

**QQ-M-56b****OCTOBER 24, 1960****SUPERSEDING****Fed. Spec. QQ-M-56a****September 3, 1957****FEDERAL SPECIFICATION****MAGNESIUM ALLOY, SAND CASTINGS**

*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 presents requirements for magnesium alloy sand castings.

**1.2 Classification.**

**1.2.1 Alloys.**—Magnesium alloy sand castings shall be of the following alloys:

|       |       |
|-------|-------|
| AZ68A | HK81A |
| AZ81A | HZ82A |
| AZ91C | ZK51A |
| AZ92A | ZH62A |
| EZ38A | ZK61A |

**1.2.2 Tempers.** — Magnesium alloy sand castings shall be furnished in the following tempers, as specified:

- F.—As cast.
- T4.—Solution heat treated.
- T5.—Artificially aged.
- T6.—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:

*Federal Specifications:*

- QQ-S-781—Strapping, Flat Steel.
- PPP-B-585—Boxes, Wood, Wirebound.

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

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

PPP-B-636—Box, Fiberboard.

PPP-T-60—Tape, Pressure Sensitive, Adhesive, Waterproof, for Packaging and Sealing.

*Federal Standards:*

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, Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, Seattle, and Washington, D. C.)

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

*Military Specifications:*

- MIL-P-116—Preservation, Methods of.
- MIL-M-8171—Magnesium Alloy, Process for Corrosion.

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**MIL-C-6021** — Castings: Classification and Inspection (For Aeronautical Applications).

**MIL-M-6857**—Magnesium Alloy Castings, Heat Treatment of.

**MIL-I-6865**—Inspection; Radiographic.

**MIL-I-6869** — Impregnants for Aluminum Alloy and Magnesium Alloy Castings.

**MIL-B-10877**—Box, Wood Cleated, Veneer, Paper Overlaid.

**MIL-L-10547**—Liner, Case, Waterproof.

**MIL-R-11471**—Radiographic Inspection of Metals.

**MIL-W-18326**—Welding of Magnesium Alloys, Gas and Arc, Manual and Machine, Processes for.

**Military Standards:**

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

**MIL-STD-147** — Palletized Unit Load (40" x 48"—4-Way Partial and 4-Way Pallets)

**MIL-STD-276**—Impregnation of Porosity in Castings, Process for.

(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 Materials.**—The metal used shall be of a quality suitable to produce castings which comply with all the requirements of this specification.

**3.2 Foundry control.** — Unless otherwise specified in the invitation for bids and in the contract or order, castings shall be produced under foundry control approved by the procuring agency. 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 procuring agency or agreed upon by the procuring agency and contractor. When foundry practices have been so

established the production method shall not be significantly or materially changed without demonstrating to the satisfaction of the procuring agency that the change does not adversely affect the quality of the castings. For the U.S. Air Force, Navy Bureau of Naval Weapons and Army Quartermaster Corps, foundry control and inspection tests shall be made by radiographic examination conducted in accordance with the requirements of Military Specification MIL-I-6865.

**3.3 Soundness.** — When specified in the contract or order, the soundness of castings shall meet standards furnished or approved by the procuring agency. The areas of the castings subject to soundness requirements shall be as specified and the number and extent of blowholes, sponginess, and other defects in such areas shall be not greater than indicated by the standard. (See 6.2.)

**3.4 Identification and repair marking.** — Unless otherwise specified in the contract or order, each casting shall be identified with the pattern or part number by the use of raised numerals in a location indicated on the drawing. When no location is shown on the drawing, the number shall be so located as not to be machined off in finishing to the required dimensions. When practicable, each casting shall also be marked with the lot number.

**3.4.1** If the location of impression markings is not specified on the drawing, it shall be fixed by the contractor preferably on a cast-in, raised pad, in such a manner as to minimize the danger of its having a deleterious effect on the static or fatigue strength of the casting.

**3.4.2** Marking other than impression stamping shall be applied to the material by means of a hand stamp and a suitable marking fluid or other approved means. All marking, and marking symbols, such as those specified in 3.10.3.4, 3.10.4, and 3.10.5 for repaired castings, shall be clearly legible.

**3.5 Straightness.**—Castings shall be furnished in condition ready for machining and shall not require further straightening. After

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the yield strength of the castings has been increased by an aging operation straightening shall not be permitted, except that minor restraightening to remove any slight warping caused by aging if approved by the inspector shall be permitted.

**3.6 Heat treatment.**

3.6.1 Castings shall be heat-treated in such 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. Castings shall be heat-treated in accordance with the manufacturer's recommendations and in accordance with the best commercial practices. Requirements for the heat treatment of castings for the U.S. Air Force, Bureau of Naval Weapons and Army Quartermaster Corps shall be in accordance with Military Specification MIL-M-6857.

