

NATIONAL STOCKPILE
PURCHASE SPECIFICATION

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Federal Emergency Management Agency

BERYLLIUM METAL, HOT-PRESSED POWDER BILLET

Grade A
Type 1 and Type 2

I. DESCRIPTION

This specification covers beryllium metal hot-pressed powder billet suitable for use by the Department of Defense and the Department of Energy in weapon production.

II. Requirements

All metal purchased under this specification shall be weldable beryllium in billet form produced by vacuum hot-pressed powder metallurgy.

Recycling of machine chips or scrap beryllium without first remelting shall not be accepted.

Every billet shall be inspected. Any billet which fails to comply with any specification requirement shall be rejected.

The billet shall be 30-36 inches in diameter and 38-46 inches in length.

A. Chemical Composition

Chemical analysis methods to be used must be approved by the procuring activity.

The billet shall comply with the following chemical requirements:

		<u>Percent by Weight</u> <u>(Dry Basis)</u>

Beryllium	Minimum	98.0
Beryllium Oxide	Maximum	1.5
*Aluminum	Maximum	0.07
*Iron	Maximum	0.12
Carbon	Maximum	0.10
Magnesium	Maximum	0.08
Silicon	Maximum	0.08
Sulfur	Maximum	0.04
Uranium	Maximum	0.04
Nickel	Maximum	0.04
Chromium	Maximum	0.04
Manganese	Maximum	0.04
Copper	Maximum	0.04
Titanium	Maximum	0.04

*The iron to aluminum ratio shall be maintained within the acceptable window shown in Figure 1.

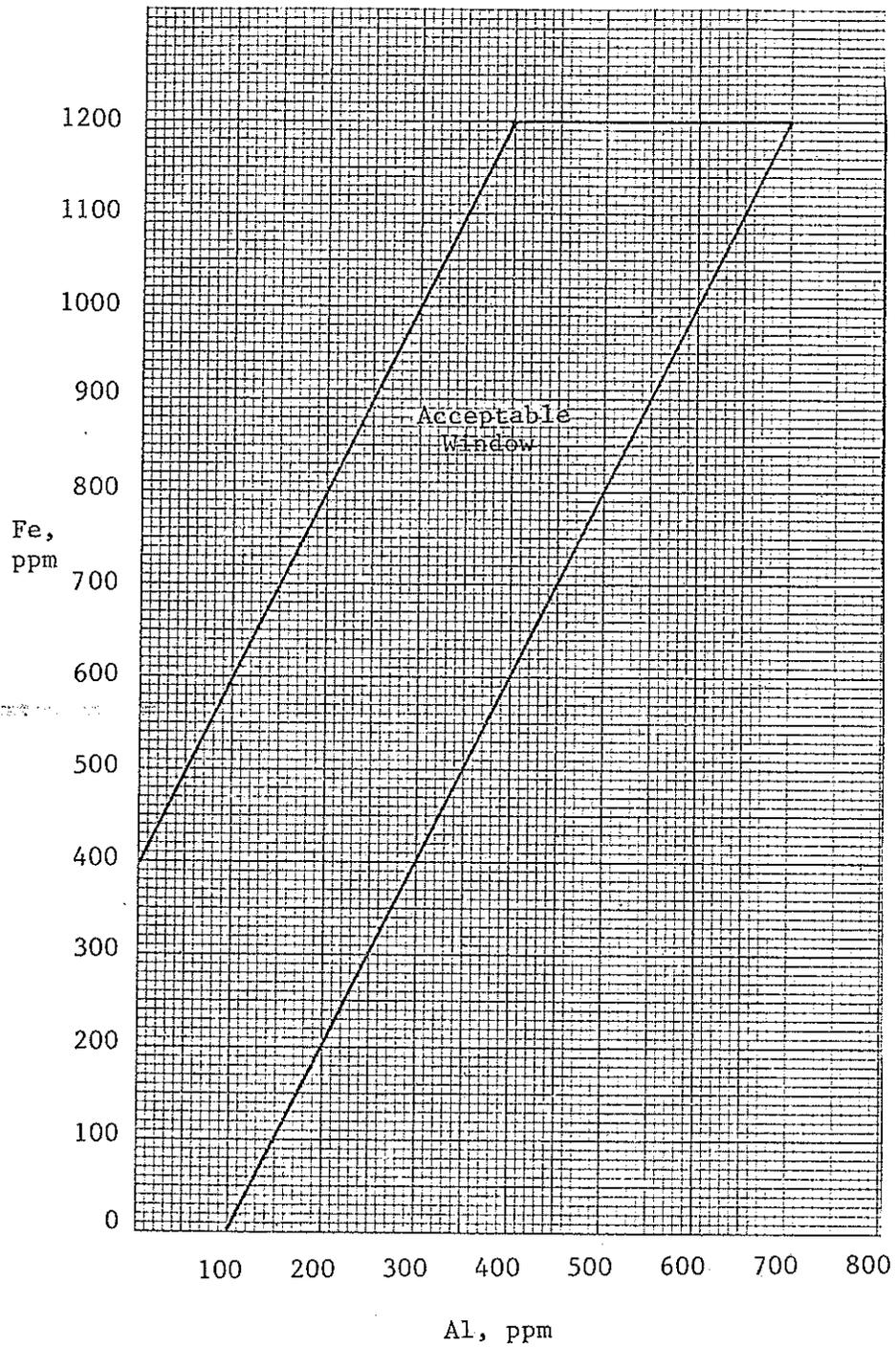


Figure 1

B. Bulk Density

The billet shall have a minimum bulk density of 99.3% of theoretical density calculated as follows:

$$\text{Theoretical Density} = \frac{100}{\frac{100 - \% \text{ BeO}}{1.847} + \frac{\% \text{ BeO}}{3.009}} \text{ gm/cc}$$

The bulk density test shall be performed on the complete billet prior to test sample removal.

