

QQ-M-40b

November 22, 1963

SUPERSEDING

Fed. Spec. QQ-M-40a

April 30, 1956

FEDERAL SPECIFICATION**MAGNESIUM ALLOY FORGINGS**

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

1. SCOPE AND CLASSIFICATION

1.1 **Scope.** This specification covers the requirements of fully worked magnesium alloy forgings.

1.2 Classification.

1.2.1 **Compositions.** Magnesium alloy forgings covered by this specification shall be of the following compositions as specified (see 6.2):

AZ31B—Magnesium—3.0 Zinc	Aluminum—1.0
AZ61A—Magnesium—6.5 Zinc	Aluminum—1.0
AZ80A—Magnesium—8.5 Zinc	Aluminum—0.5
HM21A—Magnesium—2.0 Manganese	Thorium—0.5
MIA—Magnesium—1.2 Manganese	
TA54A—Magnesium—3.5 Tin	Aluminum—5.0
ZK60A—Magnesium—5.5 Zirconium	Zinc—0.45

1.2.2 **Conditions.** Magnesium alloy forgings shall be furnished in the following conditions as specified (see 6.2):

- (F) Forged
- (T5) Forged and artificially aged
- (T6) Forged solution heat treated and artificially aged

2. APPLICABLE SPECIFICATIONS, AND STANDARDS

2.1 The following specifications and standards, of the issues in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

Federal Specifications:

PPP-B-601—Boxes, Wood, Cleated-Plywood.

PPP-B-621—Boxes, Wood, Nailed and Lock-Corner.

Federal Standards:

Fed. Std. No. 102—Preservation, Packaging, and Packing Levels.

Fed. Std. No. 123—Marking for Domestic Shipment (Civilian agencies).

Fed. Test Method Std. No. 151—Metals, Test Methods.

(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, Standards, and Handbooks 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 25, D. C.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Washington, D. C., Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, and Auburn, Wash.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Hand-

MISC

QQ-M-40b

books and the Index of Federal Specifications, Standards, and Handbooks from established distribution points in their agencies.)

Military Specifications:

MIL-C-132—Crate, Wood, Open, Maximum Capacity 2,500 Pounds.

MIL-M-3171—Magnesium Alloy, Process for Corrosion Protection of.

MIL-L-10547—Liners, Case and Sheet, Overwrap, Water-Vaporproof or Waterproof, Flexible.

Military Standards:

MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-129—Marking for Shipment and Storage.

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

3. REQUIREMENTS

3.1 Chemical composition.

3.1.1 The chemical composition of the forgings shall be as specified in table I.

3.1.2 The contractor shall furnish an analysis of each melt showing the percentage of each of the elements designated in table I.

3.1.3 Chemical analysis by the contractor of the individual melts may be waived at the discretion of the procuring agency, provided that the producer's method of composition control is acceptable to it, or that all 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.

3.2 Mechanical properties. The mechanical properties of test specimens taken from the magnesium alloy forgings shall be as specified in table II for the condition specified.

TABLE I—Chemical composition limits¹

Com- position No.	Alumi- num Percent	Man- ganese Percent	Zinc Percent	Silicon (max.) Percent	Copper (max.) Percent	Nickel (max.) Percent	Iron (max.) Percent	Thorium Percent	Tin Percent	Calcium (max.) Percent	Zir- conium (min.) Percent	Magnesium		Total Other Elements (max.) Percent	
												Percent	Remainder	Percent	Remainder
AZ31B	2.5-3.5	0.20 min.	0.6-1.4	0.10	0.05	0.005	0.005	—	—	0.04	—	—	Remainder	0.30	0.30
AZ61A	5.8-7.2	0.15 min.	0.40-1.5	0.10	0.05	0.005	0.005	—	—	—	—	—	Remainder	0.30	0.30
AZ80A	7.8-9.2	0.12 min.	0.20-0.8	0.10	0.05	0.005	0.005	1.5-2.5	—	—	—	—	Remainder	0.30	0.30
HM 21A	—	0.45-1.1	—	—	—	—	—	—	—	—	—	—	Remainder	0.30	0.30
MIA	—	1.2 min.	—	0.10	0.05	0.01	—	—	—	0.30	—	—	Remainder	0.30	0.30
TA54A	3.0-4.0	0.20 min.	0.30 max.	0.30	0.05	0.01	—	—	4.0-6.0	—	—	—	Remainder	0.30	0.30
ZK60A	—	—	4.8-6.2	—	—	—	—	—	—	—	0.45	—	Remainder	0.30	0.30

¹ Analysis shall be made 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.

