

AEROSPACE MATERIAL SPECIFICATION

Beryllium Sheet and Plate 98Be

(Composition similar to UNS R19801)

1. SCOPE:

1.1 Form:

This specification covers beryllium in the form of sheet and plate produced by hot rolling beryllium block.

1.1.1 Sheet: Thickness 0.020 to 0.250 inch (0.51 to 6.35 mm), inclusive.

1.1.2 Plate: Thickness over 0.250 inch (6.35 mm).

1.2 Application:

These products have 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 Classification:

There are three sheet classifications based on flatness tolerances (See 3.5.5).

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.

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

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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.

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 Steels and Corrosion and Heat Resistant Steels and Alloys
AMS-STD-2154 Inspection, Ultrasonic, Wrought Metals, Process for

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 1417 Liquid Penetrant Examination
ASTM E 1742 Radiographic Examination

2.3 ASME Publications:

Available from ASME, Order/Inquiries, P.O. Box 2300, Fairfield, NJ 07007-2300 or www.asme.org.

ASME B46.1 Surface Texture, Surface Roughness, Waviness and Lay
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, and silicon by DC plasma emission spectrometry; and carbon by combustion. Beryllium shall be determined by difference.

TABLE 1 - Composition

Element	min	max
Beryllium Oxide	--	2.0
Aluminum	--	0.16
Carbon	--	0.15
Iron	--	0.18
Magnesium	--	0.08
Silicon	--	0.08
Other Metallic Impurities, each	--	0.04
Beryllium	98.0	--

3.2 Condition:

Hot rolled, stress relieved, ground, and etched.

3.2.1 The product shall be furnished with a machined surface. The standard surface finish shall be no greater than 55 Ra (63 microinches (3 μ m)), 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 specified in Table 2, determined at room temperature in accordance with ASTM E 8 or ASTM E 8M.

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

Normal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 1 Inch %
0.020 to 0.250, incl	70	50.0	10
Over 0.250 to 0.450, incl	65	45.0	4
Over 0.450 to 0.600, incl	60	40.0	3
Over 0.600	40.0	30.0	1

TABLE 2B - Minimum Tensile Properties, SI Units

Normal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 25.4 mm %
0.51 to 6.35, incl	483	345	10
Over 6.35 to 11.43, incl	448	310	4
Over 11.43 to 15.24, incl	414	276	3
Over 15.24	276	207	1

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 The product shall be free from cracks and internal defects, determined as in 3.4.1.1, 3.4.1.2, 3.4.1.3, and 3.4.1.4.

3.4.1.1 Visual: No restrictions to size or number of visual imperfections if they do not hold fluorescent penetrant dye.

3.4.1.2 Fluorescent Penetrant Inspection: Shall be performed in accordance with ASTM E 1417, Type 1, Level 2. The maximum allowable size and number of indications per side in a 12-inch (305-mm) square area shall be as shown in Table 3:

TABLE 3A - Fluorescent Penetrant Inspection Requirements, Inch/Pound Units

Indication Size Inch	Maximum Acceptable Number of Indications
Up to 0.003, incl	Not counted unless in a cluster where visible with no magnification
Over 0.003 to 0.005, incl	5 - no more than two in a 2-inch diameter circle.
Over 0.005 to 0.010, incl	3 - at least 2 inches apart.
Over 0.010	0

TABLE 3B - Fluorescent Penetrant Inspection Requirements, SI Units

Indication Size Millimeters	Maximum Acceptable Number of Indications
Up to 0.08, incl	Not counted unless in a cluster where visible with no magnification
Over 0.08 to 0.13, incl	5 - no more than two in a 51-mm diameter circle.
Over 0.13 to 0.25, incl	3 - at least 51 mm apart.
Over 0.25	0

- 3.4.1.3 Ultrasonic Inspection: When specified, product shall be subjected to ultrasonic inspection in accordance with AMS-STD-2154, except that a beryllium reference block may be used, and shall meet Class AA requirements of AMS-STD-2154.
- 3.4.1.3.1 If a material other than beryllium is used as the reference block, the difference in attenuation, noise level, and velocity shall be taken into account.
- 3.4.1.4 Radiographic Inspection: When specified, product shall be subjected to radiographic inspection in accordance with ASTM E 1742, to a penetrameter sensitivity of 2% except as specified by 3.4.1.4.1, and shall meet the acceptance criteria of 3.4.1.4.2, 3.4.1.4.3, and 3.4.1.4.4.
- 3.4.1.4.1 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).
- 3.4.1.4.2 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 in³ [1.07 mm³]). For calculation purposes, assume all indications are spherical.
- 3.4.1.4.3 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 with beryllium of 5% in thickness, placed as follows:
- 3.4.1.4.3.1 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.
- 3.4.1.4.3.2 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.

