MILITARY SPECIFICATION

CABLE, RADIO FREQUENCY, COAXIAL, SEMIRIGID, CORRUGATED OUTER CONDUCTOR, GENERAL SPECIFICATION FOR

This limited coordination military specification has been prepared by the Naval Electronic Systems Command based upon currently available technical information but it has not been approved for promulgation as a coordinated revision of MIL-C-28830. It is subject to modification. However, pending its promulgation as a coordinated military specification, it may be used in procurement.

1. SCOPE

1.1 Scope. This specification covers coaxial, semirigid, radio frequency cable with corrugated outer copper conductors (see 6.1).

1.2 Classification.

1.2.1 Military part number. Part number shall be in the following form:

M28830/1-I
(1.2.1.1) (1.2.1.2)

1.2.1.1 Military specification sheet number. The military specification sheet number designation consists of a prefix M which indicates a military specification item, the specification number and the specification sheet number followed by a hyphen.

1.2.1.2 Jacket material. Jacket material shall be as specified in the specification sheet. The following table applies:

1. Type I - Unjacketed.
2. Type II - Jacketed (polyethlyene).
3. Type III - Jacketed (polyether urethane).

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

L-P-390	- Plastic, Molding and Extrusion Material, Polyethylene and Copolymers (Low, Medium, and High Density).
QQ-C-576	- Copper Flat Products with Slit, Slit and Edge-Rolled, Sheared, Sawed or Machine Edges, (Plate, Bar, Sheet, and Strip).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Electronic Systems Command, ATTN: ELEX 5043, Department of the Navy, Washington, DC 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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MIL-P-116	-Preservation-Packaging, Methods of.
MIL-C-12000	-Cable, Cord, and Wire, Electric, Packaging of.
MIL-C-45662	-Calibration System Requirements.
MIL-P-47082	-Plastic, Ether Polyurethane, for Extrusion and Molding.

STANDARDS

FEDERAL

FED-STD-228	- Cable and Wire, Insulated; Methods of Testing.

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MIL-STD-109	- Quality Assurance Terms and Definitions.
MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-414	- Sampling Procedure and Tables for Inspection by Variables for Percent Defective.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

DEFENSE LOGISTICS SERVICE CENTER

H4-1 - Federal Supply Code for Manufacturers Part 1, Name to Code.
H4-2 - Federal Supply Code for Manufacturers Part 2, Code to Name.

(Application for copies should be addressed to Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B224	- Standard Classification of Coppers.
ASTM B566	- Standard Specification for Copper-Clad Aluminum Wire.

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

3. REQUIREMENTS

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

3.2 Qualification. Cables furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.6 and 6.3).

3.3 Materials. Unless otherwise specified (see 3.1), the materials for the principal components of the cable shall be as specified herein. Prior approval to use substitute material must be obtained from the qualifying activity. When a definite material is not specified, a material shall be used that will enable the finished products to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.3.1 Virgin material. For purposes of this specification, virgin material shall be 100 percent new material which has been through only the processes essential to its manufacture and its application to the finished cable and has been through these essential processes one time only. Any material which has previously been processed in any other manner is considered non-virgin material. This requirement shall apply to the manufacture of all ingredients and components used.

3.3.2 Copper clad aluminum. Copper clad aluminum wire shall conform to ASTM B566-72.

3.3.3 Copper. Copper strip shall be type XLP or DLP per QQ-C-576.

3.3.4 Foam polyethylene. Foam polyethylene shall conform to L-P-390, type II, class L (see 4.3). Vendor blends are acceptable if their dissipation factor is less than 0.0003.

3.3.5 Polyethylene. Polyethylene shall conform to L-P-390, type III, class L, grade 04 (see 4.3).

3.3.6 Polyether urethane. Polyether urethane shall conform to MIL-P-47082 (see 4.3).

3.4 Design, construction and dimensions. Design, construction, and dimensions of the cable shall be as specified in the specification sheet (see 3.1).

