

INCH-POUND

MIL-DTL-28839A
w/AMENDMENT 1
12 February 2004
SUPERSEDING
MIL-DTL-28839A
22 July 2003

DETAIL SPECIFICATION

WAVEGUIDES, ELLIPTICAL GENERAL SPECIFICATION FOR

THIS SPECIFICATION IS INACTIVE FOR
NEW DESIGN AFTER 8 MAY 1998

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 flexible and semi-rigid waveguides with elliptical inside configuration (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

- | | | |
|-------------|---|---|
| MIL-PRF-131 | - | Barrier Materials, Watervaporproof, Greaseproof, Flexible, Heat-Sealable. |
| MIL-C-5541 | - | Chemical Conversion Coatings on Aluminum and Aluminum Alloys. |
| MIL-F-22191 | - | Barrier Materials, Transparent, Flexible, Heat Sealable. |

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: DSCC-VAT, P.O. Box 3990, Columbus, OH 43216-5000 or e-mailed to TubeFiberOptic@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

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MIL-W-28839/1 - Waveguides, Elliptical, Semi-rigid.

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-129 - Military Marking for Shipment and Storage.
MIL-STD-202 - Electronic and Electrical Component Parts.
MIL-STD-1285 - Marking of Electrical and Electronic Parts.
MIL-STD-1916 - DoD Preferred Methods for Acceptance of Product.
MIL-STD-2073-1 - DoD Standard Practice for Military Packaging.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Service Standardization Document Order Desk, Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094. or available online at www.dodssp.daps.mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-B241/B241M - Aluminum and Aluminum-Alloy, Seamless Pipe and Seamless Extruded tube.
ASTM-B152/B152M - Copper Sheet, Strip, Plate, and Rolled Bar.

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

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), the contractor shall furnish a sample unit for first article inspection and approval (see 4.4 and 6.3).

3.3 Materials. The material shall be as specified (see 3.1). Acceptance or approval of any constituent material shall not be construed as a guaranty of the finished product.

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3.3.1 Aluminum alloy. Aluminum alloys 1060, 1100, 6061, and 6063 shall conform to the chemical composition limits of ASTM B241/B241M. The minimum resistivity shall be as follows:

- a. 1060, 28 micro ohms/centimeter.
- b. 1100, 2.90 micro ohms/centimeter.
- c. 6061, 4.0 micro ohms/centimeter.
- d. 6063, 3.4 micro ohms/centimeter.

3.3.2 Copper. Copper type OF shall conform to ASTM B152/B152M.

3.3.3 Jacket. Waveguide jacket material shall meet or exceed all requirements of this specification (see 6.6).

3.4 Design and construction. Waveguides shall be of the design, construction, and physical dimensions specified (see 3.1).

3.4.1 Finish. The interior and exterior (except for jacketed waveguides) surfaces of the waveguide shall be bright, smooth, dry, and free of scales or oxide. All aluminum alloy waveguides shall be chemically treated in accordance with MIL-C-5541.

3.4.2 Length. The length of the finished waveguide shall be as specified (see 3.1). The waveguide length tolerance shall be in accordance with table I.

TABLE I. Length tolerances.

Waveguide length	Tolerance
(feet)	
0-25	-0 +1 inch
25 or greater	± 2 percent

3.5 Voltage standing wave ratio (VSWR). When waveguides are tested as specified in 4.6.2, the VSWR shall not exceed the value specified (see 3.1).

3.6 Attenuation. When waveguides are tested as specified in 4.6.3, the attenuation shall not exceed the value specified (see 3.1).

3.7 Pressurization (flexible type only). When waveguides are tested as specified in 4.6.4, there shall be no leakage, no distortion of aperture due to pressure, and the pressure shall not have dropped more than 2 lb_f/ft². After the test, the VSWR shall be as specified in 3.5.

