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 SUPERSEDING
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FEDERAL SPECIFICATION

ALUMINUM ALLOY PERMANENT AND SEMIPERMANENT MOLD CASTINGS

This specification was approved by the Commissioner, Federal Supply Service, General Administration for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers aluminum alloy permanent and semipermanent mold casting.

1.2 Classification.

1.2.1 Alloys and tempers. Aluminum alloy permanent and semipermanent mold castings shall be furnished in the alloys and tempers shown in Table I, as specified (see 6.2).

TABLE I. Alloys and tempers

Alloy	Description	Design ation	Temper
			Description
213.0	7 percent copper-silicon-zinc	F	As cast.
222.0	10 percent copper-magnesium	T551 ¹ / T65	Artificially aged. Solution heat treated & artificially aged.
242.0	4 percent copper-magnesium-nickel	T571 ¹ / T61	Artificially aged. Solution heat treated & artificially aged.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: DRXMR-LS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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TABLE I. Alloys and tempers (cont'd)

Alloy	Description	Temper	
		Design ation	Description
296.0	4-1/2 percent copper-silicon	T4	Solution heat treated.
		T6	Solution heat treated & artificially aged.
		T7 ₁ /	Solution heat treated & stabilized.
308.0	5-1/2 percent silicon-copper	F	As cast.
319.0	6 percent silicon-copper-iron-zinc	F	As cast.
		T6	Solution heat treated & artificially aged.
336.0	12 percent silicon-nickel-magnesium-copper	T55 ₁ /	Artificially aged.
		T65	Solution heat treated & artificially aged.
332.0	9-1/2 percent silicon-magnesium-copper	T5 ₁ /	Artificially aged.
		T65	Solution heat treated & artificially aged.
333.0	9 percent silicon-copper	F	As cast.
		T5	Artificially aged.
		T6	Solution heat treated & artificially aged.
		T7	Solution heat treated & stabilized.
355.0	5 percent silicon-copper-magnesium	T6	Solution heat treated & artificially aged.
		T5 ₁ /	Artificially aged.
		T62	Solution heat treated & artificially aged.
		T7 ₁ /	Solution heat treated & stabilized.
C355.0	5 percent silicon-copper-magnesium	T61	Solution heat treated & artificially aged.

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TABLE I. Alloys and tempers (cont'd)

Alloy	Description	Design ation	Temper
			Description
356.0	7 percent silicon-magnesium	T51	Artificially aged.
		T6	Solution heat treated & artificially aged.
		T7	Solution heat treated & stabilized.
A356.0	7 percent silicon-magnesium	T61	Solution heat treated & artificially aged.
357.0	7 percent silicon-magnesium	T6	Solution heat treated & artificially aged.
B443.0	5 percent silicon	F	As cast.
513.0	3.8 percent magnesium-zinc	F	As cast.
705.0	3 percent zinc-magnesium	T5 ₁ /	Aged not less than 21 days after casting or artificially aged.
707.0	4 percent zinc-magnesium	T5 ₁ /	Aged not less than 21 days after casting or artificially aged.
		T7 ₁ /	Solution heat treated & stabilized.
713.0	7-1/2 percent zinc-magnesium	T5	Aged not less than 21 days after casting or artificially aged.
850.0	6-1/2 percent tin-copper-nickel	T5	Artificially aged.
851.0	6-1/2 percent tin-silicon-copper -nickel	T5	Artificially aged.
852.0	6-1/2 percent tin-copper-nickel magnesium	T5	Artificially aged.

1/The material in this condition is required to have heat treatment which shall insure stability and a minimum of dimensional changes under service or storage conditions.

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2. APPLICABLE DOCUMENTS

2.1 The following documents of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Standards:

- Fed. Std. No. 123 Marking for Domestic Shipment (Civilian Agencies).
- Fed. Test Method Std. No. 151/GEN - Metals; Test Methods.
- Fed. Test Method Std. No. 151/111 - Chemical Analysis
- Fed. Test Method Std. No. 151/112 - Spectrochemical Analysis

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge from General Services Administration Business Office Centers in Boston, New York, Philadelphia, PA., Washington, DC, Atlanta, Chicago, Kansas City, MO., Ft. Worth, Houston, Denver, San Francisco, Los Angeles, and Seattle, Wash.

(Federal Government activities may obtain of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Specifications:

- MIL-C-6021 Castings: Classification and Inspections of (For Aeronautical Applications).
- MIL-H-6088 Heat Treatment of Aluminum Alloys.
- MIL-I-13857 Impregnation of Metal Castings.

