Designation: B955/B955M – 14

Standard Specification for Aluminum-Alloy Centrifugal Castings[1]

This standard is issued under the fixed designation B955/B955M; 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 aluminum-alloy centrifugal castings designated as shown in Table 1.

1.2 This specification is not intended for aluminum-alloy centrifugal castings used in aerospace applications.

1.3 Alloy and temper designations are in accordance with ANSI H35.1/H35.1 (M). The equivalent unified numbering system alloy designations are in accordance with Practice E527.

1.4 Unless the order specifies the "M" specification designation, the material shall be furnished to the inch-pound units.

1.5 For acceptance criteria for inclusion of new aluminum and aluminum alloys and their properties in this specification, see Annex A1 and Annex A2.

1.6 *Units*—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 with the standard.

1.7 *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 limitation prior to use.*

2. Referenced Documents

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

2.2 *ASTM Standards:*[2]

B179 Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes
B275 Practice for Codification of Certain Zinc, Tin and Lead Die Castings
B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
B660 Practices for Packaging/Packing of Aluminum and Magnesium Products
B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products
B917/B917M Practice for Heat Treatment of Aluminum-Alloy Castings from All Processes
B985 Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis
D3951 Practice for Commercial Packaging
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys
E94 Guide for Radiographic Examination
E155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings
E165 Practice for Liquid Penetrant Examination for General Industry
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
E607 Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)[3]
E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis
E1251 Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry
E2422 Digital Reference Images for Inspection of Aluminum Castings

[1] This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloysand is the direct responsibility of Subcommittee B07.01 on Aluminum Alloy Ingots and Castings.

Current edition approved Oct. 1, 2014. Published October 2014. Originally approved in 2007. Last previous edition approved in 2011 as B955/B955M – 11. DOI: 10.1520/B0955_B0955M-14.

[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] The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Chemical Composition Limits[A,B,C]

Alloy		Composition, %												
ANSI[D]	UNS	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Nickel	Zinc	Titanium	Tin	Other Elements[E] Each	Other Elements[E] Total[F]	Aluminum
356.0	A03560	6.5–7.5	0.6[G]	0.25	0.35[G]	0.20–0.45	...	...	0.35	0.25	... ...	0.05	0.15	Remainder
505.0		0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.35	...	0.25	0.15	... ...	0.05	0.15	Remainder
709.0		0.40	0.50	1.2–2.0	0.30	2.1–2.9	0.18–0.28	...	5.1-6.1	0.20	... ...	0.05	0.15	Remainder
850.0	A08500	0.7	0.7	0.7–1.3	0.10	0.10	...	0.7–1.3	...	0.20	5.5–7.0 ...	...	0.30	Remainder

[A] When single units are shown, these indicate the maximum amounts permitted.
[B] Analysis shall be made for the elements for which limits are shown in this table.
[C] The following applies to all specified limits in this table: For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall 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 method of Practice E29.
[D] ASTM alloy designations are defined in ANSI H35.1/H35.1 (M).
[E] *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic *Others* elements. Should any analysis by the producer or the purchaser establish that an *Others* element exceeds the limit of *Each* or that the aggregate of several Others elements exceeds the limit of *Total*, the material shall be considered nonconforming.
[F] *2Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.
[G] If the iron content exceeds 0.45 %, manganese content shall not be less than one half of the iron.

2.3 *ANSI Standard:*[4]
H35.1/H35.1 (M) American National Standard Alloy and Temper Designation Systems for Aluminum
Z1.4 Sampling Procedures and Tables for Inspection by Attributes

2.4 *Military Standards:*[5]
MIL-STD-129 Marking for Shipment and Storage
MIL-STD-276 Impregnation of Porous Nonferrous Metal Castings

2.5 *Naval Standard:*[6]
S9074-AR-GIB-010/278 Requirements for Fabrication Welding and Inspection, and Casting Inspection and repair for Machinery, Piping, and Pressure Vessels

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

2.7 *Other Standards:*[7]
CEN EN 14242 Aluminum and Aluminum Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis

3. Terminology

3.1 *Definitions*—Refer to Terminology B881 for definitions of product terms used in this specification.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *hot isostatic processing (HIP, HIPped, and HIPping), n*—the process of applying high pressure and temperatures to a part through the medium of a pressurized gas, such as Argon or Nitrogen to remove internal porosity voids.

[4] Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, http://www.aluminum.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 Naval Sea Systems Command (NAVSEA), 1333 Isaac Hull Ave., SE, Washington, DC 20376, http://www.navsea.navy.mil.
[7] Available from European Committee for Standardization (CEN), 36 Rue de Stassart, B-1050, Brussels, Belgium, http://www.CEN.eu/esearch.