3.8 Bending radius (flexible type only). When waveguides are tested as specified in 4.6.5, the bend shall be smooth and continuous without distortion of the cross-sectional aperture. After this test, the VSWR shall be as specified in 3.5.

3.9 Axial twist. When waveguides are tested as specified in 4.6.6, the twist shall be smooth and continuous without distortion of the cross-sectional aperture. After this test, the VSWR shall be as specified in 3.5.

3.10 Vibration, high frequency (flexible type only). When waveguides are tested as specified in 4.6.7, there shall be no mechanical damage to the jacket or the metal structure, as applicable. After this test, the VSWR and attenuation shall be as specified in 3.5 and 3.6, respectively.

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3.11 Shock (specified pulse), (flexible type only). When waveguides are tested as specified in 4.6.8, there shall be no evidence of cracking or separation of the jacket, as applicable. After this test, the VSWR and attenuation shall be as specified in 3.5 and 3.6, respectively.

3.12 Moisture resistance (flexible type only). When waveguides are tested as specified in 4.6.9, there shall be no evidence of cracking or separation of the jacket, as applicable. After this test, the VSWR and attenuation shall be as specified in 3.5. and 3.6, respectively.

3.13 Thermal shock (flexible type only). When waveguides are tested as specified in 4.6.10, there shall be no evidence of damage to the jacket or metal structure. After this test, the VSWR and attenuation shall be as specified, in 3.5 and 3.6, respectively.

3.14 Power handling capability (when specified, see 3.1 and 6.2). When waveguides are tested as specified in 4.6.11, there shall be no evidence of mechanical damage to the metal structure or the jacket, as applicable. After this test, the VSWR shall be as specified in 3.5.

3.15 Surface roughness. When waveguides are tested as specified in 4.6.12, the interior surface roughness shall not exceed the value specified (see 3.1).

3.16 Marking. The waveguide shall be marked in accordance with method I of MIL-STD-1285, with the part number and the manufacturer's source code. The manufacturer's name or trademark may also be marked on the waveguide, provided such letters are not expressly forbidden in the contract. The marking shall be applied with a permanent ink or paint along one side of the waveguide. Not more than 12-inch intervals shall be permitted from the end of one marking to the beginning of the next marking.

3.17 Workmanship. The waveguide shall be free from defects of a nature that may interfere with normal military applications. The waveguide shall be uniform in composition, free from internal and external mechanical imperfections, and shall have a clean, bright appearance in accordance with good commercial practice. The interior surface of the waveguide shall be free from burrs, die marks, dirt, grease, scales, and splinters.

3.18 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

4. VERIFICATION

4.1 Classification of inspections. The inspections specified herein are classified as follows:

- a. Materials inspection (see 4.3).
- b. First article inspection (see 4.4).
- c. Conformance inspection (see 4.5).

4.2 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table II, used in fabricating the waveguide, are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

TABLE II. Materials inspection.

Material	Requirement paragraph	Applicable specification
Aluminum alloy	3.3.1	ASTM B241/B241M
Copper	3.3.2	ASTM B152/B152M
Jacket	3.3.3	(see 6.6)

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4.4 First article inspection. First article inspection shall be performed by the contractor, after award of contract and prior to production, at a location acceptable to the Government. First article inspection shall be performed on a sample unit which has been produced with equipment and procedures normally used in production. First article approval is valid only on the contract under which it is granted, unless extended by the Government to other contracts.

4.4.1 Sample size. One waveguide shall be subjected to first article inspection.

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in table III, in the order shown.

TABLE III. First article inspection.

Inspection	Requirement paragraph	Test method paragraph
Visual and mechanical inspection	3.3 thru 3.4.2, 3.16, and 3.17	4.6.1
VSWR	3.5	4.6.2
Attenuation	3.6	4.6.3
Pressurization <u>1/</u>	3.7	4.6.4
Bending radius	3.8	4.6.5
Axial twist	3.9	4.6.6
Vibration, high frequency <u>1/</u>	3.10	4.6.7
Shock (specified pulse) <u>1/</u>	3.11	4.6.8
Moisture resistance <u>1/</u>	3.12	4.6.9
Thermal shock <u>1/</u>	3.13	4.6.10
Power handling capability <u>2/</u>	3.14	4.6.11
Surface roughness	3.15	4.6.12

1/ Flexible type only.