3.4.1 Splices. Each specified length of cable (see 6.2) shall be electrically and mechanically continuous. No cable splices shall be allowed after fabrication of the cable.

3.4.2 Dimensional errors and tolerances. The cumulative dimensional errors shall not result in the cables failing the voltage standing wave ratio (VSWR) test.

3.5 Performance.

3.5.1 Continuity. Each conductor in each reel of cable shall be electrically continuous between ends (see 4.8.2).

3.5.2 Dielectric withstanding voltage. The completed cable shall withstand the voltage specified in the applicable specification sheet (see 3.1) without breakdown when tested as specified (see 4.8.3).

3.5.3 Spark test (jacketed cable only). Jacketed cable shall have a continuous jacket without cracks, breaks, or holes. A puncture of the jacket by the applied voltage shall constitute a point of failure (see 4.8.4).

3.5.4 Insulation resistance. The insulation resistance shall be not less than 100,000 megohms/1000 feet (see 4.8.5).

3.5.5 Leak test (type 1). The cable shall not increase in capacitance by more than 5 percent of the initial capacitance (see 4.8.6).

3.5.6 Attenuation. The attenuation in decibels (dB)/100 feet shall not exceed the specified maximum values (see 3.1 and 4.8.7).

3.5.7 Velocity of propagation (when applicable, see 3.1). The velocity of propagation of the cable shall be as specified (see 4.8.8).

3.5.8 Capacitance (when applicable, see 3.1). The cable capacitance shall be as specified (see 4.8.9).

3.5.9 Impedance. When tested in accordance with 4.8.10 the impedance of the cable shall be as specified (see 3.1).

3.5.10 Voltage standing wave ratio (VSWR). The cable shall have a maximum VSWR as specified (see 3.1) with respect to a 50 ohm load for the test frequencies specified (see 4.8.11). For qualification tests, the VSWR shall be recorded over the entire frequency range of interest, using swept measurement techniques. For quality conformance, VSWR shall be checked at frequency specified (see 3.1)

3.5.11 Cold bend (jacketed cable only). The cable jackets shall show no evidence of cracking or splitting (see 4.8.12).

3.5.12 Flexibility. The finished cable shall not exhibit kinking, wrinkling, or cracking. The cable shall then meet the requirements of 3.5.5 and 3.5.10 (see 3.1 and 4.8.13).

3.5.13 Temperature cycling. The cable shall not exhibit any evidence of mechanical damage. The cable shall then meet the requirements of 3.5.10 (see 4.8.14).

3.5.14 Thermal shock. There shall be no physical damage of any dielectric material and the change in dimensions from the original measurements shall be .062 inch maximum for the center conductor and .125 inch maximum for the dielectric material (see 4.8.15).

3.6 Identification of product. Unless otherwise specified (see 3.1), the marking shall contain:

a. The military part number (see 1.2.1).
b. The manufacturer's code designation in accordance with publications H4-1 and H4-2.
c. Date of manufacture, lettering shall be Futura or Gothic capitals and numerals Arabic. Marking shall be on the outermost insulation (or cable) surface and shall be at intervals of every meter, as measured from the beginning of one complete marking to the beginning of the succeeding complete marking. Marking of the unjacketed cable shall be specified by the procuring activity (see 6.2).

3.7 Workmanship. Cables shall be processed in such a manner as to be uniform in quality, and shall be free from any burrs, die marks, chatter marks, foreign material, or other defects that will affect life, serviceability, or appearance.

3.8 Continuous lengths (see 4.8.16). Unless otherwise specified by the contracting officer in the contract or order, the footage of the individual continuous lengths in each spool or reel shall be marked on the spool or reel in the sequence in which the lengths will be unwound by the user. Continuous lengths of cable in the inspection lot shall conform to TABLE I.

TABLE I. Continuous lengths.

Minimum footage	Minimum percentage
100 feet	50 percent
75 feet	80 percent
50 feet	100 percent

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-C-45662.

