MILITARY SPECIFICATION

WAVEGUIDE, RIDGED ASSEMBLIES, FLEXIBLE AND RIGID

GENERAL SPECIFICATION FOR

1. SCOPE

1.1 SCOPE.- This specification is a performance type of specification for Ridged Waveguide Assemblies. These Ridged Waveguide Assemblies, rigid and flexible, shall be constructed in accordance with the mechanical and electrical requirements of the applicable drawings in order to insure interchangeability.

1.2 CLASSIFICATION

1.2.1 DESIGNATION.- The designation of waveguide assemblies shall be as indicated on the applicable drawing.

1.2.1.1 SIZE.- The size is identified by the detail drawing indicating the inner wide dimension of the matched rigid waveguide, to the nearest hundredth of an inch, with which the waveguide assembly will mate.

1.2.1.2 IDENTIFICATION NUMBER.- The identification number for the waveguide assemblies shall be as shown on the detail drawing.

1.2.1.3 LENGTH.- The length of the assemblies shall be as required on the detail drawings.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and publications, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

Federal

NN-B-591	Boxes, Fiberboard, Wood-Cleated (for Domestic Shipment)
NN-B-621	Boxes, Wood, Nailed, and Lock-Corner
NN-B-631	Boxes, Wood, Wirebound (for Domestic Shipment)
NN-P-515	Plywood, Container Grade

LLL-B-631	Boxes; Fiber Corrugated (for Domestic Shipment)
LLL-B-636	Boxes, Fiber, Solid (for Domestic Shipment)
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-676	Boxes, Set-Up, Paperboard
QQ-A-601	Aluminum Base Alloys; Sand Castings
QQ-B-691	Bronze Castings

Military

JAN-P-103	Packaging and Packing for Overseas Shipment -Boxes; Wood Cleated; Solid Fiberboard
JAN-P-106	Packaging and Packing for Overseas Shipment -Boxes; Wood, Nailed
MIL-B-107	Boxes, Wood, Wirebound (Overseas Type)
JAN-P-108	Packaging and Packing for Overseas Shipment -Boxes, Fiberboard (V-Board and W-Board), Exterior and Interior
MIL-P-116	Preservation, Methods of
JAN-P 120	Packaging and Packing for Overseas Shipment -Cartons, Folding, Paperboard
MIL-F-3922	Flanges, Waveguide, and Associated Fittings
MIL-B-4229	Boxes, Paperboard, Metal-Stayed
MIL-B-10377	Box, Wood, Cleated, Veneer, Paper Overlaid
MIL-L-10547	Liners, Case, Waterproof

STANDARDS

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-202	Test Methods for Electronic and Electric Component Parts

DRAWINGS

Air Force

5784239	Flange, Waveguide Tapped Hole
5784240	Flange, Waveguide Plain Hole
5784241	Waveguide Assembly, Double Ridge Straight, 90° Twist

57B4242	Waveguide Assembly, Transistron Double Ridged
57B4243	Waveguide Assembly, 90° Elbow, "H", Plane, Double Ridged
57B4244	Waveguide Assembly, 90° Elbow, "E" Plane, Double Ridged
57B4245	Waveguide Assembly, 45° Elbow, "H" Plane, Double Ridged
57B4246	Waveguide Assembly, 45° Elbow, "E" Plane, Double Ridged
57B4247	Waveguide Assembly, Double-Ridge Flexible
57B4248	Waveguide, Double-Ridge, Rigid
57B4249	Waveguide Assembly, Double Ridge, Rigid
57B4486	Flange-Waveguide, Plain Hole, Pressurized
57B4487	Flange Waveguide, Tapped Hole, Pressurized
57B4545	Electrical Characteristics, Waveguide Assemblies, Requirements for
57B4580	Gasket
57B4581	Gasket
57B4582	Gasket Assembly

PUBLICATIONS

Federal

Cataloging Handbooks H4-1 and H4-2, Federal Supply Code for Manufacturers.

(Copies of specifications, standards, specification sheets, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 OTHER PUBLICATIONS.-The following documents form a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

CONSOLIDATED CLASSIFICATION COMMITTEE

Consolidated Freight Classification Rules.

(Application for copies should be addressed to the Consolidated Classification Committee, 202 Chicago Union Station, Chicago 6, Illinois).

3. REQUIREMENTS

3.1 DETAIL SPECIFICATIONS.-Air Force Drawings shall serve as the detail specifications for the purposes of this specification.

3.2 MATERIAL.- The material for each part shall be as specified. However, when a definite material is not specified, a material shall be used which will be suitable for its intended use. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.2.1 COPPER ALLOY

3.2.1.1 COMPOSITION.- Copper alloy shall be of the following chemical composition, known commercially as 90/10 bronze:

Copper	89.00-92.00
Lead, maximum	0.05
Iron, maximum	.05
Other elements, maximum	.10
Zinc	(remainder)

3.2.1.2 ALTERNATE MATERIAL.- As an alternate material, deoxidized, high conductivity, low-phosphorized copper (DLP) may be used and shall be of the following chemical composition:

Copper, minimum	99.90
Phosphorous	0.003
Tin	.003
Tellurium	.001
Lead	.001
Iron	.001
Arsenic	.001
Antimony	.001
Nickel	.001
Bismuth	.0001

3.2.1.3 ROCKWELL HARDNESS.- Copper-alloy waveguides shall be supplied in either a light-annealed or half-hard condition, as specified. Waveguides in the light-annealed condition shall have a Rockwell hardness of F50 to F70 and waveguides in the half-hard condition shall have a Rockwell hardness of B40 to B75, when tested as specified.

3.2.2 ALUMINUM ALLOY

3.2.2.1 COMPOSITION.- Aluminum alloy shall be of the following chemical composition, known commercially as 2S alloy:

Aluminum, minimum	99.00
Iron plus silicon, maximum	1.00
Copper, maximum	0.20
Manganese, maximum	.10
Zinc, maximum	.10
Other elements, each 0.05 percent maximum	.15

3.2.2.2 HARDNESS.- Aluminum waveguides shall be furnished in the temper as fabricated, and shall have a minimum tensile strength of 17,000 pounds per square inch.