**3.7 Chemical composition.**

3.7.1 The chemical composition of the material shall be within the limits specified in table I.

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

3.7.3 Chemical analysis by the contractor of the individual melts may be waived at the discretion of the inspector, provided that the foundry's method of composition control is acceptable to him, 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.

**3.8 Mechanical properties.**

3.8.1 Unless otherwise specified in the contract or order, the mechanical properties as determined from separately cast test bars shall conform to the requirements shown in table II. (See 6.1.)

3.8.2 *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 procuring agency.
- (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 not met the mechanical property requirements of this specification.
- (d) When separately cast specimens are not available.

The average and minimum tensile strength, tensile yield strength and elongation of test specimens cut from castings shall conform to the requirements shown in Table III. See note (B) table III. (See 6.1.)

3.8.3 *Mechanical 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 casting 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 note (B) table III.

TABLE I.—*Chemical requirements*<sup>1</sup>

| Composition | Magnesium      | Aluminum       | Zinc           | Manga-<br>nese,<br>minimum | Silicon,<br>maximum | Copper,<br>maximum | Nickel,<br>maximum | Rare<br>earth  | Zirconium      | Thorium        | Total<br>other<br>elements<br>maximum |
|-------------|----------------|----------------|----------------|----------------------------|---------------------|--------------------|--------------------|----------------|----------------|----------------|---------------------------------------|
|             | <i>Percent</i> | <i>Percent</i> | <i>Percent</i> | <i>Percent</i>             | <i>Percent</i>      | <i>Percent</i>     | <i>Percent</i>     | <i>Percent</i> | <i>Percent</i> | <i>Percent</i> | <i>Percent</i>                        |
| AZ63A.....  | Remainder      | 5.3-6.7        | 2.5-3.5        | 0.15                       | 0.30                | 0.10               | 0.01               | -----          | -----          | -----          | 0.30                                  |
| AZ81A.....  | Remainder      | 7.0-8.1        | 0.40-1.0       | .13                        | .30                 | .10                | .01                | -----          | -----          | -----          | .30                                   |
| AZ91C.....  | Remainder      | 8.1-9.3        | .40-1.0        | .13                        | .30                 | .10                | .01                | -----          | -----          | -----          | .30                                   |
| AZ92A.....  | Remainder      | 8.3-9.7        | 1.6-2.4        | .10                        | .30                 | .10                | .01                | -----          | -----          | -----          | .30                                   |
| EZ33A.....  | Remainder      | -----          | 2.0-3.1        | ----                       | ----                | .10                | .01                | 2.5-4.0        | 0.50-1.0       | -----          | .30                                   |
| HK31A.....  | Remainder      | -----          | .30 max.       | ----                       | ----                | .10                | .01                | -----          | .50-1.0        | 2.5-4.0        | .30                                   |
| HZ32A.....  | Remainder      | -----          | 1.7-2.5        | ----                       | ----                | .10                | .01                | 0.10 max.      | .50-1.0        | 2.5-4.0        | .30                                   |
| ZK51A.....  | Remainder      | -----          | 3.6-5.5        | ----                       | ----                | .10                | .01                | -----          | .50-1.0        | -----          | .30                                   |
| ZH62A.....  | Remainder      | -----          | 5.2-6.2        | ----                       | ----                | .10                | .01                | -----          | .50-1.0        | 1.4-2.2        | .30                                   |
| ZK61A.....  | Remainder      | -----          | 5.5-6.5        | ----                       | ----                | .10                | .01                | -----          | .60-1.0        | -----          | .30                                   |

<sup>1</sup> 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 above limits.

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TABLE II.—Mechanical property requirements for separately cast specimens