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

Materials inspections (see 4.3).
Qualification inspection (see 4.6).
Quality conformance inspections (see 4.7).

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

TABLE II. Materials inspection.

Material	Requirement paragraph	Applicable specification
Copper-clad aluminum wire	3.3.2	ASTM B566
Phosphor reduced copper	3.3.3	QQ-C-576
Polyethylene, foam	3.3.4	L-P-390 or vendor blends with dissipation factor less than .0003
Polyethylene	3.3.5	L-P-390
Polyether urethane	3.3.6	MIL-P-47082

4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in Section 6 of FED-STD-228.

4.5 Inspection terms and definitions. Inspection terms and definitions shall conform to MIL-STD-109 with the following additions.

4.5.1 Specimen. A specimen is an individual piece of cable taken from a sample unit.

4.5.2 Sample unit. The sample unit shall be as specified.

4.5.3 Defective unit. A defective unit shall be a sample unit which failed to meet the requirements of the specification.

4.6 Qualification inspection. Qualification 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 and shall consist of the tests shown in TABLE III.

TABLE III. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph
Leak test (type 1 only)	3.5.5	4.8.6
Attenuation	3.5.6	4.8.7
VSWR	3.5.10	4.8.11
Impedance	3.5.9	4.8.10
Velocity of propagation 1/	3.5.7	4.8.8
Capacitance 1/	3.5.8	4.8.9
Cold bend	3.5.11	4.8.12
Cable flexture	3.5.12	4.8.13
Temperature cycling	3.5.13	4.8.14
Thermal shock	3.5.14	4.8.15

1/ When applicable.

4.6.1 Sample size. Five hundred (500) feet of cable of the type and size to be qualified shall be subjected to qualification inspection.

4.6.2 Failures. One or more failures shall be cause for refusal to grant qualification approval.

4.6.3 Retention of qualification. To retain qualification, the supplier shall forward a report at 12 month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

a. An annual summary of the results of the tests performed for inspection of product for delivery, groups A and B, indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all re-worked lots shall be identified and accounted for.
b. The results of tests performed for qualification verification inspection, group C, including the number and mode of failures. The report shall include results of all qualification verification inspection tests performed and completed during the 12 month period. If the test results indicate nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 60 days after the end of the 12 month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 12 month period that the inspection data indicates failure of the qualified product to meet the requirements of this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during 2 consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit group C test results covering a representative product from each group, as defined by 4.6.

4.7 Quality conformance inspection.

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

4.7.1.1 Inspection lot. An inspection lot shall consist of all cable covered by a single specification sheet produced under essentially the same conditions, and offered for inspection at one time.

4.7.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in TABLE IV, in the order shown.

TABLE IV. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	Sample Size
Subgroup 1			
Visual and mechanical	3.1,3.3,3.4, 3.6,3.7	4.8.1	See 4.7.1.2.1
Subgroup 2			
Continuity	3.5.1	4.8.2	100% of reels
Dielectric withstanding voltage	3.5.2	4.8.3	shall be inspected
Spark test	3.5.3	4.8.4	
Insulation resistance	3.5.4	4.8.5	
Leak test (type 1 only)	3.5.5	4.8.6	

4.7.1.2.1 Sampling plan. Statistical sampling and inspection for subgroup 1 shall be in accordance with TABLE V, except that the number of sample units shall be not more than two times the number of reels in the inspection lot. No more than two sample units shall be selected from each reel of cable. When two sample units are required from one reel, they shall be cut from each end of the reel. For subgroup 2, each reel in the inspection lot shall be tested.

4.7.1.2.2 Sample unit. For subgroup 1, a sample unit is a piece of cable three feet in length and cut from the reel of cable. For subgroup 2, the complete length of cable on each reel shall be tested.

TABLE V. Sampling plan for Group A and C inspection.