3.2.3 SILVER ALLOY.- Silver alloy shall be made of commercial coin silver having a composition of 90 percent silver and 10 percent copper.

3.2.4 CASTINGS

3.2.4.1 BRONZE.- Bronze castings shall conform to composition 1 of Specification QQ-B-691.

3.2.4.2 SILVER.- Silver castings shall be made of commercial coin silver having a composition of 90 percent silver and 10 percent copper.

3.2.4.3 ALUMINUM-BASE ALLOY.- Aluminum-base-alloy castings shall be made either of material conforming to composition 17 of Specification QQ-A-601, or of an aluminum alloy known commercially as A-612. For investment casting intended for subsequent dip brazing, alloys known as "ternalloy" may be used. For alloys requiring no brazing, material conforming to composition 3 of Specification QQ-A-601 may be used.

3.2.5. PREPRODUCTION.- When specified (see 6.2), waveguide assemblies furnished under this specification shall be a product which has been subjected to and has passed the preproduction tests specified in 4.4.

3.3 DEFINITIONS.- For the purpose of this specification, the following definitions shall apply:

3.3.1 WAVEGUIDE ASSEMBLY.- A waveguide assembly is an assembly consisting of a section of waveguide with all associated fittings attached thereto and which mates electrically and mechanically with a matched standard rigid waveguide. For the purpose of this specification, waveguide assemblies will be referred to as "assemblies".

3.3.2 MATCHED STANDARD RIGID WAVEGUIDE.- A matched standard rigid waveguide is the standard rigid waveguide with which the assembly mates electrically with a minimum of mismatch.

3.3.3 RELAXED POSITION.- An assembly is in the relaxed position when it is in a horizontal position under no stress except gravity.

3.3.4 MINIMUM BENDING RADIUS.- The minimum bending radius is the radius to the centerline of the assembly to which the assembly can be bent without causing mechanical damage or causing the electrical properties to exceed the values specified. Minimum bending radius is measured in inches.

3.3.5 E-PLANE.- The E-plane is the longitudinal plane which bisects the wide sides of the assembly.

3.3.6 H-PLANE.- The H-plane is the longitudinal plane which bisects the narrow sides of the assembly.

3.3.7 AXIAL TWIST.- Axial twist is the maximum angle through which one flange of an assembly can be rotated with respect to the other flange without causing mechanical damage or causing the electrical properties to exceed the values specified. Axial twist is measured in degrees per foot.

3.3.8 SAFE EXTENSION.- Safe extension is the extension from the relaxed-position length to which the assembly can be stretched without causing mechanical damage or causing the electrical properties to exceed the values specified. Extension is measured in inches per foot.

3.3.9 FLEXURE.- Flexure is the number of cycles through which an assembly can be bent without causing mechanical damage or causing the electrical properties to exceed the values specified.

3.3.10 REPEATED TWIST.- Repeated twist is the number of cycles through which an assembly can be twisted without causing mechanical damage or causing the electrical properties to exceed the values specified.

3.3.11 ATTENUATION.- Attenuation is the one-way power transmission loss through an assembly, measured in decibels (db) per foot.

3.4 DESIGN AND CONSTRUCTION.- Assemblies shall be so designed and constructed as to comply with this specification. Unless otherwise specified (see 3.8) all assemblies shall be terminated at ends by a cover flange. In assembling flanges to a section of waveguide, 1 inch by 1/2 inch and larger sizes, the flange face shall make an angle of $90^{\circ} \pm 30'$ with the E and H plane of the internal surfaces of the waveguide. Unless otherwise specified (see 3.9), flexible assemblies shall be protected from mechanical damage by a jacket constructed of material of suitable thickness.

3.4.1 FINISH

3.4.1.1 SURFACE ROUGHNESS.- All internal surfaces of waveguide assemblies shall have a finish of 63 micro-inches in accordance with Standard MIL-STD-10; all mating surfaces of waveguide assemblies shall have a finish of 16 micro-inches.

3.4.1.2 ALUMINUM-BASE-ALLOY SURFACES.- All aluminum-base-alloy surfaces shall be chemically treated in accordance with Specification MIL-C-5541.

3.4.1.3 INTERNAL SURFACES OF COPPER-BASE ALLOY.- The internal surfaces of copper-base alloy shall have a bright finish; silver plated not less than 0.0002; rhodium plated over silver 0.00001" ± 0.000005".

3.4.1.4 EXTERNAL SURFACES.- All external surfaces of waveguide assemblies, except those surfaces that are required to make electrical contact, shall be painted in accordance with type 1 of Specification MIL-F-14072 with a lusterless black enamel; except for Navy purchases, type II, final film E shall be used.

3.5 PERFORMANCE REQUIREMENTS

3.5.1 ATTENUATION.- The attenuation of the assembly, when measured as specified in 4.6.2.2, shall not exceed the values specified. (See 3.9.)

3.5.1.1 STABILITY OF ATTENUATION.- The maximum attenuation of the assembly shall not exceed the value specified (see 3.9) by more than 25 percent, after the test specified in 4.6.2.2.4.

3.5.2 VSWR.- The overall VSWR of the assembly, including reflections from the cover joints necessary to couple the assembly to the test equipment, shall not exceed the value specified (see 3.9), when measured as specified in 4.6.2.3. Measurements shall be made at specified frequencies (see 3.9).

3.5.3 MINIMUM BENDING RADIUS.- The assembly shall be capable of being bent to the minimum bending radius specified (see 3.8) without causing mechanical damage or electrical deterioration when tested as specified in 4.6.3. After the test, the measured attenuation and VSWR shall be as specified in 3.5.1.1 and 3.5.2, respectively.

3.5.4 FLEXURE.- When assemblies are tested as specified in 4.6.4 flexure shall not be less than the value specified (see 3.9). After the test, the measured attenuation and VSWR shall be as specified in 3.5.1.1 and 3.5.2, respectively.