4. Ordering Information

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

4.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),

NOTE 1—For inch-pound application, specify Specification B955 and for metric application specify Specification B955M. Do not mix units.

4.1.2 Alloy (Section 7 and Table 1),
4.1.3 Temper (Section 9 and Table 2 [Table 3]),
4.1.4 Applicable drawing or part number, and
4.1.5 The quantity in either pieces or pounds.

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:

4.2.1 Whether chemical composition samples are to be taken from the castings (7.2),

4.2.2 Whether foundry control is required (Section 8.2),

4.2.3 Whether yield strength tests are required (9 and Footnote D in Table 2 [Table 3]),

4.2.4 Whether test specimens are to be cut from castings in addition to or instead of centrifugally cast test blocks (Sections 9, 10.1, 11.2, and 13),

4.2.5 Whether special tensile test sampling agreement is required for large castings (10.3.2),

4.2.6 Whether repairs are permissible (Section 16),

4.2.7 Whether inspection is required at the producer's works (Section 17),

4.2.8 Whether surface requirements will be checked visually or by observational standards where such standards are established (18.1),

4.2.9 Whether liquid penetrant inspection is required (18.2),

4.2.10 Whether radiographic inspection is required and, if so, the radiographic grade of casting required (18.3 and Table 4),

4.2.11 Whether certification is required (Section 21),

4.2.12 Whether Practices B660 apply and, if so, the levels of preservation, packaging, and packing required (22.4), and

TABLE 2 Tensile Requirements, (Inch-Pound Units)[A,B]

Alloy		Temper[C]	Tensile Strength, min, ksi	Yield Strength[D] (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter, min, %	Typical Brinell Hardness[E] 500-kgf load, 10-mm ball
ANSI[F]	UNS					
356.0	A03560	T6 separately cast specimens	33.0	22.0	3.0	85
505.0		T61 specimens cut from castings[G]	43.0	37.0	7.0	95
709.0		T61 specimens cut from castings[H]	74.0	64.0	4.0	150
850.0	A08500	T5 separately cast specimens	18.0	...	8.0	...

[A] If agreed upon by manufacturer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving.
[B] For purposes of determining conformance with this specification, each value for tensile strength and yield strength shall be rounded off to the nearest 0.1 ksi, and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding method of Practice E29.
[C] Temper designations are defined in ANSI H35.1/H35.1 (M) T61 Hot Isostatic Pressed (HIP), solution heat-treated, and then artificially aged.
[D] Yield strength to be evaluated only when specified in contract or purchase order.
[E] Hardness values given for information only, not required for acceptance.
[F] ASTM alloy designations are recorded in Practice B275.
[G] These properties apply only to castings having section thicknesses not greater than 2.5 in. Tensile specimens were taken from the casting after HIPping was completed. The data used to calculate the minimum values came from samples taken in the axial direction. While not combinable with the axial data, tangential values are marginally higher.
[H] These properties apply only to castings having section thicknesses not greater than 2.5 in. Tensile specimens were taken from the casting after HIPping was completed. Samples were taken in both the axial and tangential directions and the data was found to be combinable. The data represents both directions.

TABLE 3 Tensile Requirements, (SI Units) [Metric][A,B,C]

Alloy		Temper[D]	Tensile Strength, min, MPa	Yield Strength[E] (0.2 % offset), min, MPa	Elongation in 5D min, %	Typical Brinell Hardness[F] 500-kgf load, 10-mm ball
ANSI[G]	UNS					
356.0	A03560	T6 separately cast specimens	230	150	3.0	85
505.0		T61 specimens cut from castings[H]	295	255	6.0	95
709.0		T61 specimens cut from castings[I]	510	440	4.0	150
850.0	A08500	T5 separately cast specimens	125	...	7.0	....

[A] If agreed upon by manufacturer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving.
[B] For purposes of determining conformance with this specification, each value for tensile strength and yield strength shall be rounded off to the nearest 1 MPa, and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding method of Practice E29.
[C] Guidelines for metric conversion from the "Tempers for Aluminum and Aluminum Alloys, Metric Edition" (Tan Sheets) Appendix A, *were used to convert the tensile and yield values to SI units.*[3]
[D] Temper designations are defined in ANSI H35.1/H35.1 (M) T61 Hot Isostatic Pressed (HIP), solution heat-treated, and then artificially aged.
[E] Yield strength to be evaluated only when specified in contract or purchase order.
[F] Hardness values given for information only, not required for acceptance.
[G] ASTM alloy designations are recorded in Practice B275.
[H] These properties apply only to castings having section thicknesses not greater than 2.5 in. Tensile specimens were taken from the casting after HIPping was completed. The data used to calculate the minimum values came from samples taken in the axial direction. While not combinable with the axial data, tangential values are marginally higher.
[I] These properties apply only to castings having section thicknesses not greater than 2.5 in. Tensile specimens were taken from the casting after HIPping was completed. Samples were taken in both the axial and tangential directions and the data was found to be combinable. The data represents both directions.