TABLE II—*Mechanical properties*

Composition No.	Condition	Tensile strength, minimum	Yield strength at 0.2 percent offset or at extension indicated		Elongation in 2 inches, or in 4D minimum ¹
			Minimum	Extension under load	
		<i>P.s.i.</i>	<i>P.s.i.</i>	<i>Inch per inch</i>	<i>Percent</i>
AZ31B	F	34,000	19,000	0.0049	6.0
AZ61A	F	38,000	22,000	0.0054	6.0
AZ80A	F	42,000	26,000	0.0060	5.0
HM21A	T5	42,000	28,000	0.0063	2.0
	T5	34,000	25,000	0.0058	3.0
MIA	F	37,000	27,000	0.0124	6.0
	F	30,000	18,000	0.0048	3.0
TA54A	F	36,000	22,000	0.0054	7.0
ZK60A	T5 ²	42,000	26,000	0.0060	7.0
	T6 ³	43,000	32,000	0.0069	4.0

¹ The letter "D" in the expression "4D" in the heading of the last column represents the diameter of the specimen.

² Properties are for forgings of 3 inches or less section thickness.

³ Properties are for forgings of 2 inches or less section thickness.

3.3 Dimensions and tolerances. Dimensions and tolerances shall be as shown on applicable drawings or as specified in the contract or order.

3.4 Protective finish. Unless otherwise specified in the contract or order, all forgings shall be given a protective treatment of the chrome-pickle type, prior to shipment. Unless otherwise specified, for Army, Navy, and Air Force purchases the chrome pickle treatment shall be in accordance with type I of MIL-M-3171.

3.5 Heat treatment. The forgings shall be given such heat treatment and aging, in accordance with the manufacturer's practice, as is necessary to produce material in either the (F) or the (T5) conditions that will meet the requirements specified. Forgings shall be given a solution heat treatment and then artificially aged as specified in 4.7 to produce material that will meet the requirements specified for the (T6) condition. Treatments shall be performed on the whole of a piece, never on a part only, and shall be applied in a manner that will produce the utmost uniformity.

3.5.1 When specified in the contract or order, or on request, the contractor shall furnish the Government agency involved with a complete record of the heat treatment performed on the forgings.

3.6 Identification markings. Unless otherwise specified in the contract or order, forgings shall be marked continuously along the length with the alloy composition designation, followed by the condition designation and specification number. The characters, recurring at intervals not exceeding 6 inches, shall be clearly legible and shall not be harmful to alloy nor obliterated by ordinary handling.

3.7 Workmanship. The forgings shall be of uniform quality and condition, free from blisters, fins, folds, seams, laps, cracks, segregations, spongy areas or other defects, which may adversely affect their serviceability. Apparent surface defects may be explored and if they can be removed so they do not appear on re-etching and the required section thickness can be maintained, they shall not be cause for rejection.

3.7.1 Grain flow pattern. Sufficient working shall be done to produce a uniform wrought metallurgical structure. When spec-

QQ-M-40b

ified in the contract or order, the grain flow pattern shall conform with that of a sample forging, photograph, or drawing approved by the procuring agency.

3.7.2 The forgings shall not be repaired by plugging or welding.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

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, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the specifications set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Lot. Unless otherwise specified in the contract or order, a lot shall consist of all forgings submitted at one time of the same composition, condition, pattern, and size, and subject to the same aging process. For forgings weighing 5 pounds or less, the maximum weight of a lot shall be 2000 pounds, and for larger forgings it shall be 4000 pounds.

4.3 Sampling.

4.3.1 For visual and dimensional examination. Samples for visual examination shall be selected from each lot of magnesium alloy forgings in accordance with the provisions of MIL-STD-105. Samples selected for dimensional examination may be the same as those selected for visual examination.

4.3.2 For chemical analysis. Samples for chemical analysis shall be selected as described in method 111 or method 112 of Fed. Test Method Std. No. 151 to represent each 2000 pounds of metal comprising the lot.

4.3.2.1 Chemical analysis. A composite sample of at least 75 grams of chips or drillings shall be obtained by drilling or machining the sample forgings of 4.3.2 in accordance with method 111 of Fed. Test Method Std. No. 151. Chips or drillings shall be cleaned with a magnet. The sample shall be free from dirt, oil, grit, and other foreign matter.

4.3.2.2 Spectrochemical analysis. A piece of metal weighing not less than 20 grams shall be taken from each of the sample forgings of 4.3.2. Specimens for spectrochemical analysis shall be prepared in accordance with method 112 of Fed. Test Method Std. No. 151. The samples shall be free from dirt, oil, grit, and other foreign matter.