2/ When specified (see 3.1 and 6.2).

4.4.3 Failures. One failure shall be cause for refusal to grant first article approval.

4.5 Conformance inspection.

4.5.1 Inspection of product for delivery. An inspection of product for delivery shall consist of groups A and B inspection.

4.5.1.1 Inspection lot. An inspection lot shall consist of all the waveguides of the same part number, produced under essentially the same conditions, and offered for inspection at one time.

4.5.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table IV, in the order shown.

TABLE IV. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph
Visual and mechanical inspection	3.3 thru 3.4.2, 3.16, and 3.17	4.6.1
VSWR	3.5	4.6.2
Attenuation	3.6	4.6.3
Pressurization <u>1/</u>	3.7	4.6.4

1/ Flexible type only.

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4.5.1.2.1 Group A sampling plan. Statistical sampling and inspection shall be performed on an inspection lot basis with a random sample of waveguides selected in accordance with table V. Acceptance levels shall be based upon the zero defective sampling plan. No failures shall be permitted.

TABLE V. Group A sampling plan.

Lot size	Sample size
1-13	100 percent
14-150	13
151-280	20
281-500	29
501-1,200	34
1,201-3,200	42
3,201-10,000	50

4.5.1.2.2 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.5.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table VI, in the order shown. The sample for group B inspection shall be selected from inspection lots that have passed the group A inspection.

TABLE VI. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
Bending radius	3.8	4.6.5
Axial twist	3.9	4.6.6
Vibration <u>1/</u>	3.10	4.6.7
Shock (specified pulse) <u>1/</u>	3.11	4.6.8
Moisture resistance <u>1/</u>	3.12	4.6.9
Thermal shock <u>1/</u>	3.13	4.6.10
Power handling capability <u>2/</u>	3.14	4.6.11

1/ Flexible type only.

2/ When specified (see 3.1 and 6.2).

4.5.1.3.1 Group B sampling plan. One length of the production lot shall be tested. If the size of the production lot is greater than 25 pieces, one additional length shall be tested per each 25 additional pieces in the lot.

4.5.1.3.2 Failures. If one or more sample units fail to pass group B inspection, the lot shall be considered to have failed.

4.5.1.3.3 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on the contract.

4.6 Methods of inspection.

4.6.1 Visual and mechanical inspection. Waveguides shall be examined to verify that the materials, design, construction, physical dimensions, finish, length, marking and workmanship are in accordance with the applicable requirements (see 3.3 thru 3.4.2, 3.16 and 3.17).

