SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 7903A

Issued APR 1991
Revised SEP 2001

Superseding AMS 7903

Beryllium Bars, Rods, Tubing, and Shapes
4.25Be0 - 94Be
High Micro-Yield Strength

1. SCOPE:

1.1 Form:

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

1.2 Application:

These products have been used typically for parts requiring a combination of high strength-to-weight ratio, high micro-yield strength, high modulus of elasticity, and excellent dimensional stability, but usage is not limited to such applications.

1.3 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.

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

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

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, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 8 Tension Testing of Metallic Materials
ASTM E 8M Tension Testing of Metallic Materials (Metric)
ASTM E 112 Determining Average Grain Size
ASTM E 1417 Liquid Penetrant Examination
ASTM E 1742 Radiographic Examination

2.3 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI B46.1 Surface Texture
ANSI Y14.5M Dimensioning and Tolerancing

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1.

TABLE 1 - Composition

Element	min	max
Beryllium Oxide	4.25	--
Aluminum	--	0.16
Carbon	--	0.25
Iron	--	0.25
Magnesium	--	0.08
Silicon	--	0.08
Other Metallic Impurities, each	--	0.10
Beryllium	94.0	--

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 µm) 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 shown in Table 2, determined at room temperature in accordance with ASTM E 8 or ASTM E 8M:

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	60 ksi (414 MPa)
Micro-Yield Strength	9.0 ksi (62 MPa)

3.3.1.1 Micro-Yield Strength: The stress required to produce a permanent strain of 1.0×10^{-6} inch/inch (cm/cm). The test procedure consists of repeated static loading and unloading the test specimen. The stresses are higher on each succeeding cycle and any permanent strain is recorded to the accuracy of 0.1×10^{-6} after each cycle. The procedure is repeated until the permanent strain is higher than 1.0×10^{-6}.

3.3.2 Grain Size: Shall average no larger than 10 microns (10 µm), 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 or 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 Equation 1:

$$\text{Theoretical Density } (\text{gm/cm}^3) = \frac{100\%}{\frac{100 - \%\text{Be0}}{1.8477 \text{gm/cm}^3} + \frac{\%\text{Be0}}{3.009 \text{ gm/cm}^3}} \quad \text{(Eq. 1)}$$

3.4.1.3 Radiographic Inspection: Radiographic inspection, to a penetrameter sensitivity of 2%, shall be performed in accordance with ASTM E 1742; 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 dimension, 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^3) of All Indications: The total combined volume per cubic inch (16.4 cm^3) of all detectable radiographic indications shall not exceed the volume of a 0.050 inch (1.27 mm) diameter sphere (e.g., total spherical volume shall not exceed 6.5 x 10^{-5} in^3 [1.07 mm^3]). For calculation purposes, assume all indications are spherical.

3.4.1.3.1.4 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% as compared to the surrounding area of comparable section thickness. Suspect areas shall be re-radiographed and interpreted with the appropriate penetrameter or 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 areas shall appear lighter than that of the suspect more-dense area.

3.4.1.3.1.5 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 ASTM E 1417, Type 1, Level 2.

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^2) shall contain no more than three indications measuring 0.003 to 0.050 inch (0.08 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 shown in Table 3 in accordance with ANSI Y14.5M, shall apply:

TABLE 3A - Tolerances, Inch/Pound Units

Feature	Size, Inches	Tolerance, Inch plus	Tolerance, 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 3B - Tolerances, SI Units

Feature	Size, Millimeters	Tolerance, Millimeters plus	Tolerance, 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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests:

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, processed at the same time to the same condition as defined in 3.2:

4.3.1 Composition: Not less than one sample from each lot.

4.3.2 Tensile Properties: Not less than one longitudinal and one transverse round specimen from each lot at any location.

4.3.3 Grain Size: Not less than one of the broken tensile specimens from each lot.

4.3.4 Micro-Yield Strength: Not less than one longitudinal and one transverse round specimen from each lot, at any location.

4.3.5 Density: Each hot pressed billet.

4.3.6 Radiographic and Penetrant Inspection: Each part, unless a sampling plan has been agreed upon by purchaser and vendor.

4.3.7 Tolerances: Each part, unless a sampling plan has been agreed upon by purchaser and vendor.

4.4 Reports:

The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, tensile properties, and grain size of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 7903A, serial numbers, and quantity.