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NATIONAL STOCKPILE
PURCHASE SPECIFICATION

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With Approval of
Federal Emergency Management Agency

BERYLLIUM METAL, HOT-PRESSED POWDER BILLET

Instrument Grades

I. DESCRIPTION

This specification covers beryllium metal hot-pressed powder billet suitable for use by the Department of Defense and other government agencies primarily in guidance components.

II. REQUIREMENTS

All metal purchased under this specification shall be instrument grade beryllium in billet form produced by vacuum hot-pressing beryllium powder*.

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

A. Chemical Composition

The billet shall comply with the following chemical requirements:

* All beryllium acquired under this specification shall conform to the chemical and physical properties identified in this specification. The material may be produced by methods other than vacuum hot-pressing provided written certification of satisfactory performance of the material is provided to the acquiring agency. Written certification of actual satisfactory performance in the intended components shall be obtained from the manufacturer of those components. The written certification shall be obtained by the supplier of beryllium and provided to the acquiring agency prior to contract award.

| | | <u>Percent by Weight</u> <u>(Dry Basis)</u> | |
|-----------------|---------|--|-----------------------|
| | | <u>Grade B</u> | <u>Grade C</u> |
| Beryllium | Minimum | 98.0 | 94.0 |
| Beryllium Oxide | | 2.2 Max. | 9.0 Max. 4.25 Min. |
| Aluminum | Maximum | 0.10 | 0.16 |
| Iron | Maximum | 0.15 | 0.25 |
| Carbon | Maximum | 0.15 | 0.25 |
| Magnesium | Maximum | 0.08 | 0.08 |
| Silicon | Maximum | 0.08 | 0.08 |
| Sulfur | Maximum | 0.04 | 0.10 |
| Uranium | Maximum | 0.04 | 0.10 |
| Nickel | Maximum | 0.04 | 0.10 |
| Chromium | Maximum | 0.04 | 0.10 |
| Manganese | Maximum | 0.04 | 0.10 |
| Copper | Maximum | 0.04 | 0.10 |
| Titanium | Maximum | 0.04 | 0.10 |

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

B. Bulk Density

The billet shall have a minimum bulk density of 99.6% for Grade B and 99.3% for Grade C 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 billet shall be tested by immersion in distilled water at a temperature of 16°C to 24°C. Measure the actual temperature of the water to within $\pm 0.6^\circ\text{C}$ and determine the true density from the following table:

| <u>Degrees</u> <u>C</u> | <u>Density</u> <u>(g/cc)</u> | <u>Degrees</u> <u>C</u> | <u>Density</u> <u>(g/cc)</u> |
|----------------------------|---------------------------------|----------------------------|---------------------------------|
| 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>Strength</u> KSI ^{2/} Minimum | | <u>Direction</u> ^{1/} |
|---------------------------------|--|-------------------|--------------------------------|
| | <u>Grade B</u> | <u>Grade C</u> | |
| Micro Yield Strength | 5 | 9 | L & T |
| Yield Strength (0.2% offset) | 40 | N/S ^{3/} | L & T |
| Tensile Strength | 55 | 50 | L & T |
| Elongation, % in one inch | 2.0 min. | N/S ^{3/} | L & T |

^{1/} L - longitudinal: longitudinal direction is parallel to the direction of pressing.

T - transverse: Transverse direction is perpendicular to the direction of pressing.

^{2/} KSI - thousand psi

^{3/} Not specified

D. Test Procedures

1. Tensile Test

Tensile test procedures for Grade B shall follow MAB-205-M and ASTM E-8 using an average specimen strain rate of $0.005 \pm .002$ inches/inch/minute. An extensometer shall be used to measure strain. Tensile specimens shall be prepared following MAB-205-M, Section 2, and ASTM E-8 and conform to Figure 1. End loading during machining shall not exceed 5,000 psi. Micro-yield strength (MYS) for Grades B and C shall be measured using procedures specified by the acquiring activity. MYS test specimens shall conform to Figure 2 and be prepared following MAB-205-M, Section 2 using minimum end loading which, in any case, shall not exceed 3,000 psi. The MYS test specimen shall also be used to determine tensile strength for Grade C.

2. Grain Size

Maximum grain size shall not be greater than 80 microns. The average size for Grade B shall be 15 microns or less and for Grade C shall be 8 microns or less using the ASTM E-112, Linear Intercept Method.

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.

Billet Size

| <u>Grade</u> | <u>Diameter</u> | <u>Length</u> |
|--------------|---------------------|-----------------|
| B | 23 to 29 inches | 30 to 45 inches |
| C | 15.5 to 18.5 inches | 19 to 26 inches |

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 in accordance with MIL-I-6866, current revision, and shall be free of all cracks and pores greater than 0.010 inch. A maximum of three 0.010 inch pores are permitted in any one inch circle.

A maximum of 10 pores greater than 0.010 inch in size may be removed by blending to a maximum depth of 0.050 inch.