Military Standards:

- MIL-STD-105 Sampling Procedures and Tables for Inspection by attributes
- MIL-STD-129 Marking for Shipment and Storage.
- MIL-STD-271 Nondestructive Testing Requirements for Metals.
- MIL-STD-276 Impregnation of Porous Nonferrous Castings.
- MIL-STD-453 Inspection, Radiographic.
- MIL-STD-649 Aluminum and Magnesium Products; Preparation for Shipment and Storage.

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(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the purchaser or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

The Aluminum Association Standards:

Standards for Aluminum Sand and Permanent Mold Castings

(Application for copies should be addressed to The Aluminum Association, 818 Connecticut Avenue, N.W., Washington, D.C. 20006.)

American Society for Testing and Materials (ASTM) Standards:

B 108 - Aluminum-Alloy Permanent Mold Castings

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

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

National Motor Freight Traffic Association, Inc., Agent: National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Associations, Inc., Traffic Department, 1616 P Street, N.W., Washington, D.C. 20036.)

Uniform Classification Committee, Agent: Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

(Technical society and technical association specifications and standards are generally available for reference for libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Chemical composition.

3.1.1 The chemical composition of the material shall be within the limits shown in Table II.

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TABLE II. Chemical composition, percent maximum, except where indicated as a range

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium
213.0	1.0-3.0	1.2	6.0 - 8.0	0.6	0.10	---
222.0	2.0	1.5	9.2 -10.7	.50	0.15-0.35	---
242.0	0.7	1.0	3.5 - 4.5	.35	1.2 -1.8	0.25
296.0	2.0-3.0	1.2	4.0 - 5.0	.35	0.05	---
308.0	5.0-6.0	1.0	4.0 - 5.0	.50	.10	---
319.0	5.5-6.5	1.0	3.0 - 4.0	.50	.10	---
332.0	8.5-10.5	1.2	2.0 - 4.0	.50	.50-1.5	---
333.0	8.0-10.0	1.0	3.0 - 4.0	.50	.05-0.50	---
336.0	11.0-13.0	1.2	0.50 - 1.5	.35	.7 -1.3	---
355.0	4.5-5.5	0.62/	1.0 - 1.5	.50 ^{2/}	.40- .6	0.25
C355.0	4.5- 5.5	.20	1.0 - 1.5	.10	.40- .6	---
356.0	6.5- 7.5	.6	0.25	.35	.20- .45	---
A356.0	6.5- 7.5	.20	.20	.10	.25-.45	---
357.0	6.5- 7.5	.15	.05	.03	.45- .6	---
B443.0	4.5- 6.0	.8	.15	.35	.05	---
513.0	.30	.40	.10	.30	3.5 -4.5	---
705.0	.20	.8	.20	.40-0.6	1.4 -1.8	0.20-0.40
707.0	.20	.8	.20	.40- .6	1.8 -2.4	.20- .40
713.0	.25	1.1	.40- 1.0	.6	.20- .50	.35
850.0	.7	0.7	.7 - 1.3	.10	.10	---
851.0	2.0 -3.0	.7	.7 - 1.3	.10	.10	---
852.0	0.40	.7	1.7- 2.3	.10	.6 -0.9	---

Alloy	Nickel	Zinc	Tin	Titanium	Other Elements		Aluminum
					Each	Total	
213.0	0.35	2.5	---	0.25	---	0.50	Remainder
222.0	.50	0.8	---	.25	---	.35	Remainder
242.0	1.7 -2.3	.35	---	.25	0.05	.15	Remainder
296.0	0.35	.50	---	.25	---	.35	Remainder
308.0	---	1.0	---	.25	---	.50	Remainder
319.0	0.35	1.0	---	.25	---	.50	Remainder
332.0	.50	1.0	---	.25	---	.50	Remainder
333.0	.50	1.0	---	.25	---	.50	Remainder
336.0	2.0-3.0	0.35	---	.25	0.05	---	Remainder
355.0	---	.35	---	.25	.05	0.15	Remainder
C355.0	---	.10	---	.20	.05	.15	Remainder
356.0	---	.35	---	.25	.05	.15	Remainder
A356.0	---	.10	---	.20	.05	.15	Remainder
357	---	.05	---	.20	.05	.15	Remainder
B443.0	---	.35	---	.25	.05	.15	Remainder