| Alloy and temper         | Tensile strength, minimum | Yield strength at 0.2 percent offset or at extension indicated |                      | Elongation in 2 inches, minimum |
|--------------------------|---------------------------|--|----------------------|---------------------------------|
|                          |                           | Minimum  | Extension under load |                                 |
|                          | P.s.i.                    | P.s.i.   | Inch per inch        | Percent                         |
| AZ63A                    |                           |  |                      |                                 |
| F.....                   | 26,000                    | 11,000   | 0.0037               | 4                               |
| T4.....                  | 34,000                    | 11,000   | .0037                | 7                               |
| T5.....                  | 26,000                    | 12,000   | .0038                | 2                               |
| T6.....                  | 34,000                    | 16,000   | .0045                | 3                               |
| AZ81A                    |                           |  |                      |                                 |
| T4.....                  | 34,000                    | 11,000   | .0037                | 7                               |
| AZ91C                    |                           |  |                      |                                 |
| F.....                   | 23,000                    | 11,000   | .0037                | --                              |
| T4.....                  | 34,000                    | 11,000   | .0037                | 7                               |
| T5.....                  | 23,000                    | 12,000   | .0038                | 2                               |
| T6.....                  | 34,000                    | 16,000   | .0045                | 3                               |
| AZ92A                    |                           |  |                      |                                 |
| F.....                   | 23,000                    | 11,000   | .0037                | --                              |
| T4.....                  | 34,000                    | 11,000   | .0037                | 6                               |
| T5.....                  | 23,000                    | 12,000   | .0038                | --                              |
| T6.....                  | 34,000                    | 16,000   | .0048                | --                              |
| EZ33A                    |                           |  |                      |                                 |
| T5 room temperature..... | 20,000                    | 14,000   | .0042                | 2                               |
| T5 500° F.....           | 13,000                    | 8,000  | -----                | --                              |
| HK31A                    |                           |  |                      |                                 |
| T5 room temperature..... | 27,000                    | 13,000   | .0040                | 4                               |
| T5 500° F.....           | 21,000                    | 13,000   | -----                | 2                               |
| HZ32A                    |                           |  |                      |                                 |
| T5 room temperature..... | 27,000                    | 13,000   | .0040                | 4                               |
| T5 500° F.....           | 13,000                    | 8,000  | -----                | --                              |
| ZK51A                    |                           |  |                      |                                 |
| T5.....                  | 34,000                    | 20,000   | .0051                | 5                               |
| ZH62A                    |                           |  |                      |                                 |
| T5.....                  | 35,000                    | 22,000   | .0054                | 5                               |
| ZK61A                    |                           |  |                      |                                 |
| T5.....                  | 39,000                    | 26,000   | .0060                | 5                               |
| T6.....                  | 39,000                    | 26,000   | .0060                | 5                               |

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TABLE III.—Mechanical property requirements for specimens cut from castings

| Alloy and temper  | Tensile strength |                      | Yield strength at 0.2 percent offset or at extension indicated |                      |                      |                 |
|-------------------|------------------|----------------------|--|----------------------|----------------------|-----------------|
|                   | Average          | Minimum <sup>2</sup> | Average  | Minimum <sup>2</sup> | Extension under load |                 |
|                   |                  |                      |  |                      | For average          | For minimum     |
|                   | P.s.i.           | P.s.i.               | P.s.i.   | P.s.i.               | Inches per inch      | Inches per inch |
| AZ63A             |                  |                      |  |                      |                      |                 |
| T4.....           | 25,500           | 17,000               | 10,000   | 9,000                | .0035                | .0034           |
| T6.....           | 25,500           | 17,000               | 14,500   | 12,000               | .0042                | .0038           |
| AZ81A             |                  |                      |  |                      |                      |                 |
| T4.....           | 25,500           | 17,000               | 10,000   | 9,000                | .0035                | .0034           |
| AZ91C             |                  |                      |  |                      |                      |                 |
| T4.....           | 25,500           | 17,000               | 10,000   | 9,000                | .0035                | .0034           |
| T6.....           | 25,500           | 17,000               | 14,500   | 12,000               | .0042                | .0038           |
| AZ92A             |                  |                      |  |                      |                      |                 |
| T4.....           | 25,500           | 17,000               | 10,000   | 9,000                | .0035                | .0034           |
| T6.....           | 25,500           | 17,000               | 16,000   | 13,500               | .0045                | .0041           |
| FZ33A             |                  |                      |  |                      |                      |                 |
| T5 room temp..... | 15,000           | 13,000               | 12,500   | 11,000               | .0039                | .0037           |
| T5 500° F.....    | -----            | 10,000               | -----  | 6,000                | -----                | -----           |
| EK31A             |                  |                      |  |                      |                      |                 |
| T5 room temp..... | 23,000           | 19,000               | 11,700   | 10,500               | .0038                | .0036           |
| T5 500° F.....    | -----            | 14,000               | -----  | 10,500               | -----                | -----           |
| HZ32A             |                  |                      |  |                      |                      |                 |
| T5 room temp..... | 23,000           | 19,000               | 11,700   | 10,500               | .0038                | .0036           |
| T5 500° F.....    | -----            | 10,000               | -----  | 6,000                | -----                | -----           |
| ZK51A             |                  |                      |  |                      |                      |                 |
| T5.....           | 29,000           | 24,000               | 17,000   | 14,000               | .0046                | .0042           |
| ZH62A             |                  |                      |  |                      |                      |                 |
| T5.....           | 31,500           | 28,500               | 19,500   | 17,500               | .0050                | .0047           |
| ZK61A             |                  |                      |  |                      |                      |                 |
| T5.....           | 34,000           | 30,000               | 24,000   | 21,000               | .0057                | .0053           |
| T6.....           | 34,000           | 30,000               | 24,000   | 21,000               | .0057                | .0053           |

<sup>1</sup> The average percent elongation of specimens cut from castings shall be not less than 25% of the values specified for separately cast test bars.