3.5.5 AXIAL TWIST.- When assemblies are tested as specified in 4.6.5, axial twist shall be clockwise or counterclockwise as specified and shall not be less than the value specified. (See 3.9). After the test, the measured attenuation and VSWR shall be as specified in 3.5.1.1, and 3.5.2, respectively.

3.5.6 REPEATED TWIST.- When assemblies are tested as specified in 4.6.6, repeated twist shall be not less than the value specified. (See 3.9). After the test the measured attenuation and VSWR shall be as specified in 3.5.1.1 and 3.5.2, respectively.

3.5.7 EXTENSION.- When assemblies are tested as specified in 4.6.7, extension shall be not less than the value specified. (See 3.9.) After the test, the measured attenuation and VSWR shall be as specified in 3.5.1.1 and 3.5.2, respectively.

3.5.8 LEAKAGE.- When assemblies are tested as specified in 4.6.8, there shall be no leakage or nonadherence of the jacket.

3.5.9 HEAT AGING.- After completion of the tests specified in 4.6.9 to 4.6.11, inclusive, the attenuation of assemblies at midband shall not exceed the value specified (see 3.9) and the VSWR shall be as specified in 3.5.2.

3.5.10 COLD BENDING.- After completion of the tests specified in 4.6.10 and 4.6.11, there shall be no checks, cracks, fractures, or other flaws in either the jacket or the metal structure. The attenuation at midband shall not exceed the value specified (see 3.9), and the VSWR shall be as specified in 3.5.2.

3.5.11 SALT SPRAY (CORROSION).- After completion of the test specified in 4.6.11, the attenuation of assemblies at midband shall not exceed the attenuation value specified by more than 0.01 db per foot (see 3.9) and the VSWR shall be as specified in 3.5.2.

3.6 STANDARD LENGTHS.- When specified (see 6.2), assemblies shall be furnished in the following lengths: 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, and 96 inches. In the relaxed position, the overall lengths shall not deviate from the nominal by more than ±1 percent or ±1/8 inch, whichever is smaller.

3.7 MARKING.- All assemblies shall be suitably marked in accordance with Standard MIL-STD-130 on one side of the wide dimension with the type designation and the manufacturer's code letters. The code-designating letters shall be as listed in Publication NAVSHIPS 900, 152. The manufacturer's name or trade-mark may also be marked on the assembly, provided such letters are not expressly forbidden in the contract or order, and do not exceed 3/8 inch in height. All such markings shall withstand normal abuse and be legible for the life of the assembly and shall not cause the jacketing material to be indented below the mean external dimension of the jacket. The height of the letters

of the type designation shall be at least 1/8 inch but shall not exceed 1/2 inch. The letters shall be comparable in height to the manufacturer's trade-mark or code letters.

3.8 WORKMANSHIP.- Assemblies shall be manufactured and processed in a careful and workmanlike manner, in accordance with good design and sound practice so that they will satisfactorily mate with the matched standard right waveguide flange and meet the performance requirements specified herein.

3.9 AIR FORCE DRAWINGS FOR INDIVIDUAL TYPES OF WAVEGUIDE ASSEMBLIES.- All requirements specified herein apply to all types of waveguide assemblies covered by applicable Air Force Drawings. Detail requirements or exceptions applicable to individual types are specified on the Air Force Drawings. In the event of any conflict between requirements of this specification and the individual Air Force Drawings, the latter shall govern. (See 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS.- The methods of sampling, inspection, and tests conducted on waveguide assemblies shall be classified as follows:

a. Preproduction tests. (See 4.4.)
b. Inspection tests. (See 4.5.)

4.2 TEST EQUIPMENT AND INSPECTION FACILITIES.- Test equipment and inspection facilities shall be of sufficient accuracy and quality to permit performance of the required inspection tests. The manufacturer shall establish adequate calibration of test equipment to the satisfaction of the Government.

4.2.1 ACCURACY OF TEST EQUIPMENT.- The frequency-measuring device shall have an accuracy of $\pm$ 0.1 percent, or better. The overall accuracy in the determination of VSWR shall be better than $\pm$ 2 percent. The accuracy of attenuation measurements shall be better than $\pm$ 0.01 db of the measured attenuation. Such standards as are deemed necessary will be supplied by the inspecting or procuring agency to the contractor to check the test equipment; i.e., slotted section, probe, and amplifier assembly.

4.3 TEST METHODS.- The specific test methods to be employed for the particular characteristic under examination shall be only those specified herein, unless otherwise approved. When a manufacturer desires to use an alternate method of test, he should submit a request giving

all the technical details to the Armed Services Electro Standards Agency, (ASESA), Fort Monmouth, N.J., for coordination and review by the Armed Services.

4.4 PREPRODUCTION TESTS.- When required (see 6.2), preproduction tests will be performed, at a location specified by the bureau or service concerned, to determine compliance of the preproduction sample with this specification prior to production.

4.4.1 SAMPLE.- The preproduction sample shall be representative of the manufacturer's normal production and shall be taken, preferably, from a current production lot. The number of specimens to be submitted shall be as specified. (See 3.9.) The assembly type to be submitted shall be as specified. (See 6.2.)

4.4.1.1 TEST-SPECIMEN LENGTHS.- The lengths of the test specimens shall be as specified.

4.4.2 TEST DATA. The preproduction sample shall be accompanied by test data showing compliance with specified performance requirements. (See 3.3.) The test data shall comprise an engineering report stating all essential details of the testing equipment, including accuracy test procedures, observations and other data, and test results. Upon completion of the required preproduction tests, the bureau or service concerned will submit a copy of the test results to the Armed Services Electro-Standards Agency (ASESA), Fort Monmouth, N.J., for dissemination and to aid in the standardization of new types.

4.4.3 TESTS.- Tests to be performed on preproduction specimens will consist of the tests specified in table I, in the order shown.