3.4.1.4.4 Discrete high density (light radiograph) indications, or areas in product 1.000 inch (25.40 mm) and under in nominal thickness, shall not exceed 5% in radiographic density variation compared to the surrounding material.

3.5 Tolerances:

Shall conform to the dimensions and dimensional tolerances established by the purchase order and applicable drawings. If tolerances are not so specified, standard tolerances in accordance with ASME Y14.5M, as shown in Table 4, shall apply.

3.5.1 Thickness:

TABLE 4A - Thickness Tolerances, Inch/Pound Units

Thickness Inch	Tolerance Inch plus	Tolerance Inch minus
0.020 to 0.025, incl	0.003	0.003
Over 0.025 to 0.034, incl	0.004	0.004
Over 0.034 to 0.056, incl	0.005	0.005
Over 0.056 to 0.070, incl	0.006	0.006
Over 0.070 to 0.078, incl	0.007	0.007
Over 0.078 to 0.093, incl	0.008	0.008
Over 0.093 to 0.109, incl	0.009	0.009
Over 0.109 to 0.125, incl	0.010	0.010
Over 0.125 to 0.140, incl	0.012	0.010
Over 0.140 to 0.171, incl	0.014	0.010
Over 0.171 to 0.250, incl	0.015	0.010
Over 0.250 to 0.351, incl	0.015	0.010
Over 0.351 to 0.451, incl	0.020	0.010
Over 0.451 to 0.600, incl	0.025	0.015

TABLE 4B - Thickness Tolerances, SI Units

Thickness Millimeters	Tolerance Millimeter plus	Tolerance Millimeter minus
0.51 to 0.64, incl	0.08	0.08
Over 0.64 to 0.86, incl	0.10	0.10
Over 0.86 to 1.42, incl	0.13	0.13
Over 1.42 to 1.78, incl	0.15	0.15
Over 1.78 to 1.98, incl	0.18	0.18
Over 1.98 to 2.36, incl	0.20	0.20
Over 2.36 to 2.77, incl	0.23	0.23
Over 2.77 to 3.18, incl	0.25	0.25
Over 3.18 to 3.56, incl	0.30	0.25
Over 3.56 to 4.34, incl	0.36	0.25
Over 4.34 to 6.35, incl	0.38	0.25
Over 6.35 to 8.92, incl	0.38	0.25
Over 8.92 to 11.46, incl	0.51	0.25
Over 11.46 to 15.24, incl	0.64	0.38

- 3.5.1.1 Thickness measurements on sheet 1.0 inch (25 mm) or more in width, shall not be conducted closer to any edge than 0.375 inch (9.52 mm). There shall be no restriction of thickness measurement location for sheet under 1.0 inch (25 mm) wide.
- 3.5.2 Width: Shall not vary more than plus 0.125 inch (3.18 mm), minus 0.
- 3.5.3 Length: Shall not vary more than plus 0.250 inch (6.35 mm), minus 0.
- 3.5.4 Straightness: Maximum edgewise curvature (depth of arc) shall not exceed 1/16 inch/foot (5.2 mm/m) of length, measured in the plane of the sheet.
- 3.5.5 Flatness: Shall not vary more than shown in Table 5, determined by methods agreed upon by purchaser and vendor.

TABLE 5A - Flatness Tolerances, Inch/Pound Units

Thickness, Inches	Class 1	Class 2	Class 3
Up to 0.040, incl	2%	1%	0.030 inch per foot
Over 0.040 to 0.250, incl	1%	1/2%	0.030 inch per foot
Over 0.250	1%	1/2%	N/A

TABLE 5B - Flatness Tolerances, SI Units

Thickness, Millimeters	Class 1	Class 2	Class 3
Up to 1.02, incl	2%	1%	2.5 mm/m
Over 1.02 to 6.35, incl	1%	1/2%	2.5 mm/m
Over 6.35	1%	1/2%	N/A

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product shall supply 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 be all product manufactured from a single billet processed at the same time, in the same condition as defined in 3.2, and presented for vendor's inspection at one time.

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 specimen from each lot, taken from any location.