4.3.3 For tension test. Unless otherwise specified, two tension samples shall be selected from each lot.

4.3.3.1 Test specimens having maximum metal flow in the longitudinal direction shall be cut from forgings selected from the lot. In case of forgings which are too small to permit satisfactory tension-test specimens being obtained therefrom, the mechanical properties shall be determined on a test coupon forged to a size from which the standard test specimen can be machined. This test coupon shall be taken from the same stock and shall be subjected to the same treatment as the lot of forgings which it represents.

4.3.4 Flow lines examination. For determination of wrought structure, presence of internal defects and flow lines, a forging representative of each die pattern, size, and alloy shall be selected from the first lot only produced on the die.

4.4 Specimen preparation.

4.4.1 Specimens for tension test. Test specimens shall be prepared in such a manner that the longitudinal axis is approximately parallel to the direction of maximum

flow of the metal in the forging or coupon. The tension-test specimen shall be machined to the form and dimensions of types R1, R2, or R3 in accordance with method 211 of Fed. Test Method Std. No. 151. When it is impracticable to obtain specimens of the dimensions prescribed for type R1, the largest size type R2 or R3 specimen obtainable shall be used.

4.4.1.1 Test pieces shall be subjected to the same treatment as the lot represented, before machining operation.

4.4.2 *Specimens for flow lines examinations.* The sample forging shall be sectioned and deep-etched by a suitable reagent in such a manner that the flow lines are suitably developed for examination (see 6.3).

4.5 Examination.

4.5.1 *Forgings.* Sample forgings selected in accordance with 4.3.1 shall be visually examined for conformance to the requirements of 3.4, 3.6, and 3.7 and measured for compliance with the requirement of 3.3. Acceptance criteria shall be in accordance with MIL-STD-105, inspection level II, acceptable quality level 1.5 percent.

4.5.2 *Packing.* Packing and packing markings shall conform to the requirements of section 5 of this specification.

4.6 Tests.

4.6.1 *Chemical analysis.* Sample forgings selected in accordance with 4.3.2 shall be tested in accordance with method 111 or 112 of Fed. Test Method Std. No. 151 to determine conformance to the chemical requirements of table I. In case of dispute, chemical analysis by method 111 shall be the basis for acceptance.

4.6.2 *Tension tests.*

4.6.2.1 *Tension strength.* Specimens for tension tests, prepared in accordance with 4.4.1, shall be tested for tensile strength in accordance with method 211 of Fed. Test Method Std. No. 151 to determine conformance to the requirements of table II.

4.6.2.2 *Yield strength.* The yield strength of the tension-test specimens shall be determined either by the offset method or the extension-under load method as detailed in method 211 of Fed. Test Method Std. No. 151 to determine conformance to the requirements of table II. In case of dispute, the offset method shall be used.

4.6.3 *Flow-line examination.* Specimens for flow-line examination prepared in accordance with 4.3.2.2 shall be examined to determine conformance to the requirements of this specification (see 3.7.1).

4.7 *Heat treatment response.* The forgings furnished to this specification for composition ZK60A in the solution heat treated and artificially aged temper (T6) shall demonstrate ability to conform to the properties in table II based on the following heat treatment schedule:

Solution treatment—930° ± 10°F. minimum time of 1 hour, maximum time of 3 hours; in controlled sulfur dioxide furnace.

Quenching—Quenched in water whose temperature is 120° to 160°F. metal temperature should not be less than 900°F. upon entering quench media. Allowable quench delay—entire forging must be submerged within 10 seconds after leaving furnace.

Artificially aging—275° to 300°F. for 24 to 48 hours and air cooled.

4.8 Rejection and retests.

4.8.1 *Rejection.* When one or more test specimens fail to meet any of the tests required by this specification, the lot represented by the specimen or specimens shall be rejected.

4.8.2 *Retests.* Retests shall be permitted in accordance with the requirements of Fed. Test Method Std. No. 151.

4.8.3 *Resubmitted lots.* Paragraph 12.2 of MIL-STD-105 shall apply except that a re-

QQ-M-40b

submitted lot shall be inspected, using tightened inspection. For visual examination where the original acceptance number was zero, a sample size represented by the next higher sample-size code letter shall be chosen.

5. PREPARATION FOR DELIVERY

(For civil agency procurement, the definitions and application of the levels of packing shall be in accordance with Fed. Std. No. 102.)

5.1 Packing. Unless otherwise specified, all material shall be separated by size, composition, and condition when packaged for shipment. The gross weight of containers or bundles shall not exceed approximately 750 pounds whenever practical. Unless otherwise specified in the contract or order, packaging shall be as for level B (see 5.1.2).

5.1.1 Level A. Unless otherwise specified in the contract or order, forgings shall be packed in boxes in accordance with PPP-B-601 (overseas type) or PPP-B-621 (overseas type). Forgings shall be adequately supported within the container in a manner designed to provide a neat, compact, and nonshifting load. Forgings having finish-machined surfaces shall be individually protected against corrosion, or containers shall be case lined in accordance with MIL-L-10547 and the forgings blocked to prevent piercing or tearing of the lining.

