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# AEROSPACE MATERIAL SPECIFICATION



AMS 7904A

Issued APR 1991  
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Superseding AMS 7904

## Beryllium Bars, Rods, Tubing, and Shapes High Ductility Grade

### 1. SCOPE:

#### 1.1 Form:

This specification covers a beryllium in the form of bars, rods, tubing, and machined shapes from vacuum hot pressed powder.

#### 1.2 Application:

Primarily for parts requiring a combination of high strength-to-weight ratio, high modulus of elasticity, and high ductility.

#### 1.3 Precaution:

**WARNING:** Beryllium Product. Inhalation of dust or fumes may cause serious chronic lung disease. Potential cancer hazard based principally on animal tests.

#### 1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

### 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.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

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### 2.1 SAE Publications:

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

AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steel and Corrosion and Heat Resistant Steels and Alloys

### 2.2 ASTM Publications:

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

ASTM E 8 Tension Testing of Metallic Materials

ASTM E 8M Tension Testing of Metallic Materials (Metric)

ASTM E 112 Determining Average Grain Size

### 2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-453 Inspection, Radiographic

MIL-STD-2073-1 DoD Materiel, Procedures for Development and Application of Packaging Requirements

MIL-STD-6866 Inspection, Liquid Penetrant

### 2.4 ANSI Publications:

Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1 Surface Texture

ANSI Y14.5M Dimensioning and Tolerancing

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Composition:

Shall conform to the following percentages by weight shown in Table 1:

TABLE 1 - Composition

Element	min	max
Beryllium Oxide	--	1.0
Aluminum	--	0.06
Carbon	--	0.10
Iron	--	0.08
Magnesium	--	0.06
Silicon	--	0.06
Other Metallic Impurities, each	--	0.04
Beryllium	99.0	--

3.1.1 Beryllium oxide shall be determined by gas fusion; aluminum, iron, magnesium and silicon determined by DC plasma emission spectrometry; carbon determined by combustion; and beryllium determined as the difference.

### 3.2 Condition:

Hot pressed with secondary options of heat treatment, stress relief, and/or hot isostatic pressing (HIP) after hot pressing.

3.2.1 Surface Finish: The product shall be furnished with a machined surface. Surface finish shall be no greater than 110 Ra [125 microinches (3.2  $\mu$ m) rms], determined in accordance with ANSI B46.1.

### 3.3 Properties:

The product shall conform to the following requirements:

3.3.1 Tensile Properties: Shall be as follows, determined at room temperature in accordance with ASTM E 8 or ASTM E 8M.

Tensile Strength, minimum	42 ksi (290 MPa)
Yield Strength at 0.2% Offset, minimum	30 ksi (207 MPa)
Elongation in 4D, minimum	3.0%

3.3.2 Grain Size: Shall average no larger than 20 microns (20  $\mu$ m), determined in accordance with ASTM E 112, using the intercept method at 500X magnification.

### 3.4 Quality:

The product, 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 product.

## 3.4.1 Soundness:

3.4.1.1 The product shall be free from cracks, determined as in 3.4.2.1 and 3.4.2.2.

3.4.1.2 Density: Shall be at least 99.0% of theoretical density, determined using the water displacement method. Density determination shall be accurate to the second decimal place or better.

3.4.1.2.1 Theoretical density shall be calculated using the following formula:

$$\text{Theoretical Density (gm/cm}^3\text{)} = \frac{100\%}{\frac{100-\%BeO}{1.8477 \text{ gm/cm}^3} + \frac{\%BeO}{3.009 \text{ gm/cm}^3}} \quad (\text{Eq.1})$$

3.4.1.3 Radiographic Inspection: Radiographic inspection, to a penetrameter sensitivity of 2%, shall be performed in accordance with MIL-STD-453; however, exceptions are taken to the penetrameter contrast requirement and applicable area of penetrameter density ranges of +30% or -15% from the density at penetrameter location(s).