Inspection lot size cable length (feet)	Sample units		Group A accept number	Group A reject number
	Group A	Group C		
0 to 5,000	1	1	0	1
5,001 to 15,000	5	1	0	1
15,001 to 25,000	8	1	0	1
25,001 to 65,000	13	2	1	2
65,001 to 160,000	20	3	1	2
160,001 to 440,000	32	4	2	3
440,001 to 2,200,000	50	5	3	4
2,200,001 and over	80	8	5	6

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

4.7.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in TABLE VI in the order shown, and the sample shall be selected from inspection lots that have passed Group A inspection.

TABLE VI. Group B inspection.

Inspection	Requirement paragraph	Test Method Paragraph
Attenuation	3.5.6	4.8.7
VSWR	3.5.10	4.8.11

4.7.1.3.1 Sampling plan. The sampling plan shall be in accordance with TABLE VII.

TABLE VII. Sampling plan for group B inspection.

Inspection lot size cable length (feet)	Sample units	Accept number	Reject number
0 to 5,000	1	0	1
5,001 to 15,000	1	0	1
15,001 to 25,000	2	0	1
25,001 to 65,000	2	0	1
65,001 to 160,000	3	0	1
160,001 to 440,000	5	0	1
440,001 to 2,200,000	8	1	2
2,200,001 and over	8	1	2

4.7.1.3.2 Sample unit. A sample unit is a piece of cable cut from the reel of cable and of the length specified for the applicable test method.

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

4.7.1.3.4 Disposition of sample units. Sample units which have passed all the group B inspections may be delivered on the contract, if the lot is accepted and the sample units are still within specified electrical tolerances. Reworking of defective samples is not allowed.

4.7.2 Periodic inspection. Periodic inspection shall consist of group C and shall be made after 36 months of qualifying initially and every 36 months thereafter. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.7.2.1.4), delivery of products which have passed group(s) A and B shall not be delayed pending the results of these periodic inspections.

4.7.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in TABLE VIII in the order shown. Group C inspection shall be made on sample units selected from inspection lots which have passed the groups A and B inspection.

4.7.2.1.1 Sample size. Five hundred feet of cable of the type and size specified (see 3.1) shall be subject to group C inspection.

4.7.2.1.2 Failures. One or more failures shall be cause for rejection of entire sample.

TABLE VIII. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph
Velocity of propagation 1/	3.5.7	4.8.8
Capacity 1/	3.5.8	4.8.9
Impedance	3.5.9	4.8.10
Cold bend	3.5.11	4.8.12
Flexibility	3.5.12	4.8.13
Temperature cycling	3.5.13	4.8.14
Thermal shock	3.5.14	4.8.15

1/ When applicable.

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

4.7.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and 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 and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the qualifying activity). Groups A and B inspection may be reinstituted; however, final acceptance and shipment shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7.3 Inspection of packaging. The sampling and inspection of the preservation-packaging and interior package marking shall be in accordance with the group A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129.

4.8 Methods of inspection.

4.8.1 Visual and mechanical examination. The cable shall be examined to verify that the design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (3.1, 3.3, 3.4, 3.6, 3.7). A micrometer caliper or an instrument of equal accuracy shall be used to determine the proper dimensions.

4.8.2 Continuity. A direct current (DC) potential of 6 volts maximum shall be applied, through an appropriate indicator, to the inner and outer conductors of the reel of cable. The voltage may be applied to the conductors individually or in series (see 3.5.1).

4.8.3 Dielectric withstanding voltage. The cable shall be tested in accordance with method 6111 of FED-STD-228 (100 percent of cable to be tested) with the following exceptions (see 3.5.2):

a. The cable shall not be immersed in water.
b. Direct current voltage is acceptable.
c. The test shall be performed on finished cable only.
d. The high potential shall be applied to the inner conductor and the outer conductor shall be grounded.
e. Test voltage shall be applied for 1 minute.

4.8.4 Spark test (jacketed cable only). Jacketed cables shall be tested in accordance with method 6211 of FED-STD-228 (100 percent of cable to be tested). The following details shall apply (see 3.5.3):

a. The test voltage shall be a 60 hertz (Hz) root-means-square (rms) voltage as indicated in TABLE IX, unless otherwise specified (see 3.1).
b. The potential shall be applied between the outer conductor and the outer surface of the jacket.

