



AEROSPACE MATERIAL SPECIFICATION	AMS7908	REV. D
	Issued	1991-10
	Revised	2015-01
Superseding AMS7908C		
Beryllium Near-Net Preforms Standard Grade Hot Isostatic Pressed		

RATIONALE

AMS7908D results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers beryllium in the form of bar, rod, tubing, and shapes fabricated from beryllium powder consolidated by hot isostatic pressing (HIP).

1.2 Application

This product has been used typically for parts requiring high strength-to-weight ratio and high modulus of elasticity, 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

Inhaling dust or fumes containing beryllium may cause chronic beryllium disease, a serious chronic lung disease, in some individuals. Over time, lung disease can be fatal. Read the product specific Safety Data Sheet (SDS) for additional environmental, health and safety information before working with beryllium or beryllium-containing materials.

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.

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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), www.sae.org.

AMS2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels 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, www.astm.org.

ASTM E8 / E8M Tension Testing of Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E1417 Liquid Penetrant Testing

ASTM E1742 Radiographic Examination

2.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), 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 analyses by different spectrochemical methods, emission spectroscopy shall govern.

Table 1 - Composition

Element	min	max
Beryllium Oxide	--	1.5
Carbon	--	0.15
Iron	--	0.13
Aluminum	--	0.10
Magnesium	--	0.08
Silicon	--	0.06
Other Elements, each (3.1.1)	--	0.04
Beryllium	98.5	--

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

3.2 Condition

Hot isostatically pressed (HIP) with secondary options of heat treatment and/or stress relief after hot isostatic 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)], 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 E8 / E8M with the rate of strain set at 0.005 inch/inch/minute (0.005 mm/mm/minute) and maintained within a tolerance of ±0.002 inch/inch/minute (0.002 mm/mm/minute) through the 0.2% offset yield strain and may be increased thereafter to 0.05 inch/inch/minute (0.05 mm/mm/minute).

Table 2 - Minimum tensile properties

Property	Value
Tensile Strength	60 ksi (414 MPa)
Yield Strength at 0.2% Offset	43.0 ksi (296 MPa)
Elongation in 4D	3%

3.3.2 Average Grain Size

Shall be no larger than 20 microns (20 μm), determined in accordance with ASTM E112, 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 Density

Shall be at least 99.0% of theoretical density, determined by the water displacement method. The accuracy of density determination shall be to the second decimal, or better.

3.4.1.1 The theoretical density shall be calculated using Equation 1:

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

(Eq. 1)

3.4.1.2 Thermally Induced Porosity (TIP) Resistance

3.4.1.2.1 Sample product shall be subjected to a TIP test consisting of a heat treatment in inert atmosphere or under vacuum at 1450 °F (788 °C) for 1 hour.

3.4.1.2.2 The minimum density allowed following the TIP heat treatment shall be 99.0% of the theoretical density, calculated as shown in 3.4.1.2.1. The maximum drop in the density due to the TIP resistance test shall be 0.20%.

3.4.2 Radiographic Inspection

Radiographic inspection to a penetrameter sensitivity of 2% shall be performed in accordance with ASTM E1742; 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.

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

3.4.2.1.1 Maximum Dimension of Any Indication

Any dimension of any indication, measured in the plane of the radiograph, shall not exceed 0.050 inch (1.27 mm).

3.4.2.1.2 Maximum Average Dimension of Any Indication

The average dimension of any indication shall be the arithmetic average of the maximum and minimum dimensions, measured in the plane of the radiograph, and shall not exceed 0.030 inch (0.76 mm).

3.4.2.1.3 Total Combined Volume Per Cubic Inch (16.4 cm³) of All Indications

The total combined volume per cubic inch (16.4 cm³) 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 cubic inches [1.07 mm³]). For calculation purposes, assume all indications are spherical.

3.4.2.1.4 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 reradiographed 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 area shall appear lighter than that of the suspect more-dense area.

3.4.2.1.4.1 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.)

3.4.3 Surface Condition

The product shall be free from cracks, determined as in 3.4.3.1 or 3.4.3.2.

3.4.3.1 Visual

No restrictions to size or number of visual imperfections if they do not hold fluorescent penetrant dye and are acceptable in accordance with 3.4.2.2 and dimensional tolerance requirements.

3.4.3.2 Surface Indications

Penetrant inspection shall be performed in accordance with ASTM E1417, Type 1, Level 2.

3.4.3.2.1 Individual Indications

Shall not exceed 0.050 inch (1.27 mm) in major dimension.

3.4.3.2.1.1 Frequency

Any 1 square inch (6.45 cm²) 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 so specified, tolerances shown in Table 3 shall apply in accordance with ASME Y14.5M (See 8.2).

Table 3A - Dimensional tolerances, inch/pound units

Dimension	Inches	Tolerance, Inch	
		plus	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 - Dimensional tolerances, SI units

Dimension	Millimeters	Tolerance, Millimeters	
		plus	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 producer of the product shall supply all samples for producer'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 be all product manufactured from a specific powder lot and HIP cycle in the same condition.

4.3.1 Composition

Not less than one sample from each lot.

4.3.2 Tensile Properties

Not less than one round specimen from each lot at any location.