INCH-POUND

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MILITARY SPECIFICATION

TRANSMISSION LINES, TRANSVERSE ELECTROMAGNETIC MODE

This specification is approved by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This document covers the general requirements for Transverse Electromagnetic Mode (TEM) Transmission Lines (see 6.4.14) intended for use in airborne systems.

1.2 Classification. The TEM transmission lines covered by this specification shall consist of the following types and classes (see 6.4.3).

1.2.1 Types.

Type I - Designed for use in the 2.0 - 8.0 GHz range.

Type II - Designed for use in the 2.0 - 16.0 GHz range.

1.2.2 Classes.

Class 1 - Flexible construction.

Class 2 - Semiflexible construction.

Class 3 - Rigid construction.

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 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.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Air Engineering Center, Systems Engineering and Standardization Department (SESD) Code 53, Lakehurst, NJ 08733-5100, 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 5985

SPECIFICATIONS

FEDERAL

QQ-C-530	Copper-Beryllium Alloy Bar, Rod, and Wire (Copper Alloy Numbers 172 and 173)
QQ-S-763	Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
PPP-B-636	Box, Shipping, Fiberboard
PPP-T-60	Tape, Packaging, Waterproof
PPP-T-76	Tape, Pressure Sensitive Adhesive, Packaging/Paper (for Carton Sealing)

MILITARY

MIL-P-116	Preservation, Methods of
MIL-C-5410	Cleaning Compound, Aluminum Surface, Non-Flame-Sustaining
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-C-5756	Cable and Wire, Power, Electric, Portable
MIL-R-81294	Remover, Paint, Epoxy, Polysulfide and Polyurethane Systems

STANDARDS

MILITARY

DOD-STD-100	Engineering Drawing Practices
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-171	Finishing of Metal and Wood Surfaces
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-454	Standard General Requirements for Electronic Equipment

STANDARDS (continued)

MILITARY (continued)

MIL-STD-781	Reliability Tests Exponential Distribution
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-2000	Standard Requirements for Soldered Electrical and Electronic Assemblies
MIL-STD-45662	Calibration Systems Requirements

(Unless otherwise indicated, copies of federal and military specifications, standards and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DOD Cataloging Handbook H4-1	Federal Supply Code for Manufacturers United States and Canada (Name to Code)
DOD Cataloging Handbook H4-2	Federal Supply Code for Manufacturers United States and Canada (Code to Name)

(Copies of Cataloging Handbooks H4-1 and H4-2 are available from the Commander, Defense Logistics Services Center, Battle Creek, MI 49017-3084.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

ELECTRONIC INDUSTRIES ASSOCIATION

EIA RS359	Standard Colors for Color Identification and Coding

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, N.W., Washington, DC 20006.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), 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 Detail specification drawings. The individual TEM transmission line requirements shall be as specified herein and in accordance with the applicable detail specification drawings (see 6.4.4). In the event of any conflict between requirements of this specification and the detail specification drawings, the latter shall govern.

3.1.1 The procuring activity shall generate the detail specification drawings required by this document. The Government reserves the right to review and approve the detail specification drawings when such review is deemed necessary to assure the conformity of the detailed TEM transmission lines to the total system requirements.

3.2 Classification of requirements. The applicable requirements are classified herein as follows:

Requirement	Paragraph
First article	3.3
Material	3.4
Design and construction	3.5
Performance	3.6
Reliability	3.7
Marking	3.8
Workmanship	3.9

3.3 First article. When specified, samples shall be subjected to first article inspection (see 6.3) in accordance with 4.3.

3.4 Materials. Materials shall be as specified herein or in the detail specification drawing; however, when a definite material is not specified, materials used shall meet the performance requirements of this specification. Approval of any constituent material shall not be construed as a guarantee for acceptance of the finished product.

3.4.1 Dissimilar metals. When dissimilar metals are employed in intimate contact with each other, protection against electrolytic corrosion shall be provided as specified in MIL-STD-454, Requirement 16.

3.4.2 Fungus-inert material. Materials shall be fungus resistant and shall be in accordance with MIL-STD-454, Requirement 4.

3.4.3 Solder and soldering. Solder and soldering shall be as specified in MIL-STD-2000, except the solder shall have a minimum solidus temperature of +450°F (+234°C).

3.4.4 Plating of conductive surfaces. Plating may be used on the conductive surfaces, at the manufacturer's option, except that silver surfaces shall not be gold plated.

3.4.5 Contacts.

3.4.5.1 Center contacts. Center contacts shall be made of suitable conductive material that meets the requirements of 3.4.1 when interfaced with copper-beryllium per QQ-C-530. The center contact, the dielectric material, and all other parts shall be permanently captivated in both directions along the axis of the appropriate interfaces.

3.4.5.2 Outer contacts. Outer contacts shall be made of suitable conductive material that meets the requirements of 3.4.1 when interfaced with both copper-beryllium per QQ-C-530 and steel, corrosion resisting per QQ-S-763 that has been passivated per MIL-STD-171.

3.4.6 Coupling nuts. Coupling nuts and outer structural members of the interface component, intermediate interface component, and replaceable interface component shall be made of steel, corrosion resisting per QQ-S-763 that has been passivated per MIL-STD-171. Other metal parts used to assemble these items shall meet the requirements of 3.4.1.

3.5 Design and construction. The design, construction and physical dimensions of TEM transmission lines shall be as specified herein and the detail specification drawings (see 3.1). Drawings shall be interpreted in accordance with DOD-STD-100.

3.5.1 Interfaces and interface components.

3.5.1.1 Primary interfaces. Primary interfaces shall be specified in accordance with the detail specification drawings and shall conform to the requirements of figures 1 thru 6. The primary interfaces are restricted to the following precision types listed in table I.

TABLE I. Primary interfaces.

Type	Figure	Description
1 Male	1	Similar to TNC Male
1 Female	2	Similar to TNC Female
2 Male	3	Similar to SC Male
2 Female	4	Similar to SC Female
3 Male 1/	5	Similar to N Male
3 Female 1/	6	Similar to N Female

1/ Type 3 Male and Female primary interfaces are not to be used for new design. These types are included in this document for the sole purpose of retrofitting existing equipments or systems.

3.5.1.2 Intermediate interfaces. The design and construction of intermediate interfaces (see 6.4.8) shall be the option of the manufacturer, unless otherwise specified herein.

3.5.1.2.1 The manufacturer shall develop and standardize one size and configuration of intermediate interface for Type I TEM transmission lines. The intermediate interface shall be compatible with all styles of replaceable interface components specified herein for Type I TEM transmission lines.

3.5.1.2.2 The manufacturer shall develop and standardize one size and configuration of intermediate interface for Type II TEM transmission lines. The intermediate interface shall be compatible with all styles of replaceable interface components specified herein for Type II TEM transmission lines.

3.5.1.2.3 Intermediate interfaces shall be constructed so that the center contact does not extent beyond the coupling ring and is protected from damage during handling and installation.

3.5.1.3 Replaceable interface components. Replaceable interface components shall be as specified in the detail specification drawings and shall conform to the requirements of figures 7, 8 and 9. In addition, replaceable interface components shall have the required primary interfaces specified in the detail specification drawings. Replaceable interface component styles and descriptions are listed in table II.

TABLE II. Replaceable interface components.

Style	Figure	Description
A	7	Straight
B	8	90° elbow
C	9	Angular

3.5.1.3.1 Unless otherwise specified in the detail specification drawings, replaceable interface components shall not be used on TEM transmission lines less than 3 feet long.

3.5.1.3.2 Unless otherwise specified in the detail specification drawings, TEM transmission lines more than 3 feet but less than 10 feet long shall be provided with replaceable interface components.

3.5.1.3.3 Replaceable interface components shall be provided on TEM transmission lines that are greater than 10 feet long.

3.5.1.3.4 The procuring activity shall specify the required dimensions for styles A, B and C replaceable interface components in the detail specification drawings. If the system requirements are such that a special replaceable interface component is required, the procuring activity shall delineate the special replaceable interface component on the detail specification drawings. The special replaceable interface component shall not compromise the serviceability, maintainability, or performance of the TEM transmission line as detailed in this document.

3.5.2 Weight. Unless otherwise specified in the detail specification drawings (see 6.2), the TEM transmission line shall be designed for minimal weight consistent with good engineering practices.

3.5.3 Bonding, conductivity, discontinuities. The mating surfaces between all metallic parts intentionally designed to be electrically continuous to RF currents shall be clean and, as required, suitably plated metal surfaces free from anodic film, grease, paint, lacquer, or other high-resistance film.

3.5.4 Pressurization. Any design feature requiring the user to pressurize the TEM transmission line with air or any other gas is prohibited.

3.5.5 Surface finish. Dimensions of metal parts shall include any plating or finish applied to meet electrical, mechanical or service condition requirements. Surface roughness on machined surfaces shall be 63 microinches maximum.

3.5.6 Installation design features.

3.5.6.1 Primary interfaces shall be provided with torque wrench flats in accordance with figure 10.

3.5.6.2 Intermediate interfaces shall be provided with spanner wrench holes in accordance with figure 11.

3.5.6.3 Primary interfaces shall be provided with a minimum of three equally spaced safety wire holes whose diameters shall be 0.027 minimum.

3.6 Performance. TEM transmission lines shall meet the performance requirements specified herein and the detail specification drawings when tested in accordance with the methods of inspection specified in 4.7.

3.6.1 Inspection criteria. The parameters specified herein and the detail specification drawings shall be adjusted in accordance with the procedures specified in 4.1.2.

3.6.2 Coupled components. Interface components and replaceable interface components shall be capable of meeting all electrical, mechanical and service condition requirements specified in this document when connected to mating EW precision counterparts with the coupling nuts torqued to the following values:

Type	Torque (inch-pounds)
1	23 ± 3
2	23 ± 3
3	23 ± 3

In addition, replaceable interface components shall be capable of meeting all electrical, mechanical and service condition requirements specified in this document when connected to mating intermediate interface components with the associated coupling nuts torqued to a value of 45 ± 5 inch-pounds. At this value, there shall be metal-to-metal bottoming.

3.6.3 Center contact stability. In the unmated condition, center contacts of all interface components and replaceable interface components shall be capable of withstanding an axial force of 6 pounds for 1 minute when applied in either direction without displacement outside the specified dimensions that locate the center contact.

3.6.4 Electrical.

3.6.4.1 RF insertion loss. RF insertion loss requirements shall be as specified herein and in the detail specification drawings (see 6.2).

3.6.4.1.1 Insertion loss. When tested in accordance with 4.7.3 Procedure I, the RF insertion loss shall not exceed the values shown in the detail specification drawings.

3.6.4.1.2 Insertion loss uniformity (fine structure). When tested in accordance with 4.7.3 Procedure II, the maximum fine structure variation (see 6.4.5) shall not exceed the values of table III for the indicated frequency ranges (see figure 12) and, as required, the usage of replaceable interface components as specified in the detail specification drawings.

TABLE III. Maximum allowable fine structure variation.

Frequency range (GHz)	TEM transmission lines with:	
	Interface components or Style A replaceable interface components	One or two Style B or C replaceable interface components
2.0 - 8.0	0.15 dB	0.25 dB
8.0 - 16.0	0.20 dB	0.30 dB

3.6.4.1.3 Insertion loss stability. When tested in accordance with 4.7.3, Procedure III, the variation in insertion loss shall not be greater than 0.1 dB.

3.6.4.1.4 Determination of maximum allowable RF insertion loss. The maximum allowable RF insertion loss for a TEM transmission line shall be determined in accordance with the procedure set forth in Appendix A.

3.6.4.1.4.1 Unless otherwise specified in the detail specification drawing, the maximum allowable RF insertion loss for TEM transmission lines less than 2 feet in length shall be calculated as though the lines were 2 feet in length.

3.6.4.1.5 Plot of RF insertion loss curve. The maximum allowable RF insertion loss values determined by the procedure in Appendix A shall be plotted on the applicable graph form specified in Appendix A for the required type of TEM transmission line. The two points shall be connected by a straight line. The plot of the maximum allowable RF insertion loss shall be shown in the detail specification drawing.

3.6.4.1.6 The RF insertion loss for replaceable interface components (table IV) shall not be greater than that specified throughout the applicable frequency range when tested as specified in 4.7.3 Procedure IV.

TABLE IV. RF insertion loss - replaceable interface components.

Primary interface type	Frequency range	Maximum RF insertion loss	
		Style A	Styles B & C
1	2.0 - 8.0 GHz	.15 dB	.20 dB
1	8.0 - 16.0 GHz	.20 dB	.30 dB
2	2.0 - 8.0 GHz	.15 dB	.20 dB
3	2.0 - 8.0 GHz	.15 dB	.20 dB

3.6.4.2 Voltage standing wave ratio (VSWR). When tested in accordance with 4.7.4 Procedure I, the VSWR for TEM transmission lines shall not exceed the values specified in table V.

TABLE V. Maximum allowable VSWR for TEM transmission lines.

Frequency range (GHz)	Interface components or Style A replaceable interface components	Style B or C replaceable interface components
2.0 - 4.0	1.20:1.0	1.25:1.0
4.0 - 8.0	1.25:1.0	1.30:1.0
8.0 - 12.0	1.30:1.0	1.35:1.0
12.0 - 16.0	1.35:1.0	1.40:1.0

3.6.4.2.1 VSWR stability. When tested in accordance with 4.7.4 Procedure II, the VSWR of the TEM transmission line shall not vary more than 0.05.

3.6.4.2.2 The Voltage Standing Wave Ratio (VSWR) for replaceable interface components (table VI) shall not be greater than that specified throughout the applicable frequency range when tested as specified in 4.7.4 Procedure III.

TABLE VI. VSWR - replaceable interface components.

Primary interface type	Frequency range	Maximum VSWR	
		Style A	Styles B & C
1	2.0 - 8.0 GHz	1.05:1.0	1.07:1.0
1	8.0 - 16.0 GHz	1.08:1.0	1.12:1.0
2	2.0 - 8.0 GHz	1.05:1.0	1.07:1.0
3	2.0 - 8.0 GHz	1.05:1.0	1.07:1.0

3.6.4.3 Impedance. When tested in accordance with 4.7.5 Procedure I, the characteristic impedance of the TEM transmission line shall be 50.0 ± 1.0 ohms.

3.6.4.3.1 Impedance uniformity (peak to peak variation). When tested in accordance with 4.7.5 Procedure II, the peak to peak variation of impedance (see 6.4.11) shall not exceed 1.0 ohm.

3.6.4.4 Velocity of propagation. Unless otherwise specified in the detail specification drawing (see 6.2), the velocity of propagation shall not be less than 72 percent when tested in accordance with 4.7.7.

3.6.4.5 Radio frequency (RF) leakage. When tested in accordance with 4.7.8 the RF leakage power ratio shall not be greater than -90 dB per foot at any point on the TEM transmission line including connectors.

3.6.4.6 Power handling capability.

3.6.4.6.1 Continuous power handling capability. When tested in accordance with 4.7.13 Procedure I, the continuous power handling capability of the TEM transmission line shall not be less than the value specified in table VII.

TABLE VII. Power handling capability.

Cable type (see 1.2)	Input power rating 1/		Test frequency (GHz)
	Continuous power	Peak power	
I	450 watts	12.0 KW	8.0
II	60 watts	6.0 KW	16.0

1/ Ratings established for non-heat-sinked connector pairs exposed to +360°F/70,000 ft. altitude environment.

3.6.4.6.2 Peak power capability. When tested in accordance with 4.7.13 Procedure II, the peak power handling capability of the TEM transmission line shall not be less than the value specified in table VII.

3.6.4.7 High Potential Withstanding Voltage (HPWV). The high potential withstanding voltage rating for TEM transmission lines shall be as specified in table VIII. If two different interface types are required on the TEM transmission line, the high potential withstanding voltage rating of the TEM transmission line shall be that of the interface type with the lower rating. When tested as specified in 4.7.24 Procedure I, there shall be no evidence of voltage breakdown.

3.6.4.7.1 Replaceable interface components (see table IX) shall be capable of withstanding the listed voltages without evidence of breakdown when tested in accordance with the High Potential Withstand Voltage test method specified in 4.7.24, Procedure II.

TABLE VIII. High potential withstanding voltage ratings for TEM transmission lines.

Interface type (see 3.5.1)	Rating at sea level	Rating at 70,000 feet
1	3,000V (RMS)	1,800V (RMS)
2	5,000V (RMS)	3,000V (RMS)
3	2,500V (RMS)	1,500V (RMS)

TABLE IX. HPWV - replaceable interface components.

Primary interface type	Test voltage
1	3.0 KV (RMS)
2	5.0 KV (RMS)
3	2.5 KV (RMS)

3.6.4.8 Explosive atmosphere. When tested as specified in 4.7.21, the TEM transmission line shall operate satisfactorily in an explosive atmosphere environment.

3.6.4.9 Phase characteristics. When required, phase characteristics shall be specified in the detail specification drawings. Required test methods shall also be specified in the detail specification drawings and shall be in accordance with the requirements of 4.6 (see 6.2).

3.6.5 Mechanical.

3.6.5.1 Vapor leakage. When tested as specified in 4.7.6, the TEM transmission line shall have a leakage rate of less than 1 x 10^{-5} cubic centimeters per second per foot of length.

3.6.5.2 Vibration. When tested as specified in 4.7.12, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.5.3 Impact shock. When tested as specified in 4.7.14, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.5.4 Flexure. When tested as specified in 4.7.15, TEM transmission lines shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.5.5 Torque. When tested as specified in 4.7.16, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.5.6 Tensile load. When tested as specified in 4.7.17, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.5.7 Concentrated load. When tested as specified in 4.7.18, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.5.8 Abrasion. When tested as specified in 4.7.19, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.6 Environmental.

3.6.6.1 Temperature. The operating temperature test conditions shall be from -54° to +200°C (-65° to +392° Fahrenheit). When tested as specified in 4.7.9, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.6.2 Altitude. The operating altitude test conditions shall be from 0 to 70,000 feet (30.0 to 1.32 inches of mercury). When tested as specified in 4.7.10, the TEM transmission line shall meet the requirements of 3.6.4.7.

3.6.6.3 Thermal shock. When tested as specified in 4.7.11, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.6.4 Chemical resistance. When tested as specified in 4.7.20, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.5.1.

3.6.6.5 Humidity. When tested as specified in 4.7.22, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2, 3.6.4.7 and 3.6.5.1.

3.6.6.6 Salt-fog. When tested as specified in 4.7.23, the TEM transmission line shall meet the requirements of 3.6.4.1, 3.6.4.2 and 3.6.4.7.

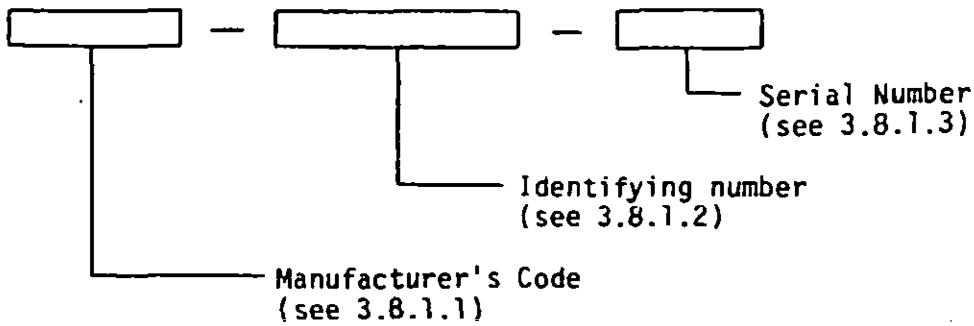
3.7 Reliability.

3.7.1 Reliability assurance tests. When specified by the procuring activity, the manufacturer shall establish a reliability program in accordance with the requirements of MIL-STD-781. The procuring activity shall specify the "Minimum Acceptable MTBF (θ_1)" or the "Specified MTBF (θ_0)" (see 6.2).

3.7.1.1 The design goal for expected operating life of a TEM transmission line is 5 years minimum.

3.8 Marking.

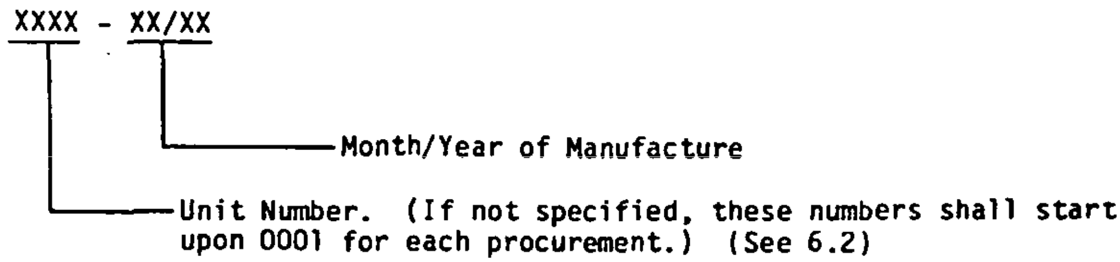
3.8.1 Marking nomenclature. In addition to any special markings specified in the detail specification drawing (see 6.2), the TEM transmission line and replaceable interface components shall be marked as follows:



3.8.1.1 Manufacturer's code. The applicable manufacturer's code as established in Cataloging Handbooks H4-1 and H4-2, "Federal Supply Code for Manufacturers" shall be used. The manufacturer is defined as the individual, firm, company or corporation engaged in the fabrication of finished TEM transmission lines or replaceable interface components.

3.8.1.2 Identifying number. The identifying number shall be assigned by the procuring activity and shall be specified in the detail specification drawings (see 6.2).

3.8.1.3 Serial number. The serial number shall be generated by the manufacturer. It shall consist of the following:



3.8.2 Method of application. Unless otherwise specified in the detail specification drawings, the required marking shall be applied to the product by a method selected by the manufacturer. The method selected shall conform to the following:

a. Lettering types shall be "Futura" or "Gothic" capitals and the numerals shall be Arabic. Type size shall be sufficient as to be clearly legible.

b. The marking shall be of a permanent type and shall be capable of withstanding the service conditions specified herein without degradation to itself or the required performances for the TEM transmission line.

c. Whenever practicable, the marking shall be located so that it is visible when the TEM transmission line is installed. When the location of the marking is specified in the detail specification drawing, the marking shall so be located.

3.8.3 Color-coding. Unless otherwise specified in the detail specification drawing, the outer covering of the TEM transmission line shall be color-coded solid violet in accordance with EIA RS-359, preferred limits, throughout its entire length. Color-coding shall be a permanent type and shall be capable of withstanding the service conditions specified herein without degradation of required performances for the TEM transmission line.

3.9 Workmanship. The TEM transmission line shall be processed in such a manner as to be uniform in quality and shall be free of defects that will affect performance, reliability or appearance.

3.9.1 Interfaces and associated metal parts shall be free of sharp edges, burrs, damaged interface surfaces and contaminants.

3.9.2 The outer covering of the assembly shall be free of cuts, dents, nicks, frayed or burned spots that might affect the appearance or performance of the TEM transmission line.

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 (examinations and tests) 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection 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 the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operation, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Establishment of inspection acceptance criteria. Prior to First Article approval, the contractor shall establish his inspection acceptance criteria (6.4.6) for use in the performance of all inspection requirements specified in this document by the following procedure.

4.1.2.1 The contractor shall prepare inspection plans that meet the requirements of first article inspection (4.3), quality conformance inspection (4.4) and methods of inspection (4.7). The plans shall include the test equipment to be used for each test and shall list the equipments' brand names, model numbers and serial numbers.

4.1.2.2 The contractor shall make an analysis of his test equipment, calibration system errors and measurement methods. From this analysis, he shall calculate the maximum residual error band of uncertainly (6.4.1) of his measurement and test system.

4.1.2.3 The contractor shall submit the inspection plans (see 4.1.2.1) and the analysis (see 4.1.2.2) to the procuring activity (see 6.3) for review and establishment of inspection acceptance criteria.

4.1.2.4 The procuring activity will review the contractor's inspection plans and will establish inspection acceptance criteria, based on the furnished analysis, that will be used by the contractor in the performance of all inspection requirements set forth in this document.

4.1.3 Test equipment calibration system. The contractor shall establish and maintain a calibration system to control the accuracy of his measuring and test equipment in accordance with the requirements of MIL-STD-45662.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.3).

b. Quality conformance inspection (see 4.4).

c. Special tests (see 4.6).

4.3 First article inspection. First article inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production. First article inspection shall consist of the examinations and tests performed in the sequence set forth in table X.

4.3.1 First article test samples. Samples submitted for first article testing shall be representative of the contractor's normal production. The quantity of test samples produced for each Type/Class of TEM transmission line shall not be less than that specified in table X.

4.3.2 Conformance criteria. Criteria for determining conformance to all specified first article requirements shall be in accordance with the Accept-Reject criteria for each applicable test paragraph. Failure of a sample unit to meet specified requirements shall be cause for first article rejection. In the event of first article rejection, the testing facility, if other than the contractor, shall notify the procuring activity, and if applicable, the contractor, of any failure that would constitute first article rejection. The contractor shall then take necessary corrective action on all first article samples before any further testing is done.

4.4 Quality conformance inspection.

4.4.1 Inspection of product for delivery. Inspection of TEM transmission lines for delivery shall consist of Groups A and B inspection (see 4.4.1.3 and 4.4.1.4).

TABLE X. First article inspection.

Examination or test	Requirement paragraph	Test paragraph	Sample units		
			1	2	3
Examination of product			X	X	X
Design and construction	3.1, 3.4, 3.5				
Marking	3.8	4.7.1			
Workmanship	3.9	4.7.2			
RF insertion loss	3.6.4.1	4.7.3	X	X	X
Voltage standing wave ratio (VSWR)	3.6.4.2	4.7.4	X	X	X
Impedance	3.6.4.3	4.7.5	X	X	X
Vapor leakage	3.6.5.1	4.7.6	X	X	X
Velocity of propagation	3.6.4.4	4.7.7	X	X	X
Radio frequency (RF) leakage	3.6.4.5	4.7.8		X	X
Temperature	3.6.6.1	4.7.9	X	X	X
Altitude	3.6.6.2	4.7.10	X	X	X
Thermal shock	3.6.6.3	4.7.11	X	X	X
Vibration	3.6.5.2	4.7.12	X	X	X
Power handling capability	3.6.4.6	4.7.13	X	X	X
Impact shock	3.6.5.3	4.7.14	X		X
Flexure at +25°C	3.6.5.4	4.7.15		X	
Flexure at -20°C			X		
Flexure at +60°C					X
Torque	3.6.5.5	4.7.16	X		X
Tensile load	3.6.5.6	4.7.17	X		X
Concentrated load	3.6.5.7	4.7.18	X		X
Abrasion	3.6.5.8	4.7.19	X		X
Chemical resistance	3.6.6.4	4.7.20	X	X	X
Explosive atmosphere	3.6.4.8	4.7.21	X		X
Humidity	3.6.6.5	4.7.22		X	
Salt fog	3.6.6.6	4.7.23	X	X	X
High potential withstanding voltage	3.6.4.7	4.7.24	X	X	X

4.4.1.1 Inspection lot. An inspection lot shall consist of all TEM transmission lines covered by one detail specification drawing, produced under the same conditions, and offered for inspection at one time.

4.4.1.2 Disposition of sample units. Sample units which have been subjected to the Group A inspection may be delivered on the contract or order. Sample units which have been subjected to Group B inspection shall not be delivered.

4.4.1.3 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table XI and shall be performed in the order shown.

4.4.1.3.1 Sampling plan. When specified, statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The sample size shall be as specified in table XI.

TABLE XI. Group A inspection quality conformance test plan.

Examination or test	Requirement paragraph	Test paragraph	Sample plan AQL	100%	Lot size 1-50	51-99	100-Up
I Examination of Product							
Design and Construction	3.1, 3.5	4.7.1		X			
Interface Gauging	3.5.1.1	4.7.2	0.4				
Marking	3.8	4.7.1	1.0				
Workmanship	3.9	4.7.1	1.0				
II Electrical Tests							
RF Insertion Loss	3.6.4.1	4.7.3		X			
VSWR	3.6.4.2	4.7.4		X			
Impedance	3.6.4.3	4.7.5			2	4	7
Velocity of Propagation	3.6.4.4	4.7.7			2	4	7
RF Leakage	3.6.4.5	4.7.8			2	4	7
III Mechanical-Environmental							
Vapor Leakage	3.6.5.1	4.7.6		X			
Thermal Shock	3.6.6.3	4.7.11			2	4	7

4.4.1.3.2 Accept-reject criteria. Accept-reject criteria for each examination or test shall be as specified in the applicable test paragraph. When specified, the acceptable quality level (AQL) shall be as specified in table XI. When discrete sample sizes are specified, the failure of a sample unit shall constitute failure of the lot.

4.4.1.3.3 Rejected lots. If an inspection lot is rejected, the contractor shall withdraw the lot, rework it to correct the defects or screen out the defective units, as applicable, and reinspect. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots. Rejected lots shall be reinspected using tightened inspection.

4.4.1.4 Group B inspection. Group B inspection shall consist of the applicable examinations and tests specified in table XII, shall be made on units previously inspected under Group A inspection and shall be performed in the sequence shown. Shipment shall not be held up pending results of this inspection.

4.4.1.4.1 Sampling plan. Each lot shall be inspected with the sample size controlled by the requirements of table XII.

4.4.1.4.2 Accept-reject criteria. Accept-reject criteria for each examination or test shall be as specified in the applicable test paragraph. Failure of a sample unit shall constitute failure of the lot.

TABLE XII. Group B inspection quality conformance test plan.

Examination or Test	Requirement Paragraph	Test Paragraph	Lot Size				
			1-24	25-49	50-74	75-99	100-Up
			Number of Samples Required				
			1	2	3	4	5
			Number of Samples To Be Tested				
Vibration	3.6.5.2	4.7.12	1	2	3	4	5
Flexure	3.6.5.4	4.7.15	1	2	3	4	5
Torque	3.6.5.5	4.7.16	1	2	3	4	5
Tensile Load	3.6.5.6	4.7.17	1	2	3	4	5
Chemical Resistance	3.6.6.4	4.7.20	1	2	2	2	2
Salt-Fog	3.6.6.6	4.7.23	1	2	2	2	2

4.4.1.4.3 Noncompliance. If a sample fails to pass Group B inspection, the contractor shall take corrective action on the materials or processes or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of related lots shall be discontinued until corrective action, acceptable to the government, has been taken. After the corrective action has been taken, Group B inspection shall be repeated on new samples. Group A inspection may be reinstituted; however, final acceptance shall be withheld until the Group B inspection has shown that the corrective action was successful.

4.5.2 Inspection of preparation for delivery. Sample packages and packs and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with requirements of Section 5 and the documents specified therein.

4.6 Special tests. Any examination or test not specified in the specification but required by the detail specification drawing or procurement document, shall be classified as a special test. These tests shall be developed by the procuring activity or, if directed, by the contractor. Special tests shall conform to the requirements of this specification and shall in no way relieve the contractor of his responsibilities for first article inspection or quality conformance inspection.

4.7 Methods of inspection.

4.7.1 Examination of product. TEM transmission lines shall be examined in accordance with the procedures specified herein to ensure conformance with this specification. These procedures assure verification of conformance to the specified requirements for design and construction, marking, workmanship and corrosion and deterioration.

4.7.1.1 Test equipment. Test equipment used to perform the examinations shall be accurate and versatile.

4.7.1.2 Test conditions. Unless otherwise specified, examinations shall be made at normal ambient conditions.

4.7.1.3 Procedure I - Design and construction.

4.7.1.3.1 The TEM transmission line shall conform to the physical dimensions as specified in the applicable detail specification drawings (3.1).

4.7.1.3.2 The TEM transmission line shall be examined to verify that the primary interfaces and, if applicable, the replaceable interface components are as specified in the detail specification drawings. In addition, when replaceable interface components are used, the examination shall ascertain that these are properly installed and are torqued to a range of 40 to 50 inch-pounds.

4.7.1.3.3 When specified, the TEM transmission line shall conform to the weight requirement specified (6.2).

4.7.1.3.4 The TEM transmission line shall be examined to determine that metallic mating surfaces meet the requirements of 3.5.3.

4.7.1.3.5 The TEM transmission line shall be examined [illegible] apertures or other devices for pressurization are not incorporated in the unit (see 3.5.4).

4.7.1.3.6 Accept-reject criteria. If the results of these examinations show that the TEM transmission line fails to meet the requirements for design and construction as set forth in this document, the TEM transmission line shall be considered to have failed the test.

4.7.1.4 Procedure II - Markings.

4.7.1.4.1 The markings on the TEM transmission line shall conform to the requirements specified in the applicable detail specification drawings.

4.7.1.4.2 When markings are not specified in the detail specification drawings, markings shall be in accordance with 3.8.

4.7.1.4.3 Accept-reject criteria. If the results of this examination show that the TEM transmission line fails to meet the specified marking requirements, the unit shall be considered to have failed this test.

4.7.1.5 Procedure III - Workmanship.

4.7.1.5.1 The outer covering of the TEM transmission line shall be examined for cuts, nicks, dents and burned or frayed areas.

4.7.1.5.2 Interfaces and associated metal parts shall be examined for sharp edges, burrs, damaged mating surfaces, and foreign objects or contaminants.

4.7.1.5.3 Accept-reject criteria. If the results of these examinations show that the TEM transmission line has workmanship defects which might affect performance or reliability, the unit shall be considered to have failed this test.