<sup>2</sup> The above minimum values, are representative of the weakest areas in any type casting for the composition listed (i.e.) adjacent to gates and risers, etc. Higher design properties for designated areas in castings are normally obtained and shall be specified in the contract drawing or order. See paragraph 8.8.3.



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**3.8.4 Mechanical properties at 500° F. —** Alloys EZ83A, HK31A, and HZ82A shall be capable of meeting the requirements shown in tables II and III when tested in the following manner. Tensile test specimens shall be heated to 500°F.  $\pm$  5°F. held for 10 minutes before testing and loaded at this temperature at a rate of 0.005 inch per inch per minute up to the yield strength and at a rate of 0.10 inch per inch per minute above the yield strength.

**3.8.5 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 procuring agency or as agreed upon between the procuring agency and contractor.

**3.9 Protective treatment. —** Unless otherwise specified in the contract or order as a final process, all castings shall be given a chrome-pickle or a dichromate surface treatment in accordance with Military Specification MIL-M-3171.

### 3.10 Workmanship.

**3.10.1 Castings shall be of uniform quality and condition, free from injurious blowholes, porosity, hard spots, shrinkage, cracks, and other injurious defects and shall be smooth and well cleaned before inspection.**

**3.10.2 Repair of castings. —** Castings shall not be repaired by welding, impregnation, peening, blending, plugging or other method without permission of the procuring agency. Such permission may 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.

**3.10.3 Welding. —** When welding is per-

mitted, it shall be done by methods suitable for the particular alloy and only in those portions of castings not highly stressed in service. Such areas shall be as indicated on the applicable drawing. Welding methods shall be in accordance with such specifications as are referenced on the drawings, as are required by the contract or order, or as specified when permission to weld is granted. Periodic checks of welded castings shall be made to insure that a satisfactory procedure for welding is being adhered to by the contractor. For Bureau of Naval Weapons and Army Quartermaster Corps purchases, welding shall be in accordance with MIL-W-18326 except in lieu of paragraph 3 thereof the welding operator shall be capable of repair welding in accordance with radiographic standards applicable to welded areas.

**3.10.3.1** When castings are to be supplied in the heat-treated condition, they shall be heat treated or reheat treated, with proper precautions against germination, to the required temper after welding except that small arc welds may be performed without subsequent heat treatment upon approval of the inspector.

**3.10.3.2** Unless otherwise specified in the contract or order, castings which have been repaired by welding shall be inspected radiographically after all reworking and heat treatment have been completed.

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

**3.10.3.4** 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 not be larger than 1/4 inch outside diameter. All welded areas shall be encircled with a ring of white paint prior to submission for final inspection.

**3.10.4 Impregnation. —** When impregnation is permitted it shall be only to correct general

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seepage leaks and shall not be used to correct poor foundry technique or significant porosity. It shall be accomplished in accordance with such specifications as may be shown on the drawing or that may be required by the contract or order, provided that, if no specifications are stipulated, the method used shall be approved by the procuring agency. Unless otherwise authorized, castings which have been impregnated shall be marked "IMP". Impregnation of castings shall be in accordance with Military Standard MIL-STD-276. For Aeronautical and Army Quartermaster Corps use impregnants used shall be in accordance with Military Specification MIL-I-6869.

**3.10.5 Peening.** — Where peening is permitted it shall be only to correct localized minor seepage leaks and small surface imperfections, or to disclose sub-surface voids for the purpose of inspection. Peening shall not be permitted to repair cracks, cold shuts, shrinks, mis-runs, 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 inspector. Peened castings shall be marked with a maltese cross approximately  $\frac{1}{4}$  inch high.

**3.10.6 Blending.** — Blending with suitable grinders or other tools shall be permitted only for the removal of surface imperfections and shall not result in dimensions below minimum drawing tolerances.

## 4. SAMPLING, INSPECTION AND TEST PROCEDURES

**4.1** Unless otherwise specified herein, the supplier is responsible for the performance of all inspection requirements prior to submission for Government inspection and acceptance. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Inspection records of the examinations and tests shall be kept complete and available to the Government as specified in the contract or order.

