

**TUNGSTEN FORGINGS**  
Pressed, Sintered, and Forged

UNS R07005

**1. SCOPE:**

- 1.1 Form: This specification covers tungsten in the form of forgings produced from billets processed by isostatically cold pressing, utilizing hydrogen reduced tungsten powder, and high-temperature sintering.
- 1.2 Application: Primarily for rocket nozzle inserts and other parts exposed to ultra high temperatures.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods  
AMS 2375 - Control of Forgings Requiring First Article Approval  
AMS 2630 - Ultrasonic Inspection, Product Over 0.5 in. (12.5 mm) Thick  
AMS 2645 - Fluorescent Penetrant Inspection

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B311 - Density of Cemented Carbides  
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of  
Metallic Materials  
ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials

SAE Technical Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

AMS documents are protected under United States and international copyright laws. Reproduction of these documents by any means is strictly prohibited without the written consent of the publisher.

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight; carbon shall be determined conductometrically, nitrogen and oxygen by the vacuum fusion or conductometric method, hydrogen by the vacuum extraction method, and metallic elements by spectrographic or other analytical methods approved by purchaser:

|                      | min | max            |
|----------------------|-----|----------------|
| Molybdenum           | --  | 0.010          |
| Carbon               | --  | 0.006          |
| Iron                 | --  | 0.003          |
| Aluminum             | --  | 0.003          |
| Nickel               | --  | 0.002          |
| Silicon              | --  | 0.002          |
| Oxygen               | --  | 0.005 (50 ppm) |
| Nitrogen             | --  | 0.002 (20 ppm) |
| Hydrogen             | --  | 0.001 (10 ppm) |
| Other Elements, each | --  | 0.001          |
| Tungsten             |     | remainder      |

3.2 Condition: Stress relieved and descaled. Forgings shall be stress relieved at such temperatures and for such times and cooling rates as may be necessary to meet the requirements of 3.3 and 3.4.

3.3 Properties: The forgings shall conform to the following requirements:

3.3.1 Hardness: Shall be 36 - 45 HRC, or equivalent, determined in accordance with ASTM E18 on forgings or representative coupons removed from forgings.

3.3.2 Tensile Properties at 400°F (205°C): Shall be as shown in Table I, determined in accordance with ASTM E21 on specimens tested at 400°F  $\pm$  10 (205°C  $\pm$  5).

TABLE I

|                       | Longitudinal          | Transverse            |
|-----------------------|-----------------------|-----------------------|
| Tensile Strength, min | 105,000 psi (725 MPa) | 100,000 psi (690 MPa) |
| Elongation in 4D, min | 10%                   | 4%                    |