4.2.13 Whether marking in accordance with Fed. Std. No. 123, Practice D3951, or MIL-STD-129 applies (22.4).

5. Responsibility for Quality Assurance

5.1 Unless otherwise specified in the contract or purchase order, the producer shall be responsible for the performance of all inspections and test requirements specified herein. Unless otherwise agreed upon, the producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein. The purchaser shall have the right to perform any of the inspections and tests set forth in the specification where such inspections are deemed necessary to confirm that the material conforms to prescribed requirements.

6. Materials and Manufacture

6.1 The responsibility of furnishing castings that can be laid out and machined to the finished dimensions within the permissible variations specified, as shown on the blueprints or drawings, shall rest with the producer, except where mold equipment is furnished by the purchaser.

7. Chemical Composition

7.1 The Product shall conform to the chemical composition limits prescribed in Table 1. Conformance shall be determined by the producer by taking samples at the time castings are poured in accordance with Practices E716 and analyzed in accordance with Practices E716, Test Methods E34, E607, or E1251, or EN 14242. If the producer has determined the

TABLE 4 Discontinuity-Level Requirements for Aluminum Castings in Accordance with Film Reference Radiographs E155 or Digital Reference Radiographs E2422

Discontinuity	Radiograph	Grade A[A]	Grade B		Grade C		Grade D	
		Section Thickness, in.						
		¼ to ¾ [6 to 19 mm]	¼ [6 mm]	¾ [19 mm]	¼ [6 mm]	¾ [19 mm]	¼ [6 mm]	¾ [19 mm]
Gas holes	1.1	none	1	1	2	2	5	5
Gas porosity (round)	1.21	none	1	1	3	3	7	7
Gas porosity (elongated)	1.22	none	1	1	3	4	5	5
Shrinkage cavity	2.1	none	1	[B]	2	[B]	3	[B]
Shrinkage porosity or sponge	2.2	none	1	1	2	2	4	3
Foreign material (less dense material)	3.11	none	1	1	2	2	4	4
Foreign material (more dense material)	3.12	none	1	1	2	1	4	3
Segregation	....	none	none		none		none	
Cracks	....	none	none		none		none	
Cold shuts	....	none	none		none		none	
Laps	....	none	none		none		none	
Surface irregularity		not to exceed drawing tolerance on any grade casting						
Core shift	....	not to exceed drawing tolerance on any grade casting						

[A] Caution should be exercised in requesting grade A because of the difficulty in obtaining this level.
[B] Not available. Use ¼ in. for all thicknesses.

composition of the material during casting, they shall not be required to sample and analyze the finished product.

7.1.1 A sample for determination of chemical composition shall be taken to represent one of the following:

7.1.1.1 Not more than 4000 lb [2000 kg] of clean castings or a single casting poured from one furnace. The maximum elapsed time between determinations shall be established for each alloy but in any case this maximum elapsed time shall not exceed eight hours.

7.2 If it becomes necessary to analyze castings for conformance to chemical composition limits, the method used to sample castings for the determination of chemical composition shall be in accordance with Practice B985. Analysis shall be performed in accordance with Practices E716, Test Methods E34, E607, or E1251, or EN 14242 (ICP method).

8. Requirements for Castings Produced for Governmental and Military Agencies

8.1 *Material Requirements:*

8.1.1 Unless otherwise specified, only aluminum alloy conforming to the requirements of Specification B179 or producers foundry scrap, identified as being made from alloy conforming to Specification B179, shall be used in the remelting furnace from which molten metal is taken for pouring directly into castings. Additions of small amounts of modifying and grain refining elements or alloys are permitted.

8.1.2 Pure materials, recycled materials, and master alloys may be used to make alloys conforming to this specification, provided chemical analysis can be taken and adjusted to conform to Table 1 prior to pouring any castings.