4.4.4 FAILURES AND RESUBMISSIONS.- Failure of any specimen in any one of the electrical tests, or failure to meet the minimum physical requirements, will be cause for refusal of approval. In the event of failure, the manufacturer may be requested to submit another group of specimens equal in number to the original submission, accompanied by a description of the changes made to correct the cause of failure.

TABLE I. - PREPRODUCTION TESTS

Test	Requirement paragraph	Test paragraph
Visual and mechanical inspection	3.4 and 3.6 to 3.9, incl.	4.6.1
Attenuation	3.5.1	4.6.2.2
VSWR	3.5.2	4.6.2.3
Minimum bending radius	3.5.3	4.6.3
Flexure	3.5.4	4.6.4
Axial twist	3.5.5	4.6.5
Repeated twist	3.5.6	4.6.6
Extension	3.5.7	4.6.7
Leakage	3.5.8	4.6.8
Heat Aging	3.5.9	4.6.9
Cold bending	3.5.10	4.6.10
Salt spray (corrosion)	3.5.11	4.6.11

4.5 INSPECTION TESTS.- Inspection tests shall be performed by the Government or under the supervision of the Government. Inspection tests shall consist of groups A and B tests.

4.5.1 LOT.- An inspection lot shall be as specified in Standard MIL-STD-105.

4.5.2 GROUP A TEST.- The group A test shall consist of visual and mechanical inspection. (See 4.6.1.) It shall be performed by either of the following methods or a combination of both:

a. 100-percent inspection.

b. Statistical sampling and inspection in accordance with Standard MIL-STD-105. The acceptable quality levels (AQL) shall be 1.0 and 4.0 (percent defective) for major and minor defects, respectively. Major and minor defects shall be as defined in Standard MIL-STD-105.

4.5.3 GROUP B TESTS.- Group B tests shall consist of those specified in table II, in the order shown. They shall be performed on sample units that have been subjected to and have passed the group A tests, unless the Government considers it more practical to select a separate sample from the lot for Group B inspection.

TABLE II. - GROUP B INSPECTION TESTS

Test	Requirement paragraph	Test paragraph
VSWR	3.5.2	4.6.2.3
Attenuation	3.5.1	4.6.2.2
Stability of attenuation	3.5.1.1	4.6.2.2.4
Leakage	3.5.8	4.6.8

4.5.3.1 SAMPLING PROCEDURE.- The sampling procedure shall be in accordance with table III and figure 1. If the number of defective units exceeds the applicable acceptance number of table III, the lot shall be rejected.

TABLE III. - SAMPLING PROCEDURE FOR GROUP B INSPECTION TESTS

Lot size[1]	Inspection Levels[2]					
	I		II		III	
	Sample size	Acceptance number	Sample size	Acceptance number	Sample size	Acceptance number
9 to 25, incl.	2	0	2	0	4	1
26 to 65, incl.	2	0	3	0	4	1
66 to 180, incl.	7	1	7	1	17	1
181 to 500, incl.	7	1	17	2	29	2
501 to 1,300, incl.	7	1	29	3	41	3
1,301 to 3,200, incl.	17	2	41	4	53	4
3,201 to 8,000, incl.	17	2	53	5	66	5
8,001 to 22,000, incl.	29	3	66	6	81	6
22,001 and over	29	3	81	7	81	6

[1] For lot sizes under 9, the sample size shall be at the option of the Government but not more than 2, and the acceptance number shall be 0.

[2] The following notes shall apply to the selection of inspection levels:

A. Calculate the estimated process average from the formula $\frac{P}{N} \times 100$;

where P equals the number of defective units found in N sample units, and N equals the number of sample units included in the estimated process average. The number of consecutive sample units used to estimate the process average shall be as determined by the Government.

B. Start with inspection level II and continue as long as the process average lies between lines A and C of figure 1.

C. Institute inspection level III when the process average goes above line A of figure 1, or a lot fails to pass.

D. Return to inspection level II from inspection III when two lots in succession pass level III inspection, and the process average falls below line B of figure 1.

E. Institute inspection level I when the process average falls below line C of figure 1, provided that at least 75 sample units are used to estimate the process average.

F. Return to inspection level II from inspection level I when the process average rises above line C of figure 1.

4.5.3.2 ACTION IN CASE OF LOT REJECTION.- If the lot is not accepted on group B tests, the manufacturer shall immediately make an investigation as to the cause of the failure. The lot shall be given 100-percent inspection and, before submission, full particulars concerning the rejection and the action taken to make the necessary corrections, both to the rejected lot and to future production, shall be furnished the Government.

4.6 TEST PROCEDURES

4.6.1 VISUAL AND MECHANICAL INSPECTION.- Assemblies shall be inspected to verify that the design and construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements. (See 3.4 and 3.6, to 3.9, incl.)

4.6.2 ATTENUATION AND VSWR.- The attenuation and VSWR at the test frequencies specified (see 3.9) shall be determined by the following procedure:

4.6.2.1 FREQUENCY.- The test frequencies shall be determined by using an absorption frequency meter, a heterodyne frequency meter, or a slotted section having an accuracy of 0.1 percent, or better, as a frequency measuring device. A transmission-type wavemeter shall not be used for frequency measurements. The test setup shall be as shown on figure 2 or 3, and preferably with the test setup intact for other measurements.

4.6.2.2 ATTENUATION.- (See 3.5.1) The attenuation of the specimen shall be measured by using any of the applicable methods specified in 4.6.2.2.1 to 4.6.2.2.3.2, inclusive. The test set up for attenuation measurements shall be as shown on figure 4.

