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Standard Specification for Centrifugally Cast Ferritic/Austenitic Stainless Steel Pipe for Corrosive Environments[1]

This standard is issued under the fixed designation A872/A872M; 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 covers centrifugally cast ferritic/austenitic steel pipe intended for general corrosive service. These steels are susceptible to embrittlement if used for prolonged periods at elevated temperatures.

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

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A488/A488M Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel

A781/A781M Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use

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 Guide for Radiographic Examination

E165 Practice for Liquid Penetrant Examination 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

E340 Test Method for Macroetching Metals and Alloys

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

2.2 *ASME Boiler and Pressure Vessel Code:*

Section IX Welding Qualifications[3]

2.3 *ASTM Adjuncts:*

Adjunct E186 Reference Radiographs—Transparencies in Ringbinders, 3 Volumes[4]

Adjunct E280 Reference Radiographs—Transparencies in Ringbinders, 2 Volumes[5]

Adjunct E446 Reference Radiographs—Transparencies in Ringbinders, 3 Volumes[6]

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 [metres] or number of lengths),

3.1.2 Name of material (centrifugally cast ferritic/austenitic steel pipe),

3.1.3 Grade (Table 1),

3.1.4 Size (outside or inside diameter and minimum wall thickness in inches [millimetres]),

3.1.5 Length (specific or random, Specification A999/A999M),

3.1.6 End finish of Specification A999/A999M,

3.1.7 Optional Requirements (S1 through S6),

3.1.8 Test report required (Section 12), and

3.1.9 Special requirements or additions to the specification.

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A999/A999M, unless otherwise provided herein.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloysand is the direct responsibility of Subcommittee A01.18 on Castings.

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[2] 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.

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

[4] Available from ASTM International Headquarters. Request RRE018601 for Vol I, RRE018602 for Vol II, and RRE018603 for Vol III.

[5] Available from ASTM International Headquarters. Request for RRE028001 Vol I and RRE028002 for Vol II.

[6] Available from ASTM International Headquarters. Request for RRE044601 Vol I, RRE044602 for Vol II, and RRE044603 for Vol III.

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

TABLE 1 Chemical Requirements[A]

Element	Grade		
	UNS J93183	UNS J93550	UNS J94300 CD4MCuMN
C	0.030	0.030	0.04
Mn	2.0	2.0	0.50–1.50
P	0.040	0.040	0.04
S	0.030	0.030	0.04
Si	2.0	2.0	1.10
Ni	4.00–6.00	5.00–8.00	4.5–6.0
Cr	20.0–23.0	23.0–26.0	24.5–26.5
Mo	2.00–4.00	2.00–4.00	2.5–4.0
N	0.08–0.25	0.08–0.25	0.18–0.26
Cu	1.00	1.00	1.3–3.0
Co	0.50–1.50	0.50–1.50	...

[A] Values are maximums unless a range or minimum is indicated. Where ellipses (...) appear in this table there is no requirement, and the element need not be analyzed or reported.

5. Materials and Manufacture

5.1 *Manufacture:*

5.1.1 The pipe shall be made by the centrifugal casting process.

5.1.2 All pipes shall be furnished in the heat-treated condition as shown in Table 2.

5.1.3 *Machining*—The pipe shall be machined on the inner surface and may be supplied either machined or unmachined in the outer surface. All machining shall be to a roughness value agreed upon between the manufacturer and purchaser.

6. Chemical Composition

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 preferably 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 thoroughly representative of the pipe being analyzed. The chemical composition thus determined shall conform to the requirements specified in Table 1.

6.3 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.

7. Tensile Requirements

7.1 *Testing*—Steel used for the castings shall conform to the tensile and hardness requirements specified in Table 3.

7.2 *Test Specimens:*

7.2.1 Test bars shall be taken from heat-treated castings.

7.2.2 Tension test specimens shall be the standard round 2-in[50-mm] gage length specimen.

7.3 *Number of Tests:*

7.3.1 One tension test shall be made from each heat.

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

7.4 *Retests*—If the results of the mechanical test for any heat do not conform to the requirements specified, the casting may be reheat treated and retested, but this may not be solution treated more than twice.

8. Quality

8.1 The surface of the casting shall be examined visually and shall be free of cracks and hot tears. Other surface defects shall be judged in accordance with visual acceptance criteria that may be specified in the order.

9. Rework and Retreatment

9.1 Defects as defined in Section 9 shall be removed and their removal verified by visual inspection of the resultant cavities. Defects that are located by inspection using Supplementary Requirement S4, S5, or S6 shall be removed or reduced to an acceptable size.

9.2 If removal of the defect does not infringe upon the minimum wall thickness, the depression shall be blended uniformly into the surrounding surface.

9.3 If the cavity resulting from defect removal infringes upon the minimum wall thickness, weld repair is permitted

TABLE 2 Heat Treatment Requirements

Grade	Condition	
	Temperature, °F [°C]	Quenching
UNS J93183	1920–2100 [1050–1150]	Water quench or rapid cooling by other means
UNS J93550	1920–2100 [1050–1150]	Water quench or rapid cooling by other means
UNS J94300 CD4MCuMN	1900 minimum	Water quench or rapid cooling by other means

TABLE 3 Tensile and Hardness Requirements[A]

Requirement	Grade		
	UNS J93183	UNS J93550	UNS J94300 CD4MCuMN
Tensile strength, min, ksi [MPa]	90 [620]	90 [620]	110 [760]
Yield strength, min, ksi [MPa]	65 [450]	65 [450]	70 [480]
Elongation in 2 in. or 50 mm, min, %	25	20	20
Hardness, max:			
Brinell	290	297	...
Rockwell C	30.5	31.5	...