8.2 *Foundry Control*—When specified, castings shall be produced under procedures established and documented for foundry control that have been approved by the purchaser. Foundry control shall consist of examination of castings by radiographic or other approved methods for determining internal discontinuities until the gating, pouring, and other foundry practices have been established to produce castings meeting the quality standards furnished by the purchaser or agreed upon by the purchaser and the producer. When foundry practices have been so established, the production method shall be documented and shall not be significantly changed without demonstrating to the satisfaction of the purchaser that the change does not adversely affect the quality of the castings. Minor changes of ±50°F [±28°C] from the established nominal pouring temperature are permissible.

9. Tensile Requirements

9.1 When specified, the tensile strength, yield strength, and elongation of test specimens cut from castings shall meet the values stated in Table 2 [Table 3].

9.2 The tensile strength, yield strength, and elongation of test specimens cut from castings or test blocks for alloys 505.0 and 709.0, which have been hipped and then heat treated shall be in accordance with Table 2 [Table 3]. For other alloys specimens cut from castings shall meet a minimum of 75 % of the tensile and yield strength values and not less than 25 % of the elongation values specified in Table 2 [Table 3]. The measurement of elongation is not required for test specimens cut from castings if 25 % of the specified minimum elongation value published in Table 2 [Table 3] is 0.5 % or less. If grade D quality castings as described in Table 4 are specified, no tensile tests shall be specified nor tensile requirements be met on specimens cut from castings.

10. Test Specimens

10.1 Test specimens shall be cut from production castings or by agreement between purchaser and producer cut from centrifugally cast test blocks as shown in Figs. 1 and 2.

10.1.1 The centrifugally cast test blocks shall be cast in molds representing the mold used for castings and cast from the same melt which is used for the castings after the last melt addition.