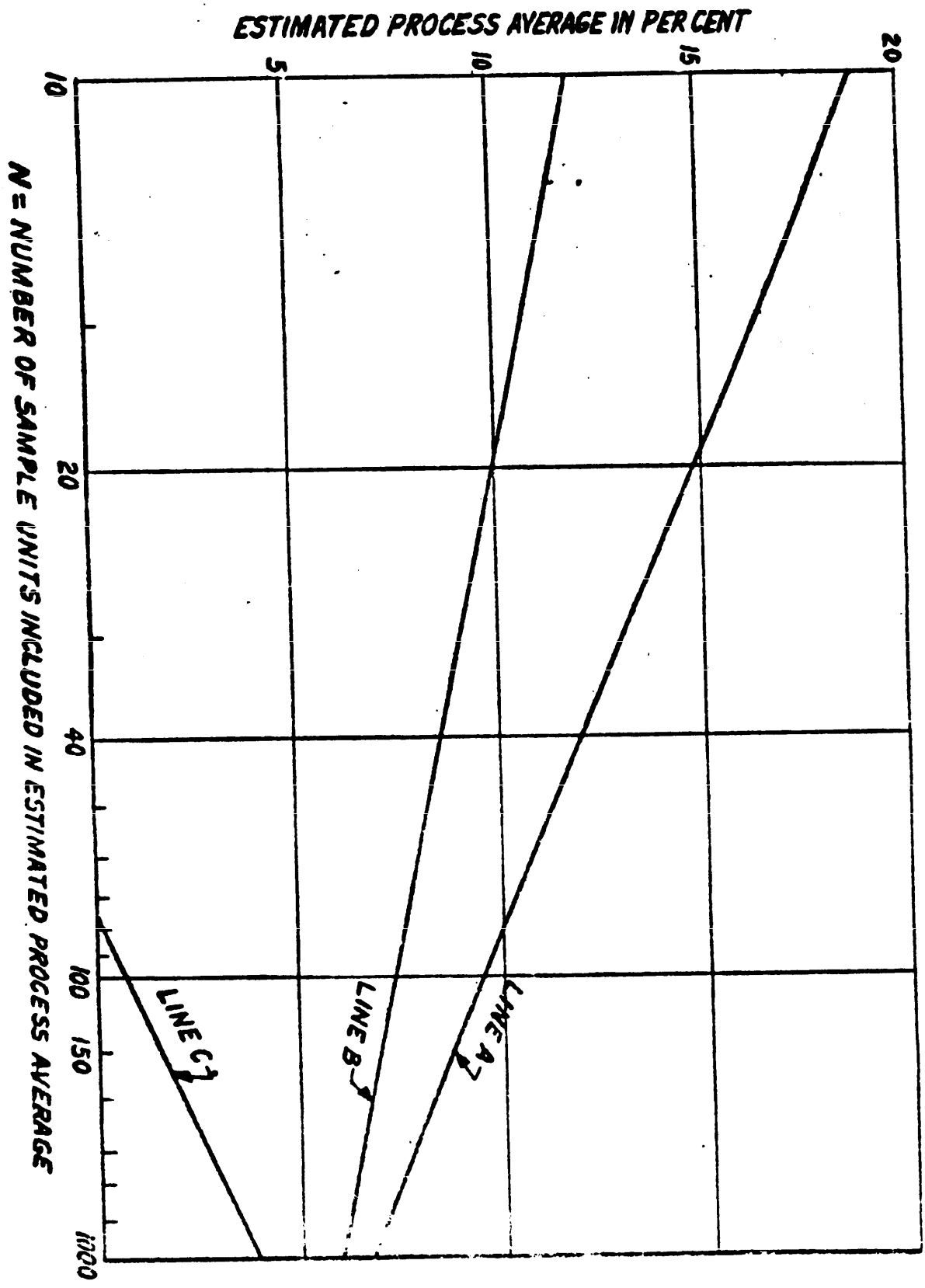

FIGURE 1

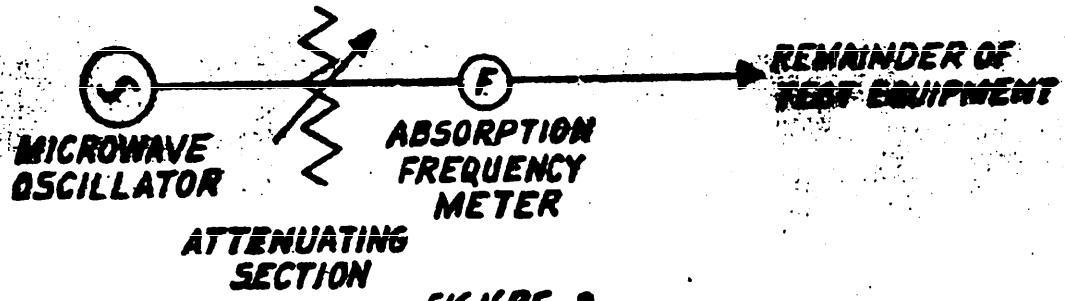

FIGURE 2

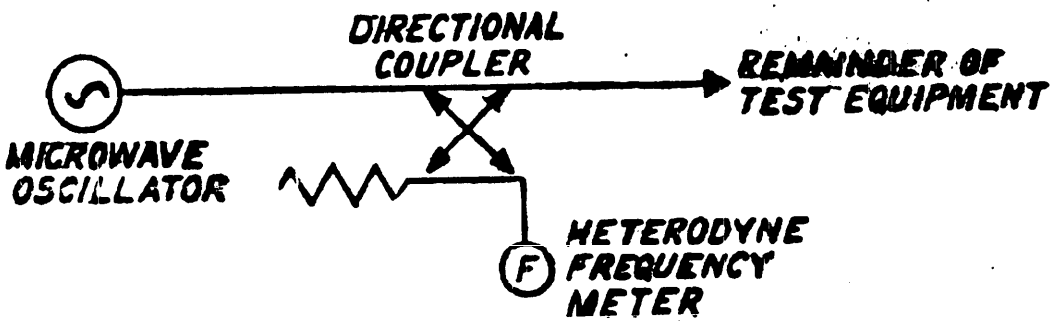

FIGURE 3

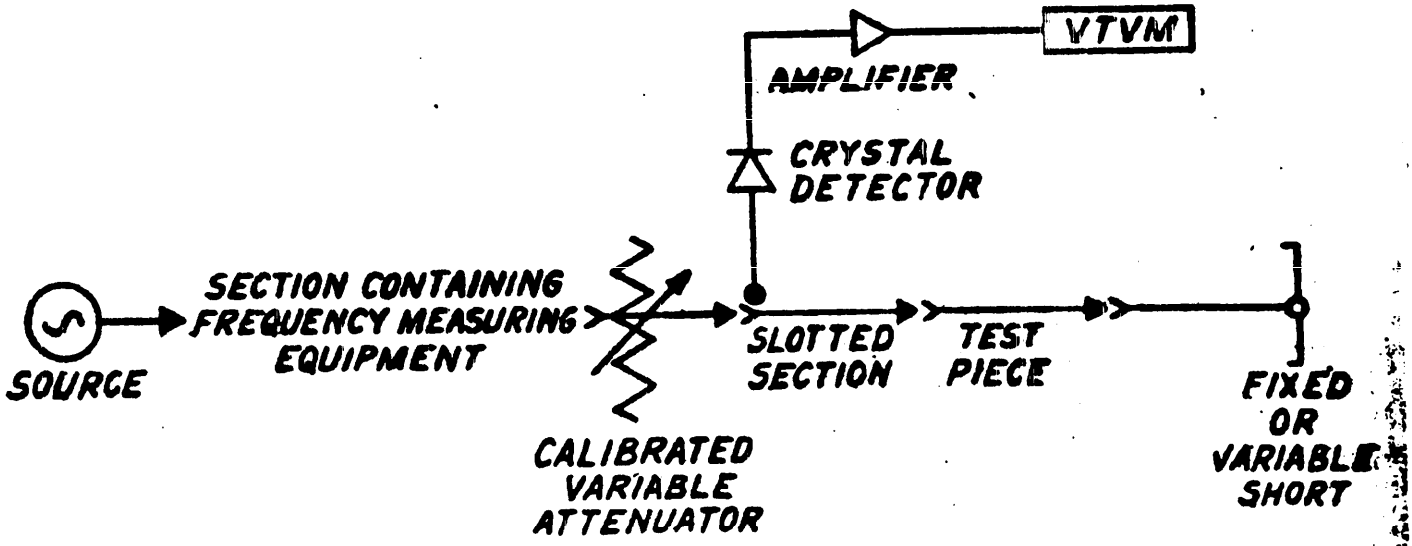

FIGURE 4

4.6.2.2.1 METHOD I.- This method may be used when the VSWR is less than 1.01:1. The VSWR shall be measured as specified in 4.6.2.3. The specimen shall be shorted with a short whose loss, when measured as specified below, together with that of the associated plumbing is as low as practicable. When the short and associated-plumbing loss is greater than 20 percent of the total measured attenuations, its value shall be subtracted from the overall measurement. The test shall be made as follows:

a. Locate the probe position for a voltage minimum; either note the output reading or adjust the amplifier gain to give a convenient reading on the output meter.

b. Locate the probe position for an adjacent voltage minimum and measure the distance between the two minima. This distance is

equal to

c. Insert 3-db attenuation by means of a calibrated attenuator and locate the probe positions for the same output reading as obtained in (a) on each side of the original probe position. From the measured distance between the two extreme probe positions, the attenuation of the test specimen shall be calculated using the following relations:

δ = attenuation of test specimen.

r = VSWR

λ_g = wavelength in assembly (cm)

X_p = distance between extreme travel of probe (cm)

L = length of assembly (inches)

$$r^2 = 1 + \frac{1}{\sin^2\left(\frac{\Delta X_p}{\frac{\lambda_g}{2}} \cdot \frac{\pi}{2}\right)}$$

$$\text{Attenuation } \delta = 10 \log_{10}\left[\frac{r+1}{r-1}\right]$$

$$\text{Attenuation per unit length} = \frac{\delta}{L}$$