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TABLE II. Chemical composition, percent maximum, except where indicated as a range^{1/}

Alloy	Nickel	Zinc	Tin	Titanium	Other Elements		Aluminum
					Each	Total	
513.0	--	1.4-2.2	--	.20	.05	.15	Remainder
705.0	--	2.7-3.3	--	.25	.05	.15	Remainder
707.0	--	4.0-4.5	--	.25	.05	.15	Remainder
713.0	0.15	7.0-8.0	--	.25	.10	.25	Remainder
850.0	0.7 -1.3	--	5.5-7.0	.20	--	.30	Remainder
851.0	.30-0.7	--	5.5-7.0	.20	--	.30	Remainder
852.0	.9 -1.5	--	5.5-7.0	.20	--	.30	Remainder

^{1/}Analysis shall regularly be made only for the elements specifically mentioned in the above table. If however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine that these other elements are not present in excess of the limits specified herein.

^{2/}When the iron exceeds 0.45 percent, the manganese content shall not be less than one-half the iron content.

3.1.2 The supplier shall furnish an analysis of each lot showing the percentage of each of the elements specified in Table II. Chemical analysis by the supplier of the individual melts may be waived at the discretion of the Government inspector, provided that the foundry's method of composition control is acceptable to him or that the material in the lot can be identified as being from melts previously analyzed and found to be in conformance with the chemical composition requirements of the alloy specified herein.

3.2 Mechanical properties.

3.2.1 Unless otherwise specified herein (see 3.2.2), the mechanical properties as determined from separately cast test bars shall conform to the requirements shown in Table III.

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TABLE III - Mechanical properties

Alloy	Temper designation	Tensile strength ksi (MPa), minimum	Elongation in 2 inches (51 mm) or 4 x diameter percent, minimum
213.0	As cast (F)	23 (159)	----
222.0	Artificially only (T551)	30 (207)	----
242.0	Artificially aged only (T571)	34 (234)	----
296.0	Solution heat treated (T4)	33 (228)	4.5
308.0	As cast (F)	24 (165)	----
319.0	As cast (F)	28 (193)	1.5
332.0	Artificially aged only (T5)	31 (214)	----
333.0	As cast (F)	28 (193)	----
	Aged (T5)	30 (207)	----
	Solution heat treated and artificially aged (T6)	35 (241)	----
	Solution heat treated and stabilized (T7)	31 (214)	----
336.0	Artificially aged only (T551)	31 (214)	----
355.0	Solution heat treated and artificially aged (T6)	37 (225)	1.5
C355.0	Solution heat treated and artificially aged (T61)	40 (276)	3.0
356.0	Solution heat treated and artificially aged (T6)	33 (228)	3.0
A356.0	Solution heat treated and artificially aged (T61)	37 (225)	5.0
357.0	Solution heat treated and artificially aged (T6)	45 (310)	3.0
B443.0	As cast (F)	21 (145)	5.0
513.0	As cast (F)	22 (152)	2.5
705.0	Aged (T5) ^{1/}	37 (255)	10.0
707.0	Aged (T5) ^{1/}	42 (290)	4.0
713.0	Aged (T5) ^{2/}	32 (221)	4.0
850.0	Aged (T5)	18 (124)	8.0
851.0	Aged (T5)	17 (117)	3.0
852.0	Aged (T5)	27 (186)	3.0

^{1/}These properties are obtainable after 21 days of room temperature aging or artificially aging at 210°F (99°C) for approximately 8 hours.

^{2/}These properties are obtainable after 21 days of room temperature aging or after artificially aging at 250°F (121°C) for 10 to 16 hours.

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3.2.2 Unless otherwise specified (see 6.2), alloys 222.0, 242.0, 296.0, 319.0, 336.0, 355.0, 356.0, and 707.0 shall conform to the alternate mechanical properties shown in Table IV. Such mechanical properties shall be determined by separately cast test bars.

