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Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings[1]

This standard is issued under the fixed designation B 86; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers commercial zinc, zinc-aluminum castings and continuous cast bar stock, as designated and specified in Table 1. Seven alloy compositions are specified and designated as follows:

Common	Traditional	ASTM[A]	UNS
Alloy 3	Zamak 3	AG 40A[B]	Z33520
Alloy 7	Zamak 7	AG 40B	Z33523
Alloy 5	Zamak 5	AC 41A[B]	Z35531
Alloy 2	Zamak 2	AC 43A	Z35541
ZA-8	ZA-8	...	Z35636
ZA-12	ZA-12	...	Z35631
ZA-27	ZA-27	...	Z35841

[A] See Table 1, Footnote C.

[B] SAE Specification, Nos. 903 and 925 conform to the requirements for alloys AG40A and AC41A, respectively.

1.2 Zinc Alloys Z33520, Z33523, Z35531, and Z35541 are used primarily in the manufacture of pressure die castings. Zinc-Aluminum Alloys Z35636, Z35631, and Z35841 are used in the manufacture of both foundry and pressure die castings. These alloys are also fabricated into continuous cast bar stock used for prototyping and screw machine stock.

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

1.4 Systems of nomenclature used to designate zinc and zinc-aluminum (ZA) alloys used for casting are described in Appendix X1.

1.5 *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 become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 The following documents of the issue in effect on date of order acceptance form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B 240 Specification for Zinc and Zinc-Aluminum (ZA) Alloys in Ingot Form for Foundry and Die Castings

B 275 Practice for Codification of Certain Nonferrous Metals and Alloys, Cast and Wrought

B 557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

B 899 Terminology Relating to Non-ferrous Metals and Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

E 23 Test Methods for Notched Bar Impact Testing of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.04 on Zinc and Cadmium.

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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.

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

TABLE 1 Chemical Requirements

Element	Alloy 3[A,B,C,D] Zamak 3 (AG40A) Z33520	Alloy 7[A,B,C,D] Zamak 7 (AG40B) Z33523	Alloy 5[A,B,C,D] Zamak 5 (AC41A) Z35531	Alloy 2[A,C,,D] Zamak (AC43A) Z355412	ZA-8[A,C,E] ZA-8 Z35636	ZA-12[A,C,E] ZA-12 Z35631	ZA-2[A,C,E] ZA-27 Z35841
Aluminum	3.5-4.3	3.5-4.3	3.5-4.3	3.5-4.3	8.0-8.8	10.5-11.5	25.0-28.0
Magnesium	0.020-0.05[F]	0.005-0.020	0.03-0.08[F]	0.020-0.050	0.015-0.030	0.015-0.030	0.010-0.020
Copper	0.25 max[G]	0.25 max	0.75-1.25	2.5-3.0	0.8-1.3	0.5-1.2	2.0-2.5
Iron, max	0.100	0.075	0.100	0.100	0.075	0.075	0.075
Lead, max	0.005	0.003	0.005	0.005	0.006	0.006	0.006
Cadmium, max	0.004	0.0020	0.004	0.004	0.006	0.006	0.006
Tin, max	0.003	0.0010	0.003	0.003	0.003	0.003	0.003
Nickel	. . .	0.005-0.020	. . .	. . .	. . .	. . .	. . .
Zinc[H]	remainder	remainder	remainder	remainder	remainder	remainder	remainder

[A] For purposes of acceptance and rejection, the observed value or calculated value obtained from analysis should be rounded to the nearest unit in the last right-hand place of figures, used in expressing the specified limit, in accordance with the rounding procedure prescribed in Practice E 29.

[B] Zinc alloy castings may contain nickel, chromium, silicon, and manganese in amounts of 0.02, 0.02, 0.035, and 0.06 % respectively. No harmful effects have ever been noted due to the presence of these elements in these concentrations and, therefore, analyses are not required for these elements, with the exception of nickel analysis for Z33522.

[C] ASTM alloy designations were established in accordance with Practice B 275. The UNS designations were established in accordance with Practice E 527. The last digit of a UNS number differentiates between alloys of similar composition. The UNS designations for ingot and casting versions of an alloy were not assigned in the same sequence for all alloys.

[D] When this material is required to conform to ISO 301$_{7,2}$, the chemical limits for thallium and indium each shall not exceed 0.001 %.

[E] Zinc-aluminum ingot for foundry and pressure die casting may contain chrome, manganese, or nickel in amounts of up to 0.01 % each or 0.03 % total. No harmful effects have ever been noted due to the presence of these elements in up to these concentrations and, therefore, analyses are not required for these elements.

[F] Magnesium may be as low as 0.015 % provided that the lead, cadmium, and tin do not exceed 0.003, 0.003, and 0.001 % respectively.