4.6.2.2.2 METHOD II.- This method may be used when the VSWR shall be determined in the following manner: With the specimen shorted, the power minimum probe position shall be located and the calibrated attenuator shall be adjusted to give a convenient output level. Then, with the probe moved to the power maximum position, the calibrated attenuator shall be adjusted alone to restore the output indication to the same value as obtained with the probe at the power minimum position. When the short and associated -plumbing loss is greater than 20 percent of the total measured attenuation its value shall be subtracted from the overall measurement. From the difference in attenuation required for the same output at the maximum and minimum positions, the attenuation of the specimen shall be calculated using the following relations:

a_1 = attenuator setting at maximum (db)

a_2 = attenuator setting at minimum (db)

r = VSWR

$$r = \log 10^{\frac{(a_1 - a_2)}{20}}$$

Attenuation $$\delta = 10 \log_{10} \frac{(r+1)}{(r-1)}$$

4.6.2.2.3 METHODS III AND IV.- Either test method III or method IV as specified in 4.6.2.2.3.1 and 4.6.2.2.3.2, respectively, shall be used when the VSWR of the specimen is greater than 1.01:1.

4.6.2.2.3.1 METHOD III.- With this method, the specimen under test shall be shorted with an adjustable short, using method II. When the short and its associated plumbing is greater than 20 percent of the total measured attenuation, its value shall be subtracted from the overall measurement. The short shall be adjusted for a maximum and minimum VSWR. From the measured maximum and minimum VSWR, the attenuation of the specimen shall be calculated as follows:

$$\text{Attenuation } \delta \geq 10 \log \left[\frac{(r_m+1)\ (r_n+1)}{(r_m-1)\ (r_n-1)}\right]^{\frac{1}{2}} = \frac{\delta_1 + \delta_2}{2}$$