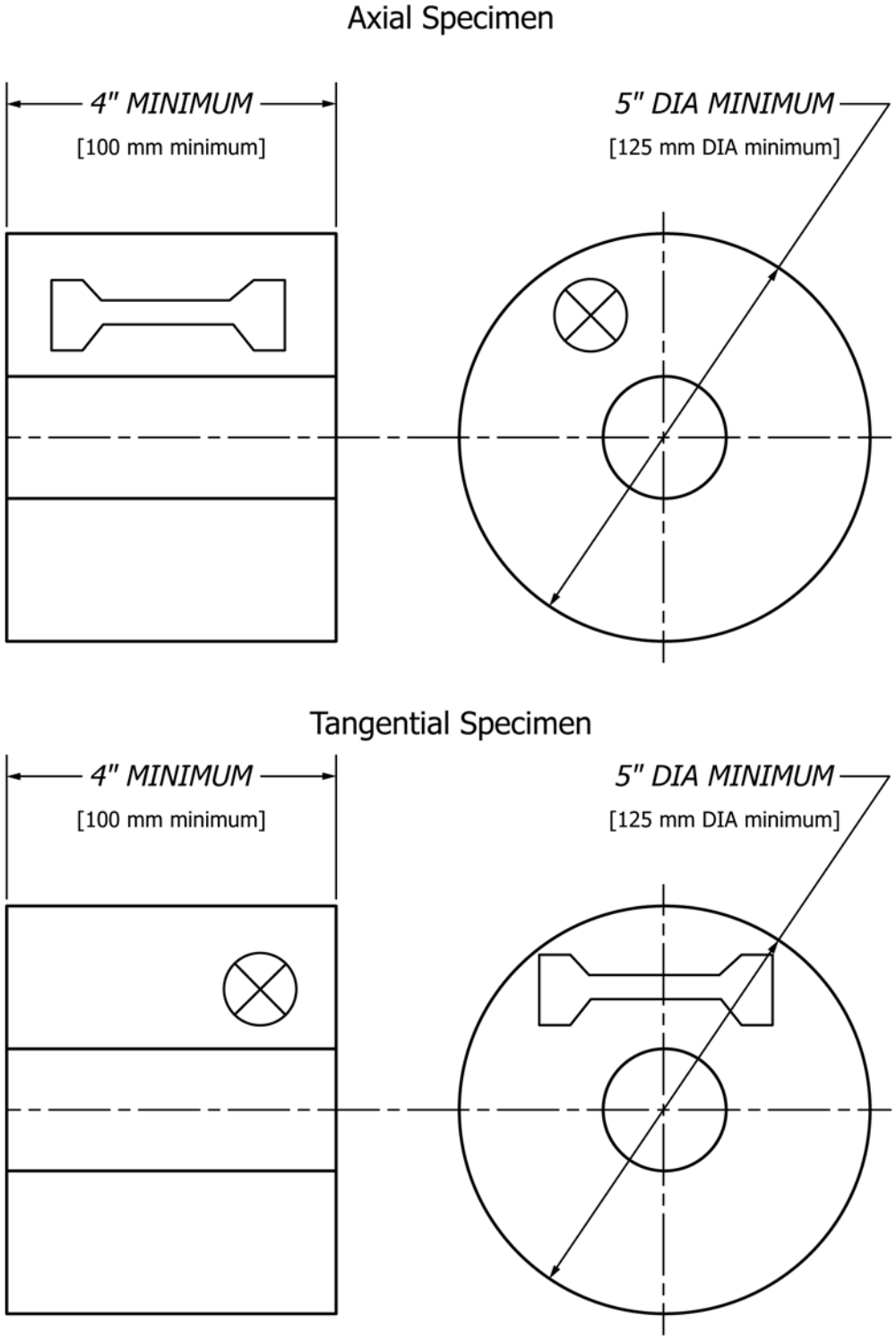

FIG. 1 Configuration of Cast Centrifugal Test Block with Potential Locations of Machined Test Specimen.

10.1.2 The centrifugally cast test blocks shall be heat treated with the castings they represent.

10.2 *Tensile Specimens*—Test specimens shall be as shown in Fig. 9 or 10 of Test Methods B557 [B557M] using the largest specimen obtainable form the casting or test block. In no case shall the smallest specimen be less than the 0.250 in. [6 mm] specimen shown in Fig. 9 of Test Methods B557 [B557M].

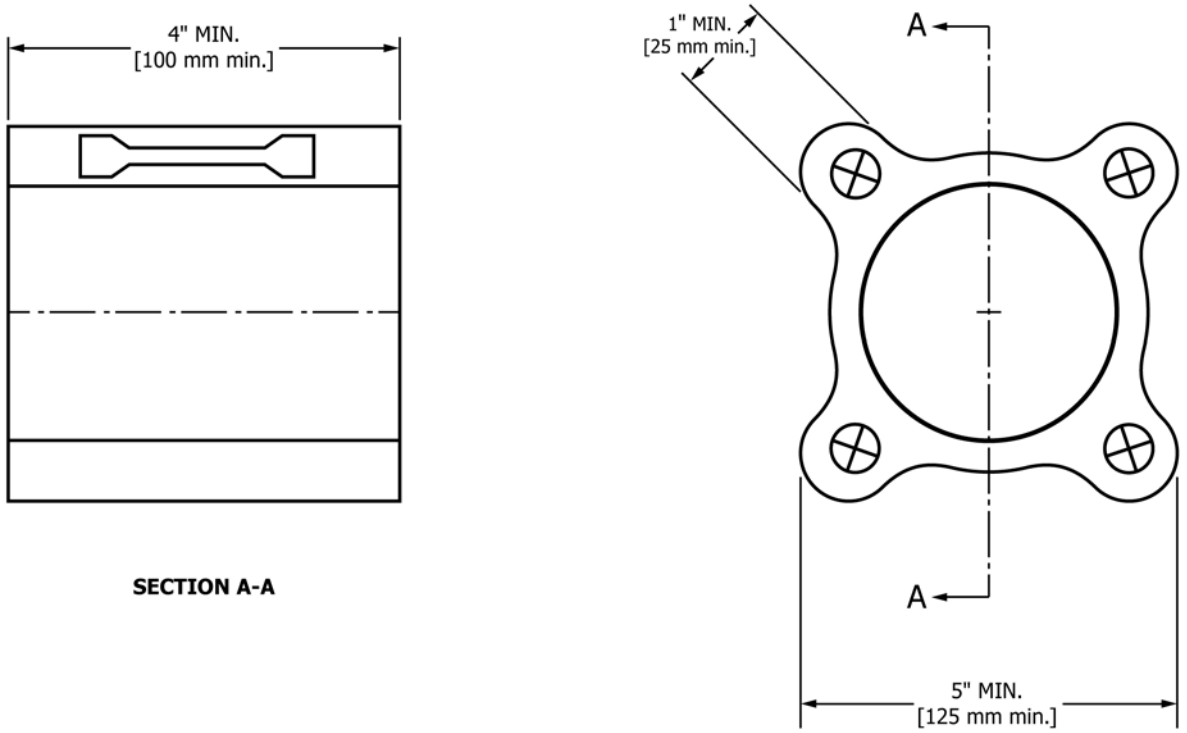

FIG. 2 Optional Configuration Cast Centrifugal Test Block with Location of Machined Test Specimen.

10.3 *Tensile Properties*—The tensile properties shall be determined in accordance with Test Methods B557 or B557M. When the size or shape of the casting restricts the use of test specimens, or when otherwise determined, the full-size casting may be tested. When a complete casting test is required, the strength requirement and the direction or method of loading of the full-size casting shall be specified on the drawing for the part concerned.