The billet shall be tested by immersion in distilled water at a temperature of 16C to 24C. Measure the actual temperature of the water to within ± 0.6C and determine the true density from the following table:

Degrees C	Density (g/cc)	Degrees C	Density (g/cc)
15	0.99913	21	0.99802
16	0.99897	22	0.99780
17	0.99880	23	0.99756
18	0.99862	24	0.99732
19	0.99843	25	0.99707
20	0.99823	26	0.99681

C. Mechanical Properties

The billet shall comply with the following mechanical requirements:

<u>Property</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Direction 1/</u>
<u>Room Temperature</u>			
*Yield strength, KSI 2/			
Type 1	30	38	L&T
Type 2	28	38	L&T
Ultimate tensile strength, KSI 2/	40		L&T
Elongation, % @ 4 x diameter	1.0 2.0		L T
*Ratio of Yield Strength to Ultimate Tensile Strength		0.9	
<u>1200F</u>			
Elongation, % @ 4 x diameter	8.0		T

*Yield strength is tensile strength at the upper yield point or at the 0.2% offset, whichever is greater.

1/ L - longitudinal: Long dimension of billet.

T - transverse: Short dimension of billet (diameter).

2/ KSI - thousand psi

Tensile test procedures shall follow MAB-205-M, except tests at room temperature shall be conducted using a constant head motion of 0.0028 inch/minute $\pm 10\%$. An extensometer shall be used to measure strain. The extensometer is not required for tests at 1200F and a faster head motion may be used.

Tensile specimens shall be prepared following MAB-205-M, Section 2, and conform to Figure 2. End-loading during machining shall not exceed 5000 psi.

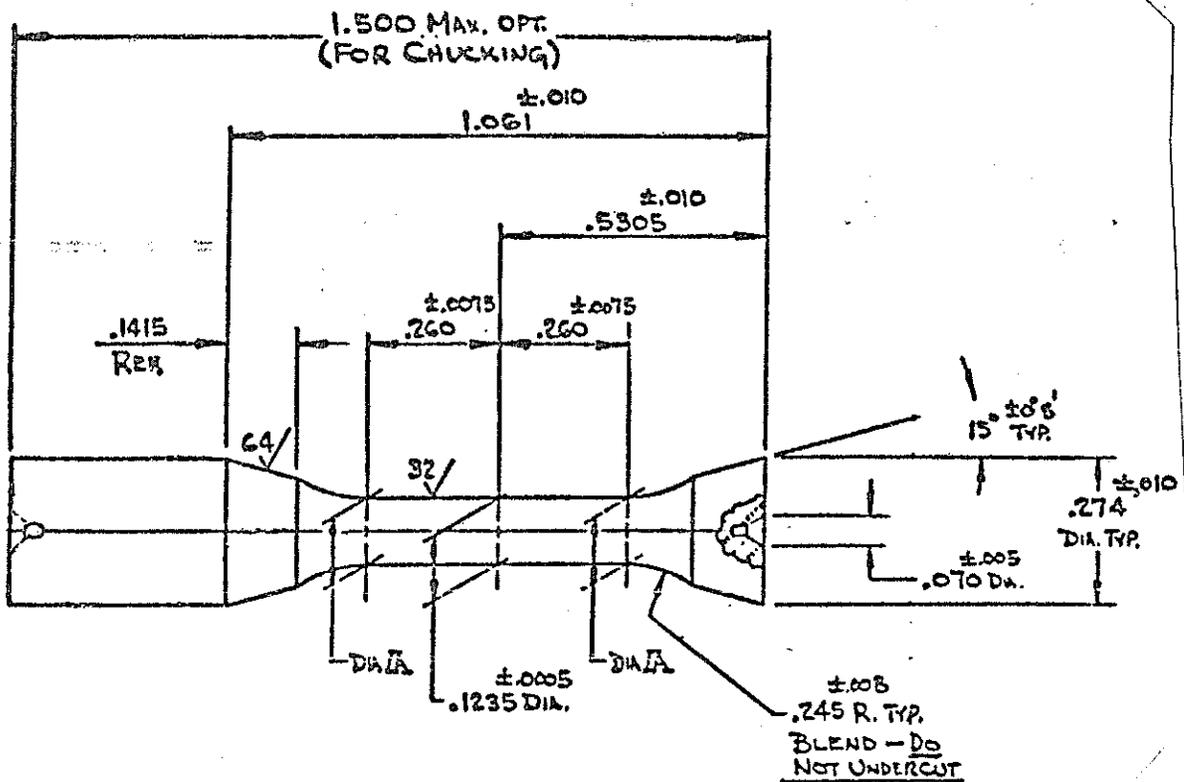


Figure 2

D. Grain Size

The average grain size shall be 25 microns or less using the ASTM intercept technique. The maximum grain size shall be 125 microns.