TABLE IV - Alternate mechanical properties

Alloy	Temper Designation	Tensile strength, ksi (MPa), minimum	Elongation in 2 inches (51 mm) or 4 x diameter, percent, minimum
222.0	Solution heat treated and artificially aged (T65)	40 (276)	-----
242.0	Solution heat treated and artificially aged (T61)	40 (276)	-----
296.0	Solution heat treated and artificially aged (T6)	35 (241)	2.0
	Solution heat treated and stabilized (T7)	33 (228)	3.0
319.0	Solution heat treated and artificially aged (T6)	34 (234)	2.0
336.0	Solution heat treated and artificially aged (T65)	40 (276)	-----
355.0	Artificially aged only (T51)	27 (136)	-----
	Solution heat treated and artificially aged (T62)	42 (290)	-----
	Solution heat treated and stabilized (T71)	34 (234)	-----
356.0	Solution heat treated and stabilized (T7)	29 (200)	4.0
	Artificially aged only (T51)	25 (172)	-----
707.0	Solution heat treated and stabilized (T7)	45 (310)	3.0

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3.2.3 Specimens cut from castings. Under any of the following conditions, conformance to mechanical property requirements shall be determined by tests on specimens cut from castings:

- (a) When specified on the applicable drawing.
- (b) When authorized by the purchaser.
- (c) When required by the inspector in the event of inferior quality in castings of a particular lot for which representative separately cast test bars have met the mechanical properties of this specification.

3.3.3.1 Unless otherwise specified (see 6.2), the average ultimate tensile strength and average elongation of test specimens cut from castings in accordance with section 4 shall be not less than 75 percent (to the nearest ksi (5 MPa)) and 25 percent (to the nearest 0.5 percent), respectively, of the values specified herein for separately cast test bars.

3.3.4 Tensile properties of designated areas of castings. When specified on the applicable drawings or in the contract or order, the mechanical properties of test specimens cut from the areas of the castings designated on the drawing or in the contract or order shall meet the values specified on the drawing or in the contract or order (see 6.2).

3.3.5 Simulated service tests. When the castings have critical functioning requirements, special tests to simulate the stress conditions incurred in service may be required. The requirements and methods of making the test shall be as specified by the purchaser (see 6.2).

3.4 Soundness. When specified (see 6.2), castings shall be subjected to radiographic examination to determine soundness (see 4.4.3). Acceptable standards of soundness shall be established by the purchaser or, if no such standards are available, they may be established by radiographing sample castings until radiographs acceptable to the purchaser are obtained. The areas of the castings subject to soundness requirements shall be as specified (see 6.2), and the number and extent of blowholes, sponginess, and the other defects in such areas shall not be greater than indicated by the standard.

3.5 Foundry control. When specified (see 6.2), castings shall be produced under foundry control approved by the purchaser. Foundry control shall consist of examination of castings by radiographic or other approved methods for determining internal defects 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 supplier. When foundry practices have been so established, the production method shall not be changed without demonstrating to the satisfaction of the purchaser that the change does not adversely affect the quality of the castings.

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3.6 Heat treatment.

3.6.1 When heat treatment is required, it shall be performed in such a manner as to produce material with the utmost uniformity which will conform to the properties specified herein. Heat treatment shall be performed on the whole casting and never on a portion only.

3.6.2 Unless otherwise specified (see 6.2), castings shall be heat treated in accordance with the manufacturer's recommendations and in accordance with the best commercial practices. When specified (see 6.2), castings which require heat treatment shall be heat treated in accordance with MIL-H-6088. Castings purchased for use on Naval Air Systems Command, and Naval Ordnance Systems Command contracts shall be heat treated in accordance with MIL-H-6088.

3.7 Dimensions. The dimensions of the castings shall be as specified (see 6.2). Casting shall be furnished in condition ready for machining and shall not require further straightening. Unless otherwise specified (see 6.2), tolerances and draft finish allowances shall be in accordance with permanent mold casting provisions of the Aluminum Association Standards for Aluminum Sand and Permanent Mold Castings.

3.8 Repairing of castings.

3.8.1 Castings shall not be repaired by welding, impregnation, peening, blending, or other methods without permission of the purchaser. Such permission shall be given only when the repaired defect will not adversely affect the strength or machinability or otherwise impair the suitability of the castings for the purpose intended. Soldering shall not be performed under any conditions. Repaired castings shall be reinspected in accordance with the applicable portions of the pertinent specifications, drawings, and directives.

3.8.2 Welding.

3.8.2.1 When welding is permitted, it shall be accomplished by methods suitable for the particular alloy. Welding methods shall be in accordance with such specifications as referenced on the applicable drawings, or as are required by the contract or order. Periodic checks of welded castings shall be made to insure that a satisfactory procedure for welding is being adhered to by the contractor.

3.8.2.1.1 All welding shall be accomplished by welders, qualified in accordance with procedures agreed to by the purchaser and the supplier (see 6.2).

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3.8.2.2 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 performed without subsequent heat treatment upon approval of the purchaser.