TABLE IX. Voltage for spark test.

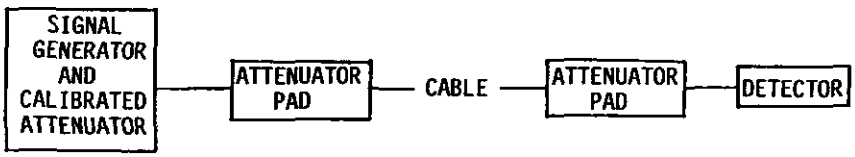
Jacket thickness (min) (in)	Voltage (rms)
0.035	7,000
0.060	9,000
0.065	10,000

4.8.5 Insulation resistance. The cable shall be tested in accordance with method 6031 of FED-STD-228 except that the cable shall not be immersed in water. The following details shall apply (see 3.5.4):

a. The test shall be performed on each length of complete cable.
b. The test voltage shall be not less than 200 volts.
c. The potential shall be applied to the inner conductor with the outer conductor grounded.

4.8.6 Leak test (type 1). The capacitance of a 7 foot specimen shall be measured and then be placed in a pressure tank filled with water so that at least 5 feet of the cable is immersed and both ends are exposed to air. The water shall then be pressurized to 25 pound per square inch gage (PSIG) for at least eight hours. The cable should then be removed and within one hour, capacitance shall be rechecked. The capacitance measuring system shall be accurate to within ±1 percent (see 3.5.5).

4.8.7 Attenuation (see 3.5.6). The attenuation, expressed in dB per 100 feet, shall be measured at a sufficiently low-power level that the resulting temperature rise will be negligible. An acceptable method for measuring attenuation is as follows:



In the block diagram, a suitable length of cable with an attenuation greater than the measuring accuracy of the equipment is inserted between the connectors. The signal generator and calibrated attenuator are adjusted to produce a reasonable indication at the detector, when the detector is tuned. The detector reading is noted, and the calibrated attenuator output level is recorded. The cable under test is then withdrawn and the circuit completed with the connectors (or a very short length of cable). With the detector tuned, the calibrated attenuator is readjusted to reproduce the original reading at the detector and the attenuator output level is again recorded. Attenuation is then computed as follows:

$$A = \frac{100}{L} \text{ (Difference in calibrated attenuator reading in dB)}$$

Where:

A = attenuation in dB per 100 feet.
L = length of cable under test in feet.

For measurement at frequencies of 400 megahertz (MHz), or less, the characteristic impedance of the attenuator pads and connectors shall preferably be the same as that of the cable under test. For measurement at frequencies of 1,000 MHz or above, the attenuator pads, connectors, and test cable shall be matched to the same characteristic impedance. Both pads shall be high enough in attenuation value to minimize the error caused by any mismatch of the signal generator and detector. For the majority of measurements, it is recommended that the attenuation of each pad be approximately 10 dB. Tuning stubs may be used in the circuit for impedance matching

purposes. Any other method approved by the procuring activity may be used in lieu of that described herein. When the attenuation of the cable under test is less than 1 dB at the test frequency, the attenuation may be measured by the short circuit method. An alternate method may be used upon approval by the Government.

4.8.8 Velocity of propagation. The velocity of propagation is determined in terms of the percentage of velocity of wave propagation along the cable to the velocity of an electromagnetic wave in free space. The velocity of propagation in the cable shall be found by resonating a length of cable at a frequency between 10 MHz and 200 MHz with one end short-circuited or open-circuited or by equivalent method subject to the approval of the procuring activity. The same sample may be used for velocity and capacitance measurements(see 3.5.7) (as applicable see 3.1).

$$\text{Percent velocity} = \frac{fr \times \text{length (ft)}}{2.46\ N}$$

Where:

fr = resonant frequency in MHz.
N = number of quarter wavelengths in the cable.

