Designation: ~~A451/A451M – 14~~ A451/A451M – 19

Standard Specification for Centrifugally Cast Austenitic Steel Pipe for High-Temperature Service[1]

This standard is issued under the fixed designation A451/A451M; 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[2] covers austenitic alloy steel pipe for use in high-temperature, corrosive, or nuclear pressure service.

1.2 Several grades of austenitic stainless steel are covered as indicated in Table 1.

1.3 Optional supplementary requirements are provided when additional testing may be required.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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~~nonconformance with the standard.

NOTE 1—This specification is not intended to cover centrifugal pipe made from alloys containing more than 0.20 % carbon, such as are covered by Specification A297/A297M.

1.4.1 Within the text, the SI units are shown in brackets.

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:*[3]

A297/A297M Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application

A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

~~E94~~E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film

~~E165~~E165/E165M Practice for Liquid Penetrant Testing for General Industry

E186 Reference Radiographs for Heavy-Walled (2 to 4½ in. (50.8 to 114 mm)) Steel Castings

E280 Reference Radiographs for Heavy-Walled (4½ to 12 in. (114 to 305 mm)) Steel Castings

E446 Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness

2.2 *ANSI Standard:*[4]

B46.1 Surface Texture

3. Ordering Information

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

3.1.1 Quantity (feet, meters, or number of lengths),

3.1.2 Name of material (centrifugally cast pipe),

3.1.3 Grade (Table 1),

[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 A01.18 on Castings.

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[2] For ASME Boiler and Pressure Vessel Code applications see related specification SA-451 in Section II of that Code.

[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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

TABLE 1 ~~Chemical~~ Requirements[A]

~~Composition, % (max. except where range or minimum is given)~~

Grade (UNS Number)	~~Carbon~~	~~Manganese~~	~~Phosphorus~~	~~Sulfur~~	~~Silicon~~	Nickel	Chromium	Molybdenum	~~Columbium~~	~~Tantalum~~	Nitrogen
~~CPF3 (J92500)~~	~~0.03~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~8.0–12.0~~	~~17.0–21.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPF3A (J92500)~~	~~0.03~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~8.0–12.0~~	~~17.0–21.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPF8 (J92600)~~	~~0.08~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~8.0–11.0~~	~~18.0–21.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPF8A (J92600)~~	~~0.08~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~8.0–11.0~~	~~18.0–21.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPF3M (J92800)~~	~~0.03~~	~~1.50~~	~~0.040~~	~~0.040~~	~~1.50~~	~~9.0–13.0~~	~~17.0–21.0~~	~~2.0–3.0~~	~~...~~	~~...~~	~~...~~
~~CPF8M (J92804)~~	~~0.08~~	~~1.50~~	~~0.040~~	~~0.040~~	~~1.50~~	~~9.0–12.0~~	~~18.0–21.0~~	~~2.0–3.0~~	~~...~~	~~...~~	~~...~~
~~CPF10MC[B]~~	~~0.10~~	~~1.50~~	~~0.040~~	~~0.040~~	~~1.50~~	~~13.0–16.0~~	~~15.0–18.0~~	~~1.75–2.25~~	~~1.2 max, 10 × C min~~	~~...~~	~~...~~
~~CPF8C[B] (J92710)~~	~~0.08~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~9.0–12.0~~	~~18.0–21.0~~	~~...~~	~~1 max, 8 × C min~~	~~...~~	~~...~~
~~CPF8C(Ta max)[C]~~	~~0.08~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~9.0–12.0~~	~~18.0–21.0~~	~~...~~	~~1 max, 8 × C min~~	~~0.10~~	~~...~~
~~CPH8 (J93400)~~	~~0.08~~	~~1.50~~	~~0.040~~	~~0.040~~	~~1.50~~	~~12.0–15.0~~	~~22.0–26.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPH20 or CPH10 (J93402)~~	~~0.20[D]~~	~~1.50~~	~~0.040~~	~~0.040~~	~~2.00~~	~~12.0–15.0~~	~~22.0–26.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPK20 (J94202)~~	~~0.20~~	~~1.50~~	~~0.040~~	~~0.040~~	~~1.75~~	~~19.0–22.0~~	~~23.0–27.0~~	~~...~~	~~...~~	~~...~~	~~...~~
~~CPE20N (J92802)~~	~~0.20~~	~~1.50~~	~~0.040~~	~~0.040~~	~~1.50~~	~~8.0–11.0~~	~~23.0–26.0~~	~~...~~	~~...~~	~~...~~	~~0.08–0.20~~

TABLE 1 Composition Requirements[A,B]