The metal shall have a uniform grain structure. Duplex grain structure that would reduce the ability of the metal to yield and redistribute stresses shall not be accepted.

Test specimens shall be prepared using ASTM E3. Photomicrographs (4 x 5 inches minimum) taken at 300x magnification shall be prepared using ASTM E2. The average grain size shall be determined using the ASTM E112 intercept technique. The maximum grain size shall be determined from the photomicrograph.

E. Internal and External Condition

The skin of each billet shall be removed to a depth that will expose material complying with specification requirements.

The billet shall be examined for surface defects by fluorescent penetrant inspection using MIL-I-6866, current revision. The billet shall be free of all cracks and pores greater than 0.010 inch. Three 0.010 inch pores will be permitted within any one-inch circle. Up to 10 pores larger than 0.010 inch in size may be removed by blending to a maximum depth of 0.050 inch.

The billet shall be clean, solid, uniform in quality and condition, free of foreign materials and internal and external imperfections detrimental to the performance of fabricated parts. Ultrasonic discontinuity indications in excess of the response from a 5/64 inch flat-bottomed hole at the estimated discontinuity depth shall not be accepted. Minor surface defects caused by handling will not be cause for rejection.

F. Powder Purity

A random half-pound sample of the final-blended powder shall be obtained from each lot prior to pressing. The powder shall be examined by radiographic inspection. The maximum inclusion count shall not exceed the following:

Inclusion Size (Inches)	Frequency (Maximum Permitted)
Greater than 0.005 and up to and including 0.010	100
Greater than 0.010 and up to and including 0.020	8
Greater than 0.020 and up to and including 0.030	4
Greater than 0.030	0

III. SAMPLING, INSPECTING, AND TESTING

Test specimens for grain size, chemical and mechanical properties shall be taken from samples which have been machined from the top and bottom of the billet. The top sample shall be machined from a core approximately 2-3/4 inches by 3-1/2 inches long which has been removed from the billet center. The bottom sample shall be machined from a chord approximately 1-3/4 inches into the billet.

The number of test specimens to be prepared from the top and bottom sample of each billet shall be the following:

Chemistry:	1 each
Mechanical:	2 each Longitudinal - room temperature
	2 each Transverse - room temperature
	1 each Transverse - 1200F
Grain Size:	1 each

If one or more specimens fail to comply with specification requirements, two additional samples may be tested. If either specimens fails in retest, the billet shall be rejected.

Inspecting and testing shall be under the direction of the procuring activity.

IV. PACKAGING, MARKING, AND SHIPPING

A. Packaging

Each billet shall be wrapped with polyethylene not less than 0.004 inch in thickness and sealed. Each billet shall be packed in a new wood crate meeting MIL-C-104A, Style A, Class II modified to be stackable two-high and with internal cradle and brace, and with no vent.

B. Marking

Each billet shall have the letter "A" and appropriate Type (1 or 2) and serial (lot) number etched on each end.

Each side and both ends of the crate shall be legibly marked with permanent ink using capital letters not less than 3/4 inch in height and of equal height. Marking shall include the following:

- "Vacuum Hot-Pressed Beryllium"
- "Grade A"
- "Type (1 or 2)"
- Gross and Net Weights
- Billet Serial (Lot) Number
- Acquisition Contract Number
- Purchase Specification and Date
- "Handle With Care"
- "Stack Only Two High"
- Date Packed

C. Shipping

The crated billet shall be loaded, braced, and blocked in the carrier's conveyance in compliance with applicable rules and regulations set forth in the carrier's classification and other tariffs.

For rail shipments, the applicable rules and regulations published by the Association of American Railroads in Pamphlet Nos. 4 and 14, and Circular No. 42, latest revisions, shall be followed.

Identifying documents shall accompany each billet during shipment. A Certificate of Analysis reporting all test results shall be enclosed in each crate. An additional Certificate of Analysis shall be furnished for each billet delivered.

V. PRECAUTIONS

A warning similar to the following shall be attached to each side of the crate:

BERYLLIUM PRODUCT

DANGER: DUST OR FUMES HAZARDOUS IF INHALED

This product is beryllium. Inhalation of concentrations of beryllium in excess of occupational standards described below can cause serious lung disorders. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational exposures. In summary, OSHA requires that:

1. Daily time-weighted average exposure over an 8-hour day not exceed 2 micrograms of beryllium per cubic meter of air, and
2. Short-term exposures greater than 5 but no greater than 25 micrograms per cubic meter may be permitted for a total of no more than 30 minutes during an 8-hour work period.

If sampling or processing produces dust or fumes, use only with exhaust ventilation or other controls designed to meet OSHA standards.

Use - For manufacturing purpose only.