The billet shall be uniform in quality and condition; clean, sound, and free of foreign materials and from internal and external imperfections detrimental to the performance of fabricated parts. Ultrasonic discontinuity indications in excess of the response from 3/64 inch diameter flat-bottomed hole at the estimated discontinuity depth shall not be accepted. Minor surface defects caused by handling shall 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 for both grades B and C. The powder shall be examined by radiographic inspection. The maximum inclusion count shall not exceed the following:

| <u>Inclusion Size</u> <u>(Inches)</u> | <u>Frequency</u> <u>(Maximum Permitted)</u> |
|--|--|
| 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 |

An inclusion is an X-ray indication whose density is equal to or greater than the film density produced by a 0.030 inch sphere of aluminum examined under the same conditions.

III. SAMPLING, INSPECTING, AND TESTING

Test samples for chemistry, mechanical properties and grain size should be obtained from edge slices or chords removed from the top and bottom of each pressing. The approximate size is 2.75 inches high by 3.0 inches deep. These chords should be taken at the same circumferential location.

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
 2 each Transverse
 Grain Size: 1 each

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

Inspecting and testing shall be under the direction of the acquiring 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 and with internal cradle and brace, and with no vent.

B. Marking

Each billet shall have the appropriate Grade "B" or "C" 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 B or C
Gross and Net Weights
Billet Serial (Lot) Number
Acquisition Contract Number
Purchase Specification and Date
"Handle With Care"
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.

Rules and regulations for shipping will be specified by the acquiring activity.

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.

PRECAUTIONS

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

BERYLLIUM PRODUCT

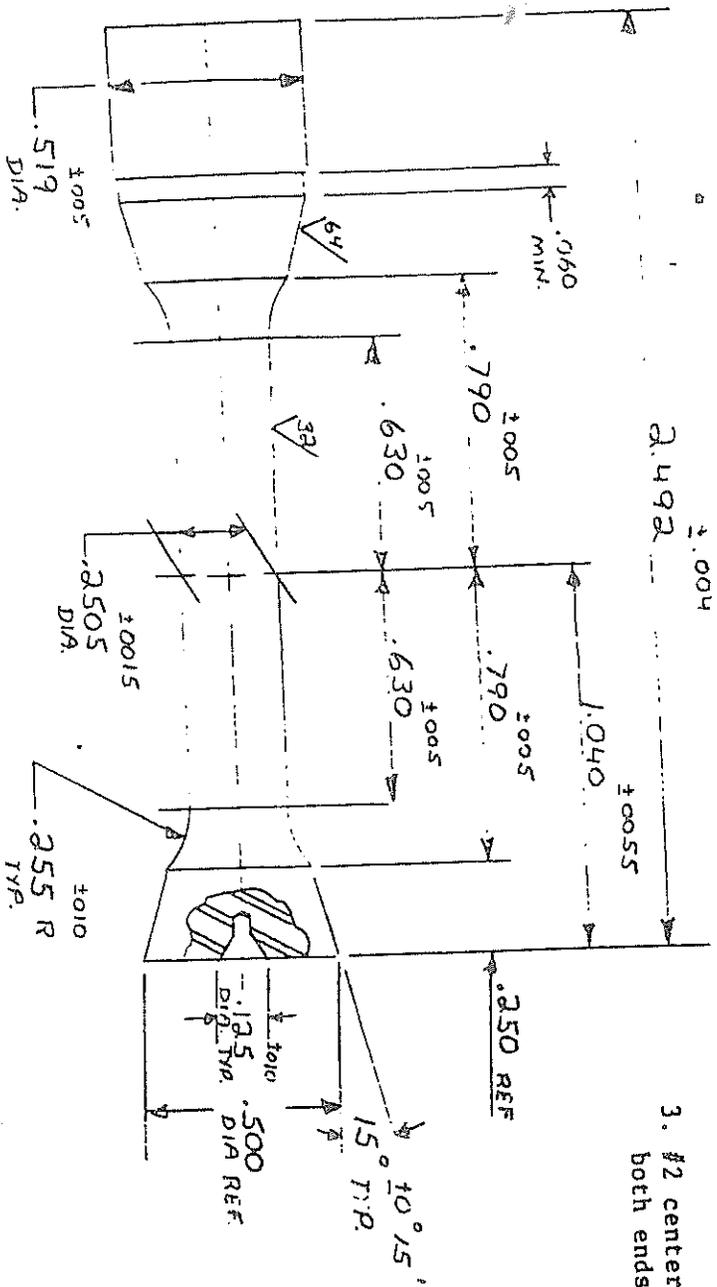
DANGER: DUST OR FUMES HAZARDOUS IF INHALED

This product is beryllium. The Occupational Safety and Health Administration (OSHA) has included beryllium in its list of suspected carcinogens. Inhalation of concentrations of beryllium in excess of occupational standards described below can cause serious lung disorders and may induce cancer. In summary, OSHA requires that:

1. Daily time-weighted average exposure over an 8-hour day not exceed two 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 of processing produces dust or fumes, use only with exhaust ventilation or other controls designed to meet OSHA standards.

Use - For manufacturing purpose only.



- NOTES:
1. Dimensions shown are after acid etch.
 2. Mark all identification on end opposite driven end.
 3. #2 center drill to dia. shown permissible both ends.

FIGURE 2

TITLE: TAPERED END 1/4 DIA.
 MICRO YIELD STRENGTH SPECIMEN
 DATE: June 14, 1985
 SCALE: 2X