



Designation: B 86 – 04^{€2}

Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings¹

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^{e1} NOTE—Editorial changes were made throughout in March 2005.

^{€2} NOTE—Editorial corrections and a Summary of Changes were added in April 2005.

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:

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

^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 the standard.

1.4 *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.*

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. 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 of 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

E 47 Test Methods for Chemical Analysis of Zinc Die-Casting Alloys³

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 (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):*

NADCA Product Specification Standards for Die Castings⁴

2.4 *Federal Standard:*

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.

⁴ Available from North American Die Casting, Assn., 2000 5th Ave., River Grove, IL 60171.

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

TABLE 1 Chemical Requirements

Element	Z33520 (AG40A) ^{A,B,C,D} Alloy 3 Zamak 3	Z33523 (AG40B) ^{A,B,C,D} Alloy 7 Zamak 7	Z35531 (AC41A) ^{A,B,C,D} Alloy 5 Zamak 5	Z35541 (AC43A) ^{A,C,,D} Alloy 2 Zamak 2	Z35636 ^{A,C,E} ZA-8	Z35631 ^{A,C,E} ZA-12	Z35841 ^{A,C,E} ZA-27
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	0.0030	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, 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.

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁵

2.5 Military Standard:

MIL-STD-129 Marking for Shipment and Storage (Military Agencies)⁵

2.6 Military Specification:

MIL-P-116 Methods of Preservation⁵

2.7 ISO Standard:

ISO 301 Zinc Alloy Ingots Intended for Casting

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.

3.2.4 *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 Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

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.

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**.

6.3.2 By agreement, an appropriate spectrographic sample may be prepared at the time of manufacture (for example, see Practice **E 634**).

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 chemical (Test Methods **E 536** or **E 47** for tin) or other test methods. In case of dispute, the results secured by Test Method **E 536** and Test Methods **E 47** for tin only shall be the basis of acceptance.

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 XI** 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 X2** 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