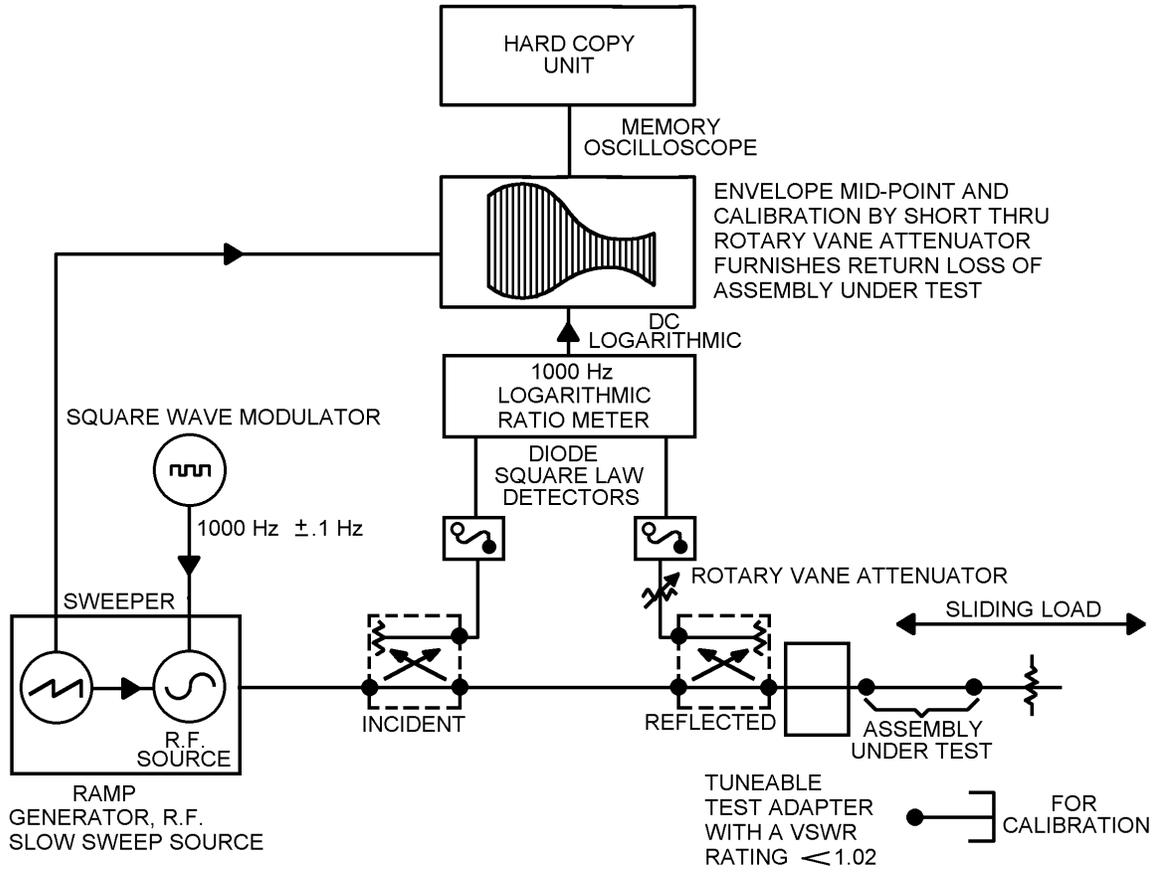


FIGURE 1. VSWR test setup (or equivalent).

4.6.2 Voltage standing wave ratio (VSWR, see 3.5). The VSWR of the waveguide shall be measured over the specified frequency range (see 3.1), using the test set up of figure 1. The test equipment shall be capable of providing a continuous measurement of VSWR over the required frequency range. A means shall be provided for producing a permanent record of the waveguides' VSWR versus frequency. The permanent record shall indicate the worst case VSWR numerically and shall provide the calculation used to obtain the calculated VSWR. The measurement system and permanent record shall provide a minimum accuracy of .03 in VSWR other test method of equal accuracy may be used.

4.6.3 Attenuation (see 3.6). The attenuation of the waveguide shall be measured over the specified frequency range (see 3.1), using the test set-up of figure 2. The test equipment shall be capable of providing a continuous measurement of attenuation over the required frequency range. A means shall be provided to produce a permanent record of the waveguide's attenuation versus frequency. The measurement system and permanent record shall provide a minimum accuracy of .01 dB for the frequency range of 2.60 thru 26.5 GHz and .02 dB for frequency ranges of .32 through 2.60 GHz and 26.5 through 90 GHz. The zero trace is formed by a measurement of the adapters back-to-back (the normalizer could then subtract this attenuation. Other test methods of equal accuracy may be used.