4.7.1.6 Procedure IV - Corrosion and deterioration.

4.7.1.6.1 The primary interfaces of the TEM transmission line shall be examined for evidence of corrosion, flaking, pitting or peeling of the electrical conductive surfaces and threaded coupling areas.

4.7.1.6.2 The interface component or replaceable interface component coupling rings shall be examined for clogging or binding.

4.7.1.6.3 The dielectric material of the primary interfaces shall be examined for displacement, shrinkage or swelling. Center contact and outer contact relationship to each other and to the dielectric material shall be measured and recorded.

4.7.1.6.4 Accept-reject criteria. If the results of these examinations reveal that corrosion, damage, deterioration or change in physical relationship outside established tolerance limits has occurred, the unit shall be considered to have failed the test.

4.7.2 Interface gauging of primary interfaces.

4.7.2.1 General. Gauging of primary interfaces is performed to determine compliance of the interfaces to required dimensions that insure proper mating to specified counterparts.

4.7.2.2 Apparatus. The apparatus required to perform the interface gauging shall be determined by the manufacturer and shall be approved by the procuring activity. The use of standardized gauging equipment and techniques is recommended.

4.7.2.3 Test conditions. Unless otherwise specified, gauging shall be conducted at normal ambient conditions.

4.7.2.4 Procedure.

4.7.2.4.1 The gauging procedure shall meet the requirements of 4.1.1.

4.7.2.4.2 The primary interface shall be examined for sharp edges, burrs, damaged mating surfaces, corrosion and flaking, peeling, or pitting of the conductive surfaces.

4.7.2.4.3 The primary interfaces shall be gauged for dimensional conformance in accordance with the following:

EW Precision Interface

Type 1 - Male (see figure 1 and table XIII)
Type 1 - Female (see figure 2 and table XIV)
Type 2 - Male (see figure 3 and table XV)
Type 2 - Female (see figure 4 and table XVI)
Type 3 - Male (see figure 5 and table XVII)
Type 3 - Female (see figure 6 and table XVIII)

NOTE: Surface finish requirements may be inspected prior to assembly of the primary interface.

4.7.2.4.4 Male primary interfaces shall be visually inspected to ascertain that the environmental seal is installed, properly located, and not damaged.

4.7.2.5 Accept-reject criteria. If the results of these examinations and gauging inspections reveal that corrosion, damage, deterioration or dimensional deficiencies exist, the unit shall be considered to have failed the interface gauging examination.

4.7.3 RF insertion loss.

4.7.3.1 General. Three tests are required to determine the RF insertion loss characteristics of a TEM transmission line. The tests are:

a. RF insertion loss. The RF insertion loss, which is defined as the ratio of the power (P_1) delivered to a load connected directly to a source and the power (P_2) delivered to a load when a test sample is inserted between the source and the load, is expressed in dB and is equal to 10 $\log_{10} (P_1/P_2)$. Procedure I describes the test requirements for RF insertion loss.

b. Insertion loss uniformity (fine structure variation). The fine structure variation is a periodic or abrupt change occurring in the plotted insertion loss that can be attributed to mismatches in the TEM transmission line. Procedure II describes the test requirements for insertion loss uniformity.

c. Insertion loss stability. This test is performed to determine the adequacy of the electrical mate between the cable and the interface components when they are subjected to side acting forces. Procedure III describes the test requirements for insertion loss stability.

4.7.3.2 Test equipment and apparatus. The test equipment used to perform these tests shall meet the requirements of 4.1.3. The test equipment shall be capable of providing a continuous measurement of RF insertion loss over the required frequency ranges. A means shall be provided for producing a permanent record of the unit's RF insertion loss versus frequency on rectangular coordinates. The permanent record shall be calibrated and capable of differentiating an insertion loss change of 0.05 dB. The measuring system response shall be such that an insertion loss variation of 1.0 dB with a frequency width as narrow as 20 MHz will be displayed with degradation limited to less than 20 percent. In addition, Procedure III requires apparatus capable of applying a force to the cable component while the body of the interface component is rigidly supported.

4.7.3.3 Test conditions. Unless otherwise specified, tests shall be conducted at normal ambient conditions.

4.7.3.4 Procedure I - RF insertion loss.

4.7.3.4.1 The TEM transmission line shall be connected in the test system and measured for RF insertion loss over the required frequency ranges as specified in 3.6.4.1.1 and the detail specification drawings.

4.7.3.4.2 The permanent record shall be marked with the maximum allowable RF insertion loss as specified in the detail specification drawings.

4.7.3.5 Accept-reject criteria - procedure I.

4.7.3.5.1 The RF insertion loss requirements specified in the detail specification drawings shall be adjusted in accordance with 4.1.2 for use as accept-reject inspection criteria.

4.7.3.5.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.3.5.1, the unit shall be considered to have failed the RF insertion loss test.

4.7.3.6 Procedure II - insertion loss uniformity.

4.7.3.6.1 The RF insertion loss uniformity shall be determined by measuring the fine structure variation (see figure 12) of the RF insertion loss. The permanent record obtained in Procedure I shall be measured to determine the maximum value of fine structure variation within the specified bandwidth.

4.7.3.7 Accept-reject criteria - procedure II.

4.7.3.7.1 The insertion loss uniformity requirements specified in 3.6.4.1.1 for a particular frequency range and replaceable interface component style shall be adjusted in accordance with 4.1.2 for use as accept-reject inspection criteria.

4.7.3.7.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.3.7.1, the unit shall be considered to have failed the insertion loss uniformity (fine structure variation) test.

4.7.3.8 Procedure III - insertion loss stability.

4.7.3.8.1 Mount the TEM transmission line with the input interface rigidly supported so the applied side acting forces are not transmitted to the electrical interface between the test sample and the measurement system. Connect the test sample in the measurement system.

4.7.3.8.2 Perform an RF insertion loss measurement as specified in Procedure I.

4.7.3.8.3 Apply a force (in pounds) equal to ten times the outside diameter of the cable component (in inches) at a point whose distance (in inches) from the rear of the interface component equals two times the outside diameter of the cable component. This force shall be applied perpendicular to the major axis of the cable component via a 1/2 x 1/2 inch rigid flat steel plate.

4.7.3.8.4 While the force specified in 4.7.3.8.3 is being applied, an RF insertion loss measurement shall be made and recorded on the same permanent record as the measurement made in 4.7.3.8.2 was recorded.

4.7.3.8.5 Three additional RF insertion loss measurements shall be made while the force specified in 4.7.3.8.3 is being applied except that the force shall be applied in each of the three remaining quadrants. Each measurement shall be recorded on the same permanent record made in 4.7.3.8.2. Therefore, when the required measurements are completed, the permanent record will show five RF insertion loss measurement traces.

4.7.3.8.6 Repeat 4.7.3.8.1 through 4.7.3.8.5 except the other primary interface of the TEM transmission line shall be used as the input.

4.7.3.9 <u>Accept-reject criteria - procedure III.</u>

4.7.3.9.1 The insertion loss stability requirements specified in 3.6.4.1.3 shall be adjusted in accordance with 4.1.2 for use as accept-reject inspection criteria.

4.7.3.9.2 If the RF insertion loss measurement traces vary from one to another by more than the accept-reject criteria established in 4.7.3.9.1, the TEM transmission line shall be considered to have failed the insertion loss stability test.

4.7.3.10 <u>Procedure IV - RF insertion loss for replaceable interface components.</u>

4.7.3.10.1 The test equipment and test methods used for this procedure shall be fully documented by the contractor and shall be approved by the procuring activity.

4.7.3.10.2 The replaceable interface component shall be connected in the test system and measured for RF insertion loss over the required frequency range(s) specified in 3.6.4.1.6.

4.7.3.11 <u>Accept-reject criteria - procedure IV.</u>

4.7.3.11.1 The RF insertion loss requirements specified in 3.6.4.1.6 shall be adjusted in accordance with 4.1.2 for use as accept-reject criteria.

4.7.3.11.2 If the replaceable interface component fails to meet the accept-reject criteria established in 4.7.3.11.1, the unit shall be considered to have failed the RF insertion loss test.

4.7.4 Voltage standing wave ratio (VSWR).

4.7.4.1 General. The voltage standing wave ratio (VSWR) test (Procedure I) is performed to determine if the TEM transmission line meets its specified requirements. The VSWR stability test (Procedure II) is performed to determine the adequacy of the electrical mate between the cable and interface components when they are subjected to side acting forces. VSWR measurements are an indication of the power reflected back into a connected power source that is caused by mismatches in the TEM transmission line.

4.7.4.2 *Test equipment*. The test equipment used to perform these tests shall meet the requirements of 4.1.3. The test equipment shall be capable of providing a continuous measurement of VSWR over the required frequency ranges. A means shall be provided for producing a permanent record of the unit's VSWR versus frequency on calibrated rectangular coordinates. In the event VSWR is not directly measured, i.e., if return loss is measured and VSWR is calculated from that measurement, the permanent record shall indicate the worst case VSWR numerically for each frequency band and shall provide the calculation used to obtain the calculated VSWR. The permanent record shall be able to differentiate a VSWR change of at least 0.02. In addition, Procedure II requires apparatus capable of applying a force to the cable component while the body of the interface is rigidly supported.

4.7.4.3 Test conditions. Unless otherwise specified, tests shall be conducted at normal ambient conditions.

4.7.4.4 Procedure I - VSWR.

4.7.4.4.1 The TEM transmission line shall be connected in the test system and measured for VSWR over the required frequency ranges as specified in 3.6.4.2.

4.7.4.4.2 Unless otherwise specified in the detail specification drawing, the TEM transmission line shall have VSWR measurements made from both primary interfaces and the resulting permanent records shall be marked to indicate which primary interface was used as the input.

4.7.4.4.3 The permanent record shall be marked with the maximum allowable VSWR, or related parameter if VSWR is not directly measured, as specified in 3.6.4.2 for the type and interface configuration of TEM transmission line being tested.

4.7.4.5 Accept-reject criteria - procedure I.

4.7.4.5.1 The VSWR requirements specified in 3.6.4.2 for a particular type and interface configuration of TEM transmission line shall be adjusted in accordance with 4.1.2 for use as accept-reject inspection criteria.

4.7.4.5.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.4.5.1, the unit shall be considered to have failed the voltage standing wave ratio test.

4.7.4.6 Procedure II - VSWR stability.

4.7.4.6.1 Mount the TEM transmission line insuring the input primary interface is rigidly supported so that the applied side acting forces are not transmitted to the electrical interface between the test sample and the measurement system. Connect the test sample in the measurement system.

4.7.4.6.2 Perform a VSWR measurement as specified in Procedure I for the first input interface.

4.7.4.6.3 Apply a force (in pounds) equal to ten times the outside diameter of the cable component (in inches) at a point whose distance (in inches) from the rear of the interface component equals two times the outside diameter of the cable component. This force shall be applied perpendicular to the major axis of the cable component via a 1/2 x 1/2 inch rigid flat steel plate.

4.7.4.6.4 While the force specified in 4.7.4.6.3 is being applied, a VSWR measurement shall be made and recorded on the same permanent record as the measurement made and recorded in 4.7.4.6.2.

4.7.4.6.5 Three additional VSWR measurements shall be made while the force specified in 4.7.4.6.3 is being applied except that the force shall be applied in each of the three remaining quadrants. Each measurement shall be recorded on the same permanent record made in 4.7.4.6.2. Therefore, when the required measurements are completed, the permanent record will show five VSWR measurement traces.

4.7.4.6.6 Repeat 4.7.4.6.1 through 4.7.4.6.5 except that the other primary interface of the TEM transmission line shall be used as the input.

4.7.4.7 Accept-reject criteria - procedure II.

4.7.4.7.1 The VSWR stability requirements specified in 3.6.4.2.1 shall be adjusted in accordance with 4.1.2 for use as accept-reject inspection criteria.

4.7.4.7.2 If the VSWR measurement traces vary from one to another by more than the accept-reject criteria established in 4.7.4.7.1, the TEM transmission line shall be considered to have failed the VSWR stability test.

4.7.4.8 Procedure III - VSWR for replaceable interface components.

4.7.4.8.1 The test equipment and test methods used for this procedure shall be fully documented by the manufacturer and shall be approved by the procuring activity.

4.7.4.8.2 The replaceable interface component shall be connected in the test system and measured for VSWR over the required frequency range(s) specified in 3.6.4.2.2.

4.7.4.9 Accept-reject criteria - procedure III.

4.7.4.9.1 The VSWR requirements specified in 3.6.4.2.2 shall be adjusted in accordance with 4.1.2 for use as accept-reject criteria.

4.7.4.9.2 If the replaceable interface component fails to meet the accept-reject criteria established in 4.7.4.9.1, the unit shall be considered to have failed the VSWR test.

4.7.5 Impedance test.

4.7.5.1 General. The purpose of the impedance test is to determine the characteristic impedance and the impedance uniformity (peak to peak variation) of the TEM transmission line. Variations in dimensions, dielectric material or manufacturing procedures can produce changes in the characteristic impedance or impedance uniformity. These changes generate reflections and degrade the electrical performance of the TEM transmission line.

4.7.5.2 Test equipment. All test equipment used to perform the impedance test shall meet the requirements of 4.1.2. The characteristic impedance shall be measured with Time Domain Reflectometry (TDR) equipment. The TDR equipment shall have a total system response of 150 pico-seconds and shall provide for a resolution of 0.1 ohm throughout the length of the test sample. The test results shall be displayed on calibrated rectangular coordinates and a permanent record of the test results shall be produced. The permanent record shall be capable of differentiating an impedance difference of at least 0.1 ohm. A section of air line with a calibrated impedance of 50.0 ± 0.1 ohms is required as a reference.

4.7.5.3 Test conditions. Unless otherwise specified, tests shall be conducted at normal ambient conditions.

4.7.5.4 Procedure I - characteristic impedance.

4.7.5.4.1 The test procedure shall meet the requirements of 4.1.2.

4.7.5.4.2 The section of air line used as a reference shall be inserted between the test equipment and the input end of the test sample.

4.7.5.4.3 Either end of the test sample may be used as the input interface.

4.7.5.4.4 The permanent record of the impedance test shall display the plots of the air line reference, the input interface, the entire length of the test sample, the output interface and any required terminating network. The record shall be marked to indicate these plots and shall identify which primary interface was used as the input interface (see figure 13 for marking requirements).

4.7.5.4.5 Examine the permanent record to ascertain the maximum and minimum points of the impedance plot for the TEM transmission line. Determine the values for these points.

4.7.5.5 Accept-reject criteria - procedure I.

4.7.5.5.1 The characteristic impedance requirements specified in 3.6.4.3 shall be adjusted in accordance with the requirements of 4.1.2 for use as accept-reject inspection criteria.

4.7.5.5.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.5.5.1, the unit shall be considered to have failed the characteristic impedance test.

4.7.5.6 Procedure II - impedance uniformity.

4.7.5.6.1 The test procedure for impedance uniformity shall be as specified in 4.7.5.4.1 through 4.7.5.4.4.

4.7.5.6.2 Examine the permanent record to ascertain the 12-inch segment of the TEM transmission line which exhibits the maximum peak to peak variation of the impedance plot (see figure 13 for clarification). Determine the value of this peak to peak variation.

4.7.5.7 Accept-reject criteria - procedure II.

4.7.5.7.1 The impedance uniformity (peak to peak variation) specified in 3.6.4.3.1 shall be adjusted in accordance with the requirements of 4.1.2 for use as accept-reject inspection criteria.

4.7.5.7.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.5.7.1, the unit shall be considered to have failed the impedance uniformity test.

4.7.6 Vapor leakage.

4.7.6.1 General. The vapor leakage test is performed to determine the environmental seal integrity of a TEM transmission line. Leaks, both gross and minute, in combination with exposure to wide differentials in atmospheric pressure will cause the TEM transmission line to "breathe" and to absorb contaminants that could degrade the line's electrical performance to an unacceptable level. This test is applicable to all classes of TEM transmission lines except that Class 3 (rigid) assemblies may be tested prior to forming or bending. If tested prior to forming or bending, Class 3 assemblies shall be further tested after forming or bending to verify conformance to the vapor leakage requirement. This verification test shall be approved by the procuring activity.

4.7.6.2 Apparatus. The apparatus required to perform this test is shown in figure 14. The mechanical pump, diffusion pump, bell jar, valves, controls, and gauges may be a self-contained vacuum system. The use of a multi-port connection between the bell jar and several sample tubes is recommended to conserve testing time; however, if this is done, each sample tube must have an individual isolation valve. Sample tube sizes should be selected so that the difference between sample tube and test sample volumes is approximately 500 cm^3. The bell jar volume should be at least 100 times greater than the aforementioned volume difference. Thermocouple gauge, M_1, shall be capable of measuring pressure to within $\pm$.01 mm Hg.

4.7.6.3 Test conditions. Tests shall be conducted at normal ambient conditions.

4.7.6.4 Procedure.

4.7.6.4.1 The test procedure shall meet the requirements of 4.1.2.

4.7.6.4.2 Place the TEM transmission line in the sample tube. The primary interfaces shall not be sealed, mated, or otherwise covered or protected. Seal the sample tube and shut the isolation valve.

4.7.6.4.3 Close the vent valve and start the evacuation of the bell jar with the mechanical pump. After reaching the optimum limits of evacuation with the mechanical pump, close the roughing valve. Evacuate the bell jar with the diffusion pump to 1×10^{-6} mm Hg or less. Close the high vacuum valve.

4.7.6.4.4 The isolation valve shall be opened for 1 to 2 seconds and then shall be closed. The test period shall start at the time, (t_o), when the isolation valve is closed. At the same time, the starting pressure, (p_o), shall be read on the thermocouple gauge, M_1. Record t_o and p_o.

4.7.6.4.5 At periodic intervals for the duration of the test, the pressure (p_x) shall be read at M_1 and the time (t_x) of the observation recorded to the nearest second. A minimum of three readings shall be made with a minimum elapsed time of 10 minutes between each reading. Additional readings may be required to ascertain leakage rates on TEM transmission lines less than 3 feet in length.

4.7.6.4.6 The vapor leakage rate, (K), for TEM transmission lines shall be calculated by the following formula:

$$K\left(\frac{cm^3}{sec}\right) = \frac{p_x - p_o}{p_o\,(t_x - t_o)}\left[\frac{(V_2 - V_x)^2}{V_1}\right]$$

where:

p_o = starting pressure (in mm Hg)

p_x = pressure (in mm Hg) at time t_x

t_o = starting time

t_x = time (in secs) at which p_x was read

V_1 = bell jar volume in cm^3

V_2 = sample tube volume in cm^3

V_x = test sample volume in cm^3

4.7.6.4.7 When a multi-port connection is used, each sample shall be subjected to the procedure described in 4.7.6.4.2 through 4.7.6.4.6.

4.7.6.4.8 If the quantity (p_x-p_0) remains constant throughout the test period, a gross leak may exist. The suspect test sample shall be removed from the sample tube and shall be visually inspected for seal ruptures. If none are found, the test sample shall be set aside for a period of at least 1 hour prior to retesting. The retest cycle shall consist of the procedure specified in 4.7.6.4.2 through 4.7.6.4.4. Record p_0 and t_0.

4.7.6.4.9 Read and record p_x at 10 second intervals for a period of 2 minutes. Calculate the vapor leakage rate for the TEM transmission line in accordance with 4.7.6.4.6.

NOTE: The retest cycle is required on braided outer conductor constructions. For solid outer conductor constructions, an alternate test method, approved by the Agent Facility, may be used.

4.7.6.5 Accept-reject criteria. If at any time during the initial test cycle or, if applicable, the retest cycle, the TEM transmission line has a vapor leakage greater than that specified in 3.6.5.1, the unit shall be considered to have failed the vapor leakage test.

4.7.7 Velocity of propagation.

4.7.7.1 General. This test is conducted to determine the velocity of propagation of a TEM transmission line over its specified design frequency range. The velocity of propagation of a TEM transmission line shall be stated as a percentage of the velocity of propagation in free space.

4.7.7.2 Test equipment. The test equipment used to perform this test shall meet the requirements of 4.1.2 and shall consist of the following:

a. A Microwave Sweep oscillator with a frequency range that covers the design frequency range of the test sample.

b. An analyzer with suitable readout features.

a A phase bridge with a measurement accuracy of ±0.1 percent.

d. A calibrated section of air line whose length equals the length of the test sample.

4.7.7.3 Test conditions. Tests shall be conducted at normal ambient conditions.

4.7.7.4 Procedure.

4.7.7.4.1 The test procedure shall meet the requirements of 4.1.2.

4.7.7.4.2 Calibrate the system over the design frequency range of the test sample with required adapters inserted in the leg of the phase bridge to be used for the test sample. Record calibration line.

4.7.7.4.3 Insert the test sample in the appropriate leg of the phase bridge and an equal length of air line in the other leg. Note the length (L) of the test sample.

4.7.7.4.4 Using the phase bridge, adjust the electrical length of the air line leg to obtain a phase balance across the design frequency of the test sample. Note the added length (ΔL).

4.7.7.4.5 Calculate velocity of propagation (V_p) of calibration line as follows:

$$V_p = \frac{L}{L + \Delta L} \times 100\%$$

4.7.7.4.6 Sweep over the design frequency of the test sample.

Note maximum deviation (ϕ in degrees) from calibration line.

4.7.7.4.7 Calculate minimum velocity of propagation V_p (MIN) as follows:

$$V_p \text{ (MIN)} = \frac{L}{(L + \Delta L) + \frac{\phi C}{360 f}} \times 100\%$$

where C is the velocity of propagation in free space and f is the frequency (in Hz) at which was measured.

4.7.7.5 Accept-reject criteria.

4.7.7.5.1 The velocity of propagation requirement specified in 3.6.4.4 or in the detail specification drawing shall be adjusted in accordance with the requirements of 4.1.2 for use as accept-reject inspection criteria.

4.7.7.5.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.7.5.1, the unit shall be considered to have failed the velocity of propagation test.

4.7.8 Radio frequency (RF) leakage.

4.7.8.1 General. This test is performed for the purpose of determining that the RF energy leaked from a TEM transmission line is within the limits specified in 3.6.4.5.

4.7.8.2 Test equipment and apparatus. Test equipment used to perform the RF leakage test shall meet the requirements of 4.1.2. The test equipment list specified in figure 15, sheet 1, is required to perform this test and it shall be capable of performing satisfactorily throughout the design frequency range of the TEM transmission line. The apparatus described in figure 15, sheets 5 through 10, is also required.

4.7.8.3 Test conditions. Tests shall be conducted at normal ambient conditions.

4.7.8.4 Procedure.

4.7.8.4.1 The test procedure shall meet the requirements of 4.1.2.

4.7.8.4.2 Test frequencies shall be selected to insure complete scanning of the TEM transmission line's design frequency range.

4.7.8.4.3 RF leakage measurements shall be made at each interface and, for braid shield constructions, at a minimum of three points along the cable component of the TEM transmission line.

4.7.8.4.4 The test routine for a single test frequency at a particular point shall be as follows:

RECORDER CALIBRATION

Step 1. Connect the test equipment as shown in figure 15, sheet 2.

Step 2. With equipment warmed up and operating, set the sweep oscillator to sweep over a minimum 5 percent bandwidth containing the intended test frequency.

Step 3. With the sweep oscillator operating at a convenient output level and using the variable attenuators for test channel level set, record calibration traces on the x-y recorder corresponding to 40, 50, [illegible] 80, 90 and 100 dB ratios of reference channel to test channel signal level versus frequency. If more than one leakage measurement is intended, remove the calibration record sheet from the recorder and retain for future use as a calibration overlay.

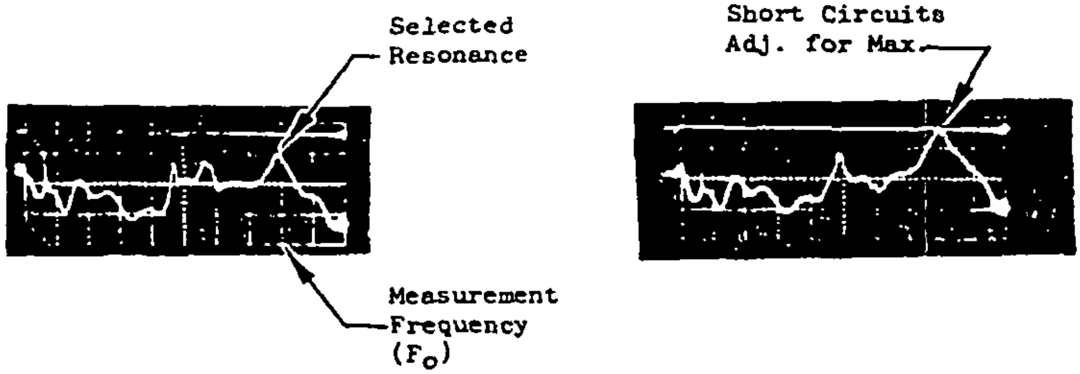
CAVITY ADJUSTMENT AND "Q" MEASUREMENT

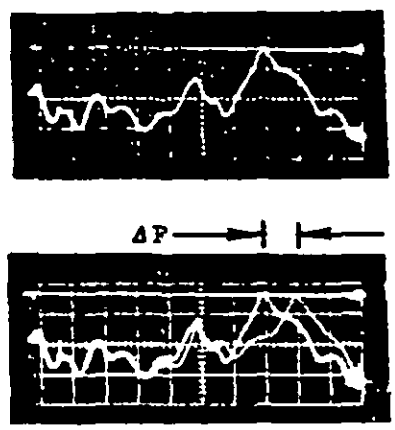
Step 4. Install test unit or mated interface pair in the test cavity using appropriately sized short circuits (see figure 15, sheets 6 through 10).

Step 5. Connect the equipment as shown in figure 15, sheet 3. Set the variable attenuators to "0" dB.

Step 6. With the test equipment warmed up and operating, set the sweep oscillator to sweep over the same frequency range used for recorder calibration (see 4.7.8.4.3). Adjust oscillator output level and oscilloscope gain controls for usable scope presentation.

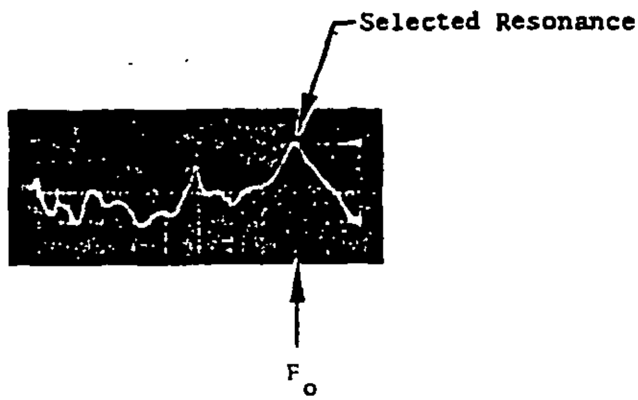
Step 7. Adjust spacing between cavity short circuits until TEM resonance as indicated by oscilloscope presentation is centered on test frequency. Keeping the spacing between the short circuits approximately constant, slide the combination with respect to the cavity coupling probe to obtain maximum amplitude of the selected resonance. Verify that the selected mode is TEM by holding one short circuit fixed and sliding the other while observing the oscilloscope. The electrical dimensions of the cavity are such that several TEM modes as well as TE and TM modes can exist within the frequency range being observed. TEM modes can be identified by (1) for a given change in cavity length they undergo a greater frequency shift than TE or TM modes and (2) they maintain a nearly constant amplitude for small changes in cavity length.





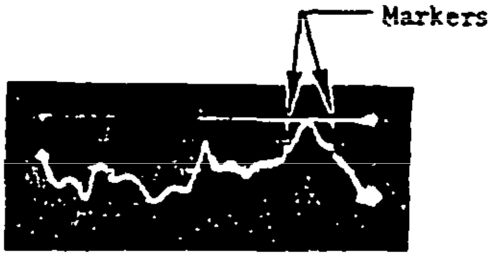
Change of resonant frequency (ΔF) resulting from small increase in cavity length.

Step 8. After verifying that the selected mode is TEM, readjust the short circuit to center the mode at the test frequency.

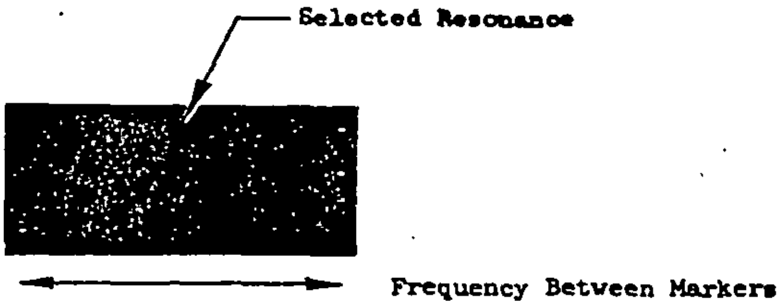


Step 9. Adjust oscilloscope controls to establish maximum deflection at a convenient level.

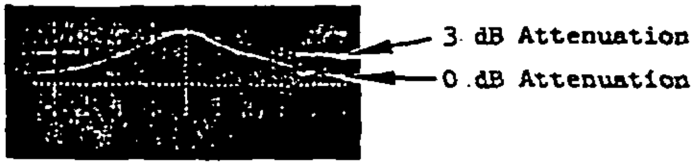
Step 10. Set sweep oscillator markers to coincide with "base" of selected resonance curve.



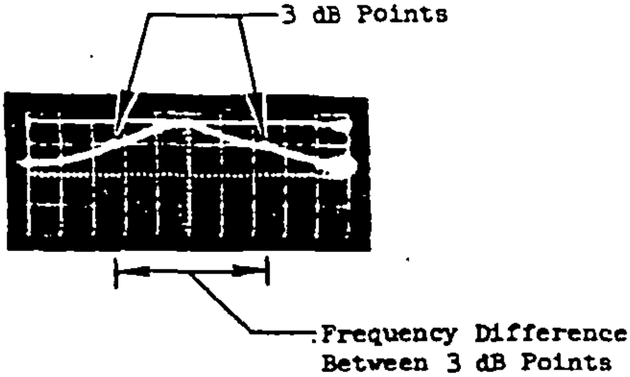
Step 11. Set sweep oscillator to "Marker Sweep" mode and adjust markers to yield symmetrical display of resonance curve on scope.



Step 12. Adjust variable attenuator to insert 3 dB attenuation and note level on oscilloscope corresponding to this condition. Remove 3 dB attenuation.



Step 13. Use frequency meter to determine the frequency spacing between the 3 dB points on the resonance curve.



Step 14. Calculate the Q of the cavity for this condition by dividing the resonant frequency by the difference in frequency between the 3 dB points. Record this value for future calculation of test sample leakage.

CAUTION

Use extreme care not to disturb the cavity adjustment until leakage measurements are completed.

LEAKAGE MEASUREMENT

Step 15. Being careful not to disturb the test sample and cavity adjustment obtained in step 8, connect the test equipment as shown in figure 15, sheet 4. Set the sweep oscillator to sweep the frequency range of step 2 and record a trace of leakage energy over this frequency range.

Step 16. Identify the recorded leakage level at the cavity resonant frequency.

Step 17. Determine and record the physical spacing between the faces of the short circuits. This determination may be made by measuring the distance between accessible locations on the adjustment handles and correcting by the distance from these locations to the face of the short circuits.

Step 18. Determine the dB value which corresponds to a power ratio equivalent to the cavity Q measured in step 14 by (dB = 10 log Q).

Step 19. Increase the numerical value measured in step 16 by the dB value determined in step 18. The resultant dB value represents the ratio of power flowing in the test sample to the energy "leaked" from the test sample over the length determined in step 17.

Step 20. Calculate the RF leakage power ratio for a 12 inch length of cable component by decreasing the numeric value determined in step 19 by the factor of:

$$10 \log \frac{12}{\text{length (inches) of spacing determined in step 17.}}$$

Step 21. Mated interface pairs shall be measured by the same procedure described above for cable with the measured value being corrected for the leakage attributable to the length of cable contained between the short circuits.

4.7.8.4.5 Measurements at each required test frequency shall be made in accordance with the requirements of 4.7.8.4.3 and 4.7.8.4.4.

4.7.8.4.6 Record the RF leakage power ratio values determined in 4.7.8.4.4, steps 20 and 21, for each test frequency and each particular point on the TEM transmission line.

4.7.8.5 Accept-reject criteria.

4.7.8.5.1 The RF leakage power ratio requirements specified in 3.6.4.5 shall be adjusted in accordance with the requirements of 4.1.2 for use as accept-reject inspection criteria.

4.7.8.5.2 If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.8.5.1, the unit shall be considered to have failed the RF leakage test.

4.7.9 Temperature test.

4.7.9.1 General. The temperature test is conducted to determine the effects of extreme temperatures on TEM transmission lines during storage or service use (see 3.6.6.1).

4.7.9.2 Apparatus. A temperature chamber capable of reaching and maintaining temperatures of -54°C and +200°C to within ±2° is required.

4.7.9.3 Test conditions. Test conditions shall be as specified in the procedures. The rate of temperature change for the test chamber shall not exceed 5°C per minute.

4.7.9.4 Procedure.

4.7.9.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.9.4.2 The TEM transmission line shall be placed in the test chamber and the internal chamber temperature shall be lowered to -54°C.

4.7.9.4.3 The internal chamber temperature shall be maintained at -54°C ± 2°C for a period of four hours.

4.7.9.4.4 After exposure at -54°C for the specified time, the internal chamber temperature shall be raised to +200°C.

4.7.9.4.5 The internal chamber temperature shall be maintained at +200°C ± 2°C for a period of four hours.

4.7.9.4.6 After exposure at +200°C for the specified time, the internal chamber temperature shall be lowered to +30°C ± 5°C and maintained for one hour.

