

Tungsten Heavy Alloy Shapes, Sintered, High Density

RATIONALE

AMS7725E results from a Five-Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers four classes of tungsten heavy metal in the form of sintered and annealed shapes.

1.2 Application

This material has been used for parts, such as counterbalance weights or projectiles, for which mechanical properties are tested from the sintered and annealed shapes and that require high weight per unit volume, but usage is not limited to such applications.

1.3 Classification

Products covered by this specification are classified as follows:

<u>Class</u>	<u>Tungsten, Nominal %</u>
1	90
2	92.5
3	95
4	97

Type 1 - Non-magnetic (See 8.8)

Type 2 - Magnetic (See 8.8)

1.3.1 If no Class is specified Class 1 shall be supplied. If no Type is specified, Type 2 shall be supplied.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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## 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

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## 2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

ASTM B 311 Density of Powder Metallurgy (PM) Materials Containing Less Than Two Percent Porosity

ASTM E 8 / E 8M Tension Testing of Metallic Materials

ASTM E 18 Rockwell Hardness of Metallic Materials

## 3. TECHNICAL REQUIREMENTS

### 3.1 Composition, Density and Hardness

Composition, density and hardness shall be as specified in Table 1.

TABLE 1 - COMPOSITION, DENSITY AND HARDNESS PROPERTIES

Class	Weight percent Tungsten, nominal	Density g/cc	Hardness HRC maximum
1	90	16.85 - 17.30	32
2	92.5	17.15 - 17.85	33
3	95	17.75 - 18.35	34
4	97	18.25 - 18.85	35

#### 3.1.1 Type 1

Shall have a nominal tungsten percentage corresponding to the Class specified with the balance being primarily an alloy of nickel and/or copper.

#### 3.1.2 Type 2

Shall have a nominal tungsten percentage corresponding to the Class specified with the balance being primarily an alloy of nickel, iron, and other elements as required.

### 3.2 Condition

Product shall be supplied either as-sintered, or sintered and annealed. If no condition is specified, either condition may be supplied.

### 3.3 Properties

The product shall conform to the following requirements:

#### 3.3.1 Tensile Properties

Specimens (See 4.3.1) shall conform to the requirements of Table 2 (See 8.2) determined in accordance with ASTM E 8/E 8M.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Class	Type	Ultimate Tensile Strength		Yield Strength at 0.2% Offset		Elongation <sup>A</sup> percent
		ksi	MPa	ksi	MPa	
1	1	94	648	75	517	2
1	2	110	758	75	517	5
2	1	94	648	75	517	2
2	2	110	758	75	517	5
3	1	94	648	75	517	1
3	2	105	724	75	517	3
4	2	100	689	75	517	2

<sup>A</sup> Determine with a Class B2 or better extensometer.

### 3.3.2 Hardness

Hardness as specified in Table 1 shall be determined in accordance with ASTM E 18.

### 3.3.3 Density

Density as specified in Table 1 shall be determined in accordance with ASTM B 311.

### 3.3.4 Magnetic Permeability

When specified (See 8.5), Type I parts shall be measured for magnetic permeability using a Severn gauge or similar equipment. Permeability shall be 1.05  $\mu$ , maximum.

### 3.3.5 Microstructure

Shall be a uniform and homogeneous distribution of tungsten particles in a metallic matrix, when examined at 200X magnification minimum.

### 3.3.6 Annealing (See 8.7)

Parts shall be subjected to post sintering annealing heat treatment in accordance with the following:

Vacuum or inert gas heat treat. Gas, if used, shall meet the requirements of AWS C5.10.

Vacuum level shall be  $10^{-4}$  Torr or lower.

Ramp to 2192 °F  $\pm$  25 (1200 °C  $\pm$  6)

Hold at temperature for 5 to 15 hours.

Forced fan cool using nitrogen\*, helium, or argon gas.

Parts shall be cooled to 932 °F (500 °C) within 5 minutes maximum.

Parts shall be processed on ceramic racks/boats. Contact with carbon based fixture or rack is not permitted.

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\*NOTE: CRACKED AMMONIA IS NOT PERMITTED AS SOURCE OF NITROGEN.

