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# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

Issued JUL 1995

## ALUMINUM ALLOY, FORGINGS 7.8Zn – 2.2Mg – 1.6Cu – 0.15Cr (7249– T74 and – T7452)

### 1. SCOPE:

#### 1.1 Form:

This specification covers an aluminum alloy in the form of die forgings, hand forgings, and forging stock.

#### 1.2 Application:

This product has been used typically for parts requiring high strength, high toughness, and good resistance to stress-corrosion cracking, but usage is not limited to such applications.

### 2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

#### 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AMS 2201 Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled or Cold Finished
- MAM 2201 Tolerances, Metric, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled, Drawn, or Cold Finished
- AMS 2355 Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
- MAM 2355 Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings, Metric (SI) Units
- AMS 2750 Pyrometry
- AMS 2808 Identification, Forgings

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## 2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

|             |                                                                                                  |
|-------------|--------------------------------------------------------------------------------------------------|
| ASTM B 594  | Ultrasonic Examination of Aluminum-Alloy Wrought Products for Aerospace Applications             |
| ASTM B 660  | Packaging/Packing of Aluminum and Magnesium Products                                             |
| ASTM E 1417 | Liquid Penetrant Examination                                                                     |
| ASTM G 34   | Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)         |
| ASTM G 47   | Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy Products |

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS 2355 or MAM 2355.

TABLE 1 - Composition

| Element                 | min       | max  |
|-------------------------|-----------|------|
| Zinc                    | 7.5       | 8.2  |
| Magnesium               | 2.0       | 2.4  |
| Copper                  | 1.3       | 1.9  |
| Chromium                | 0.12      | 0.18 |
| Iron                    | --        | 0.12 |
| Manganese               | --        | 0.10 |
| Silicon                 | --        | 0.10 |
| Titanium                | --        | 0.06 |
| Other Impurities, each  | --        | 0.05 |
| Other Impurities, total | --        | 0.15 |
| Aluminium               | remainder |      |

### 3.2 Condition:

The product shall be supplied in the following condition:

- 3.2.1 Die Forgings: Solution and precipitation heat treated to an overaged condition (-T74 temper).
- 3.2.2 Hand Forgings: Solution heat treated, stress relieved by compressing to produce a 1 to 5% permanent set, and precipitation heat treated to an overaged condition (-T7452 temper).

3.2.2.1 Other amounts of permanent set may be used for stress relieving parts of unusual geometry or for other parts when specified on the engineering drawing or approved by the cognizant engineering organization.

3.2.3 Forging Stock: As ordered by the forging manufacturer.

### 3.3 Heat Treatment:

Forgings, prolongations, or test coupons representing the forgings shall be heat treated as follows; pyrometry shall be in accordance with AMS 2750.

3.3.1 Solution Heat Treatment: Heat to  $875^{\circ}\text{F} \pm 10$  ( $468^{\circ}\text{C} \pm 6$ ), hold at heat for 60 minutes per inch (25 mm) of thickness but not less than 60 minutes, and quench in room temperature water ( $100^{\circ}\text{F}$  ( $38^{\circ}\text{C}$ ) maximum).

3.3.2 Holding Period: Hold at room temperature for 48 to 72 hours prior to precipitation heat treatment.

3.3.3 Recommended Precipitation Heat Treatment: Heat to  $250^{\circ}\text{F} \pm 10$  ( $121^{\circ}\text{C} \pm 6$ ), hold at heat for 10 hours  $\pm 1$ ; increase temperature to  $325^{\circ}\text{F} \pm 5$  ( $163^{\circ}\text{C} \pm 3$ ), hold at heat for 7 hours  $\pm 0.5$ , cool in air (See 8.1).