4.7.9.4.7 The TEM transmission line shall be removed from the test chamber and subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.9.5 Accept-reject criteria. If the TEM transmission line fails to meet accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the temperature test.

4.7.10 Altitude test.

4.7.10.1 General. The altitude test is conducted to determine the ability of the TEM transmission line to withstand momentary overvoltage conditions in a high altitude condition.

4.7.10.2 Test equipment. Test equipment shall consist of an altitude chamber and the equipment required in 4.7.24.

4.7.10.3 Test conditions. Test conditions shall be as specified in the procedure.

4.7.10.4 Procedure.

4.7.10.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.24, Procedure I.

4.7.10.4.2 The TEM transmission line shall be placed in the altitude chamber and connected as required in 4.7.24, Procedure I.

4.7.10.4.3 The internal pressure of the altitude chamber shall be reduced to 33.5 mm of HG (1.32 inches of HG or 70,000 feet above sea level) and maintained for one hour.

4.7.10.4.4 After exposure to altitude for the specified period, the TEM transmission line shall be subjected to the test specified in 4.7.24, Procedure I, with the magnitude of the test voltage as specified in 3.6.4.7.

4.7.10.4.5 After completion of the test specified in 4.7.24, Procedure I, return the test chamber internal pressure to standard ambient conditions.

4.7.10.5 Accept-reject criteria. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.24, Procedure I, the unit shall be considered to have failed the test.

4.7.11 Thermal shock.

4.7.11.1 The purpose of the thermal shock test is to determine the TEM transmission line's resistance to exposure at extremes of high and low temperatures and to the shock of alternate exposures to these extremes (see 3.6.6.3).

4.7.11.2 Apparatus. The test apparatus shall be in accordance with the requirements specified in MIL-STD-202, method 107.

4.7.11.3 Test conditions. Test conditions shall be in accordance with MIL-STD-202, method 107, test condition C-1, except the low test temperature shall be -54° (+0°, -5°) C for steps 1 and 3 only.

4.7.11.4 Procedure.

4.7.11.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.11.4.2 The TEM transmission line shall be subjected to the test procedure specified in MIL-STD-202, method 107, test condition C-1, except exposure in steps 2 and 4 shall be limited to 2 minutes maximum. The connectors shall not be mated or otherwise protected.

4.7.11.4.3 Upon completion of the specified test cycles, the TEM transmission line shall be allowed to return to thermal stability at ambient room temperature.

4.7.11.4.4 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.11.5 Accept-reject criteria. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the thermal shock test.

4.7.12 Vibration.

4.7.12.1 General. The purpose of the vibration test is to determine the TEM transmission line's ability to withstand high-frequency vibrations without degradation of electrical performance (see 3.6.5.2).

4.7.12.2 Apparatus. The test apparatus shall be capable of providing the required frequency range and vibration amplitude specified in MIL-STD-202, method 204, test condition B. Mounting fixtures shall provide adequate clamping and orientation of test samples as shown in figure 16.

4.7.12.3 Test conditions. Test conditions shall be in accordance with MIL-STD-202, method 204, test condition B.

4.7.12.4 Procedure.

4.7.12.4.1 A pair of TEM transmission lines are required for this test. The lines shall have a set of mating connectors. The TEM transmission lines shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.12.4.2 The pair of test samples shall be mounted to the vibration fixture as required in figure 16 with the mating connector pair coupled to the requirements of 3.6.2.

4.7.12.4.3 The TEM transmission lines shall be subjected to the test procedure specified in MIL-STD-202, method 204, test condition B. While subjected to this test, the TEM transmission lines shall be tested to the requirements of 4.7.3, Procedures I and II, and 4.7.4, Procedure I.

4.7.12.4.4 Upon completion of the vibration test, the TEM transmission lines shall be removed from the test fixture and shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.12.5 Accept-reject criteria. If either TEM transmission line fails at any time to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the vibration test.

4.7.13 Power handling capability.

4.7.13.1 General. The power handling capability test is divided into two categories: (1) continuous power handling capability (Procedure I) and (2) peak power handling capability (Procedure II). These two tests are conducted to determine the TEM transmission line's ability to handle continuous and pulsed RF power under temperature and altitude conditions associated with high performance military aircraft. The primary failure modes for these tests are: (1) the accumulation of heat to the point where mechanical and electrical properties of the TEM transmission line are adversely affected and, (2) voltage breakdown or arcing and burning.

4.7.13.2 Test equipment and apparatus. The test equipment and apparatus shall be as described below and shall be connected as shown in figure 17, continuous power test equipment setup, or figure 18, peak power test equipment setup.

a. Continuous Power RF power source - The continuous power RF power source shall be capable of supplying CW (continuous wave) power at a level and frequency required by the test. The power source shall include the necessary controls to establish and maintain the required frequencies and power levels. A means of monitoring the operating frequency shall be provided and the power source shall be capable of providing a stable output over an extended period of time.

b. Peak Power RF power source - The peak power RF power source shall be capable of supplying the peak pulse power at a level and frequency required for the test. The power source shall include the necessary instrumentation and controls to establish and maintain the required power, RF frequency, pulse width, and pulse repetition frequency for extended periods of time.

c. Reverse Power Monitor - A reverse power monitor consisting of a directional coupler and an average power meter shall be included in the test circuit to monitor the energy reflected by the TEM transmission line under test. The primary arm of the directional coupler shall be capable of handling the average power levels involved, and the coupling value shall be selected in accordance with the VSWR of the test item and the capability of the power meter. The coupler shall have a constant coupling value over the range of environmental conditions involved while testing.

d. Forward Power Monitor - A forward power monitor consisting of a directional coupler and an average power meter shall be included in the test circuit to monitor the input power to the test item. The equipment requirements shall be the same as those listed in (c).

e. Test Chamber RF Feedthroughs - The test chamber RF feedthroughs shall provide the test circuit a means of entry and exit from the test chamber and a transition from the TEM transmission line interfaces to the test circuit interfaces. The RF feedthrough shall be sealed and not provide an air leak path into the interface of the test item. The RF feedthrough shall not provide a good thermal path between the test specimen and the test chamber. The RF feedthrough interface dimensions and tolerances shall be maintained during the test. VSWR and insertion loss shall be as low as possible and shall remain stable throughout the test.

f. RF Termination - The test circuit shall be terminated with a device capable of dissipating the powers used and having a VSWR no greater than 1.5:1.0 at the frequency used.

g. RF Calorimeter - An RF calorimeter or other suitable device shall be used to determine the level of applied power at the interface to the test item. The calorimeter shall then be used to calibrate the forward power monitor.

h. Environmental Test Chamber - An environmental test chamber capable of operation at the specified environmental conditions shall be provided. The chamber shall be of a size so that the test item may be mounted in such a way that no point is closer than six inches from the chamber walls. The test item shall be mounted with a minimum number of low thermal conductivity mounts and shall not be placed in the air flow caused by the internal fan.

i. Temperature Recorder - A temperature recorder capable of sequentially monitoring a minimum of ten temperature sensors shall be provided. Two temperature sensors shall be used to monitor the chamber ambient temperature and shall be located in free space six inches either side of the test item. One six inches below and one six inches above. Two temperature sensors shall be used to monitor the RF feedthrough temperatures. The rest shall be located along the test item with one at each test item interface and one, if applicable, at the most severe bend in the test item.

4.7.13.3 Test conditions. Test conditions shall be as specified in the applicable procedure.

4.7.13.4 Procedure I - continuous power handling capability.

4.7.13.4.1 Two mated TEM transmission lines are required for this test. The units shall be subjected to the examinations and tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.13.4.2 Connect the required test equipment and apparatus as specified in figure 17 except the continuous power RF power source shall not be connected.

4.7.13.4.3 The mated TEM transmission lines shall be installed in the test chamber and all RF connections inspected to assure proper electrical and mechanical mate. The VSWR of the completed test circuit shall be measured at the frequency of operation prior to connection to the RF power source.

4.7.13.4.4 The RF calorimeter shall be connected to the RF power source at the interface to the test items. After operating the RF power source for a minimum of 15 minutes stable operation, the calorimeter shall be used to calibrate the forward power monitor for 90, 95, 100, 105 and 110 percent of the specified power. The RF circuit shall then be returned to the required test configuration.

4.7.13.4.5 The test chamber shall be brought to an internal temperature of 360°F and chamber pressure shall be reduced to simulate an altitude of 70,000 feet. The chamber shall be stabilized for thirty minutes. The internal temperature shall not vary more than 10°F nor shall the altitude vary more than ±5 percent over this period.

4.7.13.4.6 The continuous RF power to the test items shall be slowly increased to the value specified in 3.6.4.6.1. The temperature of the test items and reverse power shall be continuously monitored during the application of power to detect any catastrophic failure which may occur. Operation at the specified conditions shall be continued for a minimum of one hour and, if by the end of that hour, the test items' temperatures have stabilized (if the temperature sensors do not show an increase in temperature of more than 5°F in a five minute period) the test shall be terminated. If the temperatures of the test items have not stabilized, the test shall continue until stabilization is achieved. Note the maximum stabilized temperature along the length of the test samples.

4.7.13.4.7 The test items shall be removed from the test chamber and returned to ambient temperature.

4.7.13.4.8 The TEM transmission lines shall be subjected to the examinations and tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.13.5 Accept-reject criteria - procedure I. If arcing or other catastrophic failure occurs during the application of power, or if either of the TEM transmission lines fails to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the continuous power handling capability test.

4.7.13.6 Procedure II - peak power handling capability.

4.7.13.6.1 The peak power handling test shall be performed on the same two mated TEM transmission lines used to perform the continuous power handling test (Procedure I).

4.7.13.6.2 The test samples shall be subjected to the examinations and tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.13.6.3 Connect the required test equipment and apparatus as specified in figure 19 except the peak power RF power source shall not be connected.

4.7.13.6.4 The mated TEM transmission lines shall be installed in the test chamber and all RF connections inspected to assure proper electrical and mechanical mate. The VSWR of the completed test circuit shall be measured at the frequency of operation prior to connection to the RF power source.

4.7.13.6.5 Set the peak power RF source for a minimum pulse width of 1.0 microsecond and a duty cycle of 0.001.

4.7.13.6.6 The RF calorimeter shall be connected to the RF power source at the interface to the test items. After operating the RF power source for a minimum of fifteen minutes stable operation, the calorimeter shall be used to calibrate the forward power monitor for 90, 95, 100, 105 and 110 percent of the specified power. The RF circuit shall then be returned to the required test configuration.

4.7.13.6.7 The test chamber shall be brought to an internal temperature equal to the maximum stabilized temperature noted in 4.7.13.4.6 and the chamber pressure reduced to simulate an altitude of 70,000 feet. The chamber shall be stabilized for thirty minutes. The internal temperature shall not vary more than 10°F nor shall the altitude vary more than 5 percent over this period.

4.7.13.6.8 The peak RF power to the test items shall be slowly increased to the value specified in 3.6.4.6.2. The temperature of the test items and reverse power shall be continuously monitored during the application of power to detect any catastrophic failure which may occur. Operations at the specified conditions shall be continued for a minimum of one hour and, if by the end of that hour, the test items' temperatures have stabilized (if the temperature sensors do not show an increase in temperature of more than 5°F in a five minute period) the test shall be terminated. If the temperatures of the test items have not stabilized, the test shall continue until stabilization is achieved.

4.7.13.6.9 The test items shall be removed from the test chamber and returned to ambient temperature.

4.7.13.6.10 The TEM transmission lines shall be subjected to the examinations and tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.13.7 Accept-reject criteria (procedure II).

4.7.13.7.1 If arcing or other catastrophic failure occurs during the application of power, or if either of the TEM transmission lines fail to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the peak power handling test.

4.7.14 Impact shock.

4.7.14.1 General. The impact shock test is intended to simulate the effects of small hand tools striking or being dropped on a TEM transmission line. When struck by small objects, rigid lines may be bent and flexible lines may suffer outer braid damage which may cause impedance mismatches and degraded electrical performance.

4.7.14.2 Apparatus. The apparatus shall consist of the test fixture as shown in figure 19. The guides shall be positioned so as to restrict the weight to vertical movement only, but shall not retard the free movement of the weight when dropped during the test. A smooth metal base plate shall support the guides and shall provide appropriate clamps to hold the TEM transmission line in place during the test.

4.7.14.3 Test conditions. Tests shall be conducted at normal ambient conditions.

4.7.14.4 Procedure.

4.7.14.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.3, Procedure I and II, 4.7.4, Procedure I, 4.7.5 and 4.7.6. Note the connector used as the input.

4.7.14.4.2 The TEM transmission line shall be located in the impact shock fixture so that a section of the line's cable component 29 to 30 inches from the input connector lies directly beneath the weight's impact surface.

4.7.14.4.3 Locate the weight within the guides with the impact surface of the weight toward the test sample and at right angles to the centerline of the line's cable component. The distance between the impact surface and the near point of the test sample shall be 4.0 (+0.12, -0.0) inches. Drop the weight one time.

4.7.14.4.4 Repeat the test performed in 4.7.14.4.3 except the impact surface of the weight shall be parallel to the centerline of the line's cable component.

4.7.14.4.5 The TEM transmission line shall be removed from the impact shock fixture and shall be subjected to the tests specified in 4.7.3, Procedure I and II, 4.7.4, Procedure I, 4.7.5 and 4.7.6. The connector used as the input shall be the same as the one noted in 4.7.14.4.1.

4.7.14.5 Accept-reject criteria. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.3, Procedure I and II, 4.7.4, Procedure I, 4.7.5 and 4.7.6, the unit shall be considered to have failed the impact shock test.

4.7.15 Flexure.

4.7.15.1 General. This test is performed to determine the TEM transmission line's ability to withstand flexures that may be encountered during service use. Flexure is defined as the bending of a TEM transmission line at cyclic rates below 1 cycle per second. This flexure can be divided into two basic categories: (1) a large angular displacement for a small number of cycles; (2) a small angular displacement for a very large number of cycles. Either type of flexure can fatigue the TEM transmission line's components which will cause electrical performance degradation. The ability to withstand one category of flexure does not imply that the unit will necessarily withstand the other. Class 1 TEM transmission lines shall be subjected to the tests specified in Procedures I and II. Class 2 TEM transmission lines shall be subjected to the tests specified in Procedure I only.

4.7.15.2 Apparatus. The flexure test fixture shall be as specified herein and in figures 20 and 21. The apparatus shall consist of a motor driven arm capable of making repeated cycles of any arc up to 150° at a maximum cyclic rate of 40 cycles per minute. The apparatus shall provide for rigid mounting of the TEM transmission line in two places and pivotal mounting of the unit's interface component along the length of the fixture's vertical arm. One cable clamp shall be centered over the main pivot of the arm and shall conform to figure 20. The second clamp shall be located from 6 to 18 inches below the first one and shall hold the cable component firmly but shall not have sharp edges that might cut or otherwise damage the unit during testing. The pivot clamp shall be movable along the arm and shall provide for mounting various interface components at a distance of 6 to 30 inches from the cable clamp centered over the main pivot. A temperature chamber capable of containing the fixture and of reaching and maintaining -20°C and +60°C is also required.

4.7.15.3 Test conditions. Flexure tests may be performed at three ambient temperatures:

Test Condition A:	+25° ± 5°C
Test Condition B:	-20° ± 5°C
Test Condition C:	+60° ± 5°C

Unless otherwise specified, flexure tests shall be performed at test condition A.

4.7.15.4 Procedure I - (Large Angular Flexures for Class 1 and Class 2 TEM transmission lines).

4.7.15.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.15.4.2 The TEM transmission line shall be loosely clamped in the fixture as shown in figure 20. If the test sample has been subjected to impact shock (4.7.14), the unit shall be mounted so that the area that received the impact shock is directly above the cable clamp over the main pivot of the arm. One end of the test sample shall be left unmated; the other shall be properly torqued to its mating interface that is mounted to the pivot clamp. The distance between the pivot clamp and the nearer cable clamp shall be set at 30 inches for TEM transmission lines 5 feet or more in length. For lengths less than 5 feet, the distance between the pivot clamp and the nearer cable clamp shall be set at the mid-point of the TEM transmission line's length. The lower cable clamp shall be set at 18 inches if the test sample's length permits; otherwise, the lower cable clamp shall be located so only the cable component is clamped. Tighten down the pivot clamp and the cable clamps.

4.7.15.4.3 A test cycle consists of a flexure arc starting at 0° to +75° to -75° and return to 0 degrees. Set the connecting rod adjusting clamp to attain this arc and adjust the motor speed to obtain 15 cycles per minute.

4.7.15.4.4 Perform the large angular flexure test for 400 cycles at the specified test condition.

4.7.15.4.5 Remove the TEM transmission line from the fixture. Subject the unit to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.15.5 Procedure II - (Small Angular Flexures for Class 1 TEM transmission lines).

4.7.15.5.1 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.15.5.2 The TEM transmission line shall be mounted in the fixture as described in 4.7.15.4.2.

4.7.15.5.3 A test cycle consists of a flexure arc starting at 0° to +25° to -25° and return to 0 degree. Set the connecting rod adjusting clamp to attain this arc and adjust the motor speed to obtain 40 cycles per minute.

4.7.15.5.4 Perform the small angular flexure test for 100,000 cycles at the specified test condition.

4.7.15.5.5 Remove the TEM transmission line from the fixture. Subject the unit to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.15.6 Accept-reject criteria - procedures I and II. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the flexure test.

4.7.16 Torque.

4.7.16.1 General. The torque test is conducted to determine the mechanical strength and electrical stability of the cable component to connector component junction of a TEM transmission line. This test simulates the rotational forces that may be applied during in-service and maintenance periods.

4.7.16.2 Apparatus. The apparatus shall consist of the test fixture as shown in figure 22 and shall meet the following requirements:

a. Connector Clamp - This device shall provide for uniform distribution of the applied force about the circumference of the connector component and shall not interfere with electrical test equipment connection.

b. Cable Grip Fixture - This fixture shall uniformly grip and hold the cable component for a minimum of 8 inches and shall not deform or indent the test sample. A means, such as wrench flats, shall be provided to allow torque to be applied by a standard torque wrench or other acceptable means.

c. Fixed Supports and Cable Guides - The supports shall be rigid and shall not flex during the application of force. The guides shall support the test sample but shall not restrict rotation of the test sample.

4.7.16.3 Test conditions. Tests shall be conducted at normal ambient conditions.

4.7.16.4 Procedure.

4.7.16.4.1 The TEM transmission line shall be subjected to the test specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6. Note the input interface.

4.7.16.4.2 Mount the TEM transmission line in the torque test fixture so that the input interface will be subjected to the torque force. Connect the electrical test equipment required to perform the measurements specified in 4.7.16.4.5.

4.7.16.4.3 Apply 50 inch-pounds of torque to the test sample in a clockwise direction and maintain this force for 10 seconds. Release the force. Apply 50 inch-pounds of torque to the test sample in a counterclockwise direction and maintain this force for a period of 10 seconds. Release the force (this constitutes one test cycle).

4.7.16.4.4 The torque test consists of five test cycles described in 4.7.16.4.3. However, during the fifth cycle, the force shall be maintained in each direction until the measurements specified in 4.7.16.4.5 are made.

4.7.16.4.5 While the force is being applied, the TEM transmission line shall be subjected to the tests specified in 4.7.3, Procedures I and II and 4.7.4, Procedure I. Release the force and remove the TEM transmission line from the torque test fixture.

4.7.16.4.6 Repeat 4.7.16.4.1 through 4.7.16.4.5 except the other primary interface shall be used as the input interface.

4.7.16.4.7 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6. The input interface for these tests shall be the same one as noted in 4.7.16.4.1.

4.7.16.5 Accept-reject criteria. If the TEM transmission line fails at any time to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the torque test.

4.7.17 Tensile load.

4.7.17.1 General. The tensile load test is conducted to determine the mechanical strength and electrical stability of the cable component to connector component junction of a TEM transmission line. This test simulates the longitudinal forces that may be applied during in-service and maintenance periods.

4.7.17.2 Apparatus. The apparatus shall consist of the test fixture as shown in figure 23 and shall meet the following requirements:

a. Linear Actuator - This shall provide a means of applying and maintaining the required in-line force.

b. Force Measurement - This device shall directly read the applied in-line force and shall not introduce harmonic motion into the test system.

c. Movable Support - This support shall provide a surface which will allow free horizontal motion (less than 0.1 pound drag) when vertical loads up to ten pounds are applied.

d. Connector Clamp - This device shall provide for uniform distribution of the applied force about the circumference of the connector component and shall not interfere with electrical test equipment connection.

e. Fixed Support - This support shall be capable of sustaining the test system without flexing during the application of the in-line force.

4.7.17.3 Test conditions. Test conditions shall be at normal ambient conditions.

4.7.17.4 Procedure.

4.7.17.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.17.4.2 Mount the TEM transmission line in the tensile load test fixture and connect the required electrical test equipment.

4.7.17.4.3 Apply 75.0 (+3.0, -0.0) pounds force to the TEM transmission line. Maintain this force while the tests specified in 4.7.3, Procedures I and II, and 4.7.4, Procedure I are performed on the unit under test.

4.7.17.4.4 Remove the in-line force. Remove the TEM transmission line from the test fixture and perform the tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.17.5 Accept-reject criteria. If the TEM transmission line fails at any time to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the tensile load test.

4.7.18 Concentrated load.

4.7.18.1 General. The purpose of the concentrated load test is to apply a force in a concentrated area to a TEM transmission line. This application of force simulates the condition that may occur if a person steps or kneels upon a TEM transmission line and makes a deformation that could cause a degradation in electrical performance.

4.7.18.2 Apparatus. The apparatus shall consist of the test fixture as shown in figure 24. The guides shall be positioned so as to restrict the plate to vertical movement only, but shall not prevent free movement. A flat metal base shall support the guides and provide appropriate clamps so that the TEM transmission line will be positioned through the center of the plate. A means of applying 100 ± 2 pounds force to the plate shall be provided.

4.7.18.3 Test conditions. Tests shall be conducted at normal ambient conditions.

4.7.18.4 Procedure.

4.7.18.4.1 The TEM transmission line shall be subjected to the tests specified in 4.7.3, 4.7.4, 4.7.5 and 4.7.6. Note the connector used as the input.

4.7.18.4.2 Locate the TEM transmission line in the concentrated load fixture so that a section of the line's cable component seven to nine inches from the input connector lies directly beneath the center of the plate.

4.7.18.4.3 Apply force to the plate at the rate of 20 pounds per second until the force reaches 100 pounds. Hold this value for three minutes. Release the force and remove the TEM transmission line from the fixture.

4.7.18.4.4 The TEM transmission line shall be subjected to the tests specified in 4.7.3, 4.7.4, 4.7.5 and 4.7.6. The connector used as the input shall be the same one noted in 4.7.18.4.1.

4.7.18.5 Accept-reject criteria. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.3, 4.7.4, 4.7.5 and 4.7.6, the unit shall be considered to have failed the concentrated load test.

4.7.19 Abrasion test.

4.7.19.1 General. The purpose of this test is to ascertain the ability of the TEM transmission line to resist: (1) the effects of sand and dust as would be encountered in a dry dust-laden atmosphere or, (2) the effects of chafing as would be encountered in service conditions.

4.7.19.2 Apparatus and materials. The apparatus and materials used to perform the sand and dust test (Procedure I) shall be as specified in MIL-STD-202, method 110. The test apparatus used to perform the chafing test (Procedure II) shall be as specified in MIL-C-5756 for abrasion test apparatus.

4.7.19.3 Test conditions. Test conditions for the sand and dust test shall be as specified in MIL-STD-202, method 110 with the sand and dust velocity through the test chamber between 2000 and 3000 feet per minute. Test conditions for the chafing test shall be at normal ambient conditions.

4.7.19.4 Procedure I - sand and dust.

4.7.19.4.1 The TEM transmission line shall be subjected to the examinations and tests specified in 4.7.1, Procedures II and IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.19.4.2 The TEM transmission line shall be located in the test chamber so as to expose the primary interfaces to the sand and dust flow. The primary interfaces shall not be covered.

4.7.19.4.3 Conduct the sand and dust test in accordance with the requirements of MIL-STD-202, method 110, test condition B except the exposure period shall be 15 minutes.

4.7.19.4.4 After the exposure period, the TEM transmission line shall be cleaned as specified in MIL-STD-202, method 110.

4.7.19.4.5 The TEM transmission line shall be subjected to the examinations and tests specified in 4.7.1, Procedures II and IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.19.5 Accept-reject criteria - procedure I. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.1, Procedures II and IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the sand and dust test.

4.7.19.6 Procedure II (chafing).

4.7.19.6.1 This test is applicable to Class 1 and Class 2 TEM transmission lines.

4.7.19.6.2 The TEM transmission line shall be subjected to the tests specified in 4.7.4 and 4.7.6.

4.7.19.6.3 The TEM transmission line shall be securely mounted at one end and a freely suspended 3.0 pound weight attached to the other end with the TEM transmission line placed over the squirrel cage of the abrasion test apparatus.

4.7.19.6.4 The TEM transmission line shall be subjected to 20 ± 2 oscillations per minute. An oscillation shall consist of 5 bars travel forward and backward from a given point. The total number of oscillations shall be 500.

4.7.19.6.5 After exposure to 500 oscillations, the TEM transmission line shall be subjected to the test specified in 4.7.4 and 4.7.6.

4.7.19.7 Accept-reject criteria - procedure II. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.4 and 4.7.6, the unit shall be considered to have failed the chafing test.

4.7.20 Chemical resistance test.

4.7.20.1 General. The purpose of the chemical resistance test is to determine the TEM transmission line's resistance to corrosive materials. The test simulates the exposures experienced during normal service life.

4.7.20.2 Test apparatus. The apparatus used to perform this test shall consist of the following:

a. Exposure chamber with adequate ventilation and suitable containers for the required chemical materials.

b. Controlled container - Heating means capable of maintaining the temperature ±2°F throughout the range of +90°F to +150°F.

c. Racks for air-drying test units.

4.7.20.3 Chemical materials. The chemical solutions and fluids used in this test and their specified test temperatures are as follows:

Solution or Fluid	Reference Document	Test Temperature
JP-4 or JP-5 Fuel	MIL-T-5624	+100° ± 5°F
Hydraulic Fluid	MIL-H-5606	+100° ± 5°F
Cleaner/Brightener	MIL-C-5410	+140° ± 5°F
Epoxy Stripper	MIL-R-81294	+140° ± 5°F

WARNING

Toxic materials are used in this procedure that may be harmful to health if suitable safety precautions are not taken.

4.7.20.4 Procedure.

4.7.20.4.1 The TEM transmission line shall be subjected to the examinations and tests specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.20.4.2 The TEM transmission line shall be exposed to the listed fluids and solutions in the sequence shown for the specified exposure period. Exposure to all solutions and drying period shall constitute one test cycle.

Solution or Fluid	Exposure Period
JP-4 or JP-5 Fuel	4 Hours
Water Rinse	5 Minutes
Hydraulic Fluid	4 Hours
Water Rinse	5 Minutes
Cleaner/Brightener	15 Minutes
Water Rinse	5 Minutes
Epoxy Stripper	15 Minutes
Water Rinse	5 Minutes
Air Dry Storage	16-24 Hours

The TEM transmission line shall be immersed in each solution with no protective caps or coverings on the primary interfaces.

4.7.20.4.3 The chemical resistance test shall consist of ten test cycles.

4.7.20.4.4 After completion of the ten test cycles, the TEM transmission line shall be subjected to the examinations and tests as specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6.

4.7.20.5 Accept-reject criteria. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.6, the unit shall be considered to have failed the chemical resistance test.

4.7.21 Explosive atmosphere.

4.7.21.1 General. The explosive atmosphere test is conducted to determine the ability of the TEM transmission line to operate in the presence of an explosive atmosphere.

4.7.21.2 Test equipment. Test equipment shall consist of an explosion-proof chamber as specified in MIL-STD-810, method 511, an RF power source and associated equipment.

4.7.21.3 Test conditions. The test conditions shall be as specified in MIL-STD-810, method 511.

4.7.21.4 Procedure.

4.7.21.4.1 The TEM transmission line shall be subjected to the test specified in 4.7.24, Procedure I.

4.7.21.4.2 The TEM transmission line shall be subjected to the test specified in MIL-STD-810, method 511, Procedure I.

4.7.21.4.3 The TEM transmission line shall be subjected to rated peak power for two minutes at the specified test frequency (see 3.6.4.6.2 and table VII), while the TEM transmission line is exposed to the explosive mixture at each test altitude of 50,000, 40,000, 30,000, 20,000 and 10,000 feet.

4.7.21.5 Accept-reject criteria. If the TEM transmission line causes an explosion while being energized at any of the test altitudes, the unit shall be considered to have failed the test.

4.7.22 Humidity test.

4.7.22.1 General. The humidity test shall be conducted to determine the TEM transmission line's resistance to the effects of exposure to a warm, highly humid atmosphere. This imposes a vapor pressure on the item under test which constitutes the major force behind moisture migration and penetration.

4.7.22.2 Test equipment. The apparatus used as test equipment shall be as specified in MIL-STD-810, method 507.

4.7.22.3 Test conditions. The test conditions shall be as specified in MIL-STD-810, method 507.

4.7.22.4 Procedure. The test procedure shall be as specified in MIL-STD-810, method 507, Procedure IV except as modified herein.

4.7.22.4.1 Prior to placing the TEM transmission line in the test chamber, the unit shall be subjected to the test specified in 4.7.6. Measure and record the value of leakage rate found.

4.7.22.4.2 The initial measurements required in Step 4 of MIL-STD-810, method 507, Procedure IV shall consist of the tests specified in 4.7.3, 4.7.4 and 4.7.24, Procedure I.

4.7.22.4.3 Measurements required during Steps 5, 6 and 8 of MIL-STD-810, method 507, Procedure IV shall be those specified in 4.7.22.4.2.

4.7.22.4.4 In addition to the inspection specified in Step 9 of MIL-STD-810, method 507, Procedure IV, the TEM transmission line shall be subjected to the test specified in 4.7.6.

4.7.22.5 Accept-reject criteria. If the TEM transmission line fails at any time during the humidity test to meet the accept-reject criteria established in 4.7.3, 4.7.4, 4.7.6 and 4.7.24, Procedure I, the unit shall be considered to have failed the test.

4.7.23 Salt fog test.

4.7.23.1 General. The salt fog test is conducted to determine the resistance of the TEM transmission line to the effects of a salt atmosphere.

4.7.23.2 Test equipment. The apparatus used as test equipment shall be as specified in MIL-STD-810, method 509.

4.7.23.3 Test conditions. The test conditions shall be as specified in MIL-STD-810, method 509.

4.7.23.4 Procedure.

4.7.23.4.1 The TEM transmission line shall be subjected to the tests as specified in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.24, Procedure I.

4.7.23.4.2 Prepare the TEM transmission line for test as required in MIL-STD-810, method 509, and install in the test chamber.

4.7.23.4.3 The test shall be accomplished as specified in MIL-STD-810, method 509 except the test sample shall be exposed to the salt fog for a period of not less than 96 hours. Primary interfaces shall not be mated, covered, or otherwise protected during the exposure period.

4.7.23.4.4 At the conclusion of the exposure to the salt fog atmosphere the TEM transmission line shall be removed from the chamber and subjected to the examinations and tests specified in 4.7.1, Procedure IV.

4.7.23.4.5 After the examinations and tests specified in 4.7.1, Procedure IV have been performed, the TEM transmission line shall be washed and dried as specified in MIL-STD-810, method 509, and subjected to the tests specified in 4.7.24, Procedure I, 4.7.3 and 4.7.4 in the sequence listed.

4.7.23.5 Accept-reject criteria. If the TEM transmission line fails to meet the accept-reject criteria established in 4.7.1, Procedure IV, 4.7.3, 4.7.4 and 4.7.24, Procedure I, the unit shall be considered as having failed the salt fog test.

4.7.24 High potential withstand test.

4.7.24.1 General. The high potential withstanding test shall be conducted to determine the TEM transmission line's or the replaceable interface component's ability to operate safely at its rated voltage and withstand momentary over-potentials due to switching, surges, pulsing or other similar phenomena. The test serves to determine if insulating materials and fabrication methods are adequate.

4.7.24.2 Test equipment. The apparatus used as test equipment shall meet the requirements as specified in MIL-STD-202, method 301 except the fault indicator shall be a suitable oscilloscope.

4.7.24.3 Test conditions. Test conditions shall be as specified in the applicable test method.

4.7.24.4 Procedure I - for TEM transmission lines.

4.7.24.4.1 The primary interfaces of the TEM transmission line shall be mated to EW precision counterparts that are part of the test equipment setup. Sealant materials shall not be used in either the TEM transmission line interface components or their mating test equipment interface components.

4.7.24.4.2 The magnitude of the test voltage shall be as specified in 3.6.4.7 and as required by the applicable test conditions.

4.7.24.4.3 The test voltage shall be applied between the center conductor and the outer conductor of the TEM transmission line.

4.7.24.4.4 The test voltage shall be raised from zero to the specified value at a uniform rate of 500 volts (RMS) per second. The test voltage shall be maintained at the specified value for a test period of 60 seconds.

4.7.24.4.5 During the test period, monitor the fault indicator oscilloscope for evidence of a disruptive discharge.

4.7.24.4.6 Upon completion of the test period, gradually reduce the test voltage to zero.

4.7.24.5 Accept-reject criteria - procedure I. If any evidence of breakdown is indicated, or if the TEM transmission line fails to withstand the specified test voltage, the unit shall be considered to have failed the test.