5.1.2 Level B. Large forgings, or forgings having protection, or so constructed or finished that they may be damaged in handling, shall be packaged in domestic type boxes in accordance with PPP-B-601 (domestic type), PPP-B-621, or MIL-C-132. Small forgings shall be rigidly packed in boxes conforming to the above specifications, or, if acceptable to the procuring activity, they may be bundled.

5.1.3 Level C. Forgings shall be packed or otherwise prepared for shipment to insure carrier acceptance and to insure safe deliv-

ery to destination at the lowest applicable rate. Containers shall meet, as a minimum, the requirement of rules and regulations applicable to the mode of transportation selected.

5.2 Marking.

5.2.1 Civil agencies. In addition to any special marking required by the contract or order, (see 6.2), shipping containers shall be marked in accordance with Fed. Std. No. 123.

5.2.2 Military agencies. In addition to any special marking required by the contract or order (see 6.2), shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES**6.1 Intended use.**

6.1.1 Composition AZ31B alloy is used when good weldability, good strength, and good cold formability are desired. It has better press forging characteristics than any of the other alloys and may be worked on hammers or mechanical presser.

6.1.2 Composition AZ61A alloy is used when relatively easy forming and welding are desired with medium mechanical strength. This alloy is usually press forged and may be forged into more intricate parts than composition AZ80A alloy. The forgeability and mechanical properties are intermediate between those of composition AZ31B and composition AZ80A.

6.1.3 Composition AZ80A alloy is used where maximum strength is required, and can be heat treated to provide improved mechanical properties, but can be supplied only as press forgings. The material is stiff and somewhat difficult to form, but parts such as crankcases can be die pressed if sufficiently large equipment is available. The endurance limit is approximately 15,000 pounds per square inch. Aging tends to prevent growth in service. Forgings in condition F can be changed to condition T5 by aging 24 hours at 177°C (350°F.). In the case of

large and intricate forgings of this alloy, it may be difficult to develop the minimum yield strength values specified in table II.

6.1.4 Composition HM21A alloy forgings are used for parts necessary for high temperature service, especially in the temperature range of 500° to 700° F. and requiring good weldability characteristics.

Note: An Atomic Energy Commission license is required for the purchase of this material.

6.1.5 Composition MIA alloy forgings are used for parts that have to be welded to each other or to extruded assemblies of the same composition where easiest forming and welding are desired strength is not of great importance. It can be either hammer forged or press forged.

6.1.6 Composition TA54A alloy forgings are used where medium strength, maximum elongation, and easy welding are required. This material can be either hammer forged or press forged, and is suitable for difficult design. It is economical and easier to fabricate than composition AZ31B, AZ61A or composition AZ80A alloys. The corrosion resistance and mechanical properties, however, are lower than those of the other three alloys. The endurance limit is 10,000 pounds per square inch.

6.1.7 ZK60A has excellent press forging characteristics and an excellent combination of strength and ductility.

6.2 Ordering data. Purchasers should exercise any desired options offered herein and procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Composition (see 1.2.1).
- (c) Condition (see 1.2.2).
- (d) Chemical analysis (See 3.1.1).
- (e) Dimensions and dimensional tolerances (see 3.3).

(f) Grain flow pattern (see 3.7.1).

(g) Size of lot, if different from 4.2.

(h) Whether level A or level C packing is required in place of level B (see 5.1, 5.1.1, 5.1.2, and 5.1.3).

6.3 The chrome-pickle type protective finish applied in accordance with this specification is an acceptable etch for flow lines examination.

6.4 Fully worked magnesium-alloy forgings refers to material that has been worked sufficiently during the forging operations to develop maximum properties. Material that has been given smaller amounts of working will have corresponding lower properties.

6.5 Transportation description. Transportation descriptions and minimum weights applicable to this commodity are:

Rail:

Forgings, not otherwise indexed by name, magnesium metal alloy.

Carload minimum weight 30,000 pounds.

Motor:

Forgings, not otherwise indexed, magnesium metal alloy.

Truckload minimum weight 30,000 pounds, subject to Rule 115, National Motor Freight Classification.

Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
<u>INSTRUCTIONS</u>		
This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).		
SPECIFICATION		
ORGANIZATION (of submitter)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEM PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT		
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?		
A. GIVE PARAGRAPH NUMBER AND WORDING.		
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.		
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID		
3. IS THE SPECIFICATION RESTRICTIVE?		
<input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?		
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)		
SUBMITTED BY (Printed or typed name and activity)		DATE

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