[A]Where ellipses (...) appear in this table there is no requirement, and the property need not be determined or reported.

subject to the purchaser's approval. The composition of the weld rod used shall be suitable for the composition of the metal being welded.

9.3.1 Practice A488/A488M or ASME Boiler and Pressure Vessel Code, Section IX shall be used as a guide for welder and procedure qualification and shall be by agreement between the purchaser and the manufacturer. All repair welds shall be inspected to the same quality standard used to inspect the casting.

10. Permissible Variations in Dimensions

10.1 *Thickness*—The wall thickness shall not vary over that specified by more than ⅛ in. [3 mm]. There shall be no variation under the specified wall thickness.

11. Rejection

11.1 Each length of pipe received from the manufacturer may be inspected by the purchaser and if it does not meet the requirements of the specification based on the inspection and test method as outlined in the specification, the pipe may be rejected and the manufacturer shall be notified. Disposition of rejected pipe shall be a matter of agreement between the manufacturer and the purchaser.

12. Certification

12.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured sampled, tested, and inspected in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

13. Product Marking

13.1 Each length of pipe shall be legibly marked with the manufacturer's name or brand, the specification number, and the grade. In addition, heat numbers or special numbers that are traceable to heat numbers, shall be marked on each length of pipe.

14. Keywords

14.1 casting; centrifugal casting; corrosive service; ferritic/austenitic stainless steel; pipe

SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall be applied only when specified by the purchaser. Details of the supplementary requirements shall be agreed upon between the manufacturer and the purchaser. The specified tests shall be performed by the manufacturer prior to shipment of the castings.

S1. Additional Tension Tests

S1.1 Additional tension tests shall be made at a temperature to be specified by the customer, and the properties to be met are a matter of agreement between purchaser and manufacturer.

S2. Flattening Test

S2.1 The flattening test shall be made on specimens from one or both ends of each length of pipe. If the specimen from any end of any length fails to conform to the requirements of Specification A999/A999M, that length shall be rejected.

S3. Etching Test

S3.1 The steel shall be homogeneous as shown by etching tests conducted in accordance with the appropriate portions of Method E of Test Method E340. Etching tests shall be made on a cross section from one end or both ends of each pipe and shall show sound and reasonably uniform material, free of injurious laminations, cracks, and similar objectionable defects. If this supplementary requirement is specified, the number of required tests per pipe shall also be specified. If a specimen from any length shows objectionable defects, the length shall be rejected, subject to removal of the defective end and subsequent retests indicating the remainder of the length to be sound and reasonably uniform material.

S4. Radiographic Examination

S4.1 The castings shall be examined for internal defects by means of X rays or gamma rays. The inspection procedure shall be in accordance with Guide E94 and the types and degrees of discontinuities considered shall be judged by Reference Radiographs E186, E280, or E446. The extent of examination and the basis for acceptance shall be subject to agreement between the manufacturer and the purchaser.

S5. Liquid Penetrant Examination

S5.1 The castings shall be examined for surface discontinuities by means of liquid penetrant inspection. The method of performing the liquid penetrant test shall be in accordance with Test Method E165. The areas to be inspected, the methods, and types of liquid penetrants to be used, the developing procedure, and the basis for acceptance shall be as specified on the inquiry or contract or both, or as agreed upon between the manufacturer and the purchaser.

S6. Hydrostatic Test

S6.1 Each length of pipe shall be hydrostatically tested in accordance with Specification A999/A999M. Test pressure may be mutually agreed upon between the manufacturer and the purchaser.

S6.2 It is realized that the foundry may be unable to perform the hydrostatic test prior to shipment, or that the purchaser may wish to defer testing until additional work has been performed on the casting. In such cases, the foundry is responsible for the satisfactory performance of the casting when it is so tested.

S7. Charpy Impact Test

S7.1 The Charpy Impact Test shall be carried out in accordance with the requirements of Specification A781/A781M. The properties shall meet the requirements specified in Table S7.1.

TABLE S7.1 Impact Requirements[A]

Grade	UNS J93183	UNS J93550	UNS J94300 CD4MCuMN
Energy value, ft.lbf [J] min for single specimen	...	...	35 [48]
Testing Temperature °F [°C]	...	...	0 [-18]

[A]Where ellipses (...) appear in this table there is no requirement, and the property need not be determined or reported.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A872/A872M – 07a) that may impact the use of this standard. (Approved May 1, 2014.)

(1) Section 2.1. Removed reference to ASTM A370.
(2) Table 1. Added footnote A to define ellipses. The use of "max" within the table has been replaced by the footnote regarding maximums.
(3) Table 3. Added footnote A to define ellipses.
(4) Section 7.2.2. Changed the wording to remove the reference to ASTM A370.
(5) Table S7.1 Added footnote A to define ellipses.