4.7.24.6 Procedure II - for replaceable interface components.

4.7.24.6.1 The interfaces of the replaceable interface component shall be mated to counterparts that are part of the test equipment setup. Sealant materials shall not be used in either the replaceable interface component or its mating test equipment interface components.

4.7.24.6.2 The magnitude of the test voltage shall be as specified in 3.6.4.1.2 at normal ambient conditions.

4.7.24.6.3 The test voltage shall be applied between the center conductor and the outer conductor of the replaceable interface component.

4.7.24.6.4 The test voltage shall be raised from zero to the specified value at a uniform rate of 500 volts (RMS) per second. The test voltage shall be maintained at the specified value for a test period of 60 seconds.

4.7.24.6.5 During the test period, monitor the fault indicator oscilloscope for evidence of a disruptive discharge.

4.7.24.6.6 Upon completion of the test period, gradually reduce the test voltage to zero.

4.7.24.7 Accept-reject criteria - procedure II. If any evidence of breakdown is indicated, or if the replaceable interface component fails to withstand the specified test voltage, the unit shall be considered to have failed the test.

5. PACKAGING

5.1 Preservation and packaging. Preservation and packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning. Metallic surfaces of TEM transmission lines shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. TEM transmission lines shall be dried in accordance with MIL-P-116, Procedure D-1.

5.1.1.3 Unit packaging. Unless otherwise specified, TEM transmission lines shall be individually packaged in accordance with MIL-P-116, method III, insuring compliance with the general requirements paragraph under methods of preservation (unit protection) and the physical protection requirements paragraph therein.

5.1.1.3.1 Class I and Class II TEM transmission lines less than 10 feet long shall not be coiled, and shall be individually packaged in accordance with MIL-P-116, method 1A-8.

5.1.1.3.2 Class I and Class II TEM transmission lines more than 10 feet long shall be contained within a coil whose minimum diameter is 50 x the diameter of the cable, and shall be individually packaged in accordance with MIL-P-116, method 1A-8.

5.1.1.3.3 Class III TEM transmission lines shall not be coiled, bent or otherwise deformed except as specified in the detail specification drawings and shall be individually packaged in accordance with MIL-P-116, method 1A-8.

5.1.1.4 Intermediate packaging. TEM transmission lines packaged as described in 5.1.1.4 shall be placed in a fiberboard container conforming to PPP-B-636, weather resistant, style optional, special requirement.

5.1.2 Level C. TEM transmission lines shall be individually packaged in a manner that will afford adequate protection against corrosion, deterioration and physical damage during shipment from supply source to the first receiving activity.

5.2 Packing. Packing shall be level A, B or C, as specified (see 6.2).

5.2.1 Level A. The packaged TEM transmission lines shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirement. In lieu of the closure and waterproofing requirements in the Appendix of PPP-B-636, closures and waterproofing shall be accomplished by sealing all seams, corners, and manufacturer's joint with waterproof tape, 2-inch minimum width, conforming to PPP-T-60, class 1 or PPP-T-76. Banding (reinforcement PPP-B-636) shall be accomplished using nonmetallic or tape banding only.

5.2.2 Level B. Unless otherwise specified, the packaged TEM transmission lines shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirement. Closures shall be in accordance with the appendix thereto.

5.2.3 Level C. The packaged TEM transmission lines shall be packed in shipping containers in a manner that will afford adequate protection against damage during direct shipment from the supply source to the first receiving activity.

5.3 Marking. In addition to any special marking required by the contract (see 6.2), each unit package, intermediate package and exterior container shall be marked in accordance with MIL-STD-129.

5.4 General. Exterior containers shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock-numbered items to the greatest extent possible.

5.5 Inspection. Inspection of military packaging shall be in accordance with 4.5.2.

5.6 Indirect shipment. The preservation, packaging, packing and marking requirements as specified in this section apply only to direct purchases by or direct shipment to the Government and are not intended to apply to contracts or orders between the supplier and the prime contractor.

6. NOTES

6.1 Intended use. The Transverse Electromagnetic Mode (TEM) transmission lines covered by this document are intended for use with Airborne Electronic Systems and any other system requiring high-reliability low-loss coaxial transmission lines.

6.2 Ordering data. Acquisition documents shall specify the following:

a. Title, number and date of this specification.

b. The Manufacturer's Inspection Plan number.

c. Level of preservation, packaging, packing and applicable marking (see Section 5).

d. Detail specification drawings that include the following:

(1) Type (see 1.2).

(2) Class (see 1.2 and 6.4.3).

(3) Outline dimensions (see 6.4.10).

(4) Primary interfaces (see 3.5.1.1 and 6.4.12).

(5) If required, replaceable interface components (see 3.5.1.3 and 6.4.13).

(6) Weight, if applicable.

(7) Insertion loss value (see 3.6.4.1).

(8) Velocity of propagation, if applicable (see 3.6.4.4).

(9) Phase characteristics, if applicable (see 3.6.4.9).

(10) Marking information (see 3.8).

(11) Reliability assurance test information, if required (see 3.7.1).

(12) All variances, if any, from this document's requirements for First Article Inspection (see 3.3), Materials (see 3.4), Design and Construction (see 3.5), and Performance (see 3.6).

e. For First Article Inspection instructions covering sample disposition, test reports, monitoring agency and approval procedures, see 3.3, 4.3 and 6.3.

6.3 First article. When a first article inspection is required, the items should be first article samples as specified in 4.3.1 and table X. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitation for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has previously been acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Definitions. The following definitions apply to this specification.

6.4.1 Band of uncertainty. For the purpose of this specification, the "band of uncertainty" is defined as that portion of any measurement that is subject to doubt because of residual errors within the test and measurement system.

6.4.2 Cable component. A coaxial device capable of transmitting RF energy in the TEM mode over distances large in comparison to the wave-length of the energy. A cable component may be terminated by either an interface component or an intermediate interface component.

6.4.3 Classification of product.

6.4.3.1 A Class 1 (flexible construction) transmission line is one where, during installation, bending is required to facilitate running long lengths, where attachment to shock mounted equipment is required, and where large angular displacements are encountered during service and maintenance conditions.

6.4.3.2 A Class 2 (semiflexible construction) transmission line is one where, during installation, bending or forming is required to facilitate running long lengths but where attachment to shock-mounted equipment is not required. Class 2 TEM transmission lines are not intended for applications requiring continuous flexure in service.

6.4.3.3 A Class 3 (rigid construction) transmission line is one that is formed during manufacturing and cannot withstand further bending or forming during installation or service without performance degradation.

6.4.4 Detail specification drawings. Drawings that delineate all of the individual requirements for a particular TEM transmission line not specifically defined in this document, or when exceptions are made to this document.

6.4.5 Fine structure variation. A periodic or abrupt change that appears in the plotted measurement of insertion loss versus frequency as illustrated in figure 12.

6.4.6 Inspection acceptance criteria. This criteria will be dependent on the manufacturer's inspection plans, his "band of uncertainty," and the government's assumption of "user's risk." If a manufacturer has a zero "band of uncertainty," his inspection acceptance criteria would be the values specified herein. As the "band of uncertainty" increases, the manufacturer's inspection acceptance criteria would become more stringent than the values specified herein.

6.4.7 Interface component. The part of a TEM transmission line which provides a mechanical and electrical mate between the cable component and other equipment. The interface component terminates in a primary interface and is permanently attached to its appropriate cable component.

6.4.8 Intermediate interface. The electrical and mechanical transition between an intermediate interface component and a replaceable interface component. The intermediate interface does not provide the final transition from the cable component to external equipment.

6.4.9 Intermediate interface component. The part of a TEM transmission line which provides a mechanical and electrical mate between a cable component and a replaceable interface component. The intermediate interface component terminates in an intermediate interface and is permanently attached to its appropriate cable component.

6.4.10 Outline dimensions. Outline dimensions, for the purpose of this document, are defined as those that describe the physical size and shape of a TEM transmission line and, if applicable, locate required markings.

6.4.11 Peak to peak variation. The variation in the characteristic impedance plot caused by mismatches or imperfections in the TEM transmission line. Figure 13 illustrates the peak-to-peak variation.

6.4.12 Primary interface. The final electrical and mechanical transition between a TEM transmission line and external equipment. The primary interface may be part of an interface component or a replaceable interface component.

6.4.13 Replaceable interface component. The part of a TEM transmission line which provides a mechanical and electrical mate between an intermediate interface component and other equipment. The replaceable interface component is removable as a unit and terminates in an intermediate interface and a primary interface.

6.4.14 TEM transmission line. A Transverse Electromagnetic Mode (TEM) transmission line is defined, for the purpose of this document, as a complete assembly capable of mechanically and electrically interconnecting two units of a system. A TEM transmission line shall consist of a cable component of finite length terminated at each end by the required electrical interfaces (see figure 25).

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

6.6 Subject term (key word) listing.

Ratio, voltage standing wave (VSWR)
Waveguide

Preparing activity:
Navy - AS
(Project No. 5985-N611)

TABLE XIII. Interface gauging - Type 1 male primary interface (4.7.2.4.3).

Reference to Type 1 - Male Primary Interface (figure 1)			
	Max.	Min.	Notes
Coupling Ring			
Thread Size 7/16-28 UNEF-2B			
Thread Length		.156	
Thread Relief		.440	
Relief Depth		.063	
Outer Conductor			
O.D. (slotted)	.325	.322	After forming
O.D. (solid)	.317	.313	
Radius		.005	
Ref. Plane Flat	.018	.012	
Ref. Plane Finish	32√		
Center Pin			
Length (shoulder to tip)	.192	.182	
Length (contact surface)	.045	.035	
O.D. (contact surface)	.054	.053	-A-
Finish	32√		
Dielectric			
I.D.	.194	.192	
Depth from Ref. Plane	.212	.209	
Recessed Below Ref. Plane	.009	.006	
Locating Dimensions			
Ref. Plane to Center Pin Shoulder	.212	.209	
Dielectric I.D. to Center Pin Contact Surface	.002 TIR		
Outer Conductor to Ref. Plane	.0005		⊥

TABLE XIV. Interface gauging - Type 1 female primary interface (4.7.2.4.3).

Reference to Type 1 - Female Primary Interface (figure 2)			
	Max.	Min.	Notes
Outer Conductor			
O.D.	.381	.378	
Thread Size 7/16-28 UNEF-2A			
Thread Length		.187	
Thread Relief	.088	.068	
I.D. Length	.333	.329	
I.D. (mating surface at ref. plane)	.321	.319	-A-
I.D. (at chamfer)	.333	.327	
Mating Surface (at ref. plane)	.036	.026	
Radius (at ref. plane)	.004		
Ref. Plane Finish	32 √		
Dielectric			
Length (ref. plane to shoulder)	.006	.003	
Length (ref. plane to tip)	.208	.205	
Diameter (at ref. plane)	.266	.264	
Diameter (at tip)	.186	.184	
Center Contact			
O.D. (with pin gauge inserted)	.086	.085	
Finish (mating surface)	32 √		
I.D. Depth		.200	
Locating Dimensions			
Dielectric O.D. (at tip) to Outer Conductor (mating surface)	.002 TIR		
Center Contact (mating surface) to Outer Conductor (mating surface)	.004 TIR		
Ref. Plane to Outer Conductor (mating surface)	.001		⊥
Thread P.D. to Outer Conductor (mating surface)	.005 TIR		
Center Contact to Dielectric Tip	Flush to .003 Depressed		

TABLE XV. Interface gauging - Type 2 male primary interface (4.7.2.4.3).

Reference to Type 2 - Male Primary Interface (figure 3)			
	Max.	Min.	Notes
Coupling Ring			
Thread Size 0.6875-24 UNEF-2B			
Thread Length	.255	.245	
Thread Relief		.690	
Thread Depth	.223	.213	
Outer Conductor			
O.D. (slotted)	.421	.418	After forming
O.D. (solid)	.411	.407	
I.D.		.384	
Radius	.008	.005	
Ref. Plane Finish	32 √		
Center Pin			
Length (shoulder to tip)	.192	.182	
Length (contact surface)	.045	.035	
O.D. (contact surface)	.198	.196	-A-
Finish	32 √		
Dielectric			
I.D. (at center pin shoulder)	.198	.196	
I.D.	.280	.278	
Depth from Ref. Plane	.312	.309	
Recessed Below Ref. Plane	.010	.007	
Locating Dimensions			
Ref. Plane to Center Pin Shoulder	.310	.306	
Outer Conductor to Center Pin Contact Surface	.005 TIR		
Ref. Plane to Center Pin Contact Surface	.001		⊥

TABLE XVI. Interface gauging - Type 2 female primary interface (4.7.2.4.3).

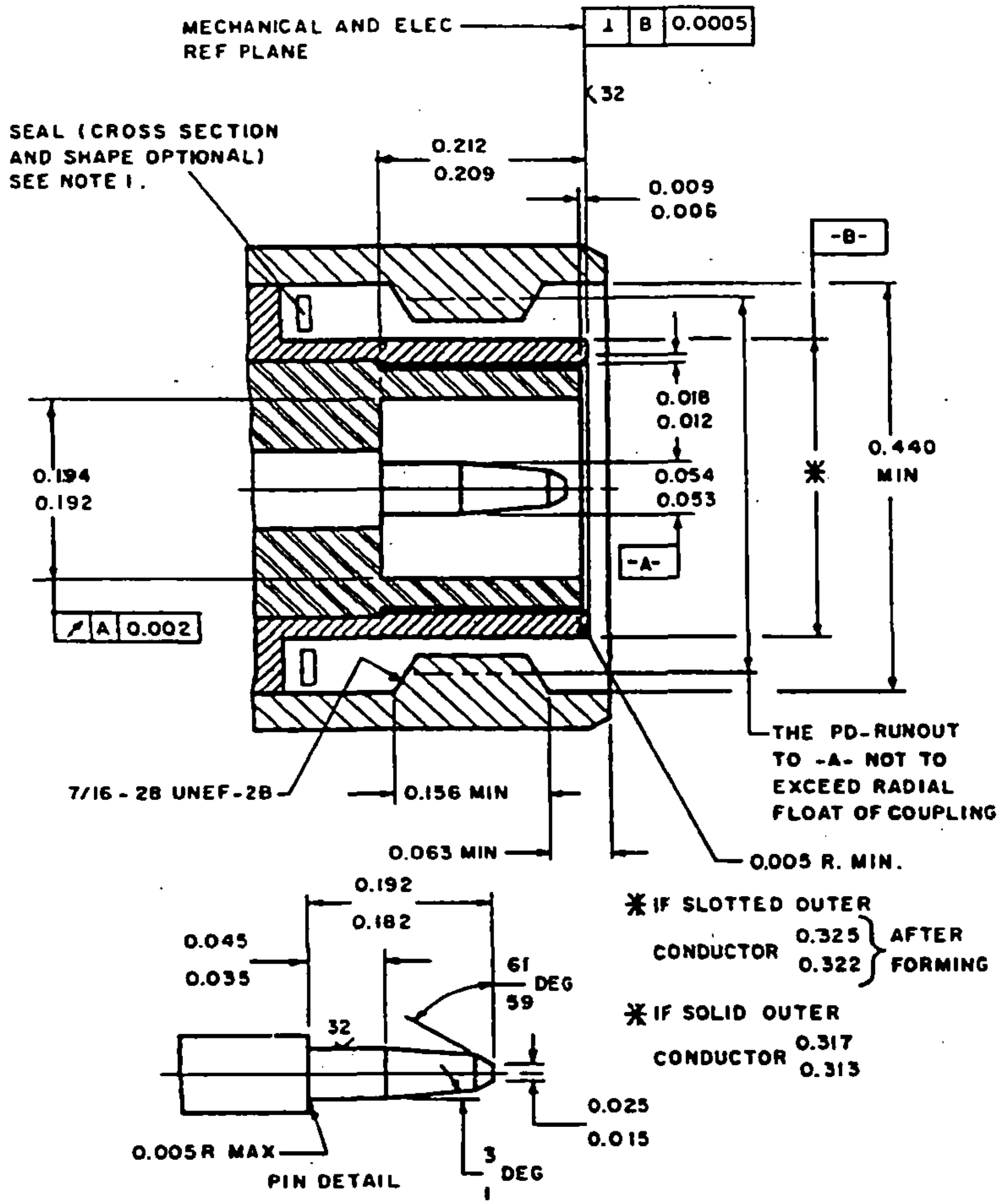
Reference to Type 2 - Female Primary Interface (figure 4)			
	Max.	Min.	Notes
Outer Conductor			
O.D.	.630		
Thread Size 0.6875-24 UNEF-2A			
Thread Length		.250	
Thread Relief	.077	.044	
I.D. Length (ref. plane to front)	.495	.491	
I.D. (mating surface at ref. plane)	.415	.411	-A-
I.D. (at front)	.498	.482	
Mating Surface (at ref. plane)	.040	.020	
Radius (at ref. plane)	.004		
Ref. Plane Finish	32 √		
Dielectric			
Length (ref. plane to shoulder)	.007	.004	
Length (ref. plane to tip)	.308	.304	
Diameter (at ref. plane)	.383	.381	
Diameter (after shoulder)	.270	.268	
Diameter (at tip)	.189	.188	
I.D. (at tip)	.129	.127	
Center Contact			
O.D. (with pin gauge inserted)	.1225	.1215	
Finish (mating surface)	32 √		
I.D. Depth		.300	
Locating Dimensions			
Ref. Plane to Tip of Center Contact	.305	.301	
Outer Conductor (mating surface) to Ref. Plane	.0005		⊥
Thread P.D. to Outer Conductor (mating surface)	.005 TIR		

TABLE XVII. Interface gauging - Type 3 male primary interface (4.7.2.4.3).

Reference to Type 3 - Male Primary Interface (figure 5)			
	Max.	Min.	Notes
Coupling Ring			
Thread Size 0.625-24 UNEF-2B			
Thread Length	.197	.177	
Thread Relief		.630	
Relief Depth	.168	.158	
Outer Conductor			
O.D. (slotted)	.327	.321	After forming
O.D. (solid)	.3165	.3150	
I.D.		.275	-A-
Radius	.008	.005	
Ref. Plane Finish	32√		
Center Pin			
Length (shoulder to tip)	.190	.180	
Length (contact surface)	.080	.070	
O.D. (contact surface)	.0655	.0645	-B-
O.D. (shoulder)	.1202	.1192	
Finish	32√		
Locating Dimensions			
Ref. Plane to Center Pin Shoulder	.211	.208	
Ref. Plane to Outer Conductor Shoulder	.412	.398	
I.D. Outer Conductor to O.D. Outer Conductor	.002 TIR		
I.D. Outer Conductor to Center Pin Contact Surface	.006 TIR		
I.D. Outer Conductor to Ref. Plane	.0005		⊥
Center Pin (shoulder) to Center Pin Contact Surface	.002 TIR		

TABLE XVIII. Interface gauging - Type 3 female primary interface (4.7.2.4.3).

Reference to Type 3 - Female Primary Interface (figure 6)			
	Max.	Min.	Notes
Outer Conductor			
Thread Size 0.625-24 UNEF-2A			
Thread Length	.202	.172	
Thread Relief (front)	.077	.047	
Thread Relief (front to rear)		.490	
I.D. Length (ref. plane to front)	.361	.357	
I.D. (mating surface at ref. plane)	.319	.317	-A-
I.D. (at front)	.344	.336	
Mating Surface (at ref. plane)	.025	.015	
Radius (at ref. plane)	.004		
Ref. Plane Finish	√32		
Center Contact			
I.D. (mating surface)	.063		After forming
Finish (mating surface)	√32		
I.D. Depth		.350	
O.D.	.1215	.1205	
Locating Dimensions			
Ref. Plane to Center Contact Tip	.207	.204	
Outer Conductor (mating surface) to Ref. Plane	.0005		⊥
Thread P.D. to Outer Conductor (mating surface)	.005 TIR		
Center Contact (mating surface) to Outer Conductor (mating surface)	.006 TIR		



NOTE 1. SEAL AND ITS LOCATING DIMENSIONS TO BE DETERMINED TO INSURE CONNECTOR MATES ELECTRICALLY AND MECHANICALLY AND SEALS TO TYPE 1- FEMALE HAVING DIMENSIONS SPECIFIED IN FIGURE 2.

FIGURE 1. Type 1 - male, E-W precision primary interface (3.5.1.1).

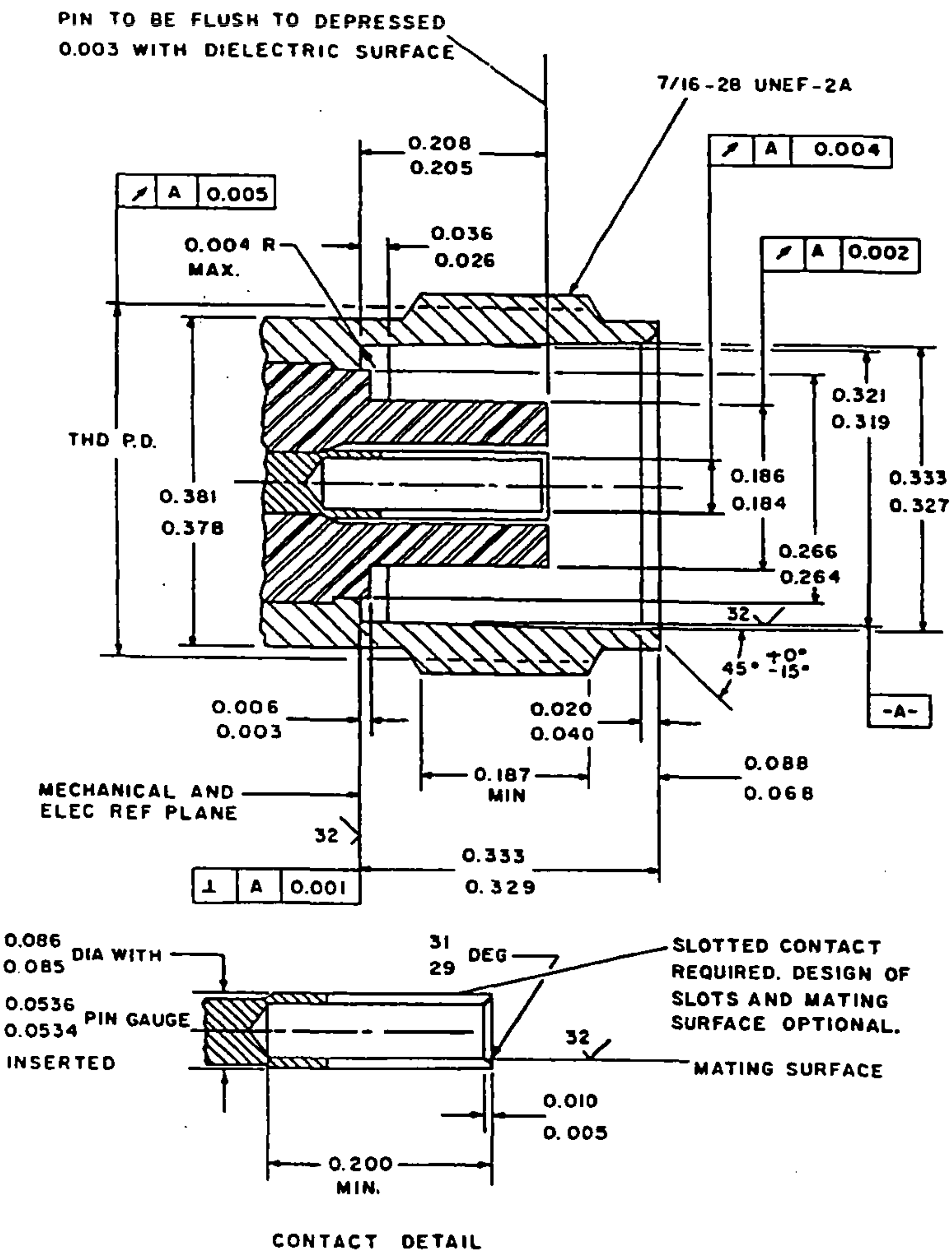
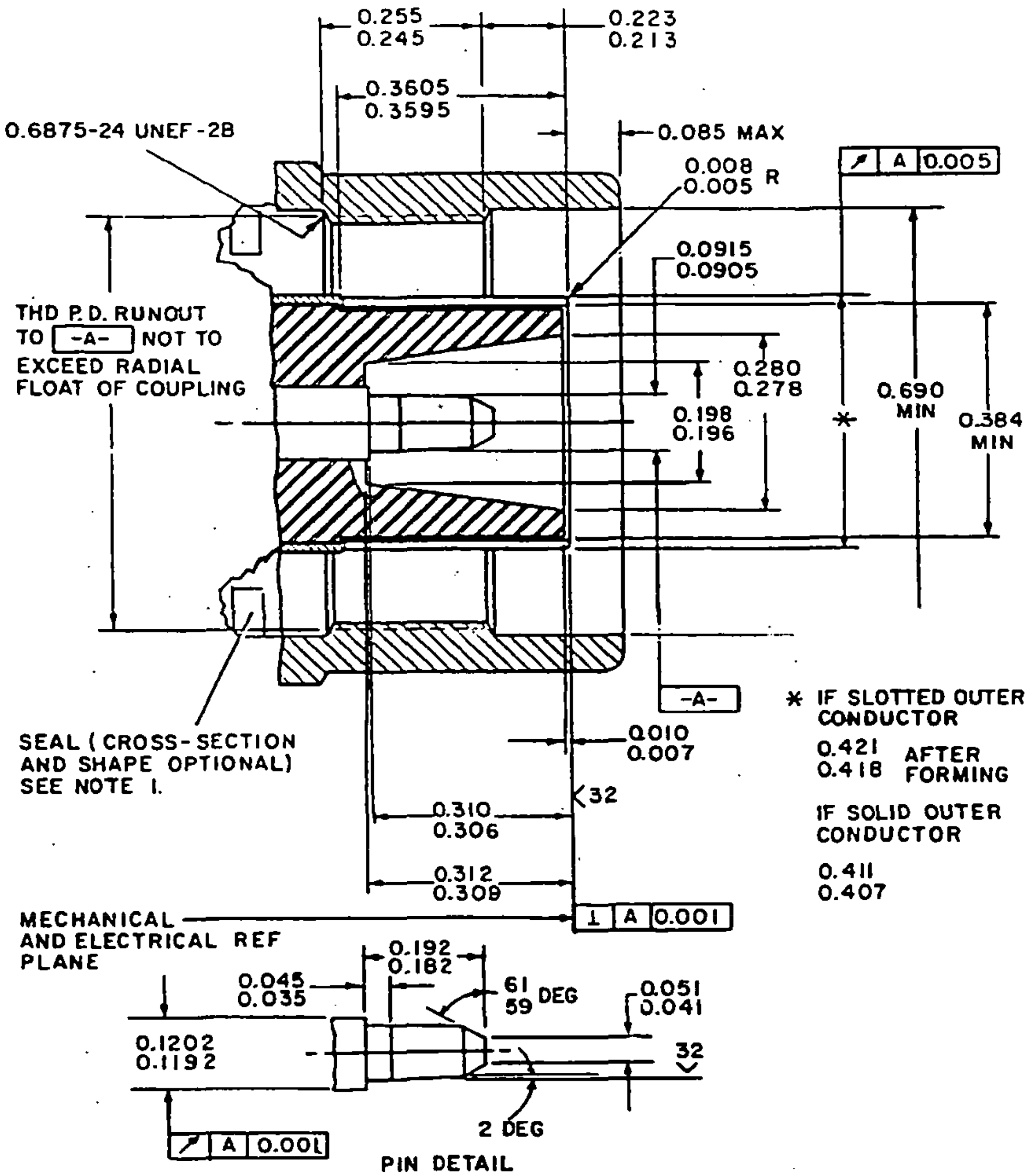


FIGURE 2. Type 1 - female, E-W precision primary interface (3.5.1.1).



NOTE 1.
SEAL AND ITS LOCATING DIMENSIONS TO BE DETERMINED TO INSURE CONNECTOR MATES ELECTRICALLY AND MECHANICALLY AND SEALS TO TYPE 2-FEMALE HAVING DIMENSIONS SPECIFIED IN FIGURE 4.

FIGURE 3. Type 2 - male, E-W precision primary interface (3.5.1.1).

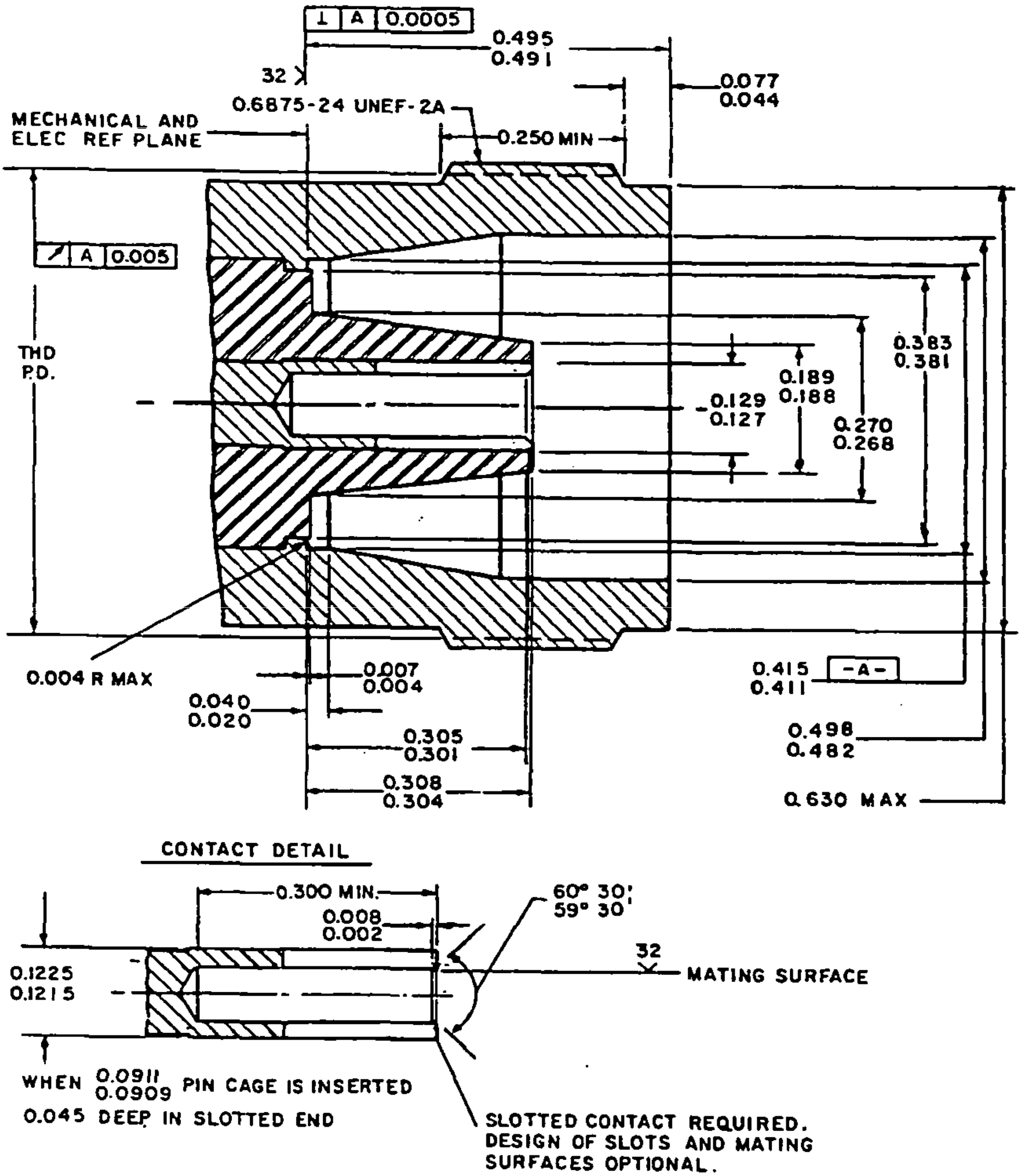
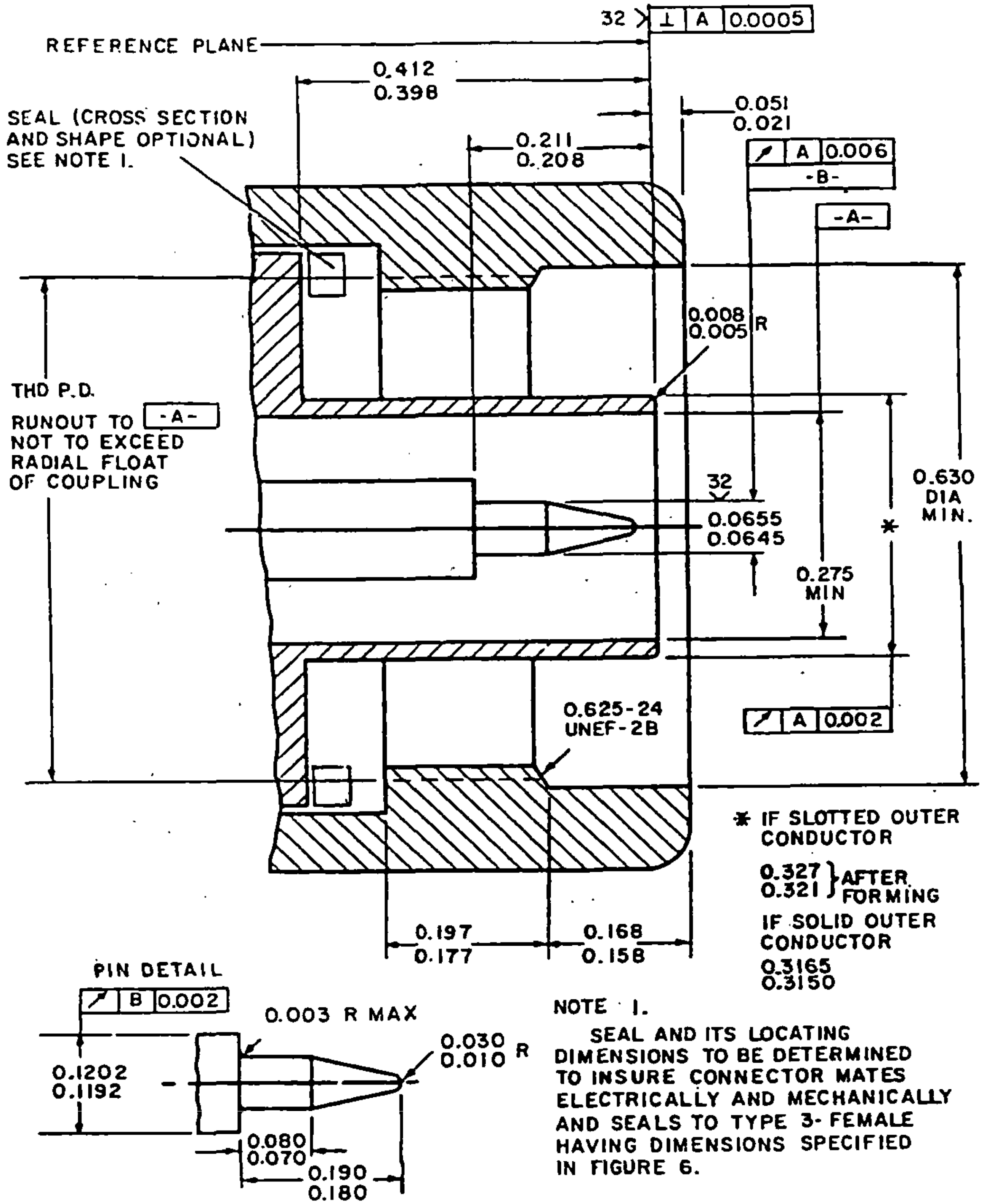


FIGURE 4. Type 2 - female, E-W precision primary interface (3.5.1.1).