**4.2** Sampling, inspection, and tests shall be conducted in accordance with Federal Test Method Standard No. 151 and as specified herein.

### 4.3 Sampling.

**4.3.1 Lot.** — A lot shall consist of not more than 1,000 pounds of cleaned castings of the same composition and temper, except where this weight limit may be exceeded by a single casting. In such cases, each casting shall be considered a lot. Unless otherwise specified in the contract or order, each lot of castings shall be from the same melt, or such groups of melts as may be designated by the inspector.

#### 4.3.2 Samples for Government analysis.

**4.3.2.1 Samples for chemical analysis.** — When samples for government analysis are specified in the contract order or required by the Inspector, at least one sample shall be taken from each heat or lot of castings. Samples for chemical analysis shall conform to the requirements of method 111 of Federal Test Method Standard No. 151. Each sample shall consist of not less than two ounces of chips.

**4.3.2.2 Samples for spectrographic analysis.** — When samples for government analysis are specified in the contract order or required by the Inspector, at least one sample shall be taken from each heat or lot of castings. Samples for spectrographic analysis shall conform to the requirements of method 112 of Federal Test Method Standard No. 151. Each sample shall weigh approximately 20 grams.

#### 4.3.3 Samples for tension test.

**4.3.3.1** Two or more test bars shall be cast from a melt in the lot to represent each lot. No separately cast test bars are required if conformance with mechanical property requirements is demonstrated by tests of speci-



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mens cut from castings in accordance with the requirements of 3.8.2.

4.3.3.2 Except in the case where castings are to be shipped in the "as cast" temper the test bars from each lot shall be heat treated to the same temper with production castings of the same alloy. When test bars are used, one of the bars representative of the particular lot shall be tested and the lot judged by the result of this test.

4.3.3.3 Each heat treating furnace charge shall be represented by at least two test bars of the same composition range. The heat treatment of a furnace charge shall be judged by these test bars. All bars shall conform to the minimum values specified in table II.

4.3.3.4 When test specimens taken from castings are required in accordance with the requirements of 3.8.2 one or more castings in the temper to be furnished shall be selected from each inspection lot and not less than three tension test specimens shall be machined therefrom, of which one shall be from the thinnest section, one from the heaviest section, and one from an intermediate section. The mechanical properties of specimens so tested shall conform to the requirements of table III or shall meet the values specified on the drawing or in the contract or order.

4.3.3.5 When test specimens taken from designated areas of castings are required in accordance with the requirements of 3.8.3, one or more castings in the temper to be furnished shall be selected from each lot or group of lots, as may be designated by the Inspector. Not less than two tension test specimens shall be machined therefrom from each designated area and tested. The mechanical properties of specimens so tested shall conform with the requirements of table III or shall meet the values specified on the drawing or in the contract or order.

4.3.3.6 Tensile test specimens cut from castings shall be flat or round, conforming to the requirements for specimen type F1,

F2, R1, R2, R3, R4, and R5 of method 211 of Federal Test Method Standard No. 151.

4.3.3.7 Unless otherwise specified in the contract or order, test bars shall be cast in accordance with the form and dimensions of either figure 1A or 1B of this specification unless the manufacturer's test bar design is acceptable to the procuring agency.

4.3.3.8 The metal for the test bars shall be part of the melt used for casting. In the event the metal for casting is given any treatment such as fluxing, or cooling and reheating, the metal for the test bars shall be given the same treatment. Test bars shall not be chill-cast.

4.3.3.9 The inspector may, at his discretion witness the pouring of the test bars and their removal from the sand, and stamp each test bar for future identification.

4.3.3.10 Unless otherwise specified in the contract or order, separately cast test bars shall be tested without machining except as it may be necessary to adapt them to the grips of the testing machine.

#### 4.4 Examination and tests.

4.4.1 *Soundness.* — Unless otherwise specified in the contract or order, when soundness is required in accordance with 3.3, it shall be determined by radiographic examination of all castings in the lot. Inspection of castings for aeronautical application shall be in accordance with Military Specifications MIL-C-6021 (ASG) and MIL-I-6865 (ASG). For Ordnance Corps use, radiographic inspection shall be in accordance with Military Specification MIL-R-11471 (ORD). For Army Quartermaster Corps use, radiographic inspection shall be in accordance with Military Specification MIL-I-6865 (ASG).

4.4.2 *Chemical analysis.* — Chemical analysis shall be made by wet chemical or spectrographic methods. In case of dispute, chemical

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analysis by wet chemical methods shall be the basis for acceptance.

### 4.4.3 *Mechanical property tests.*

4.4.3.1 *Tensile strength.* — Tension tests shall be performed in accordance with requirements of method 211 of Federal Test Method Standard No. 151.

4.4.3.2 *Yield strength.* — The yield strength shall be determined by the offset or the extension under load method described in method 211 of Federal Test Method Standard No. 151. In case of dispute the offset method shall be used.

4.4.3.3 *Workmanship.* — Each casting shall be carefully examined to determine conformance with this specification with respect to workmanship. Examination of a fraction of the inspection lot in accordance with a statistical sampling plan is acceptable provided the sampling plan is approved by the procuring agency.

4.4.4 *Dimensions.* — Sufficient spot checks shall be made to insure conformance with the dimensional tolerances specified on the applicable drawing.

### 4.5 *Rejection and retests.*

4.5.1 *Rejection.* — If the specimens or the castings fail to meet any of the tests or examinations required by this specification, the lot represented by the specimen shall be rejected.

4.5.2 *Retests.* — Retests shall be permitted in accordance with the Requirements of Federal Test Method Standard 151.

## 5. PREPARATION FOR DELIVERY

### 5.1 *Packaging.*

5.1.1 *Level A.* — Unless otherwise specified, castings having finish machined surfaces shall be preserved and packaged in ac-

cordance with Military Specification MIL-P-116, method I, type P-1 Preservative. Rough castings or castings subjected to a chrome pickle surface treatment or a dichromate surface treatment do not require a preservative. Rough castings each weighing 50 pounds and over and not having rough projections require no packaging.

5.1.2 *Level C.* — Castings shall be packaged in accordance with the manufacturer's commercial practice.

### 5.2 *Packing.*

5.2.1 *Level A.* — Castings packaged as specified in 5.1.1 shall be packed in overseas type containers conforming to Federal Specifications PPP-B-585, PPP-B-601, PPP-B-621, PPP-B-636 or Military Specification MIL-B-10877. Insofar as practical, containers shall be of uniform shape and size, be of minimum cube and tare consistent with the protection required and contain identical quantities. Castings having projections subject to damage shall be afforded adequate blocking or bracing within the container. Wood and wood cleated containers shall be provided with a case liner conforming to Military Specification MIL-L-10547 and shall be sealed in accordance with the appendix thereto. The case liner will not be required when the interior or exterior container conforms to Federal Specification PPP-B-636, type I or II, class 2 or 3, and is sealed at all joints and seams including manufacturer's joints with tape conforming to Federal Specifications PPP-T-60. Containers shall be closed and strapped in accordance with applicable container specification or appendix thereto. The gross weight shall not exceed the weight limitation of the applicable container specification.

5.2.1.1 Unless otherwise specified, rough castings weighing 50 pounds and over and not subjected to damage shall be shipped loose or in bundles or palletized loads. Bundles not exceeding 500 pounds maximum shall be securely strapped with a minimum of one

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and one quarter inch wide strapping conforming to Federal Specification QQ-S-781, type I. Palletized loads shall be in accordance with Military Standard MIL-STD-147.

**5.2.2 Level B.** — Castings packaged as specified in 5.1.1 shall be packed in domestic type containers conforming to Federal Specifications PPP-B-585, PPP-B-601, PPP-B-621, PPP-B-636 or Military Specification MIL-B-10877. Insofar as practical, containers shall be of uniform shape and size, be of minimum cube and tare consistent with the protection required and contain identical quantities. Castings having projections subject to damage shall be afforded adequate blocking or bracing within the container. Containers shall be closed and strapped in accordance with applicable container specification or appendix thereto. The gross weight shall not exceed the weight limitation of the applicable container specification.

**5.2.2.1** Unless otherwise specified, rough castings weighing 50 pounds and over and not subject to damage shall be packed as specified in 5.2.1.1.

**5.2.2.2 Level C.** — Castings, packaged as specified in 5.1.1 shall be packed to insure acceptance by common carrier and safe delivery to destination at the lowest applicable rate. Shipment shall comply to the Uniform Freight Classification Rules or other regulations as applicable to the mode of transportation.

### 5.3 Marking.

**5.3.1 Nonmilitary agencies.**—Unless otherwise specified in the contract or order, all shipping containers, bundles and unpackaged castings shall be marked with the name of the material, pattern or part number as specified on the drawings, type and composition of the castings, this specification number, the gross weight and quantity, the name of the contractor, and the number of the contract or order.

**5.3.2 Military Agencies.** — In addition to the marking specified in 5.3.1 and special marking required in the contract or order, marking shall be in accordance with Military Standard MIL-STD-129.

