Designation: A 874/A 874M – 98 (Reapproved 2004)

Standard Specification for Ferritic Ductile Iron Castings Suitable for Low-Temperature Service[1]

This standard is issued under the fixed designation A 874/A 874M; 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 ductile iron castings suitable for service at temperatures of −40°F [–40°C] and above.

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

1.3 The following precautionary statement pertains only to the test methods portion, Section 11, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 247 Test Method for Evaluating the Microstructure of Graphite in Iron Castings

E 8 Test Methods for Tension Testing of Metallic Materials

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron[3]

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition[3]

E 94 Guide for Radiographic Examination

E 165 Test Method for Liquid Penetrant Examination

E 351 Test Methods for Chemical Analysis of Cast Iron—All Types

E 562 Test Method for Determining Volume Fraction by Systematic Manual Point Count

E 689 Reference Radiographs for Ductile Iron Castings

E 709 Guide for Magnetic Particle Examination

3. Ordering Information

3.1 Orders for material under this specification shall include the following applicable information:

3.1.1 Drawing, catalog number, or part identification,

3.1.2 Quantity (weight or number of pieces),

3.1.3 ASTM designation and year of issue,

3.1.4 Marking instructions (see Section 15),

3.1.5 Place of inspection (see 13.1),

3.1.6 Limits on residual elements (see 5.2),

3.1.7 Visual and dimensional acceptance standard (see 7.1),

3.1.8 Sampling plan (see Section 9), and

3.1.9 Supplementary requirements.

4. Materials and Manufacture

4.1 Castings may be supplied either as cast or heat treated and shall have essentially a ferritic structure that contains no massive carbides.

5. Chemical Composition

5.1 The iron shall conform to the requirements for chemical composition shown in Table 1.

5.2 By agreement between the manufacturer and purchaser, analysis may be required and limits established for elements not specified in Table 1.

6. Mechanical and Microstructural Properties

6.1 *Tensile Properties*—The iron shall conform to the requirements for tensile properties shown in Table 2.

6.2 *Microstructure*—Graphite contained in the microstructure shall be evaluated in accordance with Test Method A 247. The percent of each graphite type shall be estimated, and the total of all estimates shall equal 100 %. The total percent of Types 1 and 2 graphite shall be a minimum of 90 %.

[1] This specification is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.02 on Malleable and Ductile Iron Castings.

Current edition approved Oct. 1, 2004. Published October 2004. Originally approved in 1989. Last previous edition approved in 1998 as A 874/A 874M - 98.

[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] Withdrawn.

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TABLE 1 Chemical Composition

Element	Minimum, %	Maximum, %
Total carbon	3.0	3.7
Carbon equivalent (carbon + ⅓ silicon)	. . .	4.5
Silicon	1.2	2.3
Phosphorous	. . .	0.03
Magnesium	. . .	0.07
Manganese	. . .	0.25
Copper	. . .	0.1
Nickel	. . .	1.0
Chromium	. . .	0.07

TABLE 2 Tensile Properties

Tensile Strength, min, psi [MPa]	Yield Strength, min, psi [MPa]	Elongation in 2 in. [50 mm], min, %
45 000 [300]	30 000 [200]	12 [12]

7. Workmanship, Finish, and Appearance

7.1 The surface of the casting shall be examined visually and shall be free from adhering sand, scale, cracks, and hot tears. Other surface discontinuities shall meet visual and dimensional acceptance standards specified in the order.

7.2 Conditioning of castings is permitted to the extent that the removal of metal does not extend into the envelope of the finished container and does not alter the properties of the metal remaining in the finished container.

8. Repair

8.1 Castings shall not be repaired by plugging, welding, brazing, impregnation, or any other means.

9. Sampling

9.1 Test coupons will be obtained from the casting. The location in the casting from which the test coupons are obtained and the number obtained from each location shall be agreed upon between the manufacturer and purchaser.

9.2 Metallographic samples shall be obtained from the same location as the mechanical test coupons.

9.3 Nondestructive examination methods for estimating microstructure may be used to supplement the destructive examination sampling plan.