[G] For the majority of commercial applications, a copper content in the range from 0.25 to 0.75 % will not adversely affect the serviceability of die castings and should not serve as a basis for rejection.

[H] Determined arithmetically by difference.

E 47 Test Methods for Chemical Analysis of Zinc Die-Casting Alloys[3]
E 88 Practice for Sampling Nonferrous Metals and Alloys in Cast Form for Determination of Chemical Composition
E 527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
E 536 Test Methods for Chemical Analysis of Zinc and Zinc Alloys
E 634 Practice for Sampling of Zinc and Zinc Alloys for Optical Emission Spectrometric Analysis

2.3 *North American Die Casting Association (NADCA):*[4]
NADCA Product Specification Standards for Die Castings

2.4 *Federal Standard:*[5]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.5 *Military Standard:*[5]
MIL-STD-129 Marking for Shipment and Storage (Military Agencies)

2.6 *Military Specification:*[5]
MIL-P-116 Methods of Preservation

2.7 *ISO Standards:*[6]
ISO 301 Zinc Alloy Ingots Intended for Casting
ISO 15201 Zinc and Zinc alloys — Castings — Specifications
ISO 3815-1 Zinc and zinc alloys — Part 1: Analysis of solid samples by optical emission spectrometry
ISO 3815-2 Zinc and zinc alloys — Part 2: Analysis by inductively coupled plasma optical emission spectrometry

3. Terminology

3.1 Terms shall be defined in accordance with Terminology B 899.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *continuous casting*, *n*—a casting technique in which a cast is continuously withdrawn through the bottom of the mold as it solidifies, so that its length is not determined by mold dimensions; used chiefly to produce semifinished mill products such as billets, blooms, ingots, slabs, and tubes; also known as concast.

3.2.2 *die casting*, *n*—a casting process in which molten metal is injected under high velocity and pressure into a metal die and solidified, also a product produced by such a process. Alternately known as pressure die casting.

3.2.3 *foundry casting*, *n*—metal object produced by introducing molten metal by gravity into a mold of any type and allowing it to solidify.

[3] Withdrawn.
[4] Available from North American Die Casting, Assn., 2000 5th Ave., River Grove, IL 60171, http://www.diecasting.org.
[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.
[6] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.4 *permanent mold casting*, *n*—metal object produced by introducing molten metal by gravity or low pressure into a mold constructed of durable material, usually iron or steel, and allowing it to solidify. When a graphite mold is used the process is known as *graphite permanent mold casting*.

3.2.5 *sand casting*, *n*—metal object produced by introducing molten metal by gravity into a sand mold and allowing it to solidify.

3.2.6 *semipermanent mold casting*, *n*—permanent mold casting which is made using an expendable core such as sand.

4. Ordering Information

4.1 Orders for die castings shall include the following basic information:

4.1.1 This specification number and date,

4.1.2 Quantity and delivery schedule, as required,

4.1.3 Part name and number,

4.1.4 Alloy (Table 1), and

4.1.5 Drawing of casting, when required, giving all necessary dimensions and showing latest revisions and allowances for matching, if any. Location of ejector pin marks or parting lines shall be at the option of the producer, unless specifically designated on the drawing.

4.2 Additional tests, options, and special inspection requirements as provided as follows should be justified only on the basis of need. These shall be specified in the contract or purchase order, as additional procedures and extended delivery time may be involved.

4.2.1 Chemical analysis (6.1.1),

4.2.2 Quality assurance (Section 15),

4.2.3 Special proof tests or mechanical properties (Section 7),

4.2.4 General quality options for internal soundness or for finish (Section 14),

4.2.5 Source inspection (Section 9),

4.2.6 Certification (Section 11),

4.2.7 Marking for identification (Section 12), and

4.2.8 Special packaging (Section 13).

5. Material

5.1 The metal used in the manufacture of die castings shall be zinc alloy of a specified chemical composition conforming to the requirements of Specification B 240.

6. Chemical Requirements

6.1 *Limits*—The casting shall conform to the requirements as to chemical composition prescribed in Table 1. Conformance shall be determined by the producer by analyzing samples taken at the time that castings are made. If the producer has determined the chemical composition of the metal during the course of manufacture, he shall not be required to sample and analyze the finished product.

NOTE 1—The chemical compositions prescribed in Table 1 (not including the footnotes) for Alloys 3, 5, 2, ZA-8, ZA-12, and ZA-27 conform to the prescribed chemical compositions in ISO 15201.

6.1.1 When a detailed chemical analysis is required with a shipment, it shall be called for in the contract or purchase order.

6.1.2 If the producer's or supplier's method of composition control is acceptable, sampling for chemical composition may be waived at the discretion of the purchaser.