NOTE 1.

SEAL AND ITS LOCATING DIMENSIONS TO BE DETERMINED TO INSURE CONNECTOR MATES ELECTRICALLY AND MECHANICALLY AND SEALS TO TYPE 3- FEMALE HAVING DIMENSIONS SPECIFIED IN FIGURE 6.

FIGURE 5. Type 3 - male, E-W precision primary interface (3.5.1.1).

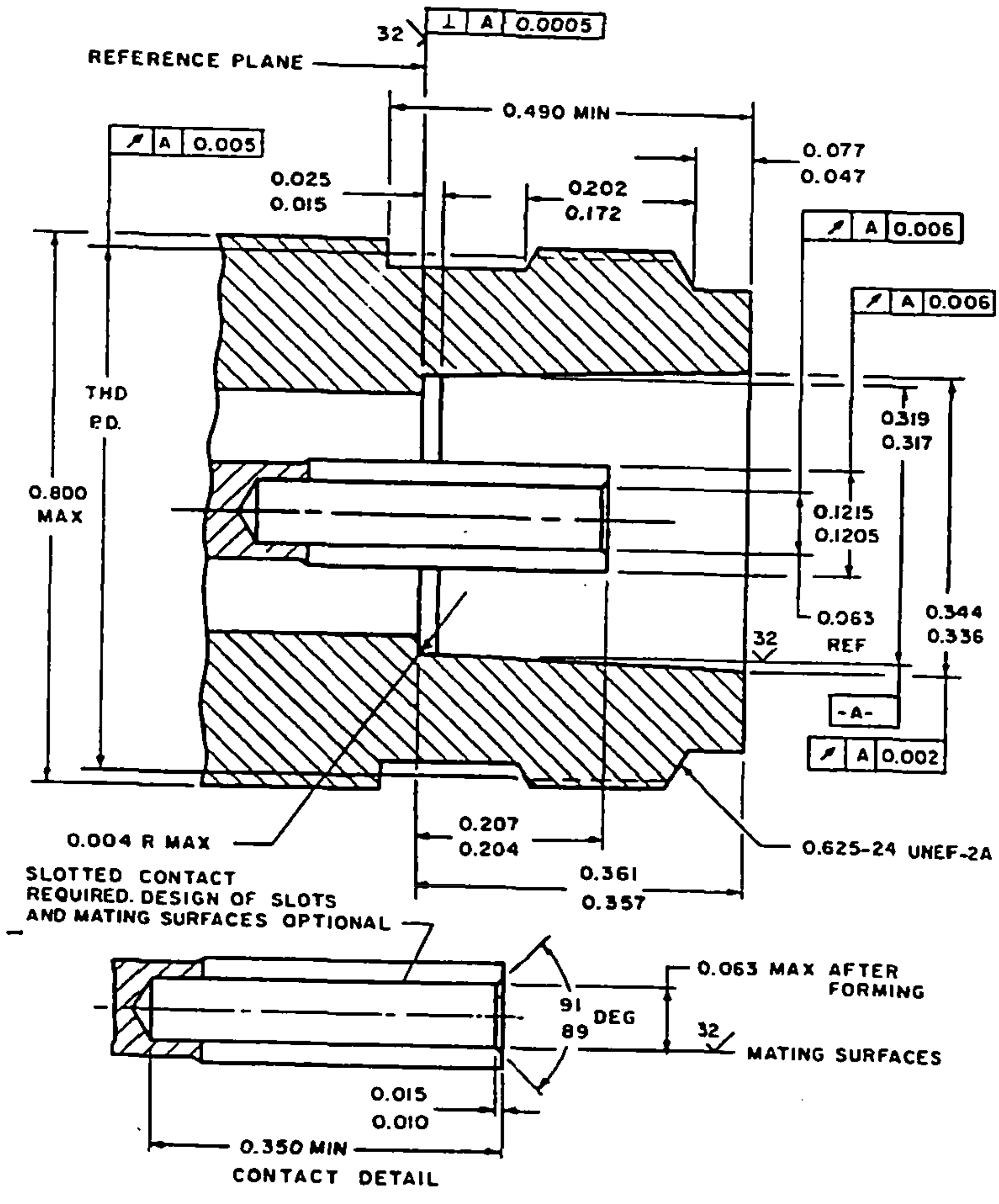


FIGURE 6. Type 3 - female, E-W precision primary interface (3.5.1.1).

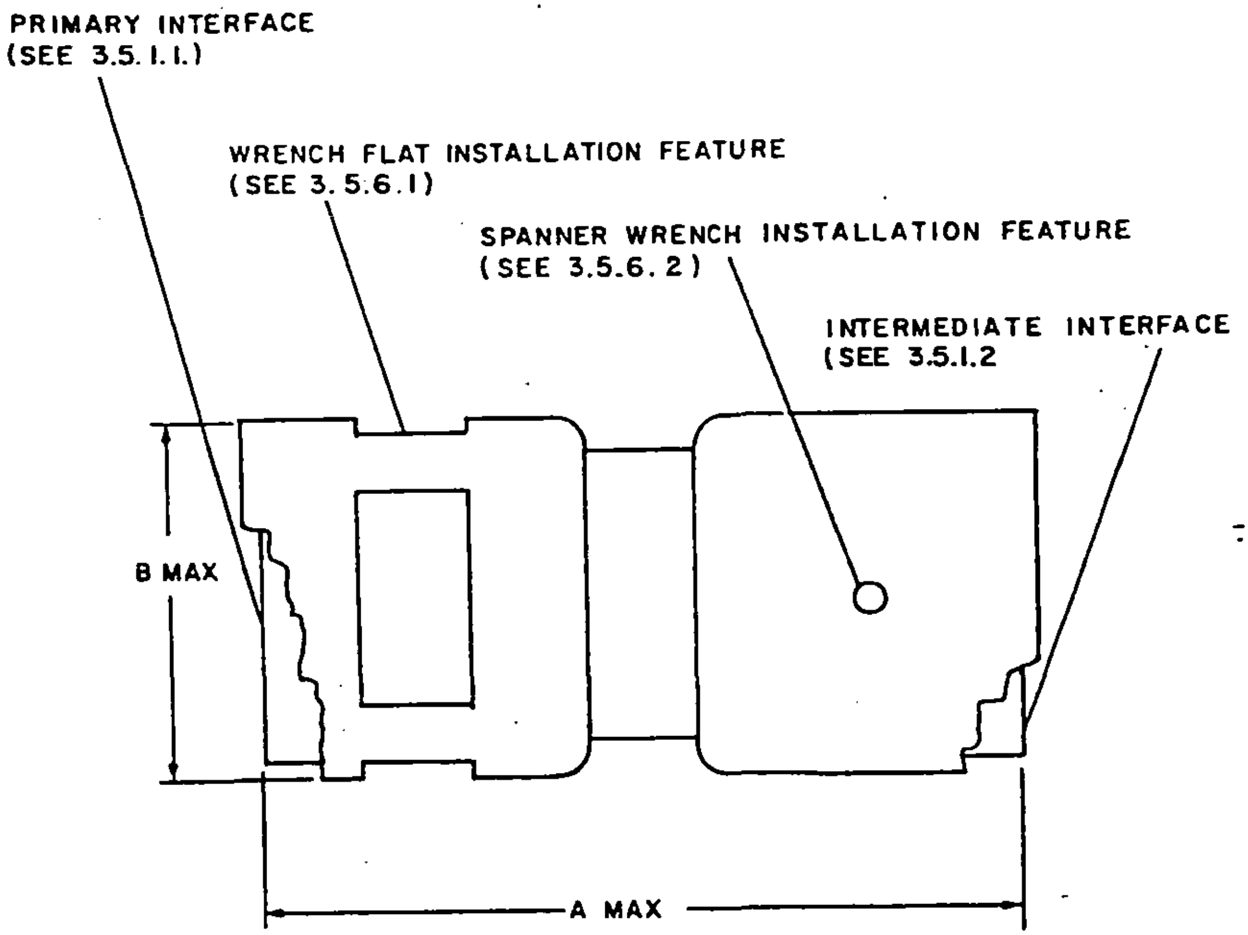


FIGURE 7. Style A, straight replaceable interface component (3.5.1.3).

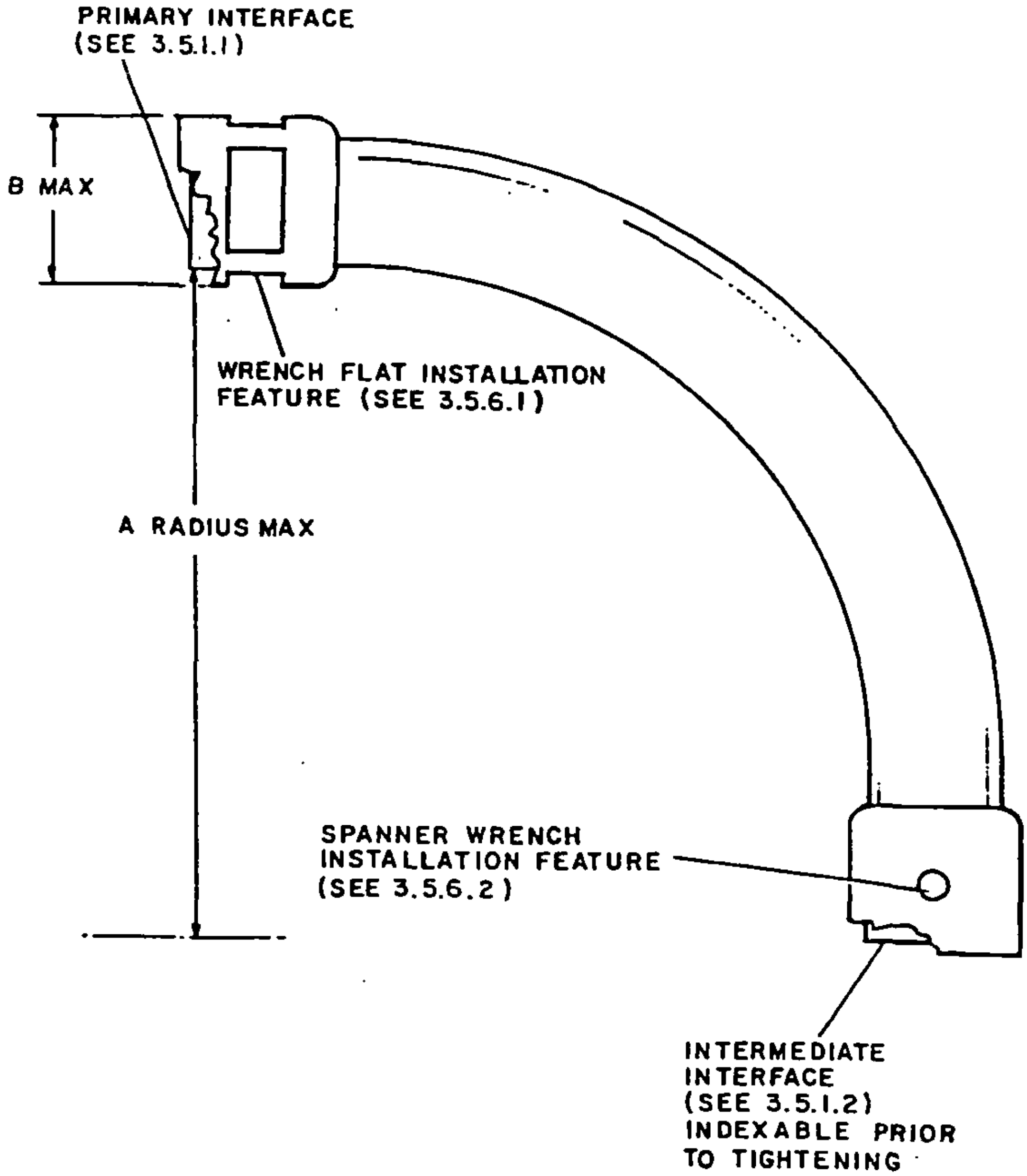


FIGURE 8. Style B, 90° elbow replaceable interface component (3.5.1.3).

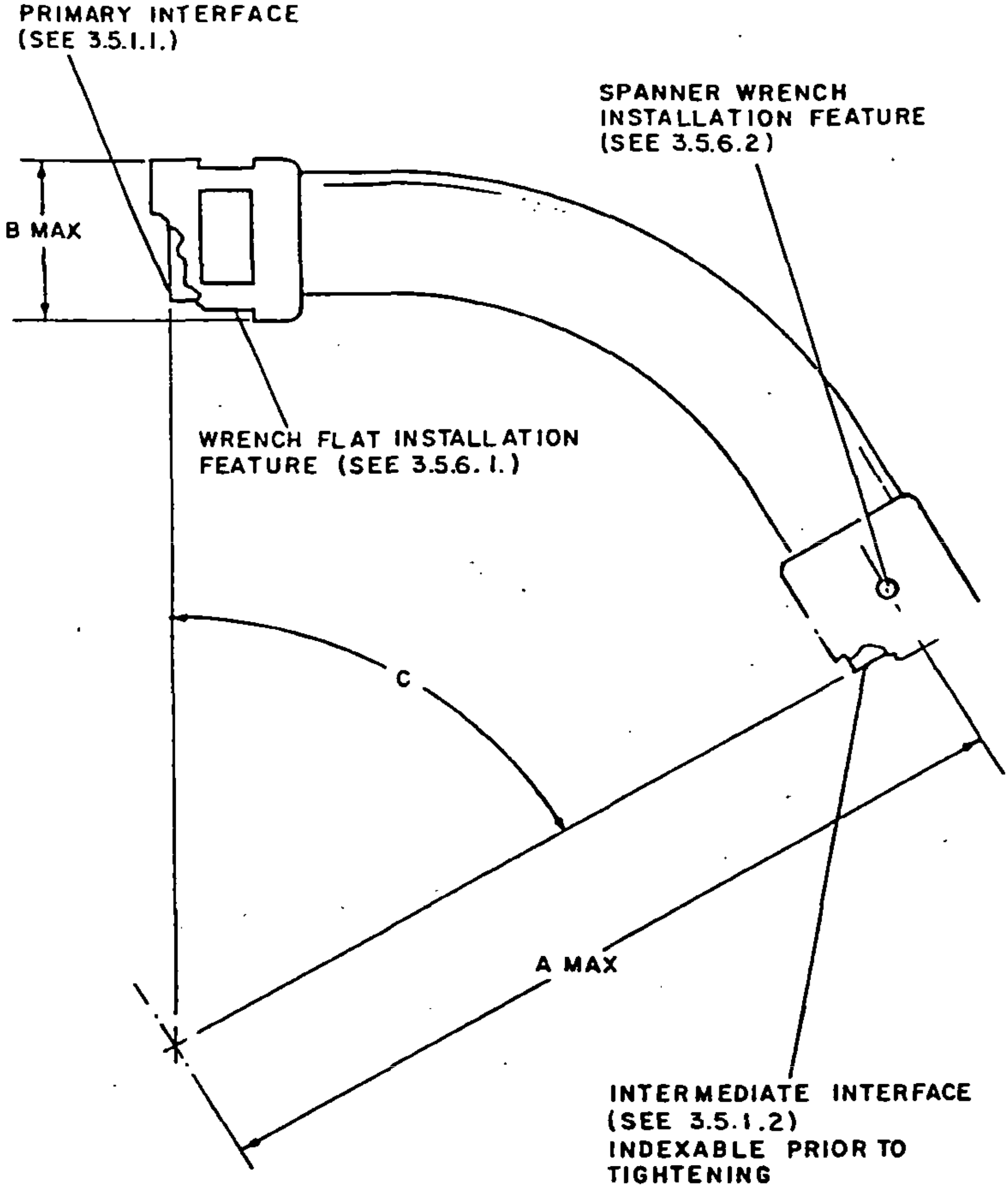
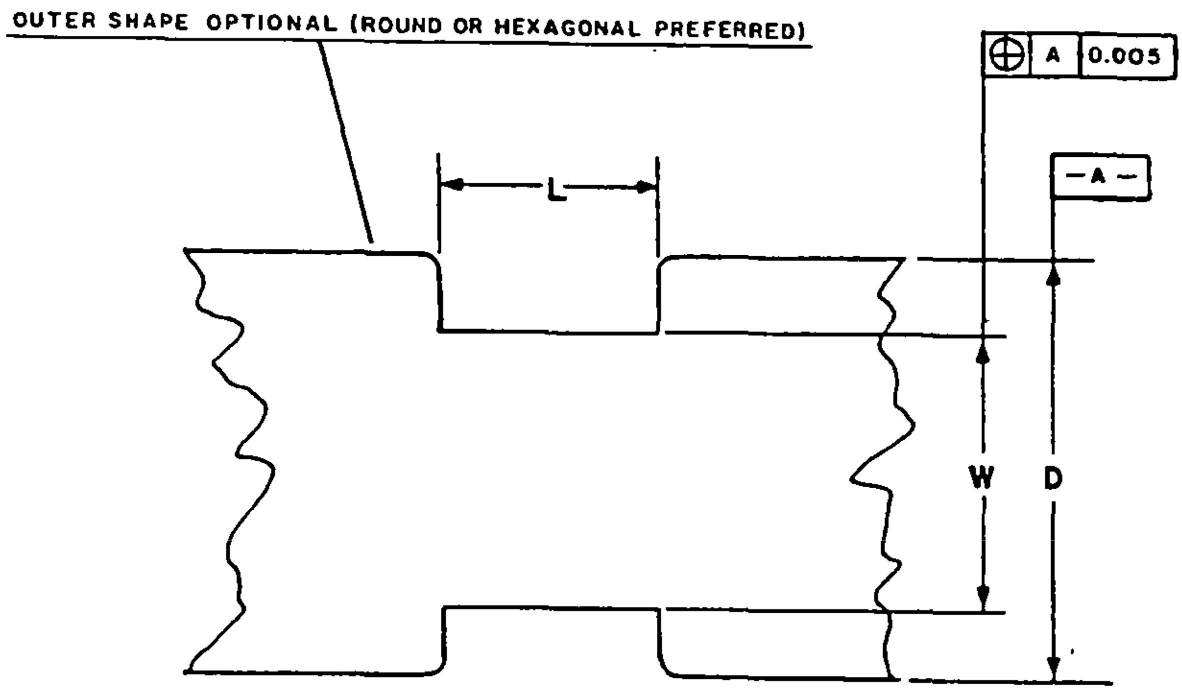
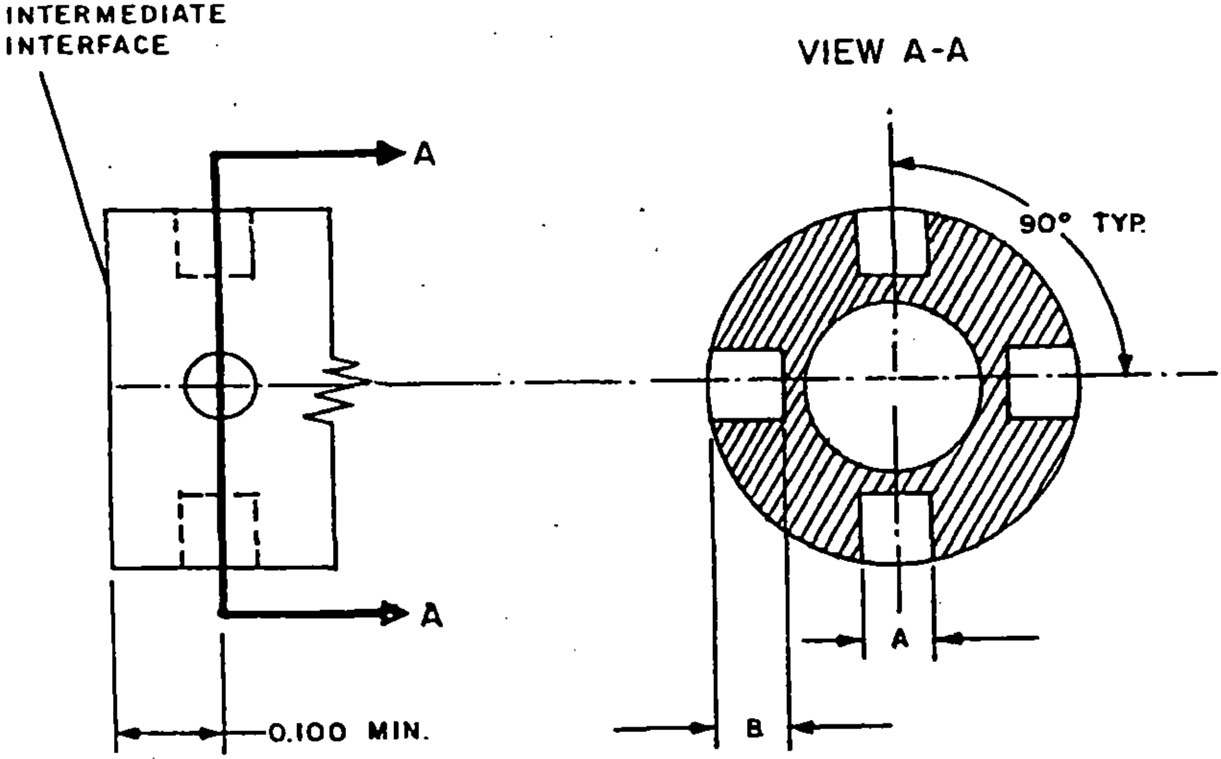


FIGURE 9. Style C, angular replaceable interface component (3.5.1.3).



PRIMARY INTERFACE TYPE	W (ACROSS FLATS)		L (FLAT LENGTH)	D (OUTER DIA.)	NOTES
	MAX.	MIN.	MIN.	MAX.	
1	0.625	0.606	0.300	0.800	EITHER SIZE ACCEPTABLE
	0.562	0.547	0.300	0.800	
2	0.781	0.759	0.500	0.800	
3	0.781	0.759	0.500	0.800	

FIGURE 10. Wrench flat sizes for primary interfaces (3.5.6.1).



TEM TRANSMISSION LINE TYPE	A (DIA)		B (MAX)
	MIN	MAX	
I	0.094	0.098	0.070
II	0.094	0.098	0.050

FIGURE 11. Intermediate interface spanner wrench holes (3.5.6.2).

TYPICAL INSERTION LOSS CURVE

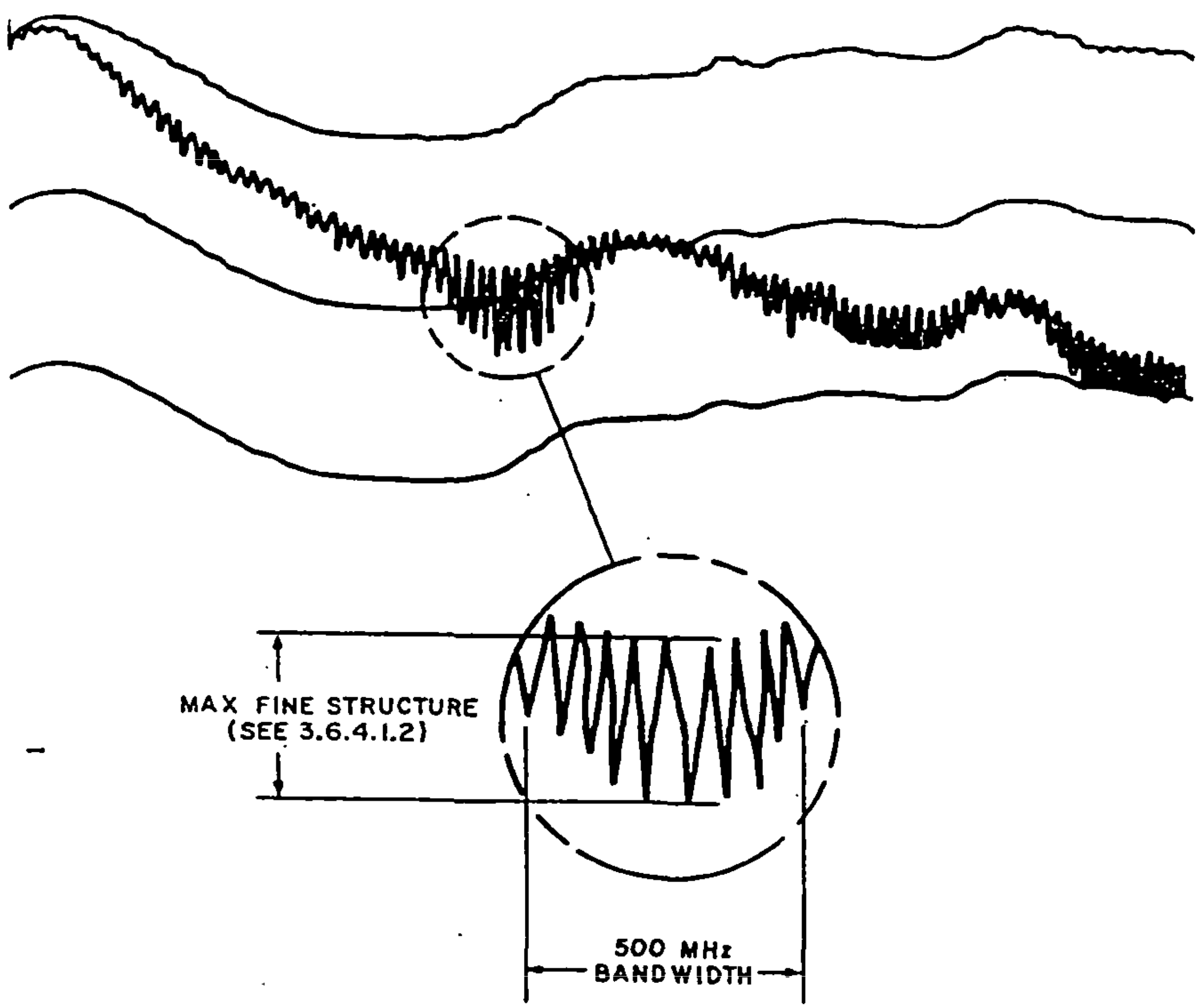


FIGURE 12. Typical fine structure variation (4.7.3.6.1).

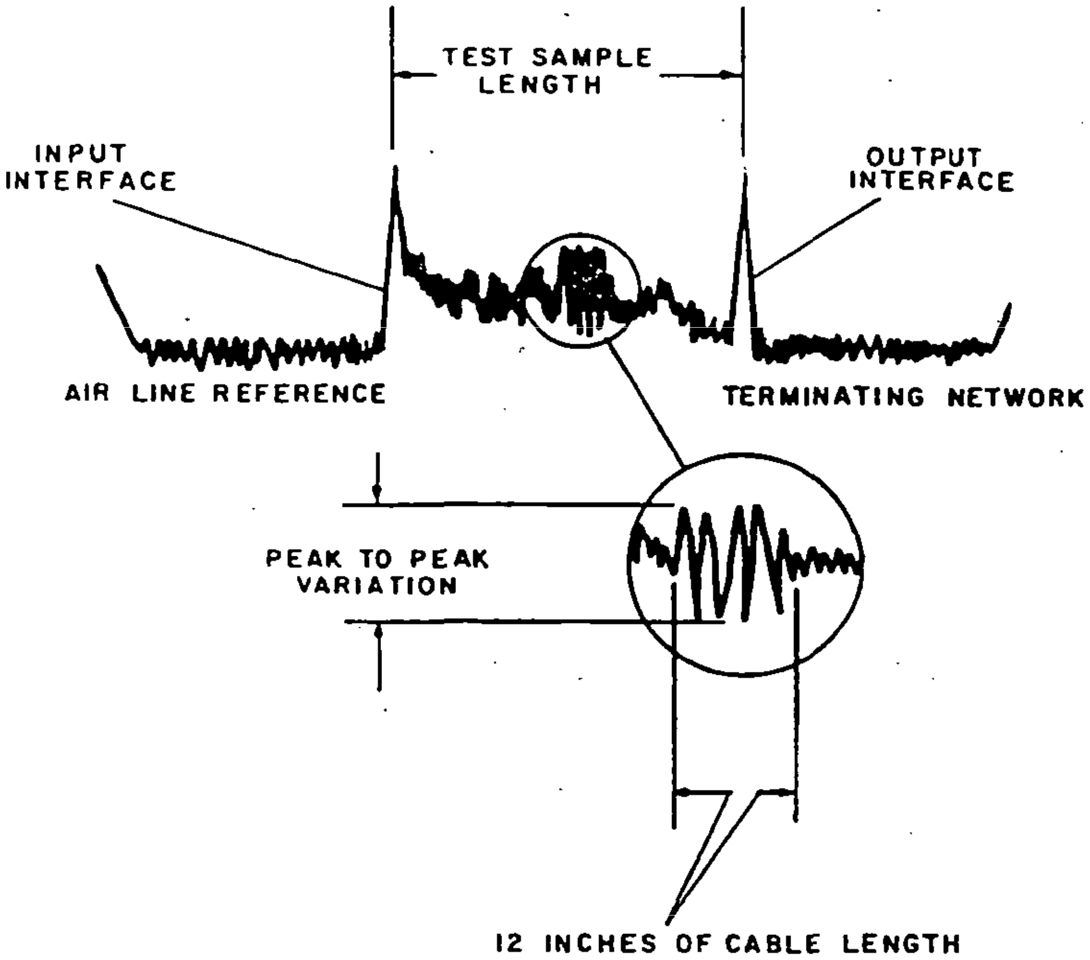


FIGURE 13. Typical impedance plot (4.7.5.4.4).