4.8.9 Capacitance. The capacitance of the cable shall be measured to three significant figures, at any one frequency between 1 kilohertz (kHz) and 1 MHz reported in picofarads (pF) per foot. An electrically short piece, that is less than 1/40 of a wavelength of cable, shall be used for this test (see 3.5.8) (as applicable see 3.1).

4.8.10 Impedance (see 3.5.9).

4.8.10.1 Specimen. The specimen shall be 10 feet minimum or 2 dB maximum at 3 GHz whichever is the shorter.

4.8.10.2 Procedure. The specimen shall be prepared for testing by assembling appropriate connections to the cable ends. The equipment shall include a Time Domain Reflectometer (TDR). The rise time of the TDR shall be 150 picoseconds or less, and the vertical sensitivity of the system shall provide for a minimum resolution of one-half ohms per centimeter (cm). A precision 30 cm air-line of the same nominal characteristic impedance as the specimen shall be connected between the TDR and the connector-cable assembly. The characteristic impedance of the specimen shall then be measured compared to the precision air-line. The connector-cable assembly shall then be turned end-to-end and the measurement repeated. For cables of other than 50 and 75 ohms characteristic impedance, where precision air-lines, loads, or proper impedance measuring equipment are not available, the characteristic impedance may be determined by calculation from the capacitance measurement determined (see 4.8.11) and the velocity of propagation measurement determined, using the following formula:

$$Z_o = \frac{101{,}670}{\text{Velocity of propagation (\%)} \times \text{Capacitance (pF/ft)}}$$

4.8.11 VSWR test. The VSWR of a suitable length of cable shall be measured over a frequency range as specified (see 3.1). A swept frequency technique capable of measuring a VSWR of 1.06 or less shall be used. The measuring system may be in the form of directional couplers, a hybrid, or a slotted line and shall have a directivity of at least 30 dB at the highest frequency of measurements (see 3.5.10).

4.8.12 Cold bend (jacketed cables only). A section of finished cable, whose length shall be sufficient to make one revolution around a mandrel with a diameter as specified (in the case of 1-5/8 inches diameter cable, it shall be one-half revolution) (see 3.1), shall be placed in a chamber and subjected to a temperature of $-30 \pm 2^{\circ}C$ for at least 48 hours. After this period, the cable shall be removed, and within 30 seconds subjected to a 180° bend around the mandrel specified (see 3.5.11).

4.8.13 Flexibility. The length of cable to be flexed shall be sufficient to provide three complete coils around the mandrel with a diameter as specified (see 3.1). One end of the cable shall be clamped circumferentially to the mandrel at any two points, approximately 45 degrees apart. The specimen shall then be coiled and uncoiled (the mandrel shall be rotated a minimum of 720 degrees) 20 times at a rate of between 1 and 5 revolutions per minute (rpm).

Although no special tools shall be used during the bending of the cable, a mechanism may be provided to guide the cable on the mandrel. After the twentieth cycle, the sample shall be tested as specified in 4.8.6 and 4.8.11. VSWR may be measured on the sample while coiled (see 3.5.12).

4.8.14 Temperature cycling. A length of cable with connectors properly attached shall be coiled on a mandrel with a diameter as specified (see 3.1). The cable shall be sufficiently long to make one complete revolution (360^{o}) around the mandrel (in the case of 1-5/8 inches diameter cable it shall be one-half revolution (180^{o}). The mandrel, with cable attached, shall be placed in a chamber and subjected to the temperature cycling specified in TABLE X. After the cycling has been completed, the cable shall be tested as specified in 4.8.9 (see 3.5.8) and 4.8.11 (see 3.5.13).

TABLE X Temperature cycling.

Step	Temperature (^{o}C)	Time (hours)	No. of Cycles
1	80	48 minimum	10
2	25	48 minimum	10

4.8.15 Thermal shock. A piece of cable, length to be as specified, shall be prepared by exposing one inch of center conductor and one inch of dielectric (see FIGURE 1).