10.3.1 *Tensile Properties—Small Castings*—Castings shall be selected at random from each lot, after heat treatment and nondestructive testing operations have been completed, in accordance with an appropriate sampling plan (recommended ANSI Z1.4, Inspection Level S-2, acceptance number zero). Tension test coupons shall be cut from locations specified on the engineering drawing. If no location is shown, three specimens shall be taken from a thick, medium, and thin section of each casting selected at random. Tests of these coupons must meet the tensile property requirements specified for the zone of the casting from which they were taken. In the event of a failure of any test the lot of castings that the sample represents shall be rejected pending material review board action by the purchaser.

10.3.2 *Tensile Properties*—Larger Castings—By agreement between the purchaser and the producer, the frequency of tensile test sampling and the locations the tension test coupons are to cut from the casting shall be determined and specified on the engineering drawing.

10.4 Test specimens shall be machined from the test blocks or production castings after all hipping, heat treatment and nondestructive testing operations have been completed.

10.5 When necessary, a rectangular specimen that is proportional to that shown for 0.500 in. [12.5 mm] wide specimen in Fig. 6 of Test Method B557 [B557M] may be used.

11. Number of Tests

11.1 Unless otherwise agreed upon by the purchaser and producer, a single test specimen shall be tested to represent the following:

11.1.1 Not more than 4000 lb [2000 kg] of clean castings (gates and risers removed) or a single casting poured from one furnace.

11.1.2 The castings poured continuously from one furnace in not more than eight consecutive hours.

11.2 When tensile properties of castings are to be determined, one per melt-heat combination shall be tested unless otherwise shown on the drawing or specified in the purchase order.

12. Test Methods

12.1 The tensile properties shall be determined in accordance with Test Methods B557 [B557M].

13. Retests

13.1 If the results of the tension test do not conform to the requirements prescribed in Table 2 [Table 3], test bars representative of the castings may be retested in accordance with the replacement tests and retest provisions of Test Methods B557 [B557M] and the results of retests shall conform to the requirements as to mechanical properties specified in Table 2 [Table 3].

14. Workmanship, Finish, and Appearance

14.1 The finished castings shall be uniform in composition and free of blowholes, cracks, shrinks, and other discontinuities in accordance with standards designated and agreed upon as acceptable by the purchaser.

15. Heat Treatment

15.1 Heat treatment of castings shall be performed in accordance with Practice B917/B917M.

16. Repair of Castings

16.1 Castings may be repaired only by processes approved and agreed upon by the producer and purchaser, such as welding, impregnation, peening, blending, soldering, and so forth. Limitations on the extent and frequency of such repairs, and methods of inspection of repaired areas should also be agreed upon.

16.2 *Repairing of Castings Produced for Governmental and Military Agencies:*

16.2.1 *Welding:*

16.2.1.1 When welding is permitted, it shall be done by methods suitable for the particular alloy. Welding methods shall be in accordance with such specifications as are referenced on the applicable drawings, or as are required by the contract or order.

16.2.1.2 The welder's level of qualification and the welding method shall be approved by the purchaser.

16.2.1.3 When castings are to be supplied in the heat treated condition, they shall be heat treated to the required temper after welding, except that small arc welds may be performed without subsequent heat treatment upon approval of the purchaser.

16.2.1.4 Unless otherwise specified, castings that have been repaired by welding shall have the welded areas examined radiographically after all reworking and heat treatment have been completed.

16.2.1.5 All welds shall be free from cracks, lack of fusion, and meet the same quality requirements as the parent material.

16.2.1.6 Welded castings shall be marked with a symbol of three concentric circles with a letter or number designating the welder adjacent to the symbol. The outer circle of the symbol shall be no larger than ¼ in. [6 mm] in outside diameter. All welded areas shall be encircled with a ring or white paint prior to submission for final inspection.

16.2.1.7 Repair welding of castings used in naval shipboard pressure vessels, piping systems, and machinery shall be performed in accordance with requirements for repair of castings specified in NAVSEA S9074-AR-GIB-010/278.

16.3 *Impregnation*—When impregnation is permitted, it shall be to correct general seepage leaks only and shall not be used to correct poor foundry technique or porosity in excess of accepted standards. It shall be accomplished in accordance with MIL-STD-276. Unless otherwise authorized by the purchaser, castings which have been impregnated shall be marked "IMP".

