

S-65-H **BERYLLIUM GRADE**

Effective: April 11, 2018

Rev. B

1. SCOPE

This specification defines the requirements for a structural grade of hot isostatic pressed beryllium block which is designated S-65-H.

2. CHEMICAL COMPOSITION

2.1. The chemical composition shall conform to the following:

Beryllium Assay, % minimum (1)	99.2
Beryllium Oxide, % maximum (2)	0.9
C, % maximum (4)	0.09
Al, % maximum (3)	0.05
Fe, % maximum (3)	0.08
Mg, Cr, each % maximum (3)	0.01
Ni, Cu, Ti, Zr, each, % maximum (3)	0.025
Zn, Mn, Ag, Co, Pb, Ca, Mo, each, % maximum (3)	0.005
Silicon, % maximum (3)	0.045
U, % maximum (5)	0.015
Other Metallic Impurities, each, % maximum (3)	0.04

- Note:
- (1) Difference (i.e. 100%-other elements)
 - (2) Leco Inert Gas Fusion
 - (3) Spectrochemical Methods
 - (4) Leco Combustion
 - (5) Glow Discharge Mass Spectrometry, Neutron Activation Analysis or Fluorescence

3. DENSITY

3.1. The minimum bulk density shall be 99.7% of Theoretical Density.

3.2. The theoretical density is to be calculated using the following formula:

$$\text{Theoretical Density} = \frac{100}{\frac{100 - \% \text{ BeO}}{1.8477} + \frac{\% \text{ BeO}}{3.009}} \text{ g/cc}$$

3.3. Density shall be determined using the water displacement method.

4. THERMALLY INDUCED POROSITY(TIP)

4.1 A sample from each HIP'd lot or sample material from material produced as an integral part (prolongation) of each HIP'd shape shall be subjected to a TIP test consisting of a heat treatment in a predominantly inert atmosphere at a temperature of 1450°F(788°C).

4.2 The minimum material density allowed following the TIP treatment shall be 99.7% of the theoretical density, calculated as shown in section 3.2, The maximum drop in the density due to the tip test is 0.20%

5. TENSILE PROPERTIES

5.1 Minimum tensile properties for the material at room temperature, as determined per ASTM E8, and MAB-205 M shall be:

Ultimate Tensile Strength, ksi (MPa), minimum	50.0 (345)
Yield Strength (0.2% offset), ksi (MPa), minimum	30.0 (207)
Elongation (% in 4 diameters). minimum	2.0

6. PENETRANT INSPECTION

6.1. Penetrant and Visual Acceptance Criteria

A. Cracks are not permissible.

B. Pores (as determined by penetrant):

1. The sizes of an individual pore on the surface may not exceed 0.050" (1.27 mm).
2. A maximum of 3 pores of the size 0.003" to 0.050" (0.076mm to 1.27mm) per square Inch (645mm²) of the surface is acceptable.
3. No restrictions to size or number if they do not hold penetrant.

6.2 Penetrant inspection shall be performed per ASTM-E-1417, using penetrant and a dry developer conforming to MIL-I-25135, Type I, Level 2, Method B, Form A. Personnel performing this inspection shall be certified in accordance with AMS-410 and MIL-STD-410.

7. RADIOGRAPHIC INSPECTION

7.1. 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). Unless otherwise specified, accept/ reject decisions shall include areas directly beneath the penetrameter(s).

Note: Due to the nature of radiographic inspection, it is pointed out that the sensitivity of the inspection method decreases with increasing material thickness.

7.2. Radiographic indications (voids and/or inclusions) shall conform to the requirements as established and defined below

7.2.1. Requirements.

Material shall conform to the following requirements, as defined in 7.2.2.

	Maximum	
Maximum	Average	Total Combined Volume
Dimension	Dimension	per Cubic Inch
0.030 inch	0.020 inch	Sphere 0.050 inch diameter
(0.76 mm)	(0.51 mm)	(Sphere 1.27 mm diameter)

7.2.2. Dimensions:

7.2.2.1. 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).

7.2.2.2. 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. The average dimension of an indication shall not exceed 0.020 inch (0.051 mm).

7.2.2.3. Total Combined Volume per Cubic Inch of all Indications.

The total combined volume per cubic inch of all indications with an average dimension larger than 0.001 inch (0.025 mm) shall not exceed the volume of a sphere of the indicated volume.

7.2.2.4. The minimum detectable size of voids and inclusions will increase as the section thickness increases, due to the decrease sensitivity referred to in paragraph 7.1.

7.2.2.5. Part Density Uniformity.

The terms variable density areas, banding or striations shall 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.

7.2.2.6. Light high density indications or areas in material 1.000" (25.4 mm) thick or less, which are 5% or less in radiographic density compared to the surrounding material, are radiographically acceptable.

8. GRAIN SIZE

8.1. The average grain size shall be determined in accordance with ASTM E-112, using the intercept method at 500x magnifications.

8.2. The average grain size shall not exceed 15 microns.

9. TOLERANCES

9.1. Materials furnished under this specification shall conform to the dimensions and dimensional tolerances as established by the purchase order and applicable drawings. If tolerances are not specified by purchase order, the following standard tolerances shall apply employing ANSI Y 14.5M:

Diameter, Width or Thickness, Inches	Tolerance
Up to 3, inclusive	-0 + 1/64 (0.40 mm)
Over 3 to 20, inclusive	-0 + 1/16 (1.59 mm)
Over 20	-0 + 1/4 (6.35 mm)

Length, Inches	Tolerance
Up to 20, inclusive	-0 + 1/8 (3.18 mm)
Over 20	-0 + 1/4 (6.35 mm)

10. SURFACE FINISH

10.1. The materials shall be furnished with a machined surface. The standard surface finish shall be 125 micro inches rms. (Approximately = 110 micro inches Ra) maximum, employing ANSI/ASME B46.1.

11. REPORTS

11.1. Certification of Compliance with this specification will be furnished on request and, when specified, actual test results will be certified. Testing in accordance with individual customer instructions will be performed, if mutually acceptable and actual test results will be certified.

12. MARKING

12.1. Surface area permitting, each part will be legibly marked employing an electroetching technique or tagging if insufficient area is available.

12.2. Marking is to include the following:

Materion Brush Inc. (MBI)

Lot and/or Part Number

Serial Number

Specification Number

X-Ray Number

Purchase Order Number

Warning Beryllium

13. SAFETY / ENVIRONMENTAL

13.1 Handling Beryllium Containing Material in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Safety Data Sheet (SDS) before working with this material. For additional information on safe handling practices or technical data on Beryllium Containing Material, contact the Materion EH&S Hotline @ 216-383-4019 (USA) or 800-862-4118 (International).