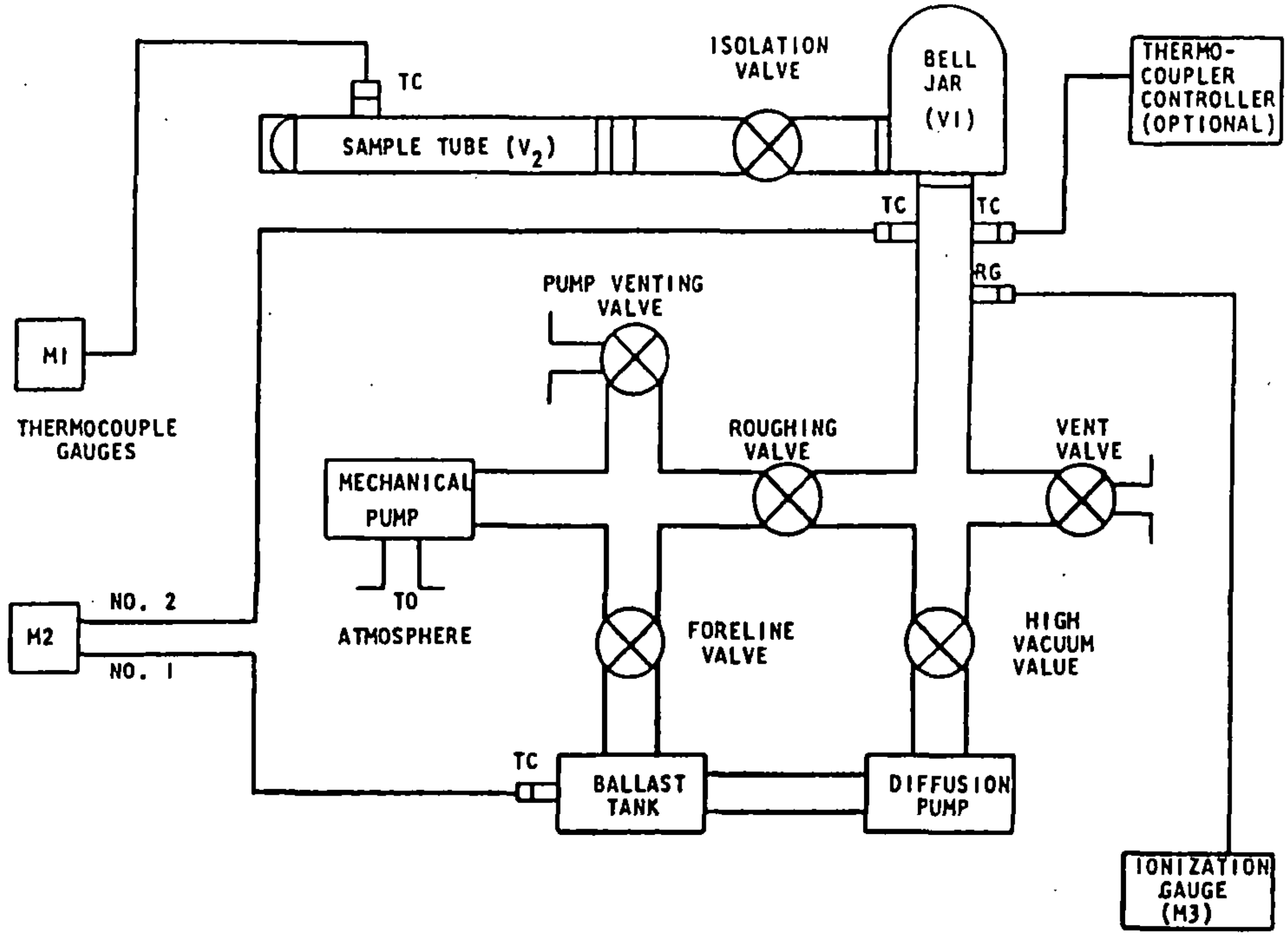


FIGURE 14. Vapor leakage test fixtures (4.7.6.2).

EQUIPMENT ITEM	EQUIPMENT NOMENCLATURE	REQUIRED PERFORMANCE PARAMETERS
1	Microwave Sweep Oscillator	Leveled output variable 0 to 100 mw minimum
2	Directional Coupler	20 dB
3	Variable Attenuator	Variable 0 to 50 dB
4	Isolator	20 dB isolation minimum
5	Direction Coupler	10 dB
6	Harmonic Frequency Converter	--
7	Network Analyzer with Gain Indicator Plug-In	--
8	X-Y Recorder	--
9	Fixed Attenuator	20 dB
10	Test Cavity	(See sheet 5 of 10)
11	DC Oscilloscope	--
12	Frequency Meter	--
13	Detector Mount	--
*	Short Circuit Assy	(See sheet 6 of 10)

FIGURE 15. RF leakage test equipment and setup (sheet 1 of 10) (4.7.8.2).

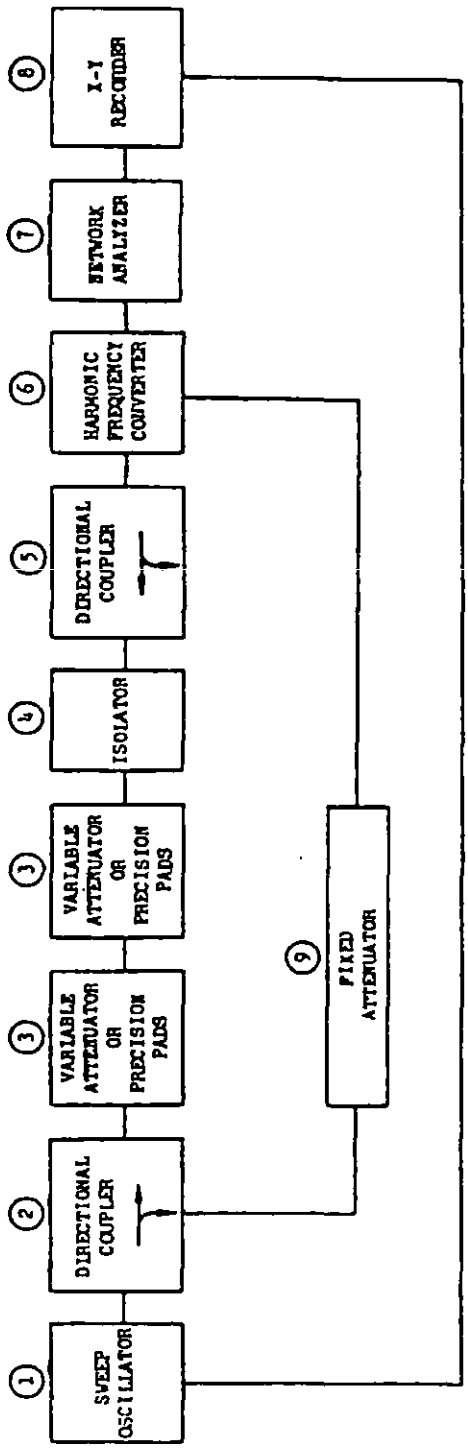


FIGURE 15. RF leakage test equipment and setup (sheet 2 of 10) (continued).

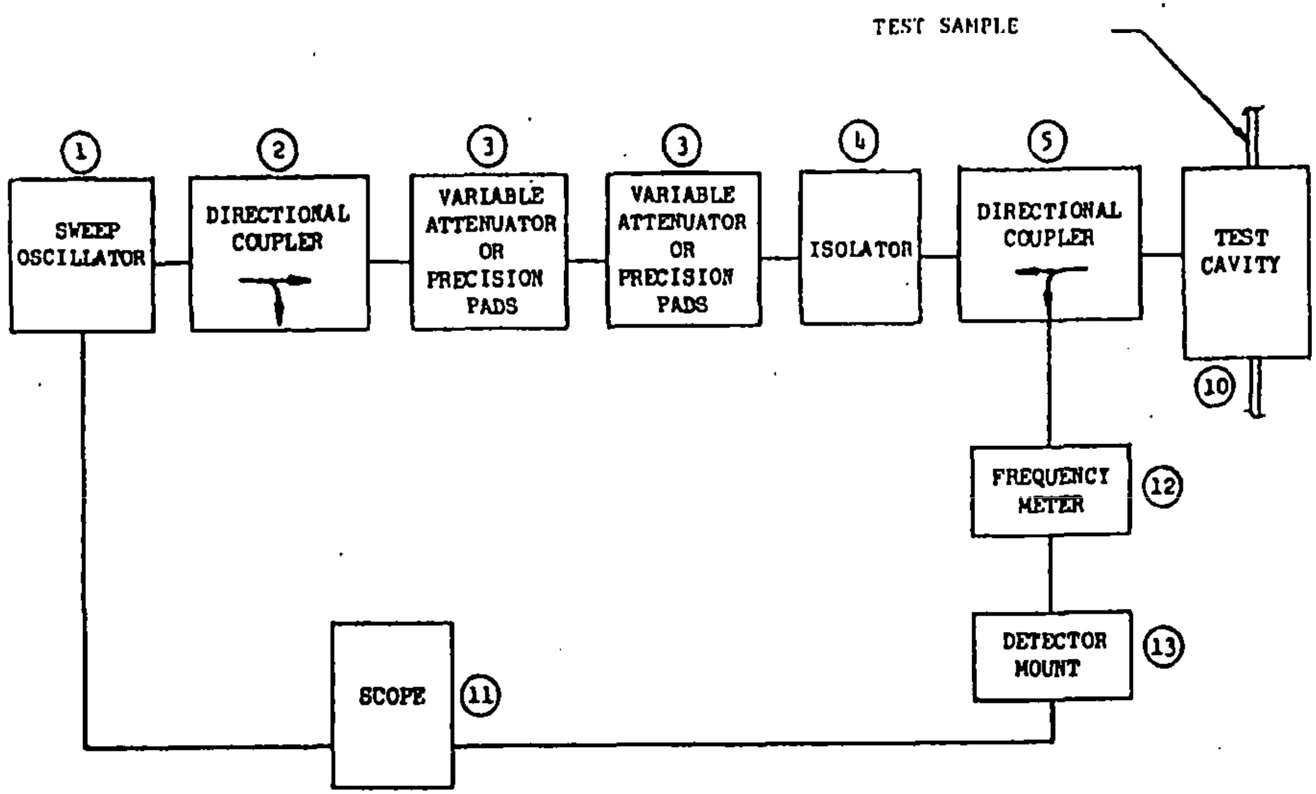


FIGURE 15. RF leakage test equipment and setup (sheet 3 of 10) (continued).

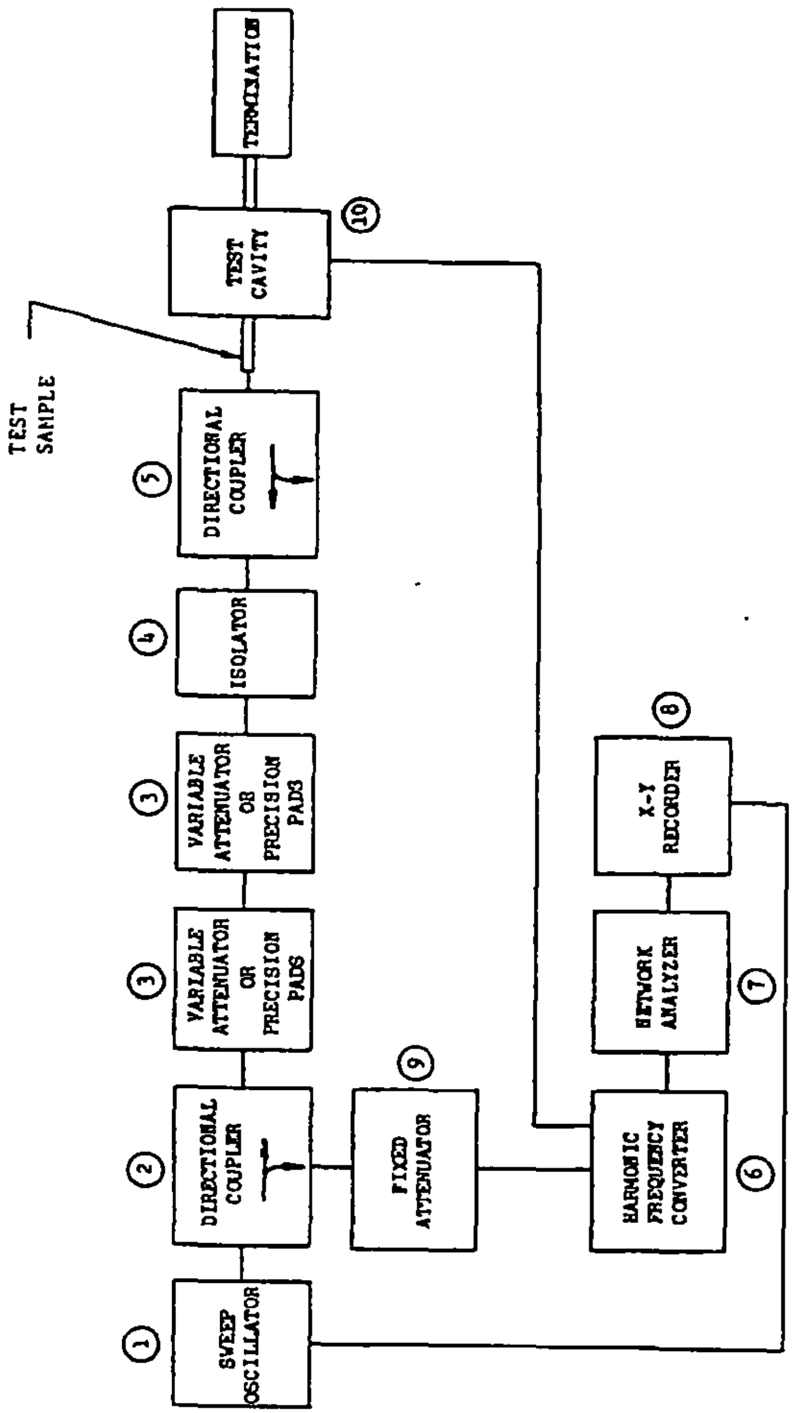


FIGURE 15. RF leakage test equipment and setup (sheet 4 of 10)(continued).

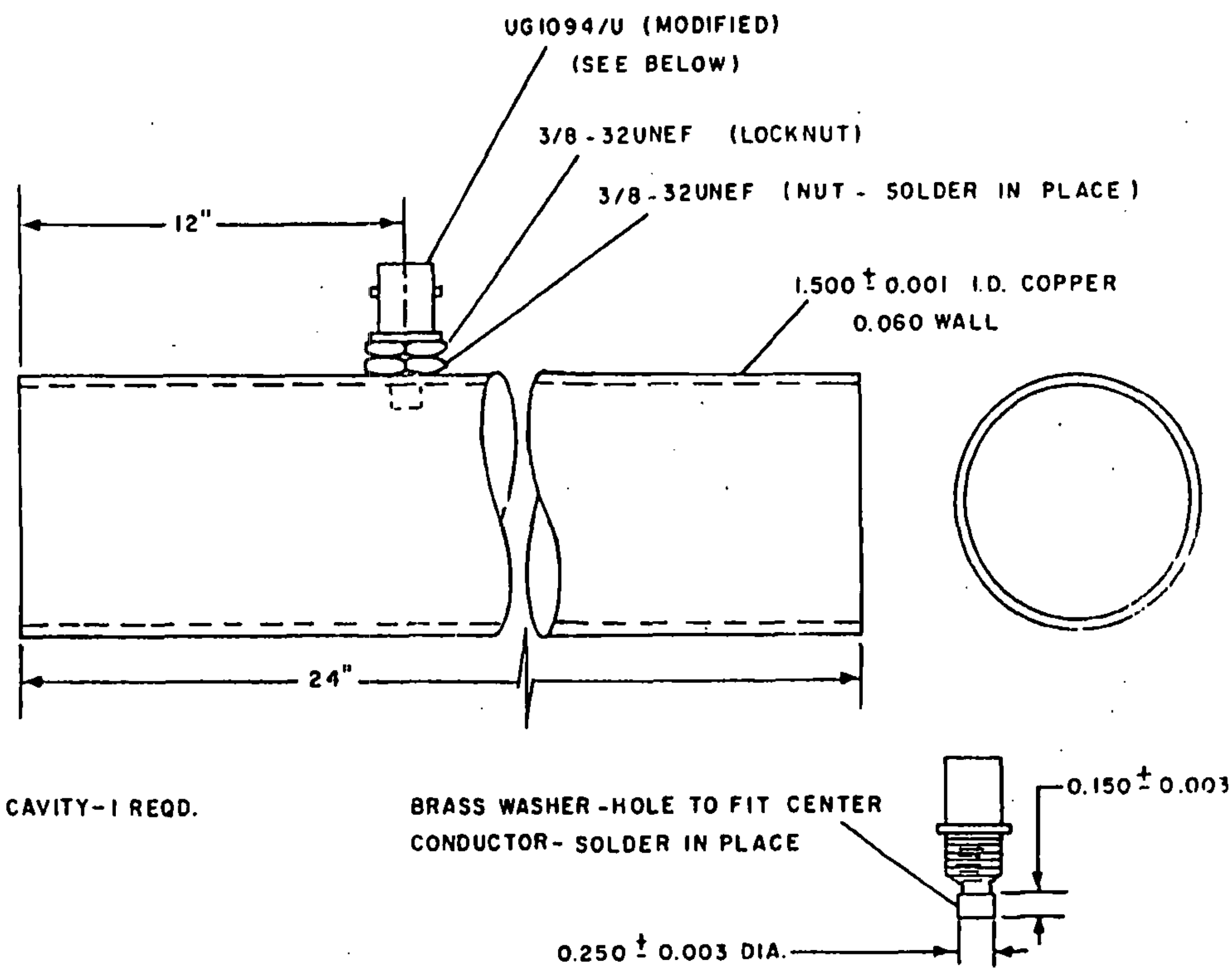
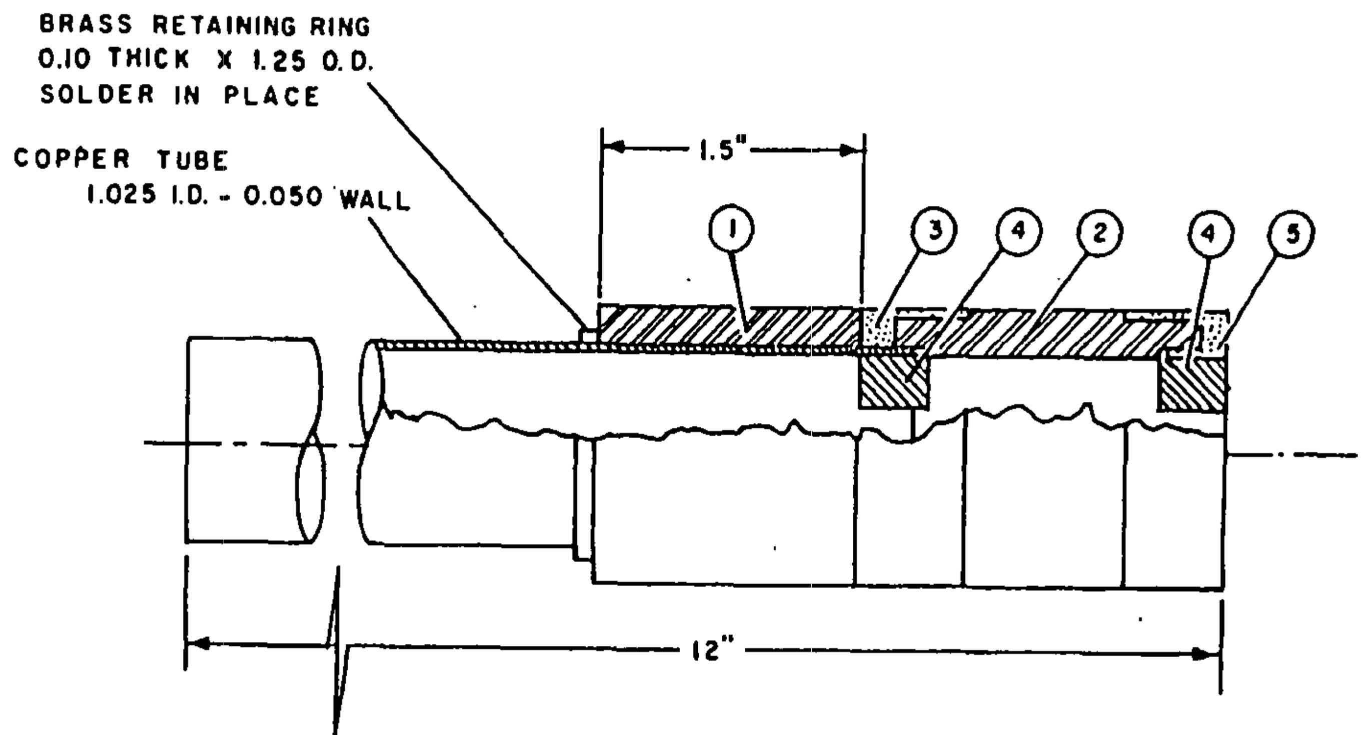


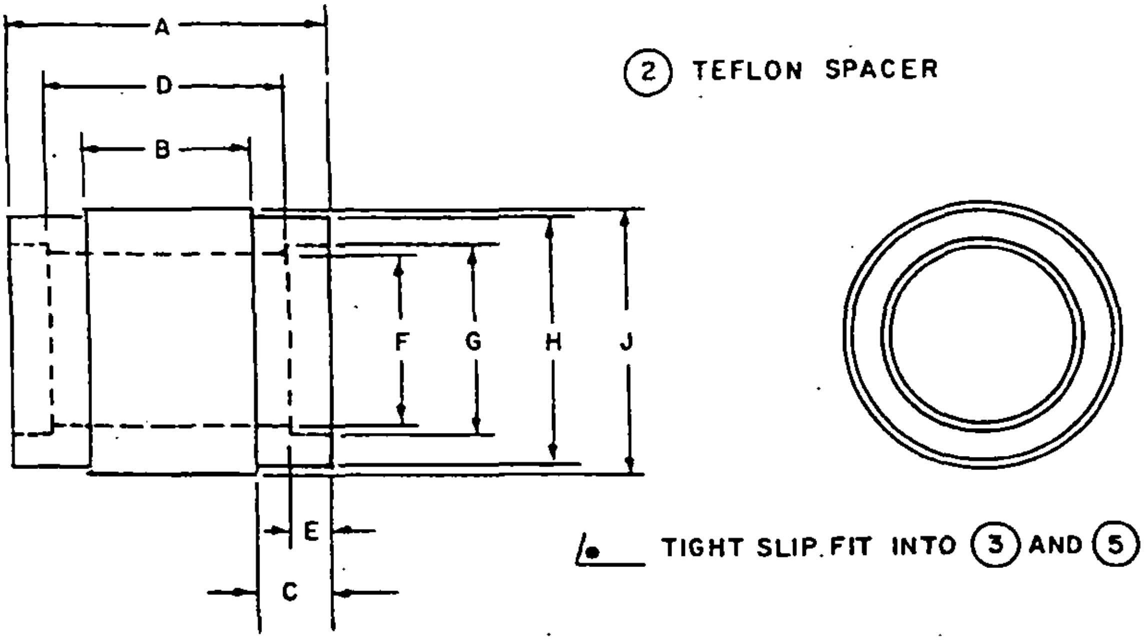
FIGURE 15. RF leakage test equipment and setup (sheet 5 of 10)(continued).



SHORT CIRCUIT ASSEMBLY
(2 – REQUIRED)

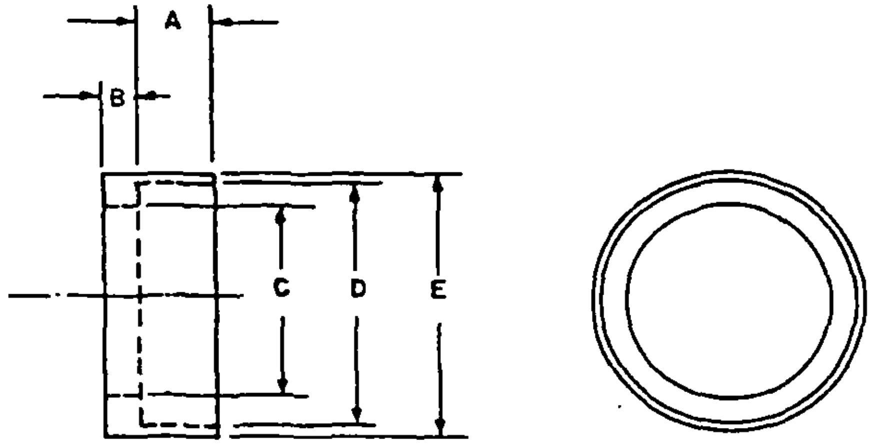
1. TEFLON TUBE – 1.499 $^{+0.000}_{-0.005}$ O.D.
   SLIP FIT OVER COPPER TUBE
2. TEFLON SPACER – 1.499 $^{+0.000}_{-0.005}$ O.D. AT MAX. DIA.
   TIGHT SLIP FIT INTO (3) AND (5) (SEE SHEET 7)
3. BRASS FERRULE (SEE SHEET 8)
   SOLDER IN PLACE ON COPPER TUBE
4. BRASS - SPLIT BUSHING (SEE SHEET 9)
5. BRASS RING (SEE SHEET 10)

FIGURE 15. <u>RF leakage test equipment and setup (sheet 6 of 10)(continued)</u>.



	2 GHz TO 8 GHz	8 GHz TO 16 GHz
A	1.740 ± 0.005	0.700 ± 0.005
B	0.900 ± 0.005	0.350 ± 0.005
C	0.420 + 0.000 − 0.005	0.175 + 0.000 − 0.005
D	1.300 ± 0.005	0.450 ± 0.005
E	0.220 ± 0.005	0.125 ± 0.005
F	1.000 + 0.000 − 0.005 DIA	1.000 + 0.000 − 0.005 DIA
G	1.125 DIA	1.125 DIA
H	1.410 DIA	1.410 DIA
J	1.499 + 0.000 − 0.005 DIA	1.499 + 0.000 − 0.005 DIA

FIGURE 15. RF leakage test equipment and setup (sheet 7 of 10) (continued).

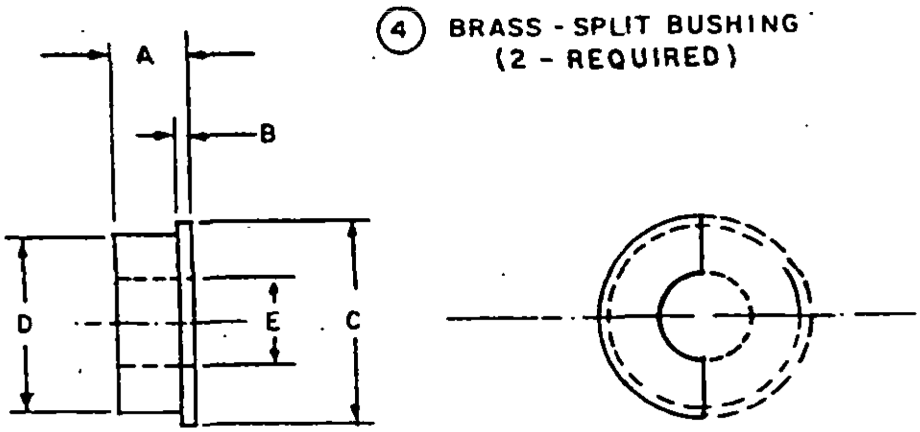


(3) BRASS FERRULE

	2 GHz TO 8 GHz	8 GHz TO 16 GHz
A	0.420 +0.005 -0.000	0.175 +0.005 -0.000
B	0.180 ±0.002	0.075 ±0.002
C	•	•
D	1.410 ±0.002 DIA	1.410 ±0.002 DIA
E	1.470 +0.005 -0.000	1.470 +0.005 -0.000

• DIA TO SLIP OVER AND SWEAT SOLDER TO 1.125 DIA COPPER TUBE.

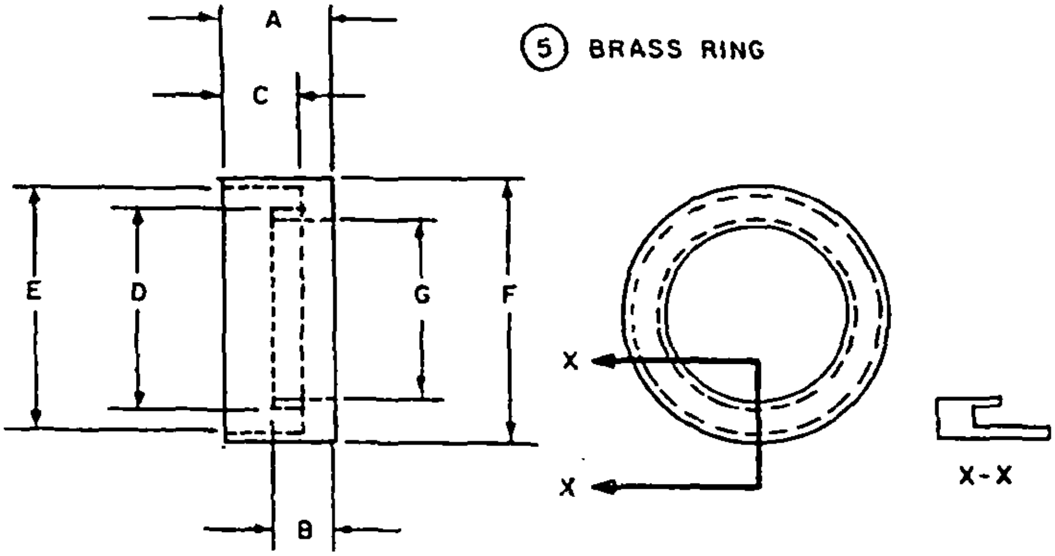
FIGURE 15. RF leakage test equipment and setup (sheet 8 of 10) (continued).



	2 GHz TO 8 GHz	8 GHz TO 16 GHz
A	0.400 ± 0.005	0.145 ± 0.003
B	0.060 ± 0.001	0.020 ± 0.001
C	1.125 ± 0.001 DIA	1.125 ± 0.001 DIA
D	1.025 + 0.000 − 0.003 DIA	1.025 + 0.000 − 0.003 DIA
E	/●	/●

/● DIA TO SLIP EASILY OVER TEST CABLE

FIGURE 15. RF leakage test equipment and setup (sheet 9 of 10) (continued).



	2 GHz TO 8 GHz	8 GHz TO 16 GHz
A	0.600 ± 0.003	0.250 ± 0.002
B	0.340 + 0.002 − 0.000	0.125 + 0.002 − 0.000
C	0.420 + 0.005 − 0.000	0.175 + 0.005 − 0.000
D	1.125 ± 0.001 DIA	1.125 ± 0.001 DIA
E	1.410 ± 0.001 DIA	1.410 ± 0.001 DIA
F	1.470 + 0.005 − 0.000	1.470 + 0.005 − 0.000
G	1.025 + 0.000 − 0.004 DIA	1.025 + 0.000 − 0.004 DIA

FIGURE 15. RF leakage test equipment and setup (sheet 10 of 10) (continued).

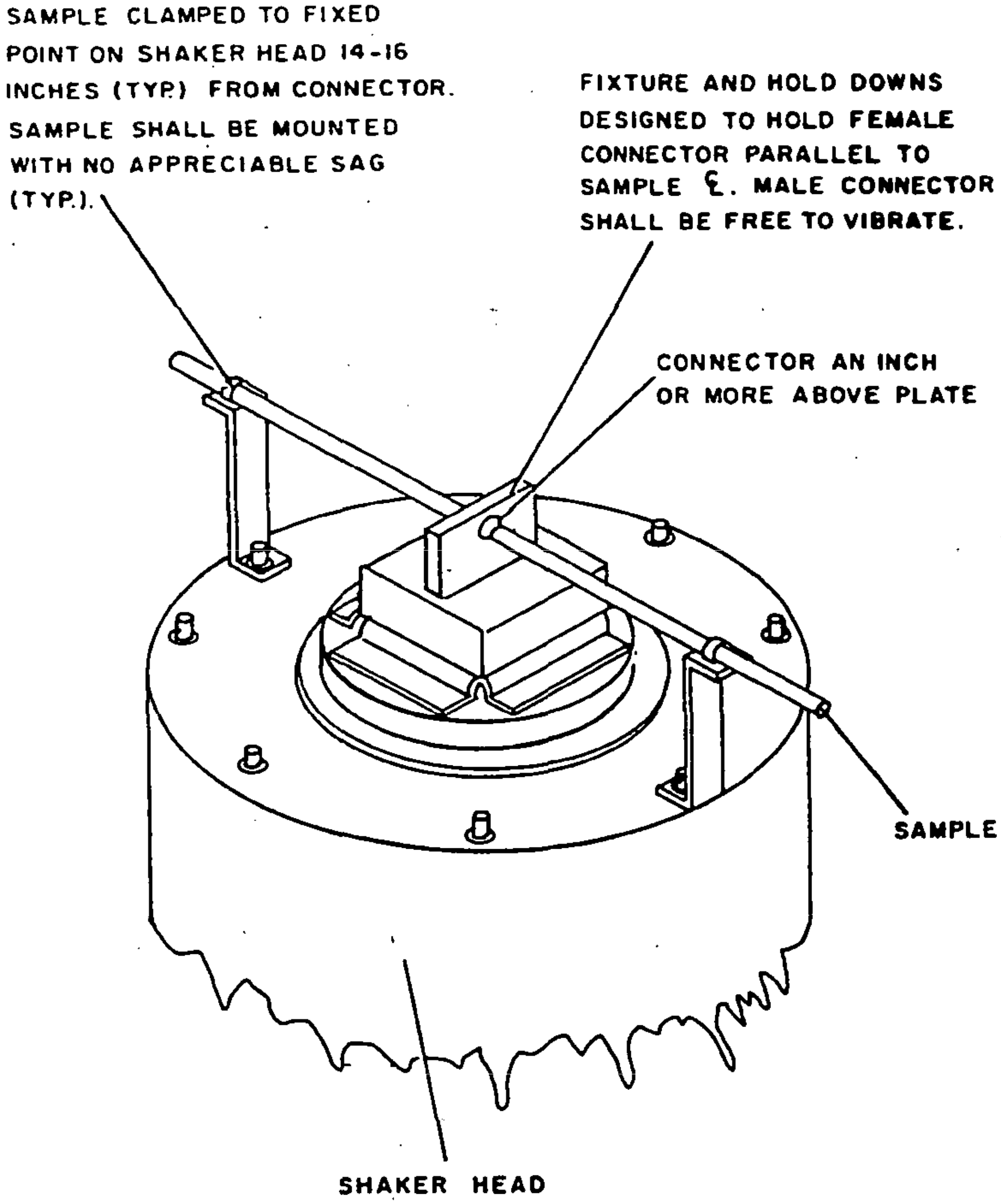


FIGURE 16. Vibration test fixture (4.7.12.2).