16.4 *Peening*—When peening is permitted, it shall be to correct localized minor seepage leaks and small surface imperfections only, or to disclose subsurface voids for the purpose of inspection. Peening will not be permitted to repair cracks, cold shuts, shrinks, misruns, defects due to careless handling, or other similar major defects. Peening may be accomplished either hot or cold and shall be performed by methods, which are acceptable to the purchaser. Peened castings shall be marked with a Maltese cross approximately ¼ in. [6 mm] high.

16.5 *Blending*—Blending with suitable grinders or other tools will be permitted for the removal of surface imperfections only, and shall not result in dimensions outside the tolerances shown on the applicable drawings.

17. Source Inspection

17.1 If the purchaser elects to make an inspection of the castings at the producer's works, it shall be so stated in the contract or order.

17.2 If the purchaser elects to have an inspection made at the producer's works, the producer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections shall be so conducted as not to interfere unnecessarily with the operation of the works.

18. Foundry Inspection

18.1 Requirements such as surface finish, parting line projections, snagging projections where gating has been removed, and so forth, may be checked visually. It is advisable to have agreed upon observational standards representing both acceptable and unacceptable material.

18.2 *Liquid Penetrant Inspection:*

18.2.1 When specified, liquid penetrant inspection shall be in accordance with Test Method E165, and the required sensitivity shall be specified.

18.2.2 Acceptance standards for discontinuities shall be agreed upon, including size and frequency per unit area and location.

18.3 *Radiographic Inspection:*

18.3.1 Radiographic inspection shall be in accordance with Guide E94 and Film Reference Radiographs E155.

18.3.2 When agreed upon between the manufacturer and purchaser digital radiographic inspection shall be in accordance with Guide E94 and Digital Reference Radiographs E2422.

18.3.3 Radiographic acceptance shall be in accordance with the requirements selected from Table 4. Any modifications of the table and the frequency per unit area and location of discontinuities should also be agreed upon.

18.3.4 Upon agreement with purchaser, radioscopic inspection may be used in accordance with an agreed upon specification.

18.3.5 The number, film size and orientation of radiographs, and the number of castings radiographically inspected shall be agreed upon by the producer and purchaser.

19. Identification and Repair Marking for Castings Produced for Government and Military Agencies

19.1 *Identification*—Unless otherwise specified, each casting shall be marked with the applicable drawing or part

number. The marking shall consist of stamped Arabic numbers (1, 2, 3... 9), and when applicable, upper-case letters. The location of the identification marking shall be as specified on the applicable drawing. When the location is not specified on the drawing, the drawing or part number, or both, shall be placed in a location mutually agreeable to the purchaser and producer.

19.2 *Lot Identification*—When practical or specified by agreement, each casting shall also be marked with the melt or inspection lot number.

19.3 *Lot*—A lot shall consist of all of the cleaned castings poured from the same heat or melt when subsequent heat treatment is not required.

19.3.1 When the castings consist of alloys that require heat treatment, the lot shall consist of all castings from the same melt or heat that have been heat treated in the same furnace charge, or if heat treated in a continuous furnace, all castings from the same melt or heat that are discharged from the furnace during a 4-h period.

19.4 *Repair Marking*—All identification markings indicating repairs, as specified in 16.2.1.6, 16.3 and 16.4, shall be made with a waterproof marking fluid.

20. Rejection and Rehearing

20.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer promptly and in writing detailing the reason for the rejection, number of parts rejected, lot numbers, and parts numbers. In case of dissatisfaction with the results of the test, the producer may make claim for a rehearing.

21. Certification

21.1 The producer shall, upon request, furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification, and has met the requirements.

22. Packaging, Marking, and Shipping

22.1 The material shall be packaged in such a manner as to prevent damage in ordinary handling and transportation. The type of packaging and gross weight of individual containers shall be left to the discretion of the producer unless otherwise agreed upon. Packaging methods and containers shall be so selected as to permit maximum utility of mechanical equipment in unloading and subsequent handling. Each package or container shall contain only one part number, alloy, and temper of material when packaged for shipment unless otherwise agreed upon.

22.2 Each package or container shall be marked with the purchase order number, part number, quantity, specification number, alloy and temper, gross and net weights, and the name of the producer.

22.3 Packages or containers shall be such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

22.4 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirement of Practices B660. The applicable levels shall be as specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 or Practice D3951 for civil agencies and MIL-STD-129 for military agencies.

23. Keywords

23.1 aluminum; centrifugal castings

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For informational purposes, refer to “Statistical Aspects of Mechanical Property Assurance” in the Related Material section of the *Annual Book of ASTM Standards*, Vol 02.02.