9.4 Sampling for chemical analysis shall be in accordance with Practice E 59.

9.4.1 The chemical analysis for total carbon shall be made on either chilled cast pencil-type specimens or thin wafers approximately 1⁄32 in. [0.8 mm] thick cut from test coupons.

10. Number of Tests and Retests

10.1 The number of tension tests and the number of microstructural examinations shall be agreed upon between the manufacturer and purchaser.

10.2 If any tension test specimen shows obvious defects, it may be discarded and another from the same coupon may be tested.

11. Test Methods

11.1 Conduct the tension test in accordance with Test Methods E 8.

11.2 Determine the yield strength using one of the following methods:

11.2.1 The 0.2 % offset method, or

11.2.2 Extension under load method where the yield strength may be determined as the stress producing an elongation under load of 0.330 %, that is, 0.0066 in. [0.165 mm] in a gage length of 2 in. [50 mm].

11.3 Determine the percent of each graphite nodule type by manual coating, semi-automatic, or automatic image analysis methods. The manual count method shall prevail when the results of other methods differ. Magnification shall be at 100 ×.

11.4 Spectrometric methods may be used for chemical analysis. Should a dispute arise concerning chemical composition, use Test Methods E 351 and E 30 for referee methods.

12. Records

12.1 Records of the chemical composition, mechanical properties, and the metallographic examination shall be systematically made and maintained.

13. Inspection

13.1 Unless otherwise specified in the contract or purchase order, the manufacturer shall perform all of the tests and inspections required by the specification.

13.2 All tests and inspections shall be made at the place of manufacture or a mutually agreed upon location.

13.3 The inspector representing the purchaser shall have entry at all times, while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy that the material is being furnished in accordance with these specifications. The inspector representing the purchaser shall not interfere unnecessarily with the operation of the works.

14. Certification

14.1 The manufacturer's certification shall be furnished to the purchaser stating the material was manufactured, sampled, tested, and inspected in accordance with this specification (including the year of issue) and was found to meet the requirement(s). In addition, a test report shall be included with the certification giving the results of all tests performed including chemical analysis.

15. Product Marking

15.1 The casting shall be identified and shall be marked in accordance with instructions issued by the purchaser.

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SUPPLEMENTARY REQUIREMENTS

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

S1. Magnetic Particle Examination

S1.1 Castings shall be examined for surface discontinuities by magnetic particle examination. The examination shall be in accordance with Guide E 709. The extent of examination and the basis for acceptance shall be agreed upon between the manufacturer and purchaser.

S2. Ultrasonic Examination

S2.1 Castings shall be examined for internal defects by ultrasonic examination. The examination procedures and acceptance criteria shall be agreed upon between the manufacturer and purchaser.

S3. Liquid Penetrant Examination

S3.1 Castings shall be examined for surface discontinuities by means of liquid penetrant examination. The examination shall be in accordance with Test Method E 165. Areas to be inspected, methods and types of liquid penetrants to be used, developing procedure, and basis for acceptance shall be agreed upon between the manufacturer and purchaser.

S4. Radiographic Examination

S4.1 Castings shall be examined for internal defects by means of X rays or gamma rays. The procedure shall be in accordance with Guide E 94, and types and degrees of discontinuities considered shall be judged by Reference Radiographs E 689. The extent of examination and basis for acceptance shall be agreed upon between the manufacturer and purchaser.

S5. Fracture Toughness

S5.1 Fracture toughness testing shall be performed on samples removed from the casting. The method of fracture toughness testing, the location from which the samples are removed, the number of tests performed, and the acceptance requirements shall be agreed upon between the manufacturer and purchaser.

S6. Nodule Count

S6.1 The nodule count per unit area shall be determined by examining 100 × micrographs.[4] The samples for the micrographs shall be removed from the casting at locations agreed upon. The inspection method and the acceptance requirements shall be agreed upon between the manufacturer and purchaser. Test Method E 562 may be used for guidance.

[4] Electric Power Research Institute Project 2813-1, "Relationships Between Ductile Iron Fracture Toughness and Microstructure,'' December 1986, provides background information.

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