4.6.4 Pressurization (see 3.7). The waveguide shall be subjected to the internal air pressure in pound-force per square foot (lb/ft^2) specified (see 3.1). The pressurization supply shall be disconnected and pressure maintained in the waveguide for 4 hours. At the end of the 4-hour period, the waveguide pressure shall not have dropped more than $2 \text{ lb}/\text{ft}^2$. The VSWR shall be measured while under pressure as specified in 4.6.2.

4.6.5 Bending radius (see 3.8). One end of the waveguide shall be fixed to a stationary platform with the waveguide supported in a horizontal position. The free end of the waveguide shall then be bent around a circular mandrel with the specified radius (see 3.1), to at least a 180-degree bend. A representative sample of the same part number as the waveguide under test may be used for this test. The length of the representative sample shall be sufficient to complete the 180-degree bend. After completion of the bend, the VSWR shall be measured as specified in 4.6.2.

4.6.6 Axial twist (see 3.9). One end of the waveguide shall be fastened to a stationary platform with the waveguide supported in a horizontal position. To prevent the waveguide from bending, a rigid shaft shall be extended through the waveguide and fastened to the stationary platform. The free end of the waveguide shall be twisted through a 90-degree angle. The length of the twisted section shall be as specified (see 3.1). A representative sample of the same part number as the waveguide under test may be used for the axial twist test. The length of the representative sample shall be sufficient to complete the 90-degree twist. After completion of the twist, the VSWR shall be measured as specified in 4.6.2.

4.6.7 Vibration, high frequency (see 3.10). Waveguides shall be tested in accordance with method 204, MIL-STD-202. The following details shall apply:

- a. Mounting - Unless otherwise specified (see 3.1), rigidly mounted to an appropriate nonresonant mounting table.
- b. Electrical load - Not applicable.
- c. Test condition letter - A.
- d. Resonance - Not applicable.
- e. Measurements after vibration - VSWR and attenuation shall be measured as specified in 4.6.2 and 4.6.3, respectively.

4.6.8 Shock (specified pulse (see 3.11)). Waveguides shall be tested in accordance with method 213, MIL-STD-202.

- a. Mounting - Unless otherwise specified (see 3.1), rigidly mounted to test platform.
- b. Test condition letter - G.
- c. Measurements after shock - VSWR and attenuation shall be measured as specified in 4.6.2 and 4.6.3, respectively.

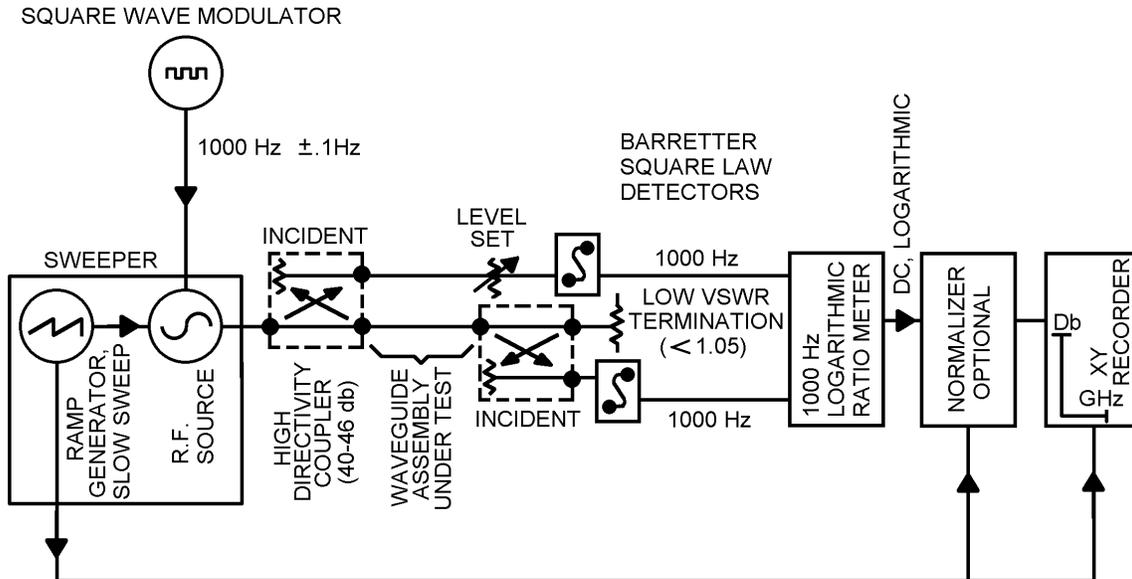


FIGURE 2. Attenuation test setup (or equivalent).