3.4.1.3.1 Radiographic indications (voids or inclusions) shall conform to the following requirements:

3.4.1.3.1.1 Maximum Dimension of any Indication: Any dimension of any indication, measured in the plane of the radiograph, shall not exceed 0.030 inch (0.76 mm).

3.4.1.3.1.2 Maximum Average Dimension of any Indication: The average dimension of an indication shall be the arithmetic average of the maximum and minimum dimensions, measured in the plane of the radiograph, and shall not exceed 0.020 inch (0.51 mm).

3.4.1.3.1.3 Total Combined Volume Per Cubic Inch (16.4 cm<sup>3</sup>) of all Indications: The total combined volume per cubic inch (16.4 cm<sup>3</sup>) of all indications, with an average dimension larger than 0.001 inch (0.03 mm), shall not exceed the volume of a 0.050 inch (1.27 mm) diameter sphere.

3.4.1.3.1.4 The minimum detectable size of voids and inclusions will increase as the section thickness increases, (See 8.1).

- 3.4.1.3.1.5 Part Density Uniformity: The terms variable density areas, banding or striations denote relatively large areas of a radiograph, which vary in density as compared to the surrounding area. These areas shall not vary in radiographic density by more than 5% compared to the surrounding area of comparable section thickness. Suspect areas shall be re-radiographed and interpreted with the appropriate penetrameter beryllium of 5% in thickness placed as follows:
- a. Less dense (darker radiograph) areas shall be covered by the penetrameter. The radiograph of the covered area shall appear lighter than that of the adjacent area.
  - b. More dense (lighter radiograph) areas shall have the penetrameter placed immediately adjacent to them. The radiograph of the covered area shall appear lighter than that of the suspect more-dense area.
- 3.4.1.3.1.6 Discrete high density (light radiograph) indications, or areas in product 1.000 inch (25.40 mm) and under in nominal thickness, which are 5% or less in radiographic density variation compared to the surrounding material, are acceptable.
- 3.4.2 Surface Condition:
- 3.4.2.1 Visual: No restrictions to size or number of visual imperfections if they do not hold fluorescent penetrant dye.
- 3.4.2.2 Surface Indications: Penetrant inspection shall be performed in accordance with MIL-STD-6866, Type 1, Level 2, Method B, Form A.
- 3.4.2.2.1 Individual Indications: Shall not exceed 0.050 inch (1.27 mm) in major dimension.
- 3.4.2.2.2 Frequency: Any one square inch (6.45 cm<sup>2</sup>) shall contain no more than three indications measuring 0.003 to 0.050 inch (0.08 mm to 1.27 mm) in major dimension.
- 3.5 Tolerances:
- Product shall conform to the dimensions and dimensional tolerances specified in the purchase order and applicable drawings. If tolerances are not specified, the following standard tolerances in accordance with ANSI Y14.5M shall apply.

TABLE 2A - Tolerances

Dimension	Inches		Tolerance	Tolerance
			Inch plus	Inch minus
Diameter, Width or Thickness	Up to	3, incl	0.016	0.000
Diameter, Width or Thickness	Over	3 to 20, incl	0.062	0.000
Diameter, Width or Thickness	Over	20	0.250	0.000
Length	Up to	20, incl	0.125	0.000
Length	Over	20	0.250	0.000

TABLE 2B - Tolerances (SI)

Dimension	Millimeters		Tolerance	Tolerance
			Millimeters plus	Millimeters minus
Diameter, Width or Thickness	Up to	76, incl	0.41	0.00
Diameter, Width or Thickness	Over	76 to 508, incl	1.57	0.00
Diameter, Width or Thickness	Over	508	6.35	0.00
Length	Up to	508, incl	3.18	0.00
Length	Over	508	6.35	0.00

#### 4. QUALITY ASSURANCE PROVISIONS:

##### 4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

##### 4.2 Classification of Tests:

Tests for all technical requirements are acceptance tests and shall be performed on each lot as applicable.

##### 4.3 Sampling and Testing:

Shall be in accordance with the following; a lot shall consist of all product manufactured from a single hot-pressed billet and in the same condition as defined in 3.2: