

MIL-T-21014D  
 22 August 1986  
 SUPERSEDING  
 MIL-T-21014C  
 26 November 1984

PROPOSED  
 MILITARY SPECIFICATION

TUNGSTEN BASE METAL, HIGH DENSITY

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for four classes of machinable, high density tungsten base metal produced by consolidation of metal powder mixtures whose composition is mainly tungsten. This material may be used for uncoated parts or parts that may be coated with other materials for protection against corrosion and abrasion such as, electrodeposited and vacuum deposited cadmium and electrodeposited chromium. Detailed requirements for coatings should be covered in the applicable part drawing, when required.

1.2 Classification. The tungsten base metal shall be of the following classes (see Tables I and II), as specified (see 6.2.1).

<u>Class</u>	<u>Nominal Percent tungsten</u>
1	90
2	92.5
3	95
4	97

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Systems Engineering and Standardization Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 9540

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## MIL-T-21014D

## SPECIFICATIONS

## FEDERAL

QQ-T-590 - Tool Steel, High Speed

## MILITARY

MIL-N-3944 - Nonferrous Products (Other Than Aluminum, Magnesium, Copper, or Their Alloys), Packaging and Packing of

## STANDARDS

## FEDERAL

FED-STD-151 - Metals, Test Methods

## MILITARY

MIL-STD-129 - Marking for Shipment and Storage

MIL-STD-130 - Identification Marking of U.S. Property

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment document which is current on the date of the solicitation.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 311 - Density of Cemented Carbides  
 ASTM D 3951 - Commercial Packaging  
 ASTM E 3 - Metallographic Specimens, Preparation of  
 ASTM E 8 - Tension Testing of Metallic Materials  
 ASTM E 18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials  
 ASTM E 407 - Microetching Metals and Alloys

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

## MIL-T-21014D

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Materials. The raw materials shall be a mixture of loose metal powders consisting mainly of tungsten and a metallic powder binder such as copper, nickel or iron, which will produce, by sintering, materials meeting the requirements of this specification.

3.2 Composition, physical and mechanical properties. The sintered material shall have properties conforming to Tables I and II as determined on standard test bars.

3.3 Microstructure. The microstructure of each sample part selected shall be a uniform distribution of tungsten particles in a binder metal matrix when viewed at a magnification of 200 times. The location may be specified (see 4.2.3.5).

3.4 Machinability. When specified (see 6.2.1), the machinability of the basic parts or of a suitable test specimen shall be such that it shall pass the test specified in 4.2.4.

3.5 Identification. Each lot and associated test bars shall be clearly marked with a lot serial number in accordance with MIL-STD-130.

### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all the requirements of sections 3 and 5. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of responsibility of assuring

## MIL-T-21014D

that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

#### 4.2 Quality conformance inspection.

4.2.1 Inspection lot. An inspection lot shall consist of a uniform blend from one batch of powder, and submitted for inspection at one time. If a shipment is made from more than one lot, the acquiring activity may choose to consider that shipment as a single inspection lot or may choose to separate the shipment into several inspection lots for acceptance purposes.

4.2.2 Sampling. Unless otherwise specified, a minimum of two sintered test bars and one chemical analysis sample shall be made from each powder lot.

4.2.2.1 Hardness tests. Each test bar shall be tested for conformance with the hardness requirements of Table I (see 4.2.3.1).

4.2.2.2 Density. Each test bar shall be tested for conformance with the density requirements of Table I (see 4.2.3.2).

4.2.2.3 Tension tests. Each test bar shall be tested for conformance with Table II (see 4.2.3.3).

4.2.2.4 Chemical composition. Unless otherwise specified, a chemical analysis sample from each lot shall be tested for the tungsten content in conformance with Table I (see 4.2.3.4).

4.2.2.5 Examination of microstructure. This test shall be accomplished on one of the test bars (4.2.3.5).

#### 4.2.3 Methods for test and examinations.

4.2.3.1 Hardness. Samples shall be tested in accordance with ASTM E 18.

4.2.3.2 Density. The equal water displacement method performed in accordance with ASTM B 311 shall be used.

4.2.3.3 Mechanical properties. Samples shall be tested in accordance with ASTM E 8.

4.2.3.4 Chemical analysis. Analysis of the lot or lots in question shall be made by Method 111 or 112 of FED-STD-151. In case of dispute, chemical analysis by Method 111 shall be the basis for acceptance.

4.2.3.5 Microstructure. A test bar shall be sectioned and a specimen shall be prepared for examination in accordance with ASTM E 3. The specimen may be etched in accordance with ASTM E 407. It shall be examined at 200 magnifications for conformance with 3.3.