## 6. NOTES

**6.1 Alloy AZ63A** is prone to excessive porosity and segregation with accompanying adverse affects on mechanical properties unless foundry procedures are closely controlled and castings are limited to relatively simple shapes and sizes.

Alloy AZ92A has slightly less resistance to corrosion than composition AZ63A. The effect of heat treating and aging on the corrosion resistance of alloys of these compositions is negligible unless the castings are in contact with salt water. These compositions find application in temper F for lightly stressed parts; in temper T5 they have high tensile strength, moderate yield strength, and good elongation; in temper T6 high tensile strength high yield strength, and low elongation. Castings of these compositions in the T4 temper when subjected to service condition temperatures of 200°F. or higher change rather rapidly to the T6 temper accompanied by a small but measurable increase in dimensions. Increased dimensional stability of an order suitable for aircraft engines is attained by using the castings in the T5 or T6 temper. AZ81A is supplied only in the T4 condition. It has superior casting characteristics combined with high tensile strength and good elongation. It was developed particularly for aircraft landing wheels. AZ91C alloy is intended for use where maximum strength and hardness consistent with good ductility are needed. This alloy is considered to have better foundry characteristics than AZ63A alloy. EZ38A is intended for use where soundness is required and where medium elevated temperatures, 300–500°F, are encountered. HK31A and HZ32A are used primarily for elevated temperature application up to 600°F. ZK51A, ZK61A and ZH62A are intended for use where maximum ultimate strength and yield strength consistent with

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good ductility are needed. ZH62A can be used to make more complicated castings than can be made with ZK51A.

**6.2 Ordering data.** — Purchasers should exercise any desired options offered herein, and the contractor should be furnished marked drawings, photographs, or castings indicating the following information:

- (a) Composition and temper of alloy (1.1, 1.2, 3.7)
- (b) Protective treatment desired (3.9)
- (c) Radiographic examination for soundness, if required, standards of acceptance and percentage of castings to be inspected if other than 100 percent. (3.2, 3.3, 4.3.1)
- (d) Location of critically stressed areas. (3.8.5)
- (e) Where applicable, those areas from which test specimens will be taken and the minimum acceptable values of mechanical properties for these test specimens. (3.8.3)
- (f) 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, or is important because of subsequent machining operations. (Impression markings improperly located may cause failure) (3.4).
- (g) Level of packing desired, wherein levels are defined as follows (see also Section 5):
  - (1) *Level A.*—Affords protection to material destined for world wide distribution with indeterminate storage.
  - (2) *Level B.*—Affords protection to material destined for domestic shipment with subsequent sheltered storage.
  - (3) *Level C.*—Affords protection to material destined for immediate use at the initial domestic destination.

**6.3 Protective treatment.**

**6.3.1** Before being subjected to the chrome pickle or dichromate treatments commonly used to protect magnesium base alloy products against corrosive attack, parts should be thoroughly cleaned to remove grease, oil, paint, oxide films, welding fluxes, etc., by means of such solvents as alkali cleaning compounds, acid pickle solutions, etc., as required by Military Specification MIL-M-8171.

**6.3.2** The chrome-pickle treatment type I, Military Specification MIL-M-8171 is recommended for castings un-machined. This process results in small dimensional reductions and should not be used where maintenance of close dimensional limits is critical. Essentially this process consists of immersing thoroughly cleaned parts in a bath containing the proper proportions of sodium dichromate, nitric acid, and magnesium sulfate followed by cold and hot water rinses. Precautions are necessary to maintain the strength and activity of the solution. When properly applied, the chrome pickle process produces a matte, gray to yellow-red, iridescent coating. Bright yellow or brass colored coatings indicate malfunctioning of the solution except for EZ38A which normally comes out with a brass color.

**6.3.3.** The dichromate process type III, Military Specification MIL-M-8171 is recommended for machined surfaces or other parts where dimensional changes must be maintained at a minimum. In this process cleaned parts are immersed in a hydrofluoric acid bath, rinsed in cold water, and then treated in a boiling solution of sodium dichromate followed by cold and hot water rinses. Properly applied coatings will vary from light brown to dark brown. The time of treatment, condition of bath and alloy composition will influence color of coating.

**6.3.4** Before they are put into service, it is generally advisable to provide magnesium alloy parts with additional protection against corrosion by the application of a zinc-chro-

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mate primer and one or more finish coats of an epoxy or vinyl paint.

6.4 It is believed that this specification adequately describes the characteristics necessary to secure the desired material and that normally no samples will be necessary prior to award to determine compliance with this specification. If for any particular purpose samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated, the specification to apply in all other respects.