Where:

r_m = maximum VSWR

r_n = minimum VSWR

δ_1 = attenuation with maximum VSWR

δ_2 = attenuation with minimum VSWR

4.6.2.2.3.2 METHOD IV.- With this method, the attenuation of the specimen under test shall be determined as specified in method II after the specimen has been shorted; first with a plane short and then with a short displaced one-quarter wavelength. When the short and associated-plumbing loss is greater than 20 percent of the total measured attenuation, its value shall be subtracted from the overall measurement. The quarter wavelength short shall be within 10 percent of a quarter wavelength in the specimen at the test frequency. From the attenuation measured with a plane short and with a quarterwave short, the attenuation shall be calculated as follows:

$$\text{Attenuation } \delta = (\delta_p \delta_q)^{\frac{1}{2}}$$

Where

δ_p = attenuation as measured with a plane short

δ_q = attenuation as measured with a quarter-wave short

4.6.2.2.4 STABILITY OF ATTENUATION.- Stability of attenuation shall be determined by measuring attenuation at midband, while the specimen is being deformed. When flexure is specified (see 3.9), the specimen shall be slowly bent by hand in the E-plane, throughout at least 75 percent of its length, to an average radius equal to the minimum bending radius specified (see 3.9). When repeated twist is specified (see 3.9) the specimen shall be slowly twisted by hand, either clockwise or counterclockwise, whichever is the lower, to an average radius equal to the value specified (see 3.9). When extension is specified (see 3.9) the specimen shall be slowly extended by hand, to an average value equal to the value specified (see 3.9). A record shall be made of the maximum attenuation observed for any deformed position. (See 3.5.1.1.)

4.6.2.3 VSWR (see 3.5.2)

4.6.2.3.1 SLOTTED SECTION.- Properly adjusted slotted line sections may be used for measuring VSWR. An external termination shall be used whose VSWR shall not be greater than 1.01:1 at the frequency of test.

4.6.2.3.2 HYBRID JUNCTIONS.- Hybrid junctions, such as magic tees, or bidirectional or unidirectional couplers, may be used for measuring VSWR when properly calibrated and adjusted to measure reflection within the limits of accuracy specified in 4.2.1.

4.6.3 MINIMUM BENDING RADIUS.- One end of the specimen shall be firmly fixed to a stationary platform, and a guide or mandrel having a set radius of curvature for the specimen to be tested shall be attached on the same end. The specimen shall be so mounted as to be under neither extension nor compression when in the straight position. The free end of the specimen shall be connected to an eccentric or oscillatory mechanism by means of a suitable connection. The mechanism should then impart an even and smooth oscillating motion to the free end so that the portion near the fixed end will bend around the mandrel. The specimen shall be so bent throughout at least two-thirds of its length or through an arc of 90°, whichever is smaller. The centerline of the free end shall be normal to the stationary platform when in the relaxed position. The specimen shall be subjected to five complete cycles of bend from the relaxed position. The stability of attenuation and VSWR shall then be measured as specified in 4.6.2.2.4 and 4.6.2.3, respectively. (See 3.5.3.)

4.6.4 FLEXURE.- A means shall be provided for setting and measuring the angle of bend specified (see 3.9), in both the E- and H- planes. This bend shall be in one direction only and is not meant to be reversed-bending. A suitable motor plus reduction gears, capable of continuous cycling at a rate of approximately 40 cycles per minute, shall be provided. Counters shall be connected to the mechanism to record the number of cycles of flexure. There shall be four specimens for each type of assembly for this test. The specimens shall be bent at the angles and to the number of cycles specified. (See 3.9.) The stability of attenuation and VSWR shall then be measured as specified in 4.6.2.2.4 and 4.6.2.3, respectively. (See 3.5.4.)

4.6.5 AXIAL TWIST.- One flange of the specimen shall be securely fastened to a stationary platform. To prevent the specimen from bending, a rigid shaft shall be mounted to the platform, which will extend through the geometrical center of the specimen, as an axis of rotation. The other flange shall be connected to this shaft and shall be free to rotate about it. The flange to be twisted shall be connected to an eccentric mechanism which will apply uniform alternating clockwise and counterclockwise twisting to the specimen about the axis. A means shall be provided for measuring and setting the angle of twist, as desired. The specimen shall be subjected to five complete cycles of clockwise and counterclockwise twist from the relaxed position. Twisting shall be performed uniformly at a rate of approximately 1 cycle per 10 seconds. At the end of the test cycle, the specimen shall be under neither compression nor tension. The stability of attenuation and VSWR shall then be measured as specified in 4.6.2.2.4 and 4.6.2.3, respectively. (See 3.5.5.)

4.6.6 REPEATED TWIST.- The same mechanical setup specified in 4.6.5 shall be utilized. A suitable motor plus reduction gears, capable of continuous cycling at a rate of approximately 40 cycles per minute, shall

be provided. Counters shall be connected to the mechanism to record the number of cycles of twist. The mechanism shall be capable of preset in order to twist the specimens at angles of $\pm 2.5^{\circ}$ and $\pm 45^{\circ}$. The stability of attenuation and VSWR shall then be measured as specified in 4.6.2.2.4 and 4.6.2.3, respectively. (See 3.5.6.)

4.6.7 EXTENSION.- The specimen shall be mounted in a straight position in such a manner that it will be under neither compression nor tension. The specimen shall be supported over its entire length so that it will maintain its straightness when subjected to tension. One end shall be securely fastened, the other end shall be connected to an eccentric mechanism which will apply repeated extension to the specimen. A scale shall also be installed which will measure the amount of elongation from the original length. Repeated extension shall be performed uniformly at a rate of approximately 1 cycle per 10 seconds. Five equal and complete cycles of repeated extension from the rest position shall be performed. The stability of attenuation and VSWR shall then be measured as specified in 4.6.2.2.4 and 4.6.2.3, respectively. (See 3.5.7.)

4.6.8 LEAKAGE.- Specimen shall be subjected to an internal gas pressure of at least 30 pounds per square inch gage while immersed in water, unless otherwise specified. (See 3.9.) Any areas of nonadherence of the jacket should be noted after the specimen has been under the pressure for 2 minutes. Ridges between convolutions in the rubber that show under pressure are to be discounted, and, in general, nonadherent areas 1/8-inch square or smaller may be disregarded. In case of doubt, any nonadherent area which does not visibly increase in size when the specimen is subjected to 30 pounds per square inch gage internal pressure for 24 hours will be acceptable. (See 3.5.8.)