Element, %

Grade (UNS Number)	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Niobium[C]	Tantalum	Nitrogen
CPF3 (J92500)	0.03	1.50	0.040	0.040	2.00	8.0–12.0	17.0–21.0	. . .	. . .	. . .	. . .
CPF3A (J92500)	0.03	1.50	0.040	0.040	2.00	8.0–12.0	17.0–21.0	. . .	. . .	. . .	. . .
CPF8 (J92600)	0.08	1.50	0.040	0.040	2.00	8.0–11.0	18.0–21.0	. . .	. . .	. . .	. . .
CPF8A (J92600)	0.08	1.50	0.040	0.040	2.00	8.0–11.0	18.0–21.0	. . .	. . .	. . .	. . .
CPF3M (J92800)	0.03	1.50	0.040	0.040	1.50	9.0–13.0	17.0–21.0	2.0–3.0	. . .	. . .	. . .
CPF8M (J92804)	0.08	1.50	0.040	0.040	1.50	9.0–12.0	18.0–21.0	2.0–3.0	. . .	. . .	. . .
CPF10MC[D]	0.10	1.50	0.040	0.040	1.50	13.0–16.0	15.0–18.0	1.75–2.25	1.2 max, 10 × C min	. . .	. . .
CPF8C[D] (J92710)	0.08	1.50	0.040	0.040	2.00	9.0–12.0	18.0–21.0	. . .	1 max, 8 × C min	. . .	. . .
CPF8C (Ta max)[E]	0.08	1.50	0.040	0.040	2.00	9.0–12.0	18.0–21.0	. . .	1 max, 8 × C min	0.10	. . .
CPH8 (J93400)	0.08	1.50	0.040	0.040	1.50	12.0–15.0	22.0–26.0	. . .	. . .	. . .	. . .
CPH20 or CPH10 (J93402)	0.20[F]	1.50	0.040	0.040	2.00	12.0–15.0	22.0–26.0	. . .	. . .	. . .	. . .

Grade (UNS Number)	Element, % Carbon	Manganese	Phosphorus	Sulfur	Silicon	Nickel	Chromium	Molybdenum	Niobium[C]	Tantalum	Nitrogen
CPK20 (J94202)	0.20	1.50	0.040	0.040	1.75	19.0–22.0	23.0–27.0	. . .	. . .	. . .	. . .
CPE20N (J92802)	0.20	1.50	0.040	0.040	1.50	8.0–11.0	23.0–26.0	. . .	. . .	. . .	0.08–0.20

[A] Where ellipses (...) appear in this table there is no requirement, and the element need not be analyzed or reported.
[B] Values are maximums unless a range or a minimum is provided.
[C] Columbium (Cb) and Niobium (Nb) are interchangeable names for the same element 41.
[D] Grades CPF10MC and CPF8C may have a columbium plus tantalum content maximum of 1.35 %.
[E] No designation as yet assigned by ASTM International or Steel Founders' Society of America.
[F] By agreement between the manufacturer and the purchaser, the carbon content of Grade CPH20 may be restricted to 0.10 % max. When so agreed, the grade designation shall be CPH10.

3.1.4 Size (outside or inside diameter and minimum wall thickness in inches or millimeters),
3.1.5 Length (specific or random, Specification A999/A999M),
3.1.6 End ~~Finish~~finish of Specification A999/A999M,
3.1.7 Optional ~~Requirements~~requirements (9.4 and Supplementary Requirements S1 through S7),
3.1.8 Test ~~Report Required~~report required (Section 14), and
3.1.9 Special ~~Requirements~~requirements or ~~Additions~~additions to ~~Specification.~~ specification.

4. Materials and Manufacture

4.1 ~~*Heat-Treatment—*~~*Heat Treatment*—The pipe shall receive a ~~heat-treatment~~ heat treatment at the temperature and time specified in Table 2, followed by a quench in water or rapid cool by other means.

4.2 *Machining*—The pipe shall be machined on the inner and outer surfaces to a roughness value no greater than ~~250-µin. [6.35-µm]~~250 µin. [6.35 µm] arithmetical average deviation (AA) from the mean line, as defined in American National Standard B46.1.

5. Chemical ~~Analysis~~Composition

5.1 *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 preferably during the pouring of the heat. The chemical composition thus determined shall conform to the requirements specified in Table 1.

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

5.3 To determine conformance with the chemical analysis requirements, an observed value or calculated value shall be rounded in accordance with Practice E29 to the nearest unit in the last right-hand place of values listed in Table 1.

6. Tensile Requirements

6.1 *Test Specimens:*
6.1.1 Test bars shall be poured in special blocks from the same heat as the castings represented. Test bars shall be supplied in sufficient number to furnish all specimens required in 6.2 and 6.3 (see Table 3).
6.1.2 Test specimens may be cut from heat-treated castings instead of from test bars when agreed upon between the manufacturer and the purchaser.
6.1.3 Tension test specimens shall be machined to the form and dimensions of the standard round 2-in. [50-mm] gage length specimen.

TABLE 2 ~~Heat-Treatment~~ Heat Treatment Requirements

Grade	Temperature, min °F	Temperature, min °C	Hold Time, h/in. of Thickness
CPF3, CPF3A, CPF8, CPF8A, CPF3M, CPF8M	1900	1040	1
CPF10MC, CPF8C, CPF8C (Ta max)	1950	1065	2
CPH8, CPH10, CPH20, CPK20	2100	1150	1
CPE20N	2225	1220	1