A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2.1 Prior to acceptance for inclusion in this specification, the composition of wrought or cast aluminum or aluminum alloy shall be registered in accordance with ANSI H35.1/H35.1 (M). The Aluminum Association[4] holds the Secretariat of ANSI H35 Committee and administers the criteria and procedures for registration.

A2.2 If it is documented that the Aluminum Association could not or would not register a given composition, an alternative procedure and the criteria for acceptance shall be as follows:

A2.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1/H35.1 (M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.3 The complete chemical composition limits are submitted.

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in this specification.

A2.2.5 For codification purposes, an alloying element is any element intentionally added for any purpose other than grain refinement and for which minimum and maximum limits are specified. Unalloyed aluminum contains a minimum of 99.00 % aluminum.

A2.2.6 Standard limits for alloying elements and impurities are expressed to the following decimal places:

Less than 0.001 %	0.000X
0.001 to but less than 0.01 %	0.00X
0.01 to but less than 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
(It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5)	
Over 0.55 %	0.X, X.X, and so forth
(Except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0.XX or 1.XX)	

A2.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc, Titanium (Note A2.1); Other Elements, Each; Other Elements, Total; Aluminum (Note A2.2).

NOTE A2.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between Titanium and Other Elements, Each, or are specified in footnotes.

NOTE A2.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

APPENDIXES

(Nonmandatory Information)

X1. PROPERTIES AND CHARACTERISTICS

X1.1 Data in Table X1.1 are approximate and are supplied for general information only.

TABLE X1.1 Properties and Characteristics (Inch-Pound Units) (SI Units) [Metric]

NOTE 1—1 indicates best of the group; 5 indicates poorest of the group.

Alloy			Foundry Characteristics					Other Characteristics								
ANSI[A]	UNS	Approximate Melting Range °F[B] [°C]	Resistance to Hot Cracking[C]	Pressure Tightness	Fluidity[D]	Solidification Shrinkage Tendency[E]	Normally Heat-Treated	Resistance to Corrosion[F]	Machining[G]	Polishing[H]	Electroplating[I]	Anodizing (Appearance)[J]	Chemical Oxide Coating (Protection)[K]	Strength at Elevated Temp[L]	Suitability for Welding[M]	Suitable for Brazing[N]
356.0	A03560	1035 to 1135 [557–613]	1	1	2	1	yes	2	3	3	1	4	2	3	2	no
505.0	...	1080 to 1206 [582–652]	1	1	3	3	yes	2	2	2	2	2	2	3	2	no
709.0	...	890 to 1175 [477–635]	4	3	4	4	yes	4	1	1	2	2	2	4	5	no
850.0	A08500	435 to 1200 [224–649]	5	5	5	5	aged only	3	1	1	5	4	5	[O]	5	no

[A] ASTM alloy designations are defined in ANSI H35.1/H35.1 (M).
[B] Temperatures of solidus and liquidus are indicated, pouring temperatures will be higher.
[C] Ability of alloy to withstand stresses from contraction while cooling through hot-short or brittle temperature range.
[D] Ability of liquid alloy to flow readily in mold and fill thin sections.
[E] Decrease in volume accompanying freezing of alloy and measure of amount of compensating feed metal required in form of risers.
[F] Based on resistance of alloy in standard type salt-spray test.
[G] Composite rating based on ease of cutting, chip characteristics, quality of finish, and tool life. Ratings, in the case of heat-treatable alloys, based on T6 temper. Other tempers, particularly the annealed temper, may have lower rating.
[H] Composite rating based on ease and speed of polishing and quality of finish provided by typical polishing procedure.
[I] Ability of casting to take and hold an electroplate applied by present standard methods.
[J] Rates of lightness of color, brightness, and uniformity of clear anodized coating applied in sulfuric acid electrolyte.
[K] Rated on combined resistance of coating and base alloy to corrosion.
[L] Rating based on tensile and yield strengths at temperatures up to 500°F, after prolonged heating at testing temperature.
[M] Based on ability of material to be fusion-welded with filler rod or same alloy.
[N] Refers to suitability of alloy to withstanding brazing temperatures without excessive distortion or melting.
[O] Not recommended for service at elevated temperatures.

X2. METRIC EQUIVALENTS

X2.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of one metre per second squared ($N = kg \cdot m/s^2$). The derived SI unit for pressure or stress is the newton per square metre (N/m^2), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B955/B955M – 11) that may impact the use of this standard. (Approved Oct. 1, 2014.)

(1) Reference to Practice B985 was added to Subsections 2.2 and 7.2.
(2) Section 7.3 was deleted.
(3) Section 7.4 and Subsection 7.4.1 were moved into Section 7.1.