### 3.4 Properties:

Forgings, prolongations, or test coupons representing the forgings shall conform to the following requirements after heat treatment and precipitation hardening, determined in accordance with AMS 2355 or MAM 2355:

3.4.1 Tensile Properties: Shall be as follows:

3.4.1.1 Die Forgings: Specimens machined from forgings with axis of specimen in area of gage length varying not more than 15 degrees from parallel to forging flow lines (longitudinal) and specimens machined from forgings with axis of specimen in area of gage length varying not more than 15 degrees from transverse to forging flow lines, heat treated in the indicated thickness, shall have the properties shown in Table 2.

TABLE 2A - Minimum Tensile Properties, Inch/Pound Units

| Nominal Thickness at<br>Time of Heat Treatment<br>Inches | Tensile<br>Strength<br>ksi | Yield Strength at<br>0.2% Offset<br>ksi | Elongation in 4D<br>% |
|----------------------------------------------------------|----------------------------|-----------------------------------------|-----------------------|
| Up to 1.5, incl                                          | 76.0                       | 68.0                                    | 12                    |
| Over 1.5 to 2.0, incl                                    | 75.0                       | 67.0                                    | 12                    |
| Over 2.0 to 2.5, incl                                    | 74.0                       | 66.0                                    | 12                    |
| Over 2.5 to 3.0, incl                                    | 73.0                       | 64.0                                    | 12                    |
| Over 3.0 to 3.5, incl                                    | 72.0                       | 63.0                                    | 12                    |
| Over 3.5 to 3.9, incl                                    | 71.0                       | 61.0                                    | 12                    |
| Over 3.9 to 4.5, incl                                    | 69.0                       | 59.0                                    | 12                    |
| Over 4.5 to 5.0, incl                                    | 68.0                       | 58.0                                    | 12                    |
| Over 5.0 to 5.5, incl                                    | 67.0                       | 56.0                                    | 12                    |
| Over 5.5 to 6.0, incl                                    | 66.0                       | 55.0                                    | 12                    |

TABLE 2B - Minimum Tensile Properties, SI Units

| Nominal Thickness at<br>Time of Heat Treatment<br>Millimeters | Tensile<br>Strength<br>MPa | Yield Strength at<br>0.2% Offset<br>MPa | Elongation in 4D<br>% |
|---------------------------------------------------------------|----------------------------|-----------------------------------------|-----------------------|
| Up to 38, incl                                                | 524                        | 469                                     | 12                    |
| Over 38 to 51, incl                                           | 517                        | 462                                     | 12                    |
| Over 51 to 64, incl                                           | 510                        | 455                                     | 12                    |
| Over 64 to 76, incl                                           | 503                        | 441                                     | 12                    |
| Over 76 to 89, incl                                           | 496                        | 434                                     | 12                    |
| Over 89 to 99, incl                                           | 490                        | 420                                     | 12                    |
| Over 99 to 114, incl                                          | 476                        | 407                                     | 12                    |
| Over 114 to 127, incl                                         | 469                        | 400                                     | 12                    |
| Over 127 to 140, incl                                         | 462                        | 386                                     | 12                    |
| Over 140 to 152, incl                                         | 455                        | 379                                     | 12                    |

3.4.1.1.1 Elongation requirements do not apply to specimens having a gage-length diameter under 0.250 inch (6.35 mm), to specimens immediately adjacent to an abrupt change in section thickness, or to specimens located so that any part of the specimen gage length is within 0.125 inch (3.18 mm) of the trimmed flash line.

3.4.1.2 Hand Forgings: Specimens machined from forgings having an essentially square or rectangular cross-section, heat treated in the indicated thickness, shall have the properties shown in Table 3.

