SAE Aerospace
An SAE International Group

# AEROSPACE MATERIAL SPECIFICATION

AMS 7904C

Issued APR 1991
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Superseding AMS 7904B

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

RATIONALE

AMS 7904C is a Five Year Review and update of this specification.

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 modulus of elasticity, and high ductility, 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 that 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: Inhaling dust or fumes may cause chronic beryllium disease, a serious chronic lung disease, in some individuals. Cancer hazard. Over time, lung disease and cancer can be fatal. Target organ is primarily the lung

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.





**TO PLACE A DOCUMENT ORDER:** **Tel: 877-606-7323 (inside USA and Canada)**
**Tel: 724-776-4970 (outside USA)**
**Fax: 724-776-0790**
**Email: CustomerService@sae.org**
**SAE WEB ADDRESS:** **http://www.sae.org**

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), 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 International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, or www.astm.org.

| | |
|---|---|
| ASTM E 8 | Tension Testing of Metallic Materials |
| ASTM E 112 | Determining Average Grain Size |
| ASTM E 1417 | Liquid Penetrant Examination |
| ASTM E 1742 | Radiographic Examination |

2.3 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, or www.asme.org.

| | |
|---|---|
| ASME B46.1 | Surface Texture |
| ASME Y14.5M | Dimensioning and Tolerancing |

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1; beryllium oxide shall be determined by gas fusion; aluminum, iron, magnesium, silicon, and other elements by spectrochemical methods; and carbon by combustion. Beryllium shall be determined by difference. In case of disputes between analysis by different spectrochemical methods, IC plasma shall govern.



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 Elements, each (3.1.1) | -- | 0.04 |
| Beryllium | 99.0 | -- |

3.1.1 Determination is not required for routine acceptance of each lot.

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

If surface finish is not specified, the material shall be furnished with an as-sawed, as HIP, and/or machined surface. Machined surfaces shall have surface finish no greater than 110 Ra [125 microinches (3.2 µm) rms], determined in accordance with ASME 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.

TABLE 2 - MINIMUM TENSILE PROPERTIES

| Property | Value |
|---|---|
| Tensile Strength | 42.0 ksi (290 MPa) |
| Yield Strength at 0.2% Offset | 30.0 ksi (207 MPa) |
| Elongation in 4D | 3.0% |

3.3.2 Grain Size

Shall average no larger than 20 microns (20 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:

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

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). The decision to accept or reject may be made directly beneath the IQI/Shim combination.

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 $cm^3$) 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 0.000065 $in^3$ [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% 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. (Note: The minimum detectable size of voids and inclusions will increase as the section thickness increases)

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 ASME 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 |