cast pipe),
- 3.1.3 Specification number,
- 3.1.4 Grade (Table 1),
- 3.1.5 Size (outside or inside diameter and minimum wall thickness),
- 3.1.6 Length (specific or random) (Section on Permissible Variation in Length of Specification A 530/A 530M),
- 3.1.7 End finish (Section on Ends of Specification A 530/A 530M),
- 3.1.8 Optional Requirements S1 through S12 and Section 14.1,
- 3.1.9 Test report required (Section on Certification of Specification A 530/A 530M),
- 3.1.10 Service temperature if over 1000°F (540°C) (Note 1), and
- 3.1.11 Special requirements or additions to specification.

4. General Requirements for Delivery

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

5. Materials and Manufacture

5.1 *Heat-Treatment*—The pipe shall be furnished in the normalized and tempered or liquid-quenched and tempered

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-426 in Section II of that Code.

³ *Annual Book of ASTM Standards*, Vol 01.03.

⁴ *Annual Book of ASTM Standards*, Vol 01.01.

⁵ *Annual Book of ASTM Standards*, Vol 01.02.

⁶ *Annual Book of ASTM Standards*, Vol 03.03.

⁷ *Annual Book of ASTM Standards*, Vol 03.01.

⁸ Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁹ Available from American Society of Mechanical Engineers (ASME), Three Park Ave., New York, NY 10016–5990.



TABLE 1 Chemical Requirements

Grade	Composition, %						
	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon	Chromium	Molybdenum
CP1	0.25 max	0.30–0.80	0.040	0.045	0.10–0.50	...	0.44–0.65
CP2	0.10–0.20	0.30–0.61	0.040	0.045	0.10–0.50	0.50–0.81	0.44–0.65
CP5	0.20 max	0.30–0.70	0.040	0.045	0.75 max	4.00–6.50	0.45–0.65
CP5b	0.15 max	0.30–0.60	0.040	0.045	1.00–2.00	4.00–6.00	0.45–0.65
CP9	0.20 max	0.30–0.65	0.040	0.045	0.25–1.00	8.00–10.00	0.90–1.20
CP11	0.05–0.20	0.30–0.80	0.040	0.045	0.60 max	1.00–1.50	0.44–0.65
CP12	0.05–0.15	0.30–0.61	0.040	0.045	0.50 max	0.80–1.25	0.44–0.65
CP15	0.15 max	0.30–0.60	0.040	0.045	0.15–1.65	...	0.44–0.65
CP21	0.05–0.15	0.30–0.60	0.040	0.045	0.50 max	2.65–3.35	0.80–1.06
CP22	0.05–0.15	0.30–0.70	0.040	0.045	0.60 max	2.00–2.75	0.90–1.20
CPCA15	0.15 max	1.00 max	0.040	0.040	1.50 max	11.5–14.0	0.50 max

condition (Note 1). The temperature for tempering shall not be less than 1250°F (677°C) except for Grades CP1, CP2, CP11, CP12, and CP15 for which the temperature for tempering shall not be less than 1100°F (595°C).

5.1.1 Heat treatment shall be performed after the pipe has been allowed to cool below the transformation range. Definition of heat-treatment terms shall be as given in Definitions E 44.

NOTE 1—It is recommended that the temperature for tempering should be at least 100°F (56°C) above the intended service temperature. The purchaser shall advise the manufacturer of the service temperature when it is over 1000°F (540°C).

5.2 *Machining*—The pipe shall be machined on the inner and outer surfaces to a roughness value no greater than 250 μ in. (6.35 μm) arithmetical average deviation (AA) from the mean line unless otherwise specified as in B46.1.

6. Chemical Analysis

6.1 *Heat Analysis*—An analysis of each heat shall be made by the manufacturer to determine the percentages of elements specified in Table 1. The analysis shall be made on a test sample taken preferable during the pouring of the heat. The chemical composition thus determined shall conform to the requirements specified in Table 1.

6.2 *Product Analysis*—A product analysis may be made by the purchaser. The sample for analysis shall be selected so as to be representative of the pipe being analyzed. The chemical composition thus determined shall conform to the requirements of Table 1.

7. Tensile and Hardness Requirements

7.1 Steel used for the castings shall conform to the tensile and hardness requirements specified in Table 2.

8. Permissible Variations in Dimensions

8.1 *Thickness*—The wall thickness shall not vary over that specified by more than 1/8 in. (3 mm). There shall be no variation under the specified wall thickness.

9. Number of Tests

9.1 One tension and one hardness test shall be made from each heat.

9.2 If a specimen is machined improperly or if flaws are revealed by machining or during testing, the specimen may be discarded and another substituted from the same heat.

TABLE 2 Tensile Properties and Hardness Requirements

Tensile strength, min, psi (MPa):	
Grade CP1	65 000 (450)
Grades CP11, CP22	70 000 (485)
Grades CP5, CP9, CPCA15	90 000 (620)
All other grades	60 000 (415)
Yield strength, min, psi (MPa):	
Grade CP1	35 000 (240)
Grades CP11, CP22	40 000 (275)
Grades CP5, CP9	60 000 (415)
Grade CPCA15	65 000 (450)
All other grades	30 000 (205)
Elongation, min, %: ^a	
Grade CP1	24
Grades CP11, CP22	20
Grades CP5, CP9, CPCA15	18
All other grades	22
Reduction of area, min, %:	
Grades CP1, CP2, CP11, CP12, CP15, CP21, CP22, CP5, CP5b, CP7, CP9	35
Grade CPCA15	30
Hardness, max, HB:	
Grades CP5, CP5b, CP9, CPCA15	225
All other grades	201

^aElongation in 2 in. (50 mm) using a standard round specimen, in either the transverse or longitudinal direction.

10. Retests

10.1 If the results of the mechanical tests for any heat do not conform to the requirements specified, the castings may be reheat-treated and retested, but may not be re-austenitized more than twice.

11. Test Specimens

11.1 Test coupons from which tension test specimens are prepared shall be removed from heat-treated casting prolongations.

11.2 When agreed upon between the manufacturer and the purchaser, test coupons from which test specimens are prepared shall be cast attached to separate blocks from the same heat as the casting represented. The test blocks shall be heat treated in the same manner as the casting represented.

11.3 Tension test specimens shall be machined to the form and dimensions of the standard round 2-in. (50-mm) gage length specimens shown in Fig. 6 of Test Methods and Definitions A 370.

12. Hydrostatic Test

12.1 Each length of pipe shall be hydrostatically tested in accordance with Specification A 530/A 530M.