3.8.2.3 Unless otherwise specified (see 6.2), castings which have been repaired by welding shall be radiographically examined after all reworking and heat treatment have been completed.

3.8.2.4 All welds shall be of high quality and shall be free from cracks, excess gas, oxide, porosity, and lack of fusion.

3.8.2.5 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 not larger than 1/4 inch (6 mm) in outside diameter. All welded areas shall be encircled with a ring of white paint prior to submission for final inspection.

3.8.3 Impregnation. When impregnation is permitted, it shall be to correct minor seepage leaks only, and shall not be used to correct poor foundry technique or significant porosity. It shall be accomplished in accordance with MIL-STD-276 or, when specified (see 6.2), MIL-I-13857. Unless otherwise authorized by the purchaser, castings which have been impregnated shall be marked "IMP".

3.8.4 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 1/4 inch (6 mm) high.

3.8.5 Blending. Blending with suitable grinders or other tools will be permitted for the removal of surface imperfection only and shall not result in dimensions below minimum drawing tolerances shown on the applicable drawing.

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3.9 Identification and repair marking.

3.9.1 Identification. Unless otherwise specified (see 6.2), each casting shall be marked with the applicable drawing or part number. The marking shall consist of raised arabic numerals and when applicable, upper case letters, cast integral. The location of the identification marking shall be as specified on the applicable drawing. When the location is not specified, the producer shall select the location such that the identification marking will not be machined off when the casting is being finished to the required dimensions (see 3.7).

3.9.1.1 Lot identification. When practicable, each casting shall also be marked with the melt or inspection lot number (see 4.2).

3.9.2 Repair markings. Unless otherwise specified (see 6.2) all identification markings indicating repairs as specified in 3.8.2.5, 3.8.3, and 3.8.4 shall be made with a waterproof marking fluids.

3.10 Workmanship. The castings shall be of uniform quality and condition and shall not contain cracks, blowholes, porosity, hard spots, voids or other defects which, due to their nature, degree, or extent, make the castings unsuitable for their intended use. The castings surface shall be smooth and they shall be cleaned by a process acceptable to the purchaser.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Certification of Quality Compliance. Unless otherwise specified (see 6.2) a certificate of quality compliance shall be prepared for each lot of material offered for acceptance (see 6.2.1). The certificate shall include actual data of specified chemical and mechanical tests. Qualitative results of nondestructive tests and other inspections or test shall be recorded on the certificate. The certificate shall also state that each lot has been sampled, tested, and inspected in accordance with the specification and meets all specification requirements. The certificate shall be signed by a responsible representative of the contractor.

4.2 Lot.

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4.2.1 For the purpose of sampling, a lot shall consist of not more than 2,000 pounds (907 kg) of cleaned castings when subsequent heat treatment is not required.

4.2.2 When the castings consist of alloys which require heat treatment, the lot shall consist of not more than 2,000 pounds (907 kg) of cleaned castings which have been heat treated in the same furnace charge, except as specified in 4.2.3.

4.2.3 If castings are heated in a continuous furnace, castings charged consecutively during continuous operation of the furnace shall be considered a furnace charge. For castings weighing 5 pounds (2.3 kg) or less, the maximum weight of a lot shall be 2,000 pounds (907 kg) and for larger castings, it shall be 6,000 pounds (2700 kg).

4.3 Sampling.

4.3.1 For chemical analysis. A sample for chemical analysis shall be taken from each lot. The sample may be taken from test coupons or from representative castings.

4.3.1.1 Wet chemical analysis. A sample for chemical analysis shall consist of not less than 2 ounces (57 grams). Samples shall be obtained either by pouring a suitable sample from the same heat or melt, in an iron mold at the same time of pouring the castings, or directly from the castings under inspection, or from broken mechanical test specimens and shall be representative of the material. The drillings or millings shall be taken from sound metal below the surface and shall be fine, clean, and free from oil, dirt, grit, or foreign matter. Procedures specified in Method 111 of Fed. Test Method Std. No. 151 shall also apply.

4.3.1.2 Spectrochemical analysis. Samples shall be obtained as specified in Method 112 of Fed. Test Method Std. No. 151.

4.3.1.3 Other methods of analysis. Samples for other methods of analysis shall be as agreed upon by the supplier and purchaser.