6.2 *Number of Samples*—When required, samples for determination of chemical composition shall be taken to represent the following:

6.2.1 A sample shall be taken from each of two representative castings selected from each lot defined in 15.2.

6.3 *Methods of Sampling*—Samples from castings for determination of chemical composition shall be taken in accordance with one of the following methods:

6.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a weight of prepared sample not less than 100 g. Sampling shall be in accordance with Practice E 88.

~~6.3.2By agreement, an appropriate spectrographic sample may be prepared at the time of manufacture (for example, see Practice E634).~~

6.3.2 By agreement, an appropriate spectrographic sample may be prepared at the time of manufacture (for example, see Practice E 634). This sample will be used for analysis by optical emission spectrometry, a common method used by the industry. ISO 3815-1 represents a typical method and may be consulted as a guide.

6.3.3 The method of sampling cast products for spectrochemical and other methods of analysis shall be suitable for the form of material being analyzed and the type of analytical method used.

6.4 *Method of Analysis*—The determination of chemical composition shall be made in accordance with suitable analytical methods. In case of dispute, the results secured by an approved method (or combination of approved methods), ~~preferably from~~

~~among those methods listed in 6.4.1,~~ or by a method agreed upon by both parties, shall be the basis of acceptance.

6.4.1 Approved methods include: Test Methods E 536, Test Methods E 47 ~~(for tin), ISO3815-1, or ISO3815-2~~(for tin) or ISO 3815-2.

7. Physical Properties, Mechanical Properties and Tests

7.1 Unless specified in the contract or purchase order, or specified on the detail drawing, acceptance of castings under this specification shall not depend on mechanical properties determined by tension or impact tests.

7.1.1 Appendix X2 shows typical mechanical properties, determined on separately cast test bars produced under carefully controlled conditions.

7.1.2 While these typical mechanical properties of separately cast test bars are useful for comparing the relative properties of various casting alloys, they should not be used to establish design limits or acceptance criteria.

7.1.3 If tension or impact tests are made on separately cast test bars, test specimens conforming to the dimensions shown in Test Methods B 557 (the figure entitled, Standard Tension Test Specimen for Die Castings), Test Methods E 8, (the figure entitled Standard Test Specimen for Cast Iron), and of Test Methods E 23 (the figure entitled, Charpy (Simple-Beam) Impact Test Specimens, Types A, B, and C) shall be used, and process operating variables shall be optimized for the specific mold or die being used.

7.1.4 When specified in the contract or purchase order, castings shall withstand proof tests without failure as defined by agreement between the purchaser and the producer or supplier.

7.2 Appendix X3 shows typical physical properties of zinc and zinc-aluminum (ZA) casting alloys and does not constitute a part of this specification but is provided for informational purposes only.

8. Dimensions, Mass, and Permissible Variations

8.1 Permissible variations in dimensions shall be within the limits specified on the drawings or in the contract or purchase order.

8.1.1 For die castings, any dimensions for which a tolerance is not specified shall be in accordance with NADCA Product Specification Standards for Die Castings.

8.2 Dimensional tolerance deviations waived by the purchaser shall be confirmed in writing to the producer or supplier.

9. Source Inspection

9.1 If the purchaser desires that his representative inspect or witness the inspection and testing of the product prior to shipment, such agreement shall be made by the purchaser and producer or supplier as part of the contract or purchase order.

9.2 When such inspection or witness of inspection and testing is agreed upon, the producer or supplier shall afford the purchaser's representative all reasonable facilities to satisfy him that the product meets the requirements of this specification. Inspection and tests shall be conducted so there is no unnecessary interference with the producer's operations.

10. Rejection and Rehearing

10.1 When one or more samples, depending on the approved sampling plan, fail to meet the requirements of this specification, the represented lot is subject to rejection except as otherwise provided in 10.2

10.2 Lots rejected for failure to meet the requirements of this specification may be resubmitted for test provided:

10.2.1 The producer has removed the nonconforming material or the producer has reworked the rejected lot as necessary to correct the deficiencies.

10.3 Individual castings that show injurious imperfections during subsequent manufacturing operations may be rejected. The producer or supplier shall be responsible only for replacement of the rejected castings to the purchaser. As much of the rejected original material as possible shall be returned to the producer or supplier.

11. Certification

11.1 The producer or supplier shall, when called for in the contract or purchase order, furnish to the purchaser a certificate of inspection stating that each lot has been sampled, tested, and inspected in accordance with this specification, and has been found to meet the requirements specified.

12. Identification Marking

12.1 When specified in the contract or purchase order, or in the detail drawing, all castings shall be properly marked for identification with the part number and name or brand of the producer as specified.

13. Preparation for Delivery

13.1 *Packaging*—Unless otherwise specified, the castings shall be packaged to provide adequate protection during normal handling and transportation. Each package shall contain only one type item unless otherwise agreed upon. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the producer's discretion, provided they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.