4.6.9 HEAT AGING.- The specimen shall be placed in an oven at a temperature of $100^{\circ} \pm 2^{\circ}$ C, for a period of 7 days. At the end of this period, the specimen shall be cooled to room temperature (approximately 20° C). The effects of heat aging shall be determined by the tests which are made subsequent to the heat-aging test. (See 4.6.10 and 4.6.11). After these tests, the attenuation at midband and the VSWR shall be measured as specified in 4.6.2.2 and 4.6.2.3, respectively. (See 3.5.9.)

4.6.10 COLD BENDING.- The specimen shall be placed in a cold chamber for a period of 20 hours at a temperature of $-55^{\circ} \pm 5^{\circ}$ C. It shall be bent three times to the minimum bending radius specified (see 3.9), in the E-plane at a rate not to exceed 5° per second. The specimen shall be bent as specified in 4.6.3, first in one direction and then in the other, at the temperature of the chamber. The specimen shall be removed from the chamber and checked for conformance with 3.5.10. The leakage test specified in 4.6.8 shall also be applied as a means of determining the

mechanical uniformity of the specimen after it has been brought back to room temperature. The attenuation at midband and the VSWR shall then be measured as specified in 4.6.2.2 and 4.6.2.3, respectively. (See 3.5.10.)

4.6.11 SALT-SPRAY (CORROSION).- The attenuation at midband shall be tested in accordance with method 101, test condition B, of Standard MIL-MIL-STD 202. After the test, the specimen shall be throughly washed with clean water and dried; the attenuation at midband shall again be measured as specified in 4.6.2.2; and the VSWR shall be measured as specified in 4.6.2.3. (See 3.5.11)

5. PREPARATION FOR DELIVERY

5.1 PRESERVATION AND PACKAGING (See 6.1.)

5.1.1 FOR DOMESTIC SHIPMENT (IMMEDIATE USE WITHOUT STORAGE).- Waveguide assemblies shall be afforded preservation and packaging in accordance with the manufacturer's replacement-parts practice.

5.1.2 FOR DOMESTIC SHIPMENT (LIMITED STORAGE).- Waveguide assemblies shall be afforded protection against corrosion and physical and mechanical damage by application of methods used by the manufacturer to afford such protection during the process of manufacture, assembly, storage, and shipment on a commercial basis. They shall be individually wrapped, bagged, boxed, or otherwise protected in a manner that will prevent the entrance of dust, dirt, or other foreign matter, or direct entry of free water. Any packaging material used in direct contact with surfaces adversely affected by hygroscopic material shall be neutral within the pH range of 6.0 through 8.0.

5.1.3 FOR OVERSEAS SHIPMENT OR EXTENDED STORAGE.- Waveguide assemblies shall be individually cushioned and unit-packaged in accordance with Specification MIL-P-116 as follows: Method IIb shall be used for assemblies weighing more than 5 pounds; method IIc shall be used for assemblies weighing 5 pounds or less. Unit containers for IIc packages shall conform to Specification PPP-B-676, JAN-P-120, or MIL-B-4229.

5.2 PACKING (see 6.1).

5.2.1 FOR DOMESTIC SHIPMENT (IMMEDIATE USE WITHOUT STORAGE).- Waveguide assemblies packaged as specified in 5.1.1 shall be packed in containers of the type, size, and kind commonly used for the purpose, in a manner that will insure acceptance by common carrier and safe delivery at destination. Shipping containers shall comply with the Consolidated Freight Classification Rules, or regulations of other carriers as applicable to the mode of transportation.

5.2.2 FOR DOMESTIC SHIPMENT AND STORAGE.- Waveguide assemblies packaged as specified in 5.1.2 or 5.1.3 shall be packed in woodcleated fiberboard, nailed wood, wirebound wood (for type 2 load), corrugated or solid fiberboard, wood-cleated plywood (domestic type), or wood-cleated paper-overlaid (domestic type) boxes conforming to Specifications NN-B-591, NN-B-621, NN-B-631, LLL-B-631, LLL-B-636, PPP-B-601, and MIL-B-10377, respectively. Closures shall be as specified in the applicable box specification. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

5.2.3 FOR OVERSEAS SHIPMENT.- Waveguide assemblies packaged as specified in 5.1.3 shall be packed in wood-cleated fiberboard, nailed wood, wirebound wood (style 3, for type 2 load), corrugated or solid fiberboard, wood-cleated paper-overlaid (overseas type), or wood-cleated plywood (overseas type) boxes conforming to Specifications JAN-P-103, JAN-P-106, MIL-B-107, JAN-P-108, JAN-P-106, MIL-B-107, JAN-P-108, MIL-B-10377, and PPP-B-601, respectively. Plywood shall be type I of II, Class 2, conforming to Specification NN-P-515. Shipping containers, other than those conforming to Specification JAN-P-103, shall have case liners conforming to Specification MIL-L-10547 and appendix thereto. Box closures shall be as specified in the appendix of the applicable box specification. The gross weight shall not exceed 65 pounds for corrugated or solid fiberboard boxes and 200 pounds for all other boxes specified above.

5.3 MARKING.- In addition to any special marking required by the contract or order, unit packages, and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129 (See 6.2)

6. NOTES

6.1 INTENDED USE.-

6.2 ORDERING DATA.- Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Title, number, and date of the applicable Military Specification sheet, and the complete type designation. (See 1.2.1 and 3.9.)
c. Length required (see 3.6) and material to be used.
d. Whether preproduction tests are required, where they are to be performed, and the assembly type required. (See 3.2 and 4.4.)
e. Whether preservation, packaging, packing, and marking are for domestic shipment for immediate use, for domestic shipment involving limited or extended storage or for overseas shipment. (See Sect. 5).
f. Any detail requirements differing from those specified herein or additional requirements not covered by an individual Military Specification sheet.

6.3 ENGINEERING INFORMATION.- The material and construction details given herein are directly applicable to the test equipment required. The performance requirement are the primary requirement for the end item waveguide assemblies.

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

WCLKM

WADC

GPO 817414-1