4.3.2 For tension tests.

4.3.2.1 Test bars. At least two test bars shall be poured to represent each lot of castings (see 4.2). Test bars shall be cast to the form and dimensions shown of figure XI of ASTM B108. Each test bar shall be machined to standard dimensions for test specimens conforming to the standard round specimen of ASTM E8 or they may be tested without machining. Test bars which are to be tested without machining shall be cast 0.505 inch (12.8 mm) in diameter. No test bars will be required if conformance with mechanical property requirements (see 3.2), is demonstrated by test of specimens from castings in accordance with 3.2.3 and 4.3.2.1.1. Tension tests shall be performed in accordance with ASTM B557.

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4.3.2.1.1 When test specimens cut from castings are required in accordance with 3.2.3, one or more castings in the temper to be furnished shall be selected from each lot or not less than two tension test specimens shall be machined therefrom, of which one shall be from the thinnest section and one from the heaviest section.

4.3.2.1.2 When test specimens cut from designated areas of castings are required in accordance with 3.2.3, one or more castings in the temper to be furnished shall be selected from each lot and not less than two tension test specimens shall be machined therefrom for each designated area and tested.

4.3.2.1.3 Specimens cut for castings shall be in the form of flat or round tension test specimens conforming to standard flat or round specimens of ASTM B557. Where a standard specimen is not feasible, the largest subsize specimen practical shall be used.

4.3.2.2 Heat treatment of test bars.

4.3.2.2.1 The test bars from each lot shall be heat treated to the same temper with production castings of the same lot. When test coupons are used, one of the bars representative of the particular lot shall be tested and the acceptability of the heat treatment shall be determined by the result of this test.

4.3.2.2.2 Each heat-treating furnace charge shall be represented by at least one set of test bars of the same composition range. The heat treatment of a furnace charge shall be determined by these test bars.

4.3.2.3 In the event the metal for castings is given any treatment such as fluxing, or cooling and re-heating, the metal for the test bars shall form a portion of the metal so treated.

4.3.3 For impregnation tests. When impregnation is permitted, sampling for impregnation tests shall be as specified by the purchaser.

4.3.4 For examination. For the purpose of examination (see 4.4), lots of castings of the same size and shape, and of the same alloy and temper may be combined up to a maximum of 10,000 pounds (4500 kg). Unless otherwise specified by the purchaser, from this accumulated lot, a sample may be selected at random in accordance with the tables of MIL-STD-105 at inspection level II, with lot acceptance and rejection based on acceptable quality level (AQL) equal to 1.5 percent defective. When the accumulation of lots is not practicable, the sample shall be selected from the lot sizes specified in 4.2. The purchaser shall provide a classification of defects for use in establishing the AQL. The samples selected for dimensional examination may be the same as those selected for visual examination, but the determination of acceptance or rejection shall not be based on the cumulative sample for both characteristics.

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4.3.4.1 Soundness. When soundness is required in accordance with 3.4, a random sample of castings shall be selected from each lot in accordance with MIL-STD-105 at inspection level II with lot acceptance and rejection based on AQL of 0.65 percent defective.

4.3.4.2 Foundry control. When specified in accordance with 3.5, radiographic or other methods of examination to establish gating, pouring, and other foundry practices shall be determined by the procuring agency.

4.4 Visual and dimensional examination. Each sample selected in accordance with 4.3.4 shall be subjected to surface examination for workmanship and dimensional requirements.

4.4.1 When aircraft structural castings are specified, the castings shall be examined in accordance with MIL-C-6021.

4.4.2 Special examination. When the purchaser advises that the presence of certain defects in any casting involves hazards to the safety of personnel (see 6.2), examination shall be conducted in accordance with MIL-STD-105, AQL of 0.15 percent defective.

4.4.3 Soundness. Castings shall be radiographed as specified by the purchaser (see 4.4.3.1. and 4.4.3.2). Each of the sample castings selected in accordance with 4.3.4.1 shall be radiographed and compared with the standard castings to determine conformance with 3.4.

4.4.3.1 When specified (see 6.2), soundness inspection tests shall be made by radiographic examination conducted in accordance with MIL-STD-453.

4.4.3.2 When specified (see 6.2), castings shall be radiographic in accordance with MIL-STD-271.

4.4.4 Examination of preparation for delivery. An examination shall be made to determine compliance with the requirements of Section 5. The sample unit shall be one shipping container fully prepared for delivery. Sampling shall be in accordance with MIL-STD-105. The inspection level shall be S-2 with an AQL of 4.0 expressed in terms of percent defective.

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4.5 Tests.

