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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 7897A

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Superseding AMS 7897

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

REAFFIRMED
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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 Ø 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 ± 10 (205°C ± 5).

TABLE I

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

3.3.3 Bend Ductility: When specified, specimens as in 3.3.3.1, suspended over a 1 in. (25 mm) span and bent by centrally loading at a minimum deflection rate of 0.020 in. (0.5 mm) per min. at 500°F + 10 (260°C + 5), shall develop a minimum bend angle of 45 deg without cracking except that specimens prepared from center web sections or other type of expendable section shall meet temperature and bend angle requirements agreed upon by purchaser and vendor. Loading punch shall have a 1/8 in. (3 mm) diameter contacting surface; support rolls shall be 3/8 in. (9.5 mm) diameter.

3.3.3.1 Longitudinal and transverse bend test specimens 1-1/2 in. ± 0.25 (37.5 mm + 6.25) long x 0.350 in. ± 0.003 (8.75 mm + 0.08) wide x 0.080 in. ± 0.003 (2.00 mm + 0.08) thick shall be prepared from forgings at locations agreed upon by purchaser and vendor. Specimens shall be finished by removing 0.003 - 0.005 in. (0.08 - 0.12 mm) of stock per side by electropolishing or, when agreed upon by purchaser and vendor, a suitable oxidation treatment may be employed.

3.3.4 Density: Shall be as follows, determined in accordance with ASTM B311:
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3.3.4.1 Preforge Billets: Not less than 17.8 g/cm^3.

3.3.4.2 Forgings: Not less than 19.0 g/cm^3.

3.3.5 Grain Size: There shall be no evidence of abnormal grain growth. Stress relieving shall have caused a minimum of recrystallization. Standards for uniformity of grain size within any area of a forging and from area to area shall be as agreed upon by purchaser and vendor.

3.4 Quality:

3.4.1 Forgings, as received by purchaser, shall be uniform in quality and condition, and free from foreign materials and from imperfections detrimental to usage of the forgings.

3.4.2 Each forging shall be fluorescent penetrant inspected in accordance with
Ø AMS 2645 and ultrasonically inspected in accordance with AMS 2630. Standards for acceptance shall be as agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of forgings shall supply all
Ø samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the forgings conform to the requirements of this specification.

4.2 Classification of Tests:
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4.2.1 Acceptance Tests: Tests to determine conformance to requirements for
Ø chemical composition (3.1) and hardness (3.3.1) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for Ø tensile properties (3.3.2), bend ductility (3.3.3), density (3.3.4), and grain size (3.3.5) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all Ø applicable technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement of forgings, substantiating test Ø data and, when requested, preproduction forgings shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be in accordance with the following; a lot shall be all Ø forgings produced from sintered preforge billets formed from one blend of powder.

4.3.1 For Acceptance Tests:

4.3.1.1 Composition: One sample from each lot. Ø

4.3.1.2 Hardness: Each forging or representative coupons from each forging Ø in each lot.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser Ø and vendor.

4.4 Approval: When specified, approval and control of forgings shall be in Ø accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of forgings shall furnish with each shipment a report showing Ø the results of tests for chemical composition of each lot, and stating that the forgings conform to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 7897A, quantity from each lot, part number, and the size and source of stock used to make the forgings.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 7897A, contractor or other direct supplier of forgings, part number, and quantity. When forgings for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of forgings to determine conformance to the requirements of this specification and shall include in the report either a statement that the forgings conform or copies of laboratory reports showing the results of tests to determine conformance.