TABLE 3A - Minimum Tensile Properties, Inch/Pound Units

| Nominal Thickness at<br>Time of Heat Treatment<br>Inches | Specimen<br>Orientation | Tensile<br>Strength<br>ksi | Yield<br>Strength at<br>0.2% Offset<br>ksi | Percent<br>Elongation<br>in 4D |
|----------------------------------------------------------|-------------------------|----------------------------|--------------------------------------------|--------------------------------|
| Up to 1.5, incl                                          | Longitudinal            | 76.0                       | 68.0                                       | 12                             |
|                                                          | Long Transverse         | 76.0                       | 68.0                                       | 12                             |
| Over 1.5 to 2.0, incl                                    | Longitudinal            | 75.0                       | 67.0                                       | 12                             |
|                                                          | Long Transverse         | 75.0                       | 67.0                                       | 12                             |
| Over 2.0 to 2.5, incl                                    | Longitudinal            | 74.0                       | 66.0                                       | 12                             |
|                                                          | Long Transverse         | 74.0                       | 66.0                                       | 12                             |
| Over 2.5 to 3.0, incl                                    | Longitudinal            | 73.0                       | 64.0                                       | 12                             |
|                                                          | Long Transverse         | 73.0                       | 64.0                                       | 12                             |
| Over 3.0 to 3.5, incl                                    | Longitudinal            | 72.0                       | 63.0                                       | 12                             |
|                                                          | Long Transverse         | 72.0                       | 63.0                                       | 10                             |
|                                                          | Short Transverse        | 72.0                       | 59.0                                       | 5                              |
| Over 3.5 to 3.9, incl                                    | Longitudinal            | 71.0                       | 61.0                                       | 12                             |
|                                                          | Long Transverse         | 71.0                       | 61.0                                       | 10                             |
|                                                          | Short Transverse        | 71.0                       | 58.0                                       | 5                              |
| Over 3.9 to 4.5, incl                                    | Longitudinal            | 69.0                       | 59.0                                       | 12                             |
|                                                          | Long Transverse         | 69.0                       | 59.0                                       | 10                             |
|                                                          | Short Transverse        | 69.0                       | 57.0                                       | 5                              |
| Over 4.5 to 5.0, incl                                    | Longitudinal            | 68.0                       | 58.0                                       | 12                             |
|                                                          | Long Transverse         | 68.0                       | 58.0                                       | 10                             |
|                                                          | Short Transverse        | 68.0                       | 56.0                                       | 5                              |
| Over 5.0 to 5.5, incl                                    | Longitudinal            | 67.0                       | 56.0                                       | 12                             |
|                                                          | Long Transverse         | 67.0                       | 56.0                                       | 10                             |
|                                                          | Short Transverse        | 67.0                       | 54.0                                       | 5                              |
| Over 5.5 to 6.0, incl                                    | Longitudinal            | 66.0                       | 55.0                                       | 12                             |
|                                                          | Long Transverse         | 66.0                       | 55.0                                       | 10                             |
|                                                          | Short Transverse        | 66.0                       | 53.0                                       | 5                              |