4.5.1 Chemical analysis. The samples selected in accordance with 4.3.1 shall be analyzed in accordance with method 111 or 112 of Fed. Test Method Std. No. 151. A single analysis of a composite sample may be made. In case of dispute, reference analysis shall be by method 111. If another method of analysis is desired, it shall be as agreed upon by the contractor and procuring agency.

4.5.2 Tension tests.

Tension test specimen or test bars obtained in accordance with 4.3.2 shall be tested in accordance with ASTM B557.

4.5.3 Impregnation. Tests for impregnation, when permitted (see 3.8.3), shall be conducted in accordance with MIL-STD-276 or, when specified, MIL-I-13857.

4.6 Rejection.

4.6.1 Examination. Any sample unit containing one or more visual or dimensional defects shall be subject to rejection. If the number of defective units in any sample exceeds the acceptance number specified in 4.3.4 for that sample size, the entire lot represented by the sample shall be rejected.

4.6.2 Tests. A lot shall be rejected for failure to meet any of the test requirements when tested in accordance with 4.5.

4.7 Retests. Retests shall be permitted in accordance with Fed. Test Method Std. No. 151.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be level A or commercial, as specified (see 6.2).

5.1.1 Level A. The aluminum alloy castings shall be packaged in accordance with the level A packaging requirements of MIL-STD-649.

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5.1.2 Commercial. The aluminum alloy castings shall be packaged in accordance with normal commercial practice. The complete package shall be designed to protect the castings against damage during multiple shipments, handling, and storage.

5.2 Packing. Packing shall be level A or commercial, as specified (see 6.2).

5.2.1 Level A. The aluminum alloy castings, packaged as specified in 5.1, shall be packed in accordance with the level A packing requirements of MIL-STD-649.

5.2.2 Commercial. The aluminum alloy castings, packaged as specified in 5.1, shall be packed in fiberboard boxes to insure delivery at destination; provide for redistribution by the initial receiving activity; and be acceptable by a common carrier under the National Motor Freight Classification and Uniform Freight Classification.

5.3 Marking.

5.3.1 Civil agencies. Marking shall be as specified in Fed. Std. No. 123.

5.3.2 Military agencies. Marking shall be as specified in MIL-STD-129.

6. NOTES

6.1 Intended use. Aluminum alloy permanent and semipermanent mold castings are intended for the uses listed in Table V.

TABLE V - Supplementary data

Alloy	Approximate specific gravity	Casting properties	Response to heat treatment	Principal use	Machinability
213.0	2.87	Good	No	General	Excellent
222.0	2.91	Good	Yes	Automotive pistons	Excellent
242.0	2.78	Fair	Yes	Aircraft and diesel engine pistons	Good
296.0	2.78	Good	Yes	General, where high strength and high ductility are required	Good
308.0	2.77	Excellent	No	General	Good
319.0	2.79	Excellent	Yes	High strength and general purpose alloy for intricate castings	Good
332.0	2.76	Fair	Yes	Automotive and diesel pistons	Fair
333.0	2.77	Good	Yes	General, high strength castings	Good
336.0	2.70	Fair	Yes	Automotive and diesel pistons	Fair
355.0 & C355.0	2.69	Good	Yes	General, where pressure tightness such as in pump bodies, liquid cooled cylinder heads, is required	Good
356.0 & A356.0	2.66	Excellent	Yes	General, where high strength and corrosion resistance are required	Good
357.0	2.66	Excellent	Yes	Same	Good
B443.0	2.64	Excellent	No	General, with maximum corrosion resistance	Fair
513.0	2.68	Fair	No	General	Excellent
705.0	2.76	Good	No	General, where high strength and ductility are required, particularly without heat treatment, in addition to excellent corrosion, resistance	Excellent
707.0	2.77	Good	Yes, but not for normal application	Same	Excellent
713.0	---	Good	No	Same	Excellent
850.0	2.88	Fair	Yes	Bearings	Excellent
851.0	2.83	Fair	Yes	Bearings	Excellent
852.0	2.88	Fair	Yes	Bearings	Excellent

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6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