4.6.9 Moisture resistance (see 3.12). Waveguides shall be tested in accordance with method 106, MIL-STD-202. The following details shall apply:

- a. Initial measurements - Not applicable.
- b. Polarization voltage - Not applicable.
- c. Loading voltage - Not applicable.
- d. Measurements after test - VSWR and attenuation shall be measured as specified in 4.6.2 and 4.6.3, respectively.

4.6.10 Thermal shock (see 3.13). Waveguides shall be tested in accordance with method 107, MIL-STD-202. The following details shall apply:

- a. Special mounting - Not applicable.
- b. Test condition letter - A.
- c. Measurements before test - Not applicable.
- d. Measurements after test - VSWR and attenuation shall be measured as specified in 4.6.2 and 4.6.3, respectively.

4.6.11 Power handling capability (when specified, see 3.1 and 6.2) (see 3.14). The waveguide shall be subjected to the radio frequency power level specified (see 3.1) at the frequency, simulated altitude, and temperature specified (see 3.1). Power shall be maintained for 1 hour after the temperature of the waveguide has reached equilibrium (temperature shall not vary more than 5°C within a 15-minute period). During the test, the waveguide shall be terminated in a matched load (1.05 VSWR, maximum). After the test, VSWR shall be measured as specified in 4.6.2.

4.6.12 Surface roughness (see 3.15). The average interior surface roughness of the waveguide shall be measured using a brush type profilometer. A 1-foot length shall be cut in half longitudinally. Then both lateral and longitudinal surface roughness tests shall be made over the entire length of the two halves.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Waveguides covered by this specification are intended for use as radio frequency transmission lines in military services electronic equipment.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification. The complete part number (see 3.1).
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2).
- c. Packaging requirements (see 5.1).
- d. Requirements for power handling capability testing (see 3.1 and 3.14).
- e. When a first article is required for inspection and approval (see 3.2, 4.4 and 6.3).
- f. If unitized loads are required (and not at the option of the contractor).

6.3 First article. The first article should be a preproduction sample, a first production item or it may be a standard production item from the contractor's current inventory. The first article should consist of one unit. The contracting officer should include specific instructions in all procurement instruments, regarding arrangements for examinations, tests, and approval of the first article.

6.4 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. Table VII lists the Environmental Protection Agency (EPA) top seventeen hazardous materials targeted for major usage reduction. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see Section 3).

TABLE VII. EPA top seventeen hazardous materials.

Benzene	Dichloromethane	Tetrachloroethylene
Cadmium and Compounds	Lead and Compounds	Toluene
Carbon Tetrachloride	Mercury and Compounds	1,1,1 - Trichloroethane
Chloroform	Methyl Ethyl Ketone	Trichloroethylene
Chromium and Compounds	Methyl Isobutyl Ketone	Xylenes
Cyanide and Compounds	Nickel and Compounds	

6.5 Subject term (keyword) listing.

axial twist	pressurization
attenuation	power handling
bending radius	semirigid
first article	VSWR
flexible	

6.6 Waveguide jacket material. Historically it has been proven that jacket material conforming to L-P-390, type III, class H has satisfied the requirements of this specification.

6.7 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

Custodian:
Army - CR
Navy - EC
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

(Project 5985-1291)

Review activities:
Army - MI
Navy - OS, SH

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at www.dodssp.daps.mil.