3.3.7 Alternate annealing processes are permissible when approved by the cognizant engineering organization only when demonstrated to produce equivalent physical and mechanical properties to the standard process. Composition shall meet the requirements in Table 1, 3.1.1, and 3.1.2 and shall be performed by any method agreed upon by the supplier and the purchaser.

### 3.4 Quality

Product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from cracks, loose particles, and other imperfections detrimental to usage of the product.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 Responsibility for Inspection

The vendor of shapes shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

### 4.2 Classification of Tests

#### 4.2.1 Acceptance Tests

Tensile properties (3.3.1), hardness (3.3.2), density (3.3.3), microstructure (3.3.4), magnetic permeability (when specified) (3.3.4) and quality (3.4) are acceptance tests and shall be performed on each lot.

#### 4.2.2 Periodic Tests

Composition (3.1) is a periodic test.

### 4.3 Sampling

Shall be in accordance with the following. A lot shall be all sintered shapes formed from one blend of powder and thermally processed in a single batch or a single continuous sinter run.

4.3.1 Tensile properties, hardness, density and microstructure shall be taken from one part per lot. One tensile specimen minimum shall be extracted from the centerline of the thickest portion of the part and tested to show conformance to the requirements of 3.3.1. Where the part is of such a size or shape as to prevent extraction of a tensile specimen, a test block with a nominal thickness of the maximum section thickness of the actual production part, formed from the same blend of powder and thermally processed with the lot may be used and the tensile specimen shall be extracted from that block.

4.3.2 Composition shall be determined from a suitable sized sample of the blended powder used to manufacture the lot of sintered parts.

### 4.4 Approval

4.4.1 Sample sintered shapes from new or reworked master patterns shall be approved by purchaser before shapes for production use are supplied, unless such approval is waived by purchaser.

4.4.2 Vendor shall use ingredients, processing techniques, and methods of inspection on production sintered shapes which are essentially the same as those used on the approved sample shapes. If necessary to make any change in ingredients, processing techniques, or methods of inspection, vendor shall submit for reapproval a statement of the proposed changes in materials, processing, or both and, when requested, sample shapes. Production shapes made by the revised procedure shall not be shipped prior to receipt of reapproval.

### 4.5 Reports

The vendor of shapes shall furnish with each shipment a report showing the results of tests on each lot in the shipment to determine conformance to the acceptance test requirements and stating that the material conforms to the other technical requirements. This report shall include the purchase order number, AMS7725E, lot number, Class, Type (1 or 2), form, size or part number, and quantity.

#### 4.6 Resampling and Retesting

If any specimen used in the above tests fails to meet the specified requirements, disposition of the shapes may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the shapes represented. Results of all tests shall be reported.

### 5. PREPARATION FOR DELIVERY

#### 5.1 Identification

Individual pieces shall have attached a durable tag marked with the purchase order number, AMS7725E, class, type, and nominal size or part number or shall be boxed and the box marked with the same information.

#### 5.2 Packaging

The product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

### 6. ACKNOWLEDGMENT

A vendor shall include this specification number and its revision letter in all quotations and when acknowledging purchase orders.

### 7. REJECTIONS

Product not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

### 8. NOTES

8.1 A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 The minimum property requirements listed in Table 1 have not been substantiated by AMS procedures.

8.3 Terms used in AMS are clarified in ARP1917.

8.4 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.5 Purchase documents should specify not less than the following:

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Material Class (if to be specified)

Material type (if to be specified)

Condition (if to be specified)

Whether magnetic permeability testing is required

Form and size or part number of product desired

Quantity of shapes desired.

- 8.6 Type 1 materials are generally more corrosion-resistant than Type 2 materials. However, both Types may require additional corrosion resistant coatings for corrosion protection.
- 8.7 Annealing is performed to improve mechanical properties, especially % elongation, in thick parts by removing residual hydrogen from sintered forms and to reduce the embrittling effects of residual elements that can accumulate along the tungsten/matrix interface during cooling from sintering.
- 8.8 Common magnetic alloy contain tungsten with transition metals such as nickel, iron or other elements. Common non-magnetic alloys contain tungsten and transition metals such as nickel, copper or other.
- 8.9 Similar Specifications

AMS-T-21014 and ASTM B 777 are listed as similar specifications; however they are typically not used for structural applications. They are listed here for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

PREPARED BY AMS COMMITTEE "G"