## MIL-T-21014D

4.2.4 Machinability. Unless otherwise specified, this test shall be made on a representative sample. Holes, 0.1695 inches in diameter and a minimum of 0.343 inches deep, shall be drilled and tapped with a No. 10-32 high speed steel tap to a minimum full thread of 0.312 inches deep. The tap shall be of high speed steel, conforming to QQ-T-590, Class M-1, heat treated to a hardness of 62-63 HRC. Machinability will be considered acceptable in each class if each of the number of holes indicated in Table III is satisfactorily threaded to a minimum of 60 percent without destruction to the tap.

4.3 Rejection. Failure to conform with any of the requirements of this specification shall be cause for rejection of the lot.

4.4 Examination for preservation, packing and marking. An examination for preservation, packing and marking shall be conducted to determine conformance with Section 5.

## 5. PACKAGING

5.1 Preservation and packing. Preservation and packing shall be in accordance with MIL-N-3944 or ASTM D 3951, as specified (see 6.2.1). The levels of preservation and packing shall be as specified (see 6.2.1).

5.2 Marking. In addition to any special markings (see 6.2.1), each shipment shall be marked in accordance with MIL-STD-129.

## 6. NOTES

6.1 Intended use. Parts are intended for use such as weights or counter balances in static or dynamic balancing, high speed rotating members, radiation shielding, and vibration damping applications.

### 6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Class, when required (see 1.2).
- c. Machinability requirements, if any (see 3.4).
- d. Quantity.
- e. Levels of preservation and packing (see 5.1).
- f. Special markings, if required (see 5.2).
- g. Method of hardness testing, if different from Rockwell "C" (see Table I).
- h. Freedom of parts from magnetic response, if required (see 6.3).

## MIL-T-21014D

6.3 Special applications. For particular applications, properties or requirements other than those specified in Section 3 of this specification may be important. These alloys may contain elements which make them magnetic. Where freedom from magnetic response is required, this should be specified in the acquisition document (see 6.2.1). Class 4 is not available in a non-magnetic grade. For purposes of this specification, non-magnetic characteristics are defined as material having a maximum magnetic permeability of 1.05. Also for special applications involving large sections, methods for determining internal quality, such as mechanical tests on specimens from these larger sections or suitable nondestructive tests may be applied. If required, these additional tests shall be specified in the acquisition document (see 6.2.1).

6.4 Specification sheets. The three specification sheets associated with the previous revision to this document have been cancelled without replacement.

6.5 Subject term (keyword) listing.

Metal

Tungsten

6.6 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:

Navy - AS

Army - MI

Preparing activity:

Navy - AS

(Project 9540-0132)

Review activities:

DLA - IS

## MIL-T-21014D

TABLE I. Composition, density and hardness properties.

Class	Nominal Tungsten (weight percent)	Density (g/cc)	Hardness <sup>1/2/</sup> Rockwell "C" (maximum)
1	90	16.85 - 17.25	32
2	92.5	17.15 - 17.85	33
3	95	17.75 - 18.35	34
4	97	18.25 - 18.85	35

1/ When specified by the acquiring activity, other hardness testing methods may be employed.

2/ For mechanically worked or aged material, the hardness can be as high as R<sub>c</sub>46.

Table II. Mechanical Properties - Minimum Values.<sup>1/</sup>

Class	Ultimate tensile strength (ksi)	Yield strength at 0.2 percent offset (ksi)	Elongation <sup>2/</sup> (percent)
1	110 <sup>3/</sup>	75	5 <sup>3/</sup>
2	110 <sup>3/</sup>	75	5 <sup>3/</sup>
3	105 <sup>3/</sup>	75	3 <sup>3/</sup>
4	100	75	2

1/ These properties only apply to test bars provided in 4.2.2.3. If test bars are machined from the actual production part, there may be deviation from the properties in this table.

2/ Determine with an extensometer accurate to 0.5 percent elongation or less.

3/ Non-magnetic composition conforming to Classes 1, 2 and 3 shall be 94 ksi minimum ultimate tensile strength. Minimum elongation shall be 2 percent on Classes 1 and 2 and 1 percent on Class 3.

## MIL-T-21014D

Table III. Machinability requirements.

Class	Number of Holes
1	8
2	6
3	4
4	2



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**NOTE:** This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

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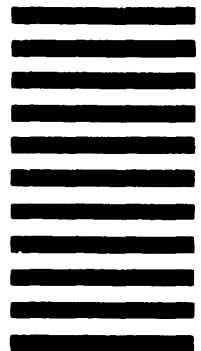
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## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER MIL-T-21014D		2. DOCUMENT TITLE TUNGSTEN BASE METAL, HIGH DENSITY	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)  <input type="checkbox"/> VENDOR  <input type="checkbox"/> USER  <input type="checkbox"/> MANUFACTURER  <input type="checkbox"/> OTHER (Specify): _____	
b. ADDRESS (Street, City, State, ZIP Code)			
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	

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