TABLE 3B - Minimum Tensile Properties, SI Units

| Nominal Thickness at<br>Time of Heat Treatment<br>Inches | Specimen<br>Orientation | Tensile<br>Strength<br>MPa | Yield<br>Strength at<br>0.2% Offset<br>MPa | Percent<br>Elongation<br>in 4D |
|----------------------------------------------------------|-------------------------|----------------------------|--------------------------------------------|--------------------------------|
| Up to 38, incl                                           | Longitudinal            | 524                        | 469                                        | 12                             |
|                                                          | Long Transverse         | 524                        | 469                                        | 12                             |
| Over 38 to 51, incl                                      | Longitudinal            | 517                        | 462                                        | 12                             |
|                                                          | Long Transverse         | 517                        | 462                                        | 12                             |
| Over 51 to 64, incl                                      | Longitudinal            | 510                        | 455                                        | 12                             |
|                                                          | Long Transverse         | 510                        | 455                                        | 12                             |
| Over 64 to 76, incl                                      | Longitudinal            | 503                        | 441                                        | 12                             |
|                                                          | Long Transverse         | 503                        | 441                                        | 12                             |
| Over 76 to 89, incl                                      | Longitudinal            | 496                        | 434                                        | 12                             |
|                                                          | Long Transverse         | 496                        | 434                                        | 10                             |
|                                                          | Short Transverse        | 496                        | 407                                        | 5                              |
| Over 89 to 99, incl                                      | Longitudinal            | 490                        | 420                                        | 12                             |
|                                                          | Long Transverse         | 490                        | 420                                        | 10                             |
|                                                          | Short Transverse        | 490                        | 400                                        | 5                              |
| Over 99 to 114, incl                                     | Longitudinal            | 476                        | 407                                        | 12                             |
|                                                          | Long Transverse         | 476                        | 407                                        | 10                             |
|                                                          | Short Transverse        | 476                        | 393                                        | 5                              |
| Over 114 to 127, incl                                    | Longitudinal            | 469                        | 400                                        | 12                             |
|                                                          | Long Transverse         | 469                        | 400                                        | 10                             |
|                                                          | Short Transverse        | 469                        | 386                                        | 5                              |
| Over 127 to 140, incl                                    | Longitudinal            | 462                        | 386                                        | 12                             |
|                                                          | Long Transverse         | 462                        | 386                                        | 10                             |
|                                                          | Short Transverse        | 462                        | 372                                        | 5                              |
| Over 140 to 152, incl                                    | Longitudinal            | 455                        | 379                                        | 12                             |
|                                                          | Long Transverse         | 455                        | 379                                        | 10                             |
|                                                          | Short Transverse        | 455                        | 365                                        | 5                              |

- 3.4.1.3 Test Coupons: Test coupons shall be removed from fully heat treated forgings from locations indicated by the engineering drawing or from locations acceptable to purchaser and vendor. However, when approved by the cognizant engineering organization, mechanical properties may be determined from prolongations or from separately-forged coupons.

- 3.4.1.3.1 Separately-Forged Coupons and Prolongations: The minimum dimension of each coupon or prolongation shall be forged or machined to a length not less than the minimum dimension of the thickest area of the forging at the time of heat treatment. Separately-forged test coupons or prolongations shall be heat treated with the forgings they represent.
- 3.4.1.4 Forging Stock: When a sample of stock is forged in the same manner as forgings to a test coupon having a degree of mechanical working not greater than the forging and is heat treated with the forgings, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1, 3.4.2, and 3.4.3. If a test specimen taken from the stock after heat treatment with the forgings conforms to the requirements of 3.4.1, 3.4.2, and 3.4.3, the test shall be accepted as equivalent to tests of a forged coupon.
- 3.4.2 Hardness: Forgings shall have hardness not lower than shown in Table 4.

TABLE 4 - Minimum Hardness Values

| Nominal Thickness<br>Inches | Nominal Thickness<br>Millimeters | Hardness<br>HB/10/500 | Hardness<br>HB 10/1000 |
|-----------------------------|----------------------------------|-----------------------|------------------------|
| Up to 3, incl               | Up to 76, incl                   | 140                   | 145                    |
| Over 3 to 4, incl           | Over 76 to 102, incl             | 138                   | 143                    |
| Over 4 to 5, incl           | Over 102 to 127, incl            | 135                   | 140                    |

- 3.4.3 Stress-Corrosion Cracking Resistance: Specimens cut from forgings 0.750 inch (19.05 mm) and over in nominal thickness shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction to 75% of the specified minimum yield strength for the principal test direction (longitudinal for die forgings or long-transverse for hand forgings). Testing shall be in accordance with ASTM G 47.
- 3.4.4 Exfoliation Resistance: At any plane, specimens cut from forgings shall show a level of exfoliation corrosion less than EB as illustrated by Photograph B of Figure 2 of ASTM G 34.
- 3.4.5 Grain Flow of Die Forgings: Except in areas which contain flash-line end grain, grain flow shall follow the general contour of the forgings showing no evidence of re-entrant grain flow.
- 3.5 Quality:

Forgings, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the forgings.