6.5 Federal specifications do not include all compositions, types, classes, grades, sizes, etc. of the commodities indicated by the titles of the specifications which are com-

mercially available, but are intended to cover the types, classes, etc., which are suitable for Federal Government requirements.

**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.

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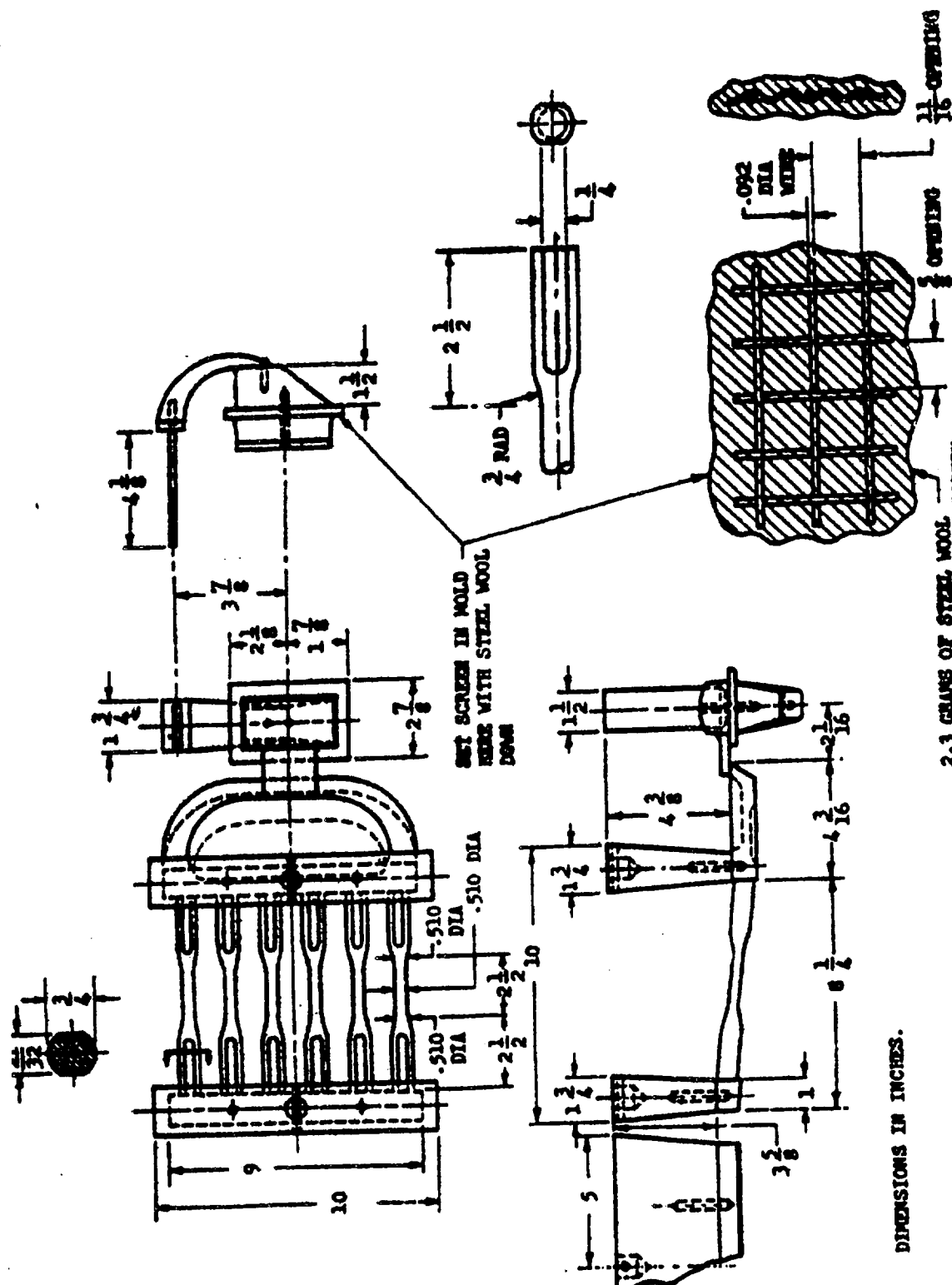
Navy—Bureau of Naval Weapons

Air Force.









2.3 CLAWS OF STEEL WOOL  
ON 2.3 x 3.6 MOVIE SCREEN

**DIMENSIONS IN INCHES.**

Copies of this specification may be purchased for 10 cents each.



**INSTRUCTIONS:** In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (**DO NOT STAPLE**), and mailed. In block 8, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 8 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

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