



AEROSPACE MATERIAL SPECIFICATIONS

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.

485 Lexington Ave., New York, N. Y. 10017

AMS 7897

Issued 9-30-66
Revised

TUNGSTEN FORGINGS Pressed, Sintered, and Forged

1. **ACKNOWLEDGMENT:** A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.
2. **FORM:** Forgings produced from isostatically pressed and high temperature sintered blanks.
3. **APPLICATION:** Primarily for rocket nozzle inserts and other parts exposed to ultra high temperatures.
4. **COMPOSITION:**

	min	max
Tungsten	99.950	--
Molybdenum	--	0.010
Carbon	--	0.006
Oxygen	--	0.006 (60 ppm)
Aluminum	--	0.003
Iron	--	0.003
Copper	--	0.002
Nickel	--	0.002
Silicon	--	0.002
Nitrogen	--	0.002 (20 ppm)
Hydrogen	--	0.001 (10 ppm)
Others, each	--	0.001

- 4.1 Unless otherwise specified, metallic elements shall be determined spectrographically, carbon shall be determined conductometrically, oxygen shall be determined conductometrically or by high temperature (1800 C min) vacuum extraction, nitrogen shall be determined by the Kjeldahl distillation method, and hydrogen shall be determined by the vacuum extraction method. Chemical analyses may be determined from specimen samples removed from material representative of each sinter lot if it can be demonstrated that subsequent forging does not alter the product beyond the composition limits of Section 4.
5. **CONDITION:** Stress relieved and descaled, unless otherwise specified.
6. **TECHNICAL REQUIREMENTS:**
 - 6.1 **Pre-forge Billets:** Shall be processed by isostatically cold pressing, utilizing hydrogen reduced tungsten powder, and high temperature sintering. Unless otherwise specified, billets shall have an as-sintered density not lower than 17.8 g per cu centimeter.
 - 6.2 **Forgings:**
 - 6.2.1 **Heat Treatment:** Forgings shall be stress relieved at such temperatures and for such times and cooling rates as may be necessary to meet the technical requirements of this specification.
 - 6.2.2 **Hardness:** Unless otherwise specified, forgings or representative coupons removed from forgings shall have hardness of Rockwell C 36 - 45 or equivalent.

- 6.2.3 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.
- 6.2.4 Density: Shall be not lower than 19.0 g per cu centimeter. Unless otherwise specified, density shall be determined by the water immersion method on each part or on a representative specimen removed from the forging.
- 6.2.5 Ductile-Brittle Transition:
- 6.2.5.1 Unless otherwise specified, longitudinal and transverse tensile specimens prepared from forgings and tested at a temperature of $400\text{ F} \pm 10$ ($204.4\text{ C} \pm 5.6$) using a strain rate of 0.003 - 0.007 in. per in. per min. to the 0.2% offset yield strength and then at a cross head speed of 0.05 in. per in. per min. to failure shall conform to the properties shown below. Tensile test specimens shall conform to Federal Test Method Standard No. 151, Type R3. The location of tensile test specimens, method of preparation, and frequency of testing shall be as agreed upon by purchaser and vendor.

	Longitudinal	Transverse
Tensile Strength, psi	105,000 min	100,000 min
Elongation, %	10 min	4 min

- 6.2.5.2 When specified, longitudinal and transverse bend test specimens $1\text{--}1/2\text{ in.} \times 0.350\text{ in.} \pm 0.003 \times 0.080\text{ in.} \pm 0.003$ shall be prepared from forgings at locations agreed upon by purchaser and vendor. All specimens shall be finished by removing 0.003 - 0.005 in. of stock per side by electro-polishing or, when agreed upon by purchaser and vendor, a suitable oxidation treatment may be employed.
- 6.2.5.2.1 The specimens of 6.2.5.2, when suspended over a 1 in. span and bent by centrally loading at a minimum deflection rate of 0.020 in. per min., at a temperature of $500\text{ F} \pm 10$ ($260\text{ C} \pm 5.6$), 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 $1/8\text{ in.}$ diameter contacting surface; support rolls shall be $3/8\text{ in.}$ diameter.
7. QUALITY: Parts shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts. Parts shall be subject to inspection techniques such as contrast dye penetrant, fluorescent penetrant, and ultrasonic testing. Techniques and limits of acceptability shall be as agreed upon by purchaser and vendor.
8. SAMPLING:
- 8.1 Unless otherwise specified, one representative forging shall be subjected to destructive testing to evaluate the properties of the material for each new lot of sinter material or when changes in manufacturing procedures (number of forging steps, configurations, temperature cycles, stress relieving, etc.) are considered necessary.
- 8.1.1 Unless otherwise specified, one half-section of each forging destroyed for test as in 8.1 shall be supplied to the purchaser.
- 8.2 Unless otherwise specified, center web or other type expendable section removed from each forging shall be employed to determine conformance to the hardness, grain size, and density requirements.