- a. Title, number, and date of this specification.
- b. Alloy and temper of castings required (see 1.2.1).
- c. Whether alternate mechanical properties are required (see 3.2.2).
- d. When mechanical properties for specimens cut from castings different than as specified herein are required (see 3.3.3.1).
- e. When applicable, those designated areas from which test specimens will be taken and the minimum acceptable values of mechanical properties for these test specimens (see 3.3.4).
- f. Simulated service tests, when required (see 3.3.5).
- g. When radiographic examination is required for soundness; the location of critically stressed areas and the percentage of castings to be inspected, if other than as specified (see 3.4 and 4.3.2).
- h. Foundry control, when applicable (see 3.5).
- i. Heat treatment in accordance with MIL-H-6088, when required (see 3.6.2).
- j. The dimensions of castings required (see 3.7).
- k. Special tolerances and draft finish allowances, when required (see 3.7).
- l. Procedures for qualifications of welders (see 3.8.2.1.1).
- m. When radiographic examination of castings repaired by welding is not required (see 3.8.2.3).
- n. When impregnation in accordance with MIL-I-13857 is required (see 3.8.3).
- o. The location or locations which are not acceptable for raised or impression marking when the improper location of such marking could have a deleterious effect on the static or fatigue strength of the part is important because of subsequent machining operations. (Impression marking improperly located may cause failure.) (See 3.9.1).
- p. When other than repair marking as specified is required (see 3.9.2).
- q. If certificate of quality compliance is not required (see 4.1.1).
- r. Whether the special examination of 4.4.2 is required.
- s. When radiographic examination in accordance with MIL-STD-453 or MIL-STD-271 is required (see 4.4.3.1 and 4.4.3.2).
- t. Levels of packaging and packing required (see 5.1 and 5.2).
- u. Quantity of castings required.

6.2.1 Data requirements. When this specification is used in a procurement which incorporates a DD Form 1423 and invokes the provisions of 7-104.9 (no of the Defense Acquisition Regulations, the data requirements identified below will be developed as specified by the Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (DD Form 1423) incorporated into the contract. When the provisions of DAR-7-104.9(n) are not invoked the procurement document will specify that the data specified below is to be delivered by the contractor (use of the DID in this case is not required). Deliverable data required by this specification is cited in the following paragraphs:

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<u>PARAGRAPH</u>	<u>DATA REQUIREMENT</u>	<u>APPLICABLE DID</u>
4.1.1	Certificate of Quality Conformance	UDI-A-23264 Certification Data/Report

(Copies of data item descriptions required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

6.3 The data shown in Table V are approximate and are supplied for general information only.

6.4 The chemical and mechanical property requirements of the alloys of this specification are similar to those alloys having the same designations in ASTM B108. The commercial designations are also the same. Table VI lists the alloys in this specification and the corresponding designations in QQ-A-596D. Also included for information only are the UNS designations.

TABLE VI - Corresponding alloy designations

QQ-A-596E, ASTM B108, commercial designation	QQ-A-596D alloy number	UNS number $\frac{1}{2}$
213.0	113	A02130
222.0	122	A02220
242.0	142	A02420
296.0	B195	A02960
308.0	A108	A03080
319.0	319	A03190
332.0	F132	A03320
333.0	333	A03330
336.0	A132	A03360
355.0	355	A03550
C355.0	C355	A33550
356.0	356	A03560
A356.0	A356	A13560
357.0	357	A03570
B443.0	43	A24430
513.0	A214	A05130
705.0	Ternalloy 5 (603)	A07050
707.0	Ternalloy 7 (607)	A07070
713.0	Tenzaloy (613)	A07130
850.0	750	A08500
851.0	A750	A08510
852.0	B750	A08520

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1/Unified Numbering Systems (UNS) numbers were developed jointly by the Society of Automotive Engineers (SAE) and the American Society for testing and Materials (ASTM). For cast aluminum alloys, the second, third, and fourth digits of the UNS number correspond to the first three digits, respectively, of the commercial designation. The first digit denotes the alloy modification (zero if original alloy). To these digits, a prefix letter "A" and a suffix number "0" are added.

6.5 The values stated in U.S. customary units are to be regarded as standard. The metric equivalents are for informational purposes only.

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Army - MR
Navy - SH
Air Force - 99

Review Activities:

Army - MI, EA

User Activities:

Army - ME
Navy - OS

Preparing Activity:

Army - MR

CIVIL AGENCY COORDINATING ACTIVITIES:

GSA - FSS
Interior - BPA
Marshall - MSF

Project No. MECA-0179

Orders for this publication are to be placed with General Services Administration, acting as an agent for the Superintendent of Documents. See Section 2 of this specification to obtain extra copies and other documents referenced herein.

U.S. GOVERNMENT PRINTING OFFICE : 1981 - 341-705/1252

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