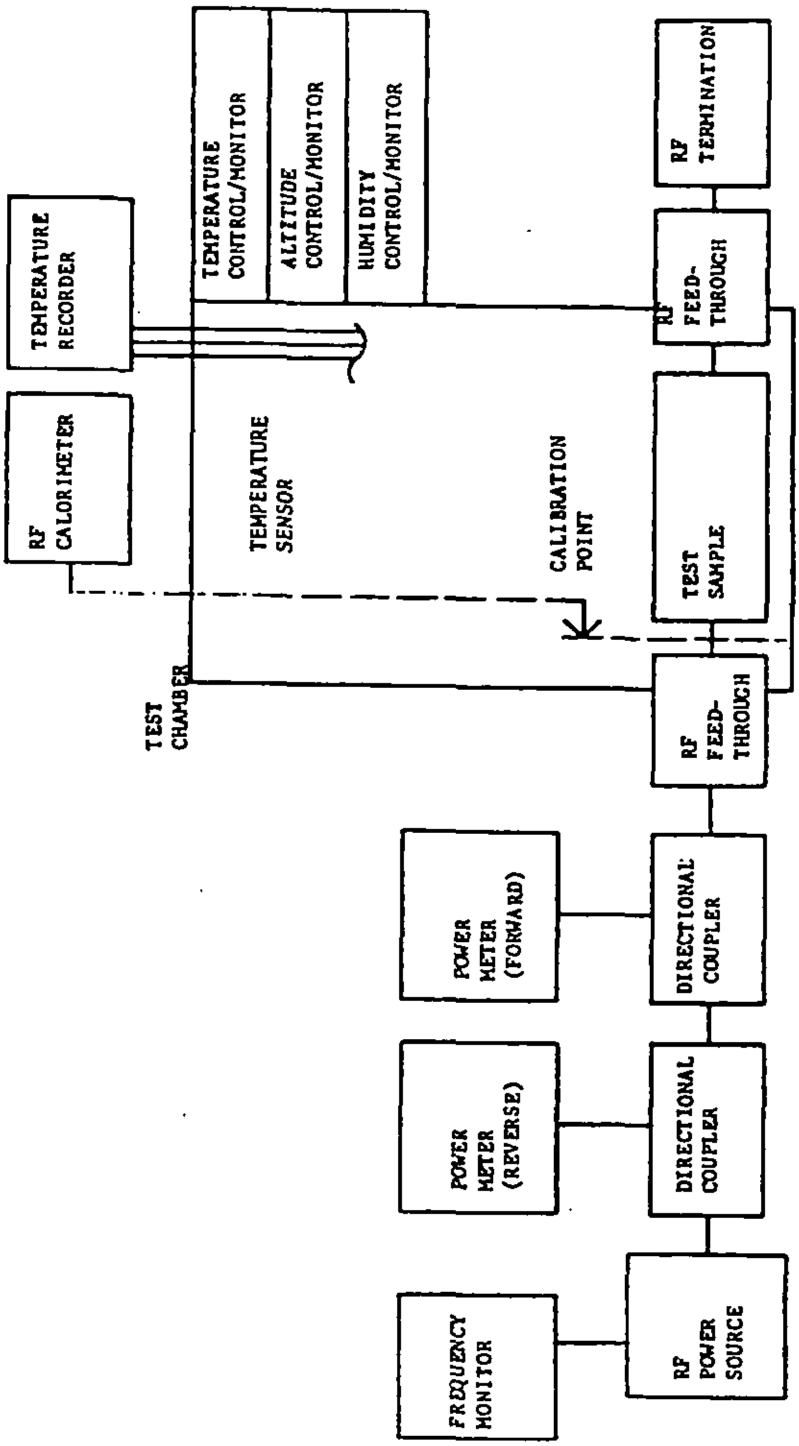


FIGURE 17. Continuous power test equipment setup (4.7.13.2).

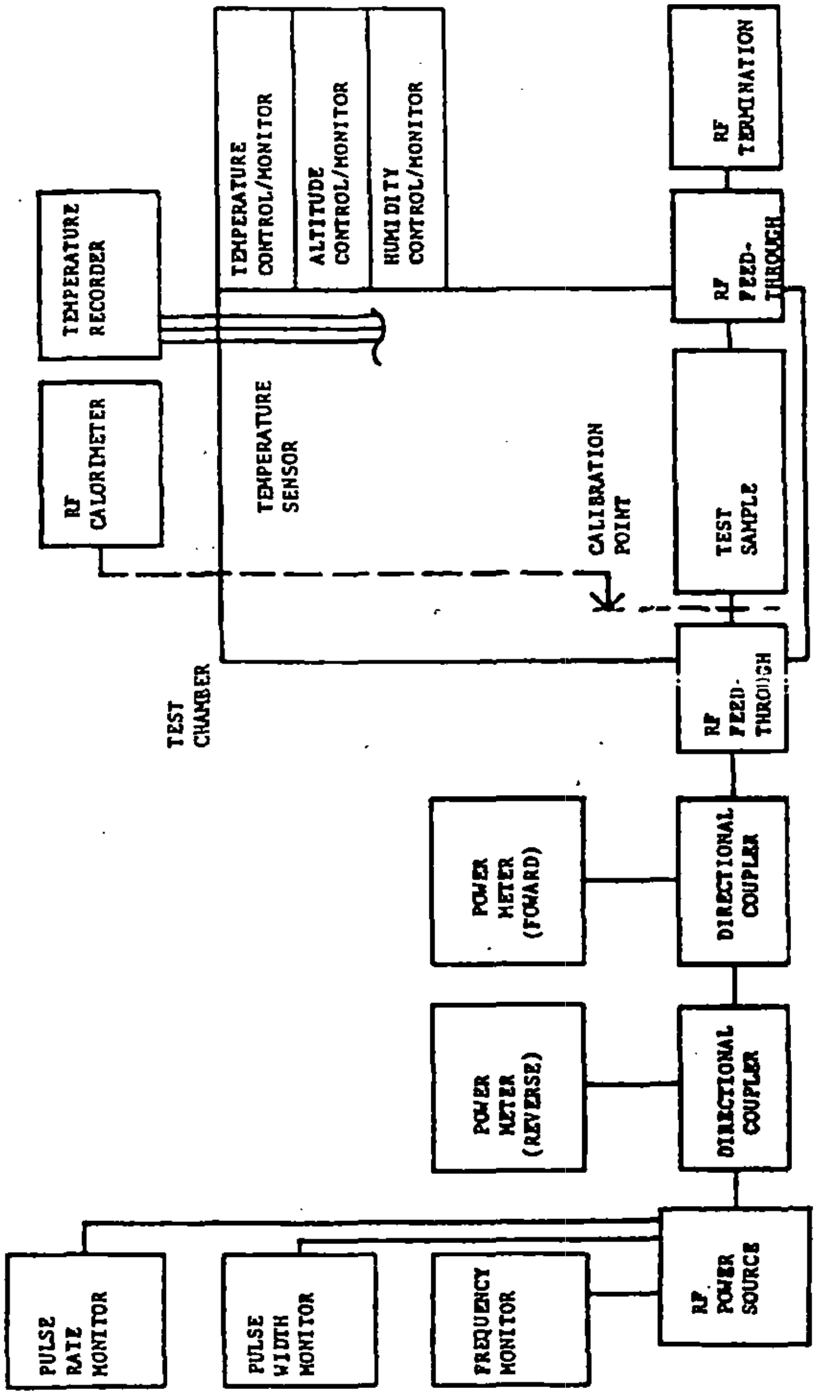


FIGURE 18. Peak power test equipment setup (4.7.13.2).

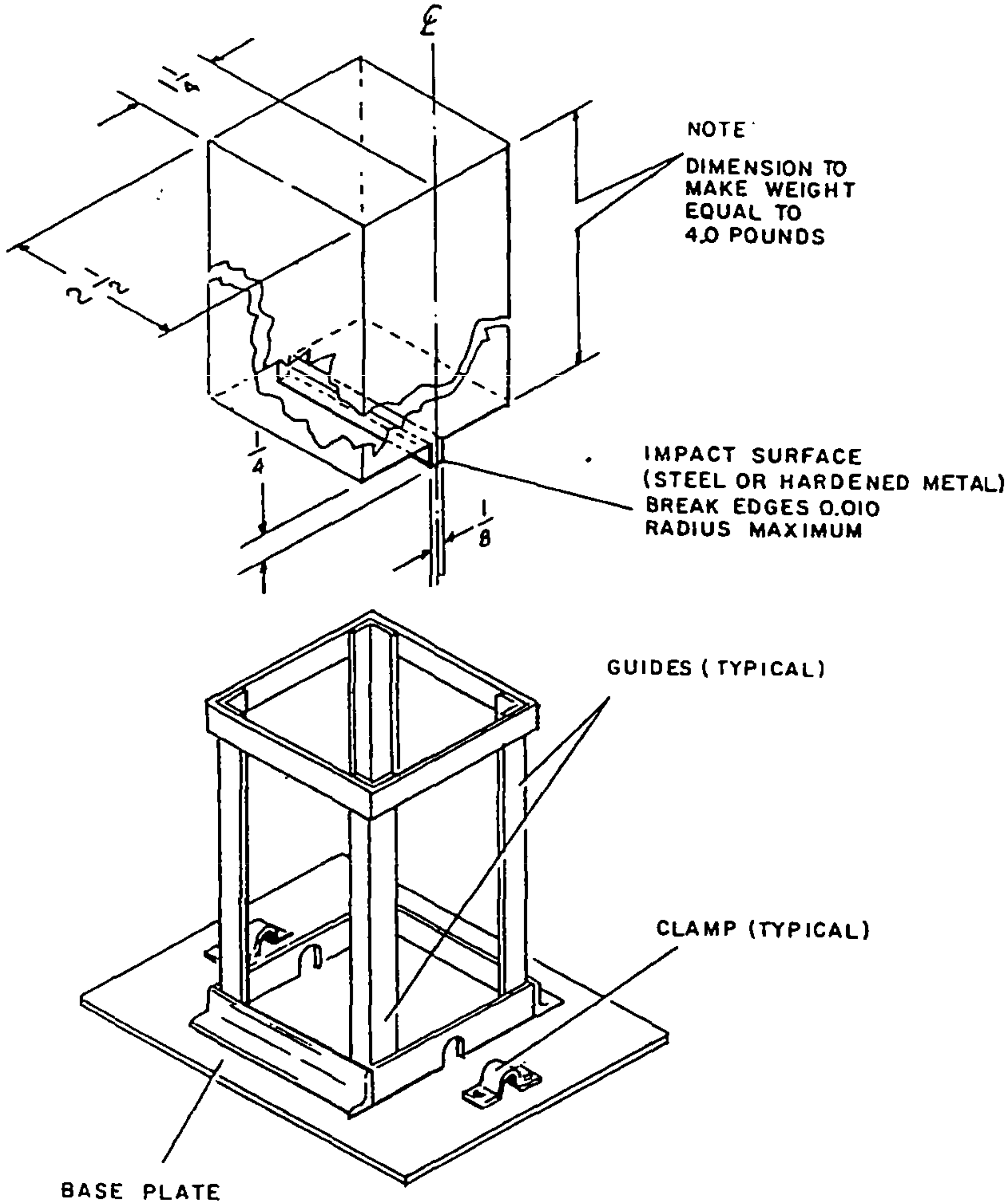


FIGURE 19. Impact shock test fixture (4.7.14.2).

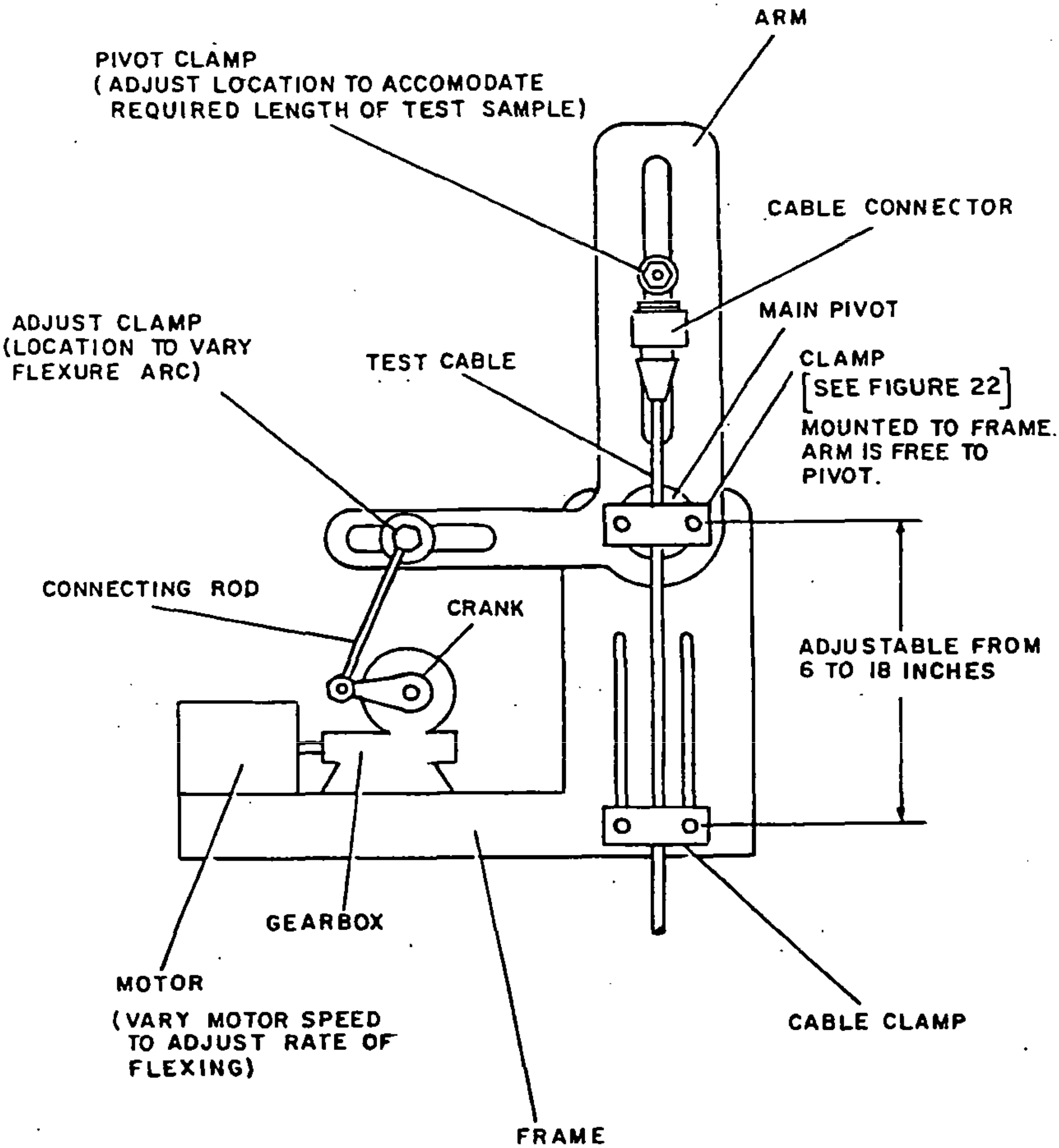
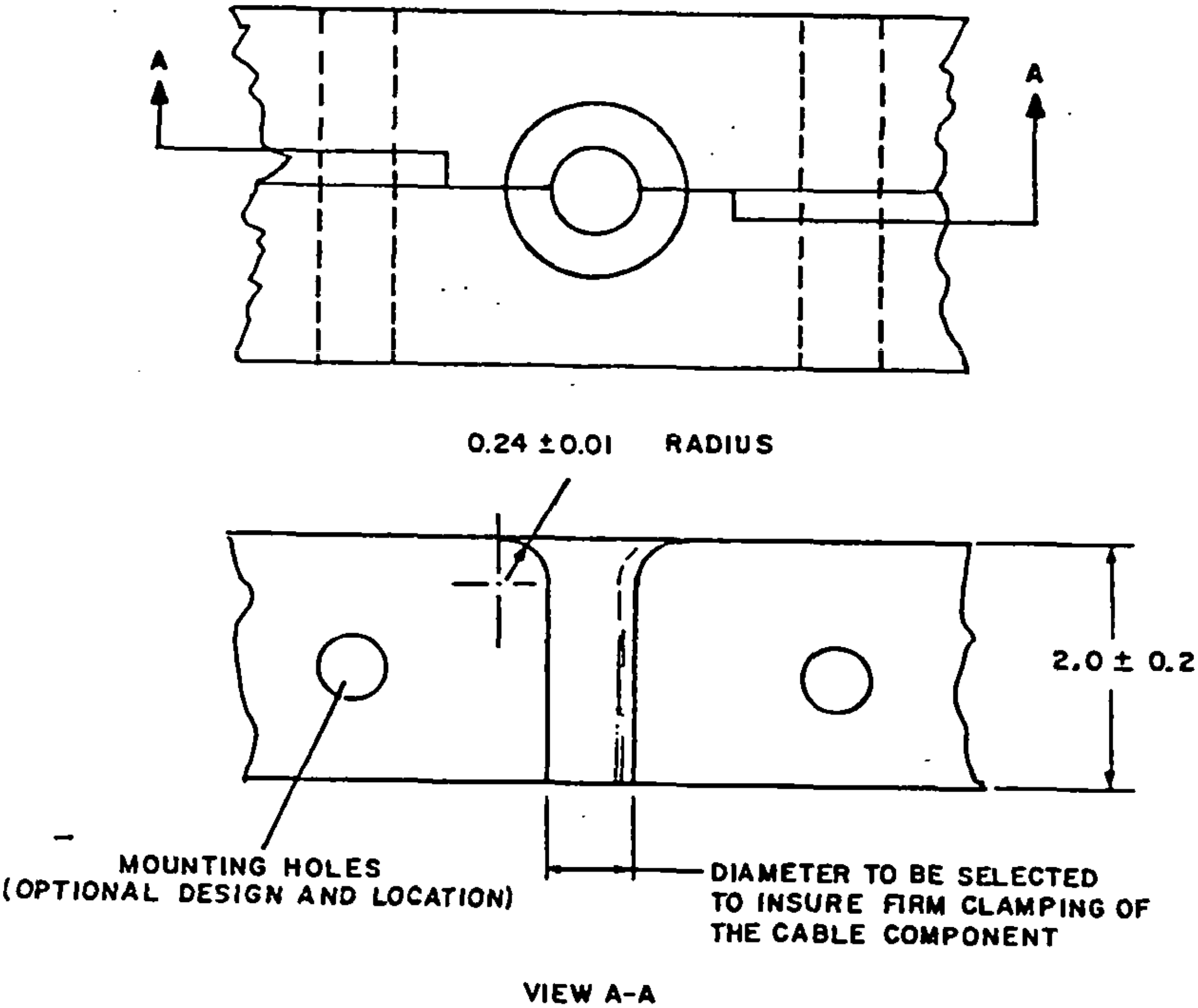


FIGURE 20. Flexure test fixture (4.7.15.2).



CABLE CLAMP

FIGURE 21. Flexure test fixture clamp (4.7.15.2).

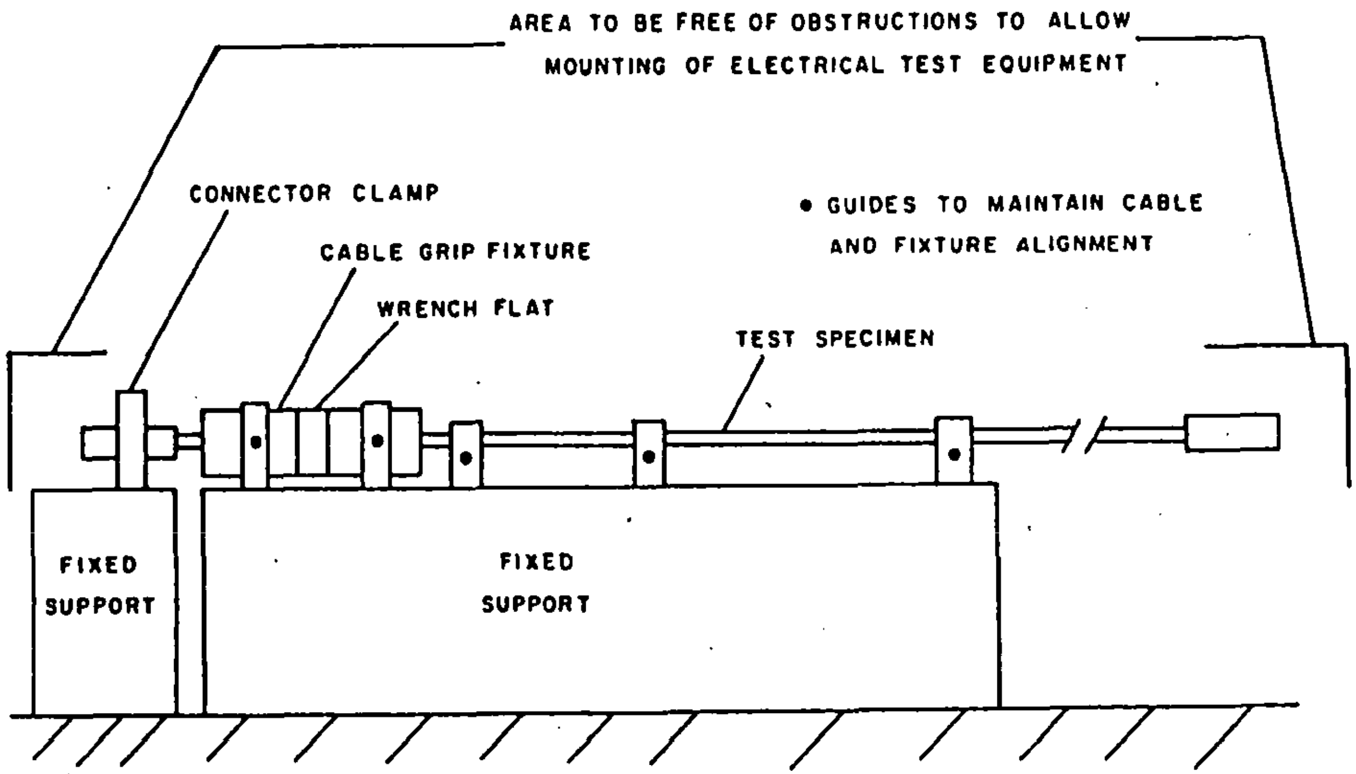


FIGURE 22. Torque load test fixture (4.7.16.2).

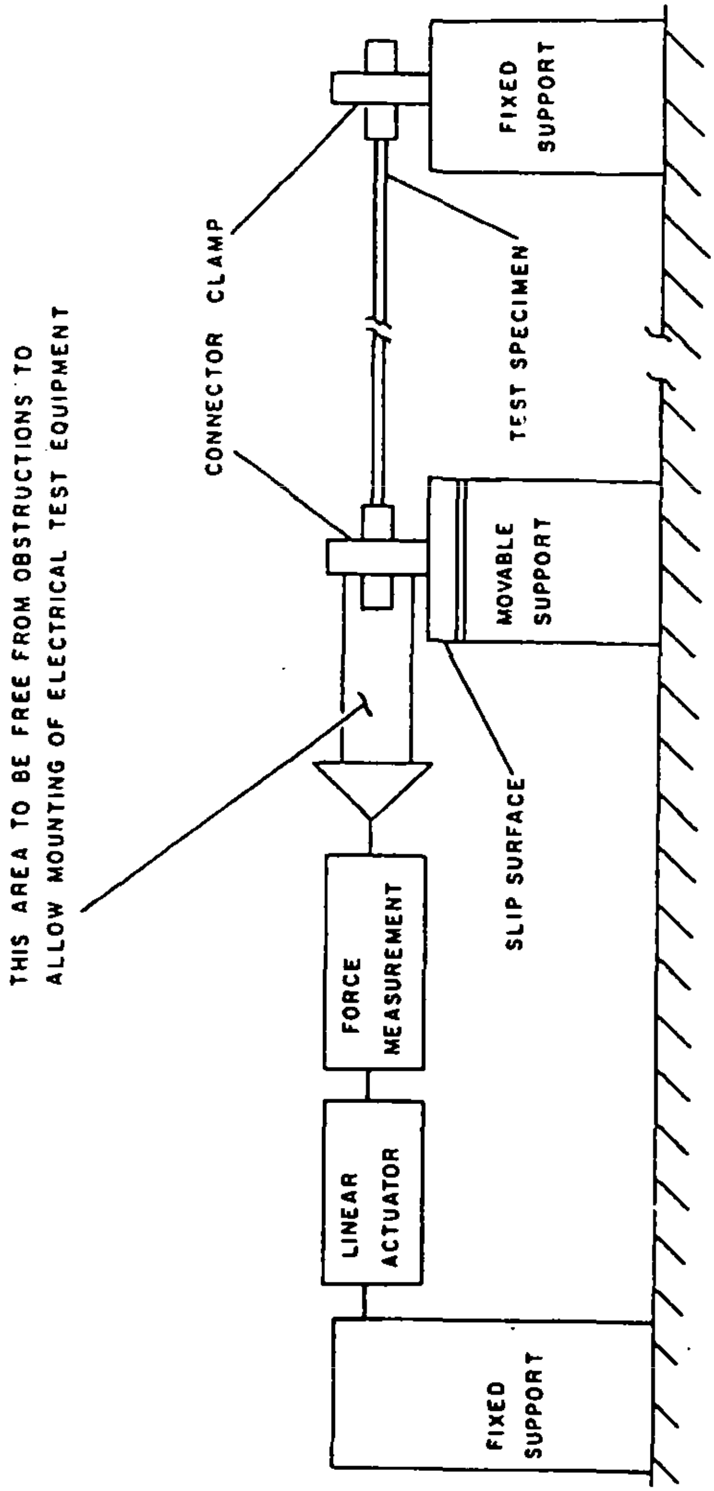


FIGURE 23. Tensile loa[illegible]st fixture (4.7.17.2).

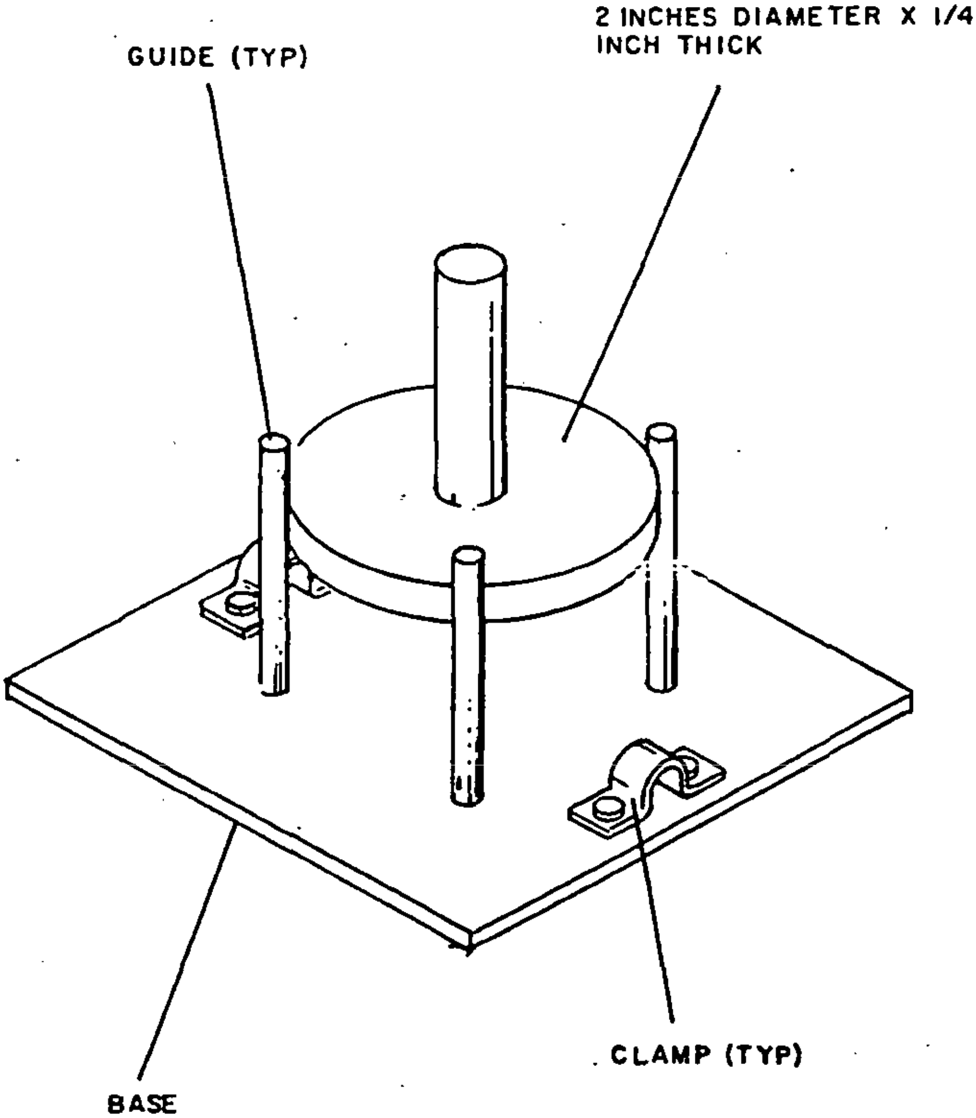
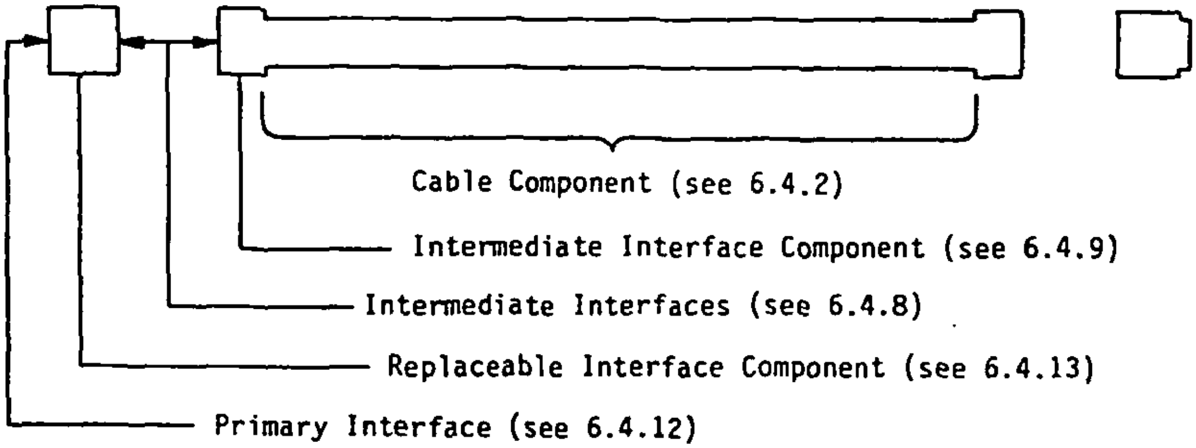


FIGURE 24. Concentrated load test fixture (4.7.18.2).

TEM Transmission Line with Replaceable Primary Interfaces



TEM Transmission Line with Non-Replaceable Primary Interfaces

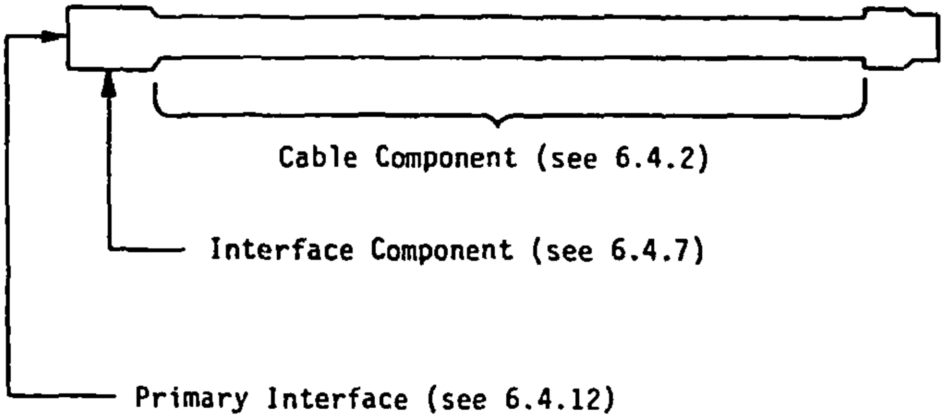


FIGURE 25. TEM transmission lines (6.4.14).

APPENDIX A

CALCULATION METHOD FOR DETERMINING MAXIMUM ALLOWABLE RF INSERTION LOSS

10. SCOPE. This appendix provides the method for calculating the maximum allowable RF insertion loss for a TEM transmission line.

20. CALCULATION METHOD. The maximum allowable RF insertion loss for a TEM transmission line shall be calculated in accordance witn the following procedure.

(1) Note the type and class of TEM transmission line required (see 1.2).

(2) Note the required interface component(s) or, if applicable, replaceable interface component style(s).

(3) Determine the length (in feet) of the TEM transmission line less replaceable interface component(s). For lengths less than 2 feet see 3.6.4.1.4.1.

The RF insertion loss shall be determined at two frequency points for the required TEM transmission line:

point (1) - minimum design frequency (see 1.2)
point (2) - maximum design frequency (see 1.2)

(4) Note the applicable design frequencies for points (1) and (2).

The RF insertion loss shall be calculated by the following formula:

$$\text{Insertion Loss (in dB)} = (L \times R_{(x)}) + C1_{(x)} + C2_{(x)}$$

where: L = Length of the TEM transmission line (determined in step 3).

$R_{(x)}$ = insertion loss value (in dB/foot) for the required TEM transmission line (noted in step 1) at a specified frequency point.

$C1_{(x)}$ and $C2_{(x)}$ = insertion loss value (in dB) for the required interface component(s) or, if applicable, replaceable interface component style(s) (noted in step 2).

Figures 26 through 33 delineate the values for $R_{(x)}$ for each type and class of TEM transmission line covered by this document. Table XIX lists the values for $C1_{(x)}$ and $C2_{(x)}$ covered by this document.

Figure	$R_{(x)}$ Values for
26	Type I Class 1 lines
27	Type I Class 2 lines
28	Type I Class 3 lines
29	Graph Form for Type I lines
30	Type II Class 1 lines
31	Type II Class 2 lines
32	Type II Class 3 lines
33	Graph Form for Type II lines

(5) Calculate the RF insertion loss for the TEM transmission line at frequency point (1) (noted in step 4). Use the following formula:

$$\text{Insertion Loss (in dB)} = (L \times R_{(1)}) + C1_{(1)} + C2_{(1)}$$

Where all (1) subscripts refer to the expressed values in figures 26 through 33 and table XIX for frequency point (1).

(6) Calculate the RF insertion loss for the TEM transmission line at frequency point (2) (noted in step 4). Use the following formula:

$$\text{Insertion Loss (in dB)} = (L \times R_{(2)}) + C1_{(2)} + C2_{(2)}$$

Where all (2) subscripts refer to the expressed values in figures 26 through 33 and table XIX for frequency point (2).

30. SAMPLE CALCULATION. A Type I Class 2 TEM transmission line with one replaceable interface component (style A with a primary interface, type 2 - Male) and one replaceable interface component (style B with a primary interface, type 1 - Male). The length of the TEM transmission line less replaceable interface components is 8.5 feet.

(1) Type I and Class 2

(2) C1 = Type 2 with Style A replaceable interface component
C2 = Type 1 with Style B replaceable interface component

(3) 8.5 feet

(4) point (1) = 2.0 GHz
point (2) = 8.0 GHz

(5) I.L. (in dB) = (8.5 ft x .06 dB/ft) + .10 + .15

= .51 + .25

I.L. = .76 dB (at frequency point (1))

(6) I.L. (in dB) = (8.5 ft x .12 dB/ft) + .15 + .20

= 1.02 + .35

I.L. = 1.37 dB (at frequency point (2))

TABLE XIX. Insertion loss values for interface components and replaceable interface components.

Type of TEM transmission line (see Step 1)	I		II	
Frequency Points (1) and (2) (See Step 4)	(1) 2.0 GHz	(2) 8.0 GHz	(1) 2.0 GHz	(2) 16.0 GHz
Interface Component Only (See 6.4.7)	.05 dB	.10 dB	.05 dB	.15 dB
Style A Replaceable Interface Component (Includes Primary Interface) (See 3.5.1.3 and 6.4.13)	.10 dB	.15 dB	.10 dB	.20 dB
Style B or C Replaceable Interface Component (Includes Primary Interface) (See 3.5.1.3 and 6.4.13)	.15 dB	.20 dB	.15 dB	.30 dB

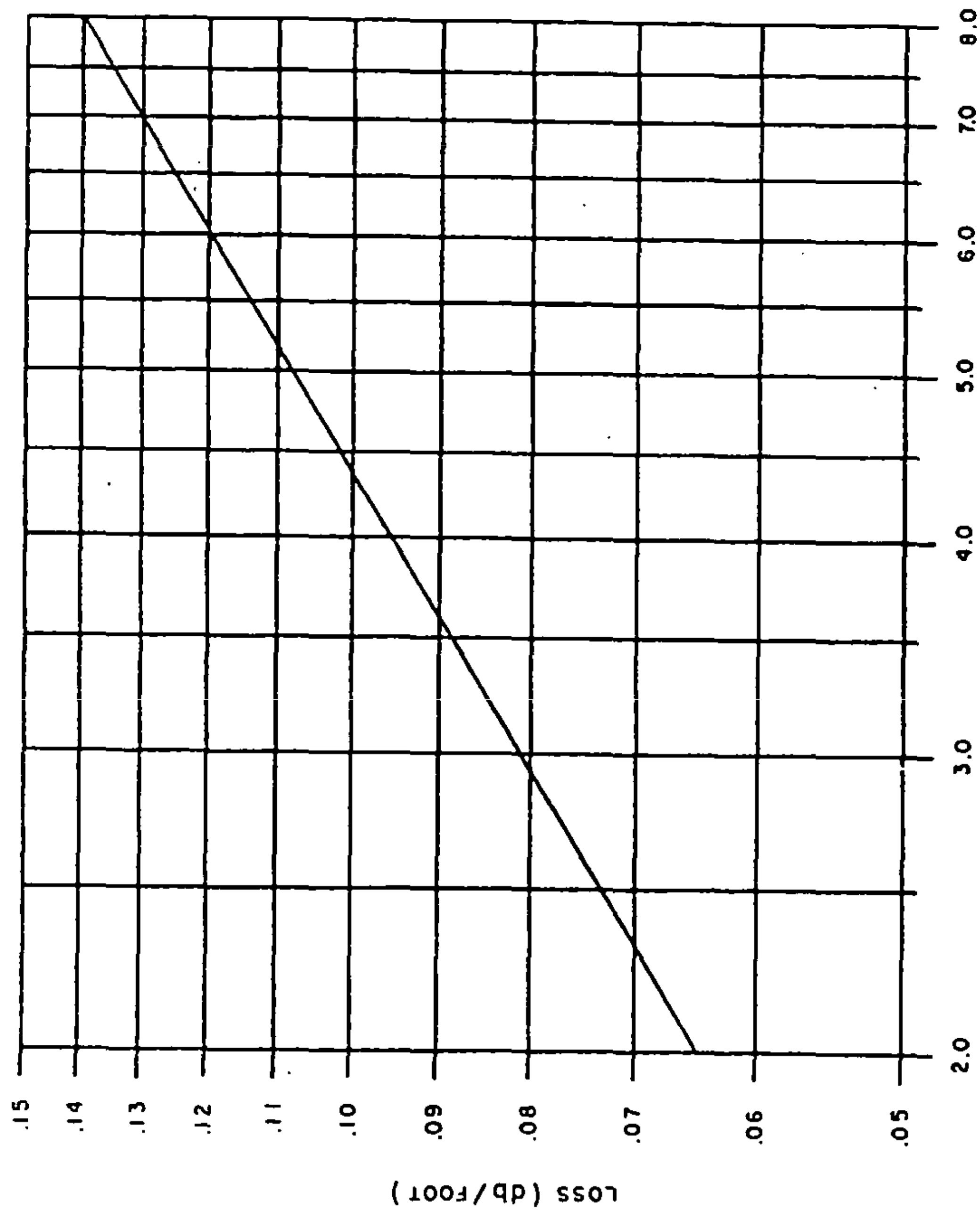


FIGURE 26. $R_{(x)}$ values for type I cl · 1 TEM transmission lines.

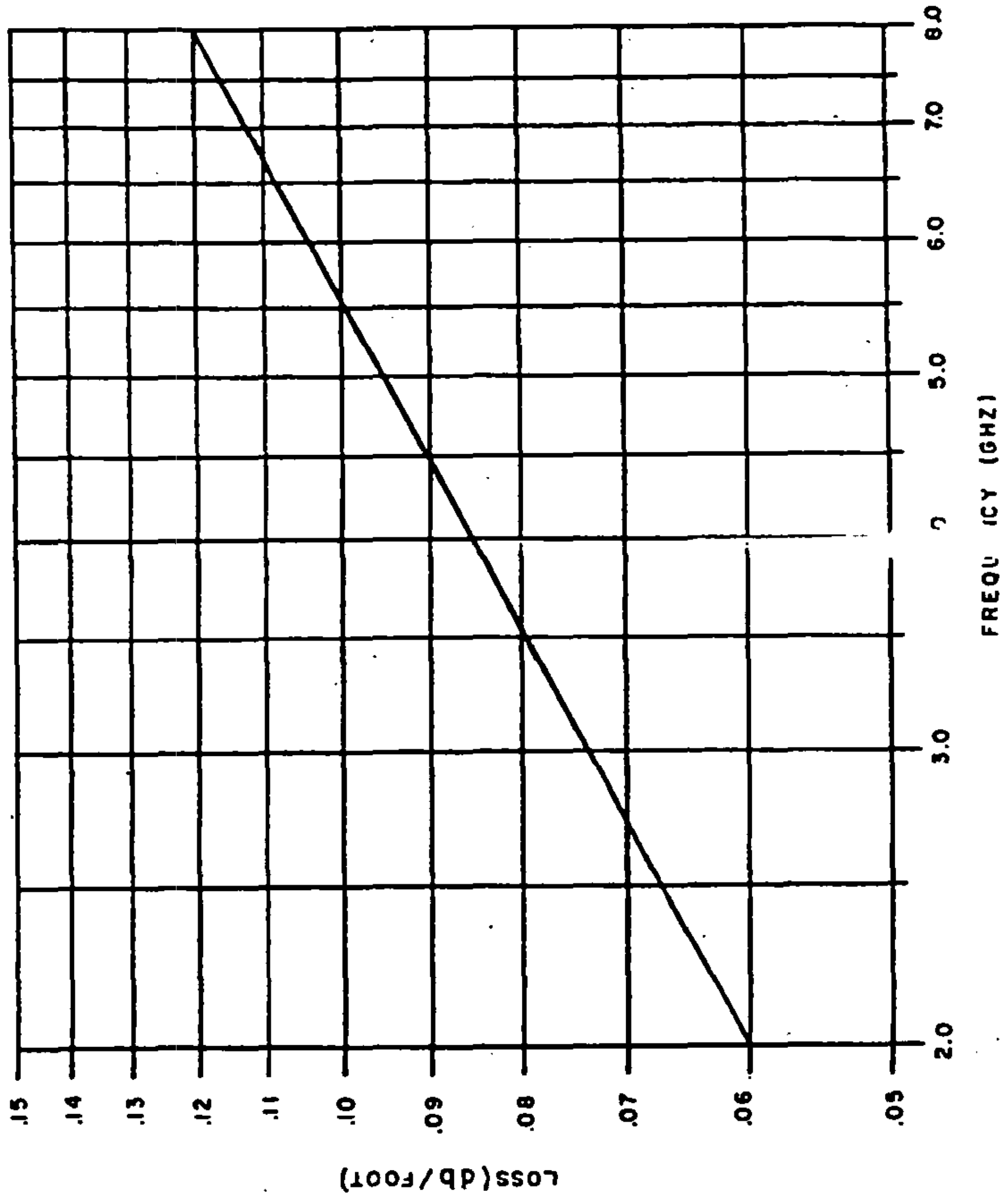


FIGURE 27. $R_{(x)}$ values for type I cl 2 TEM transmission lines.

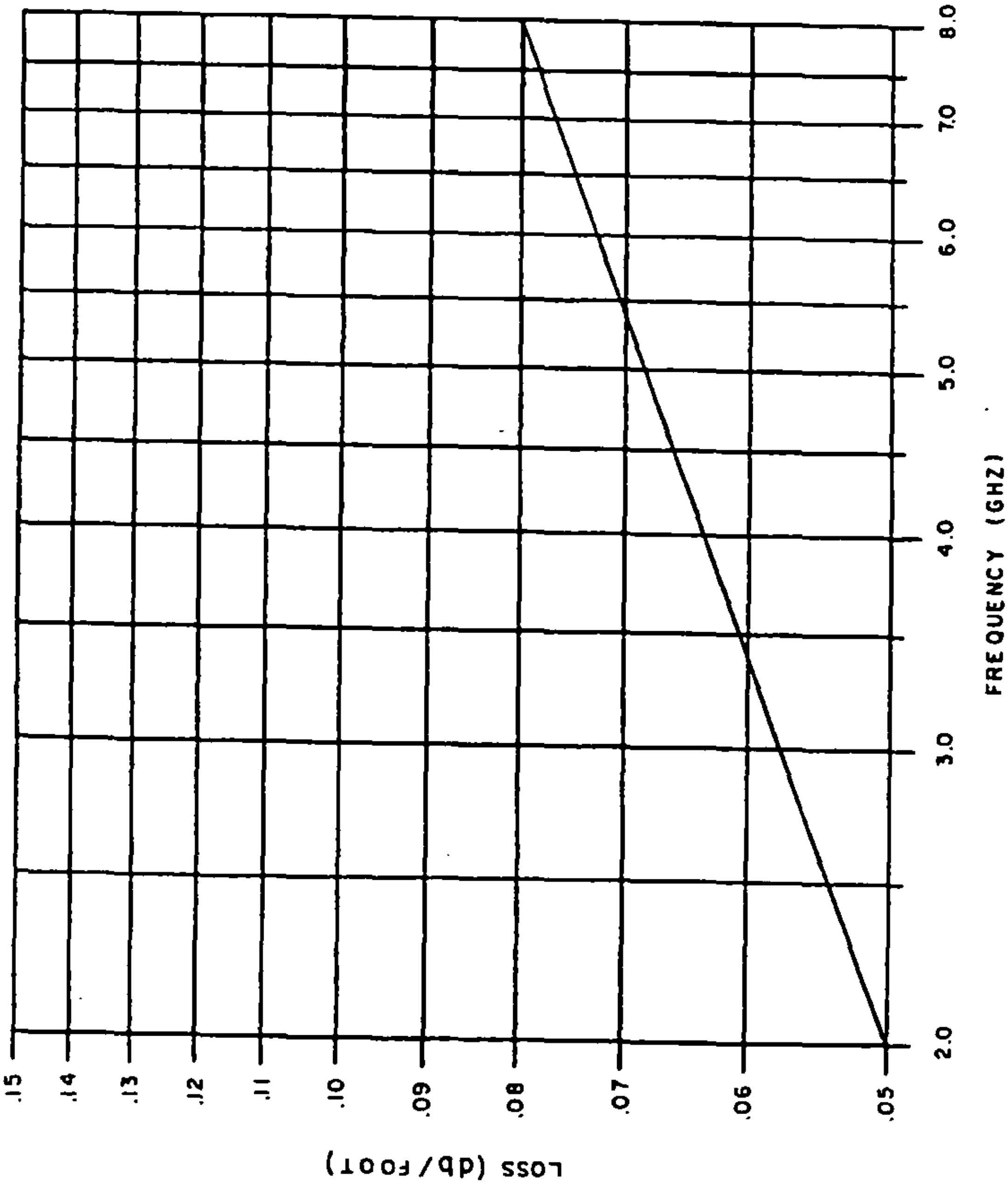


FIGURE 28. $\underline{R}_{(x)}$ values for type I class 3 TEM transmission lines.

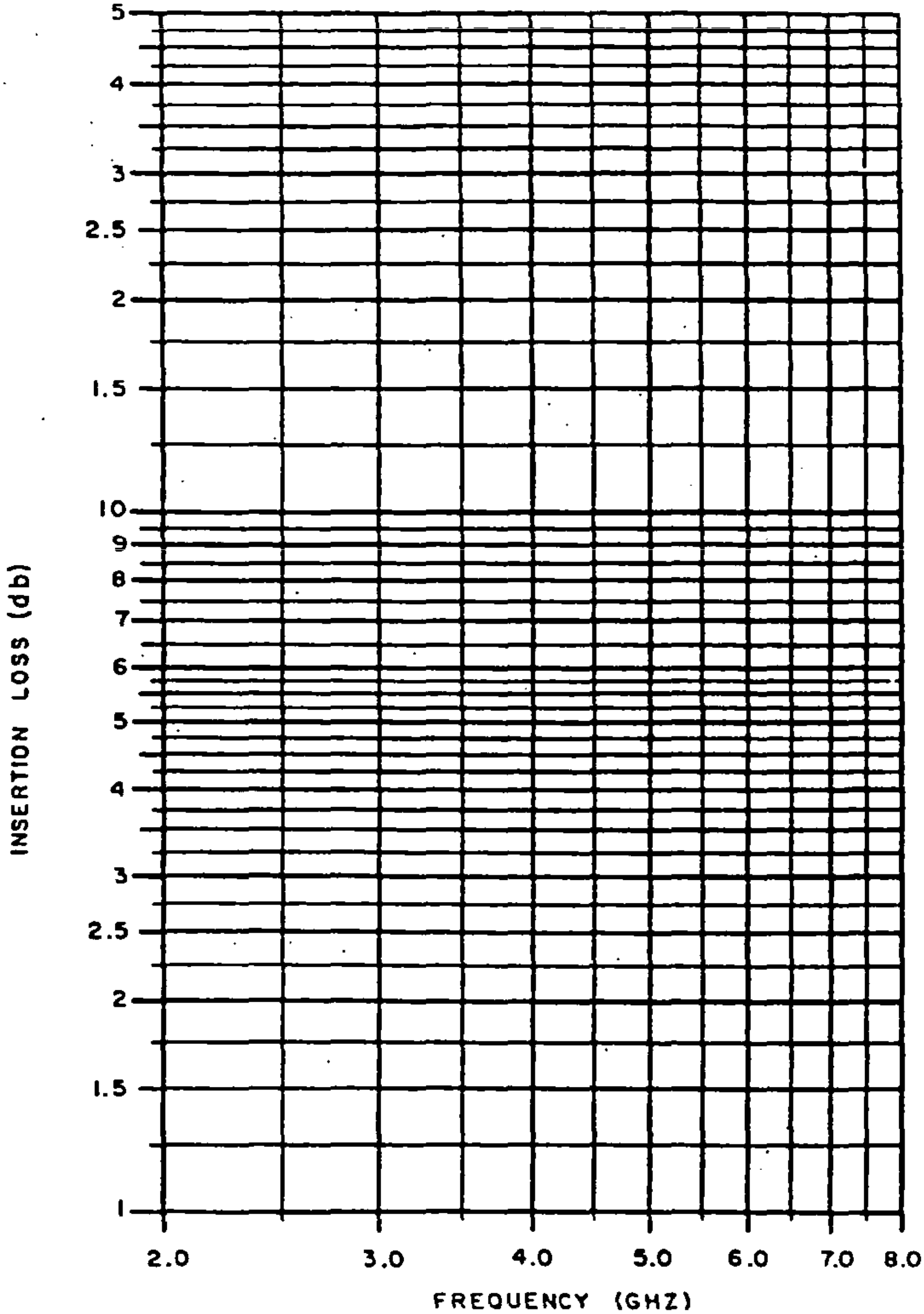


FIGURE 29. Graph form for type I lines.

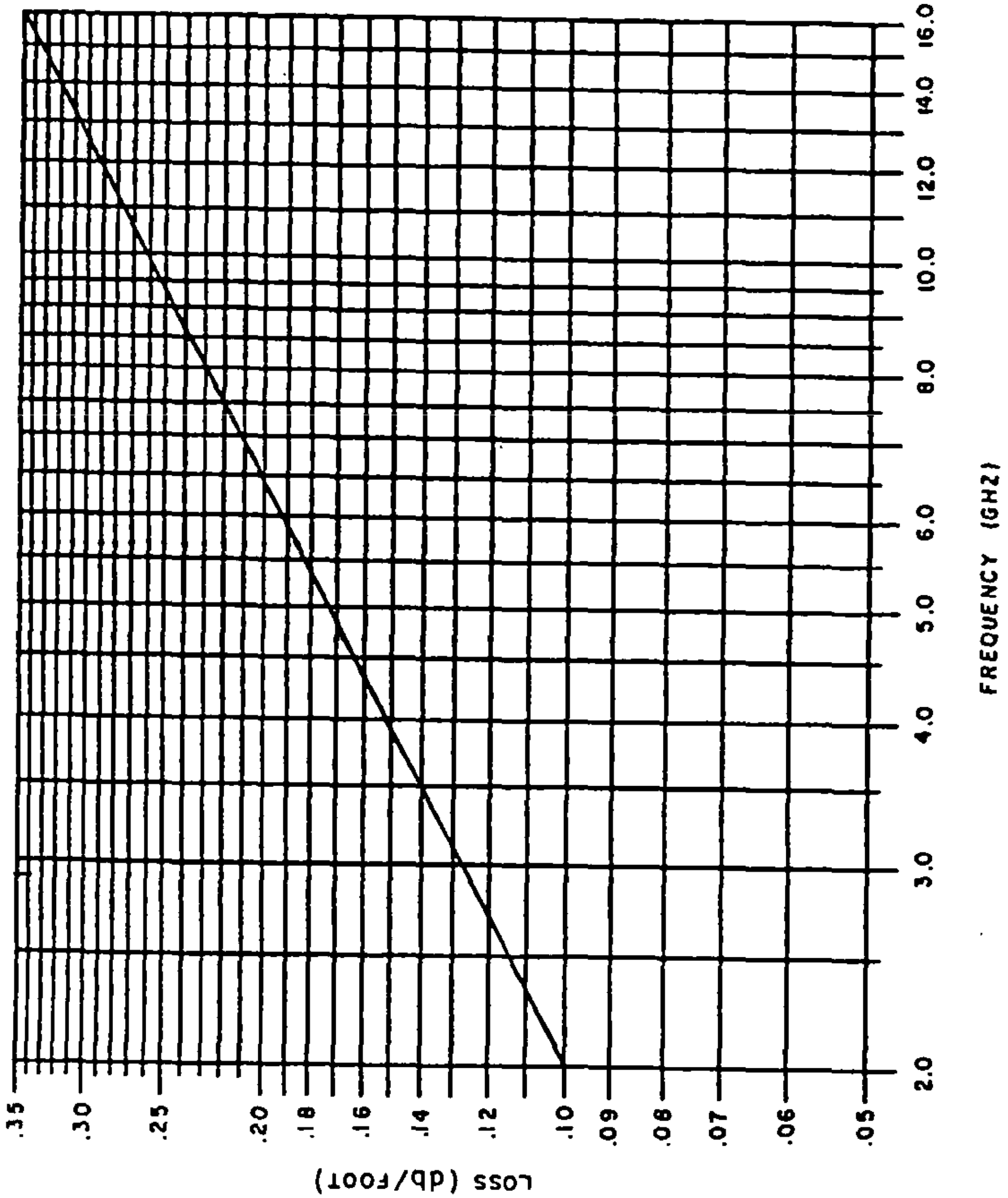


FIGURE 30. $\underline{R}_{(x)}$ values for type II class 1 TEM transmission lines.

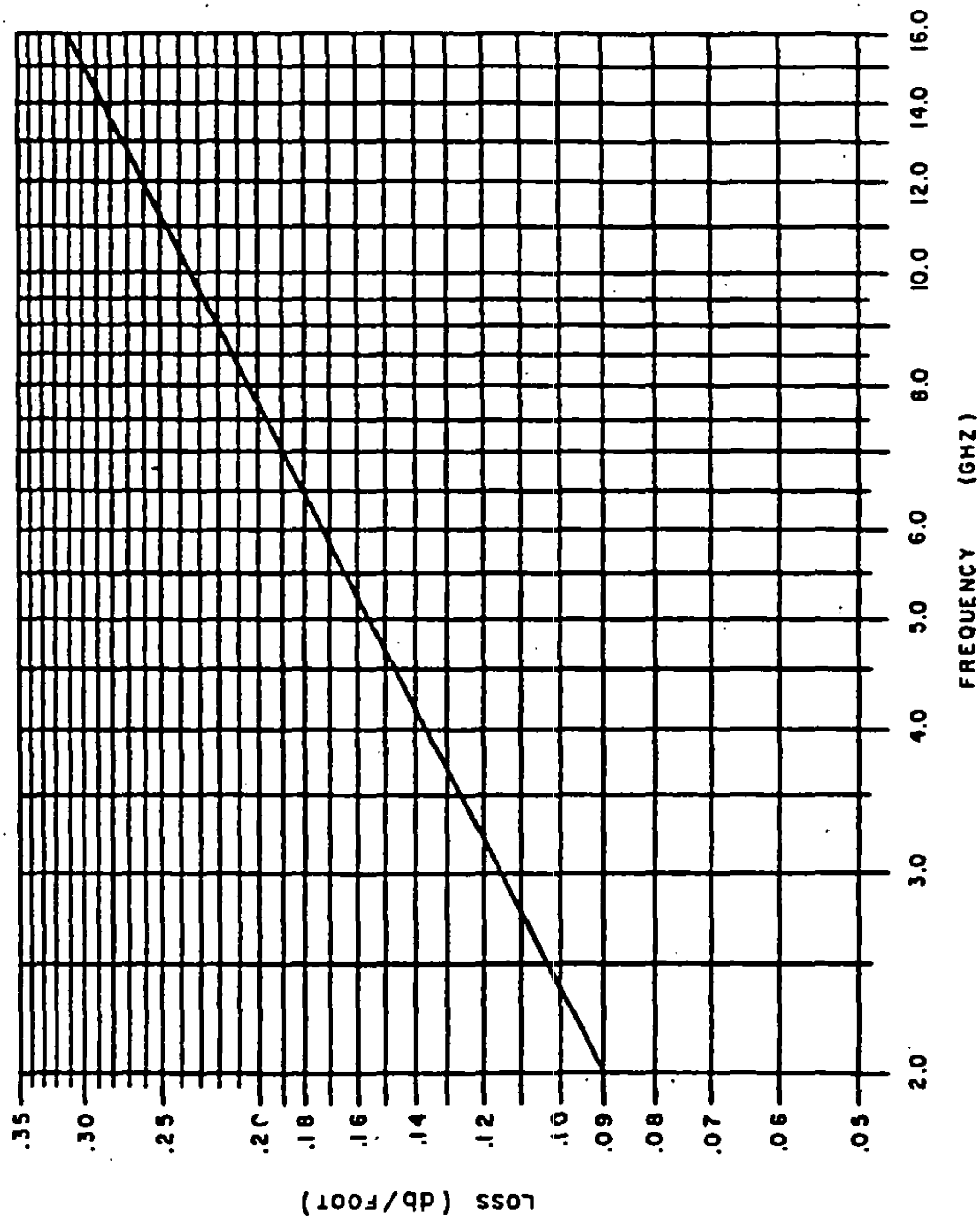


FIGURE 31. $\underline{R}_{(x)}$ values for type II class 2 TEM transmission lines.

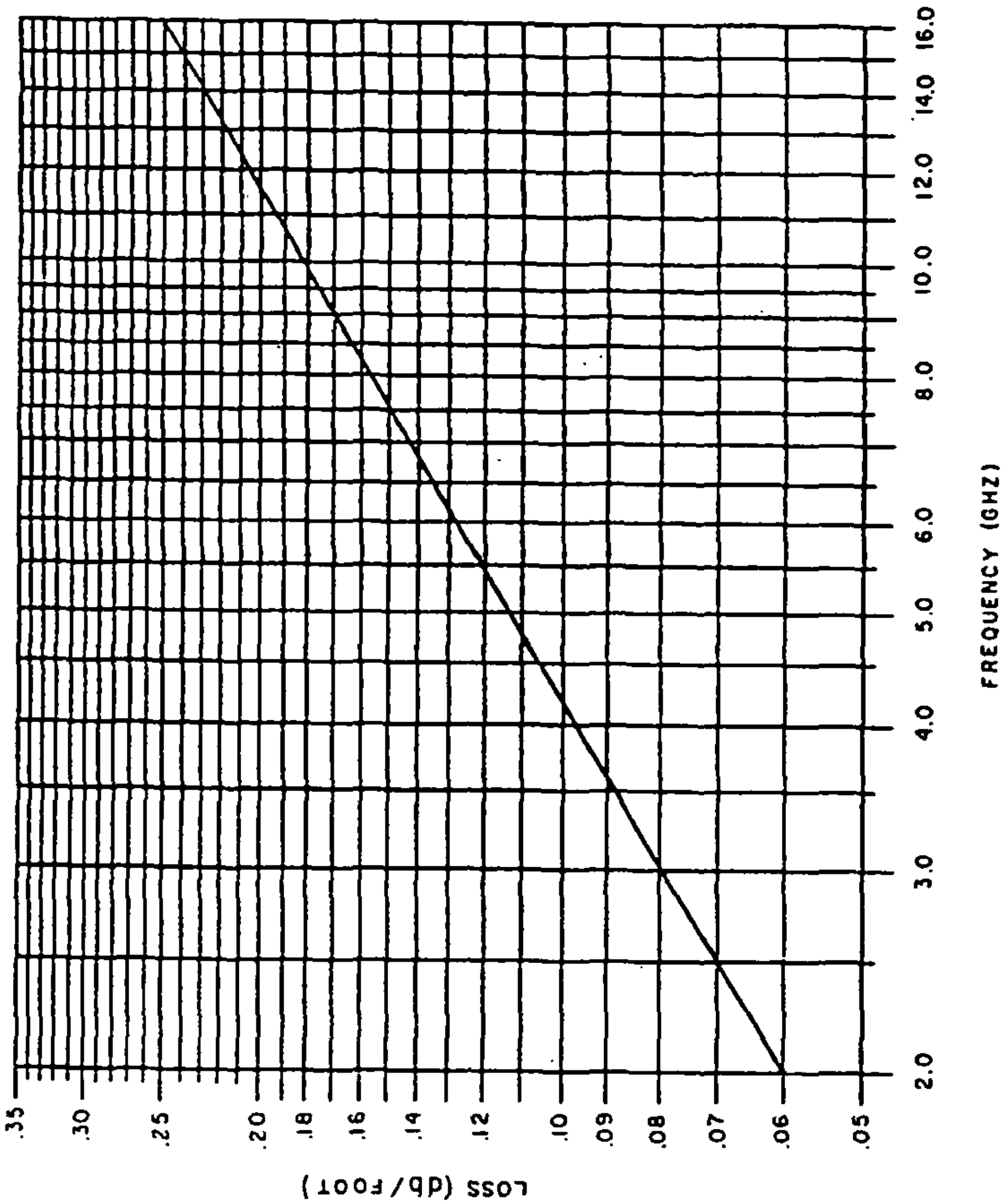


FIGURE 32. $\underline{R}_{(x)}$ values for type II class 3 TEM transmission lines.

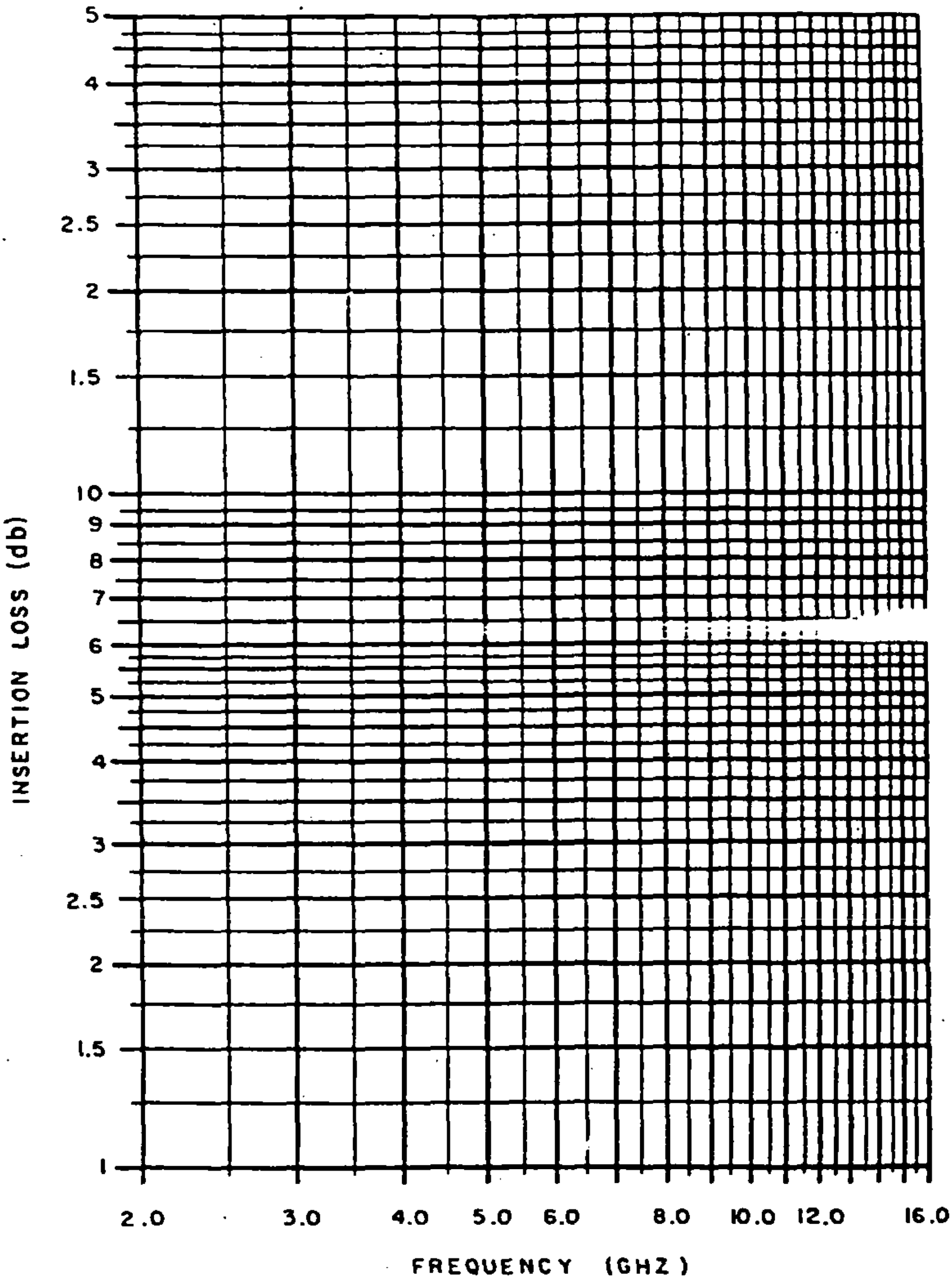


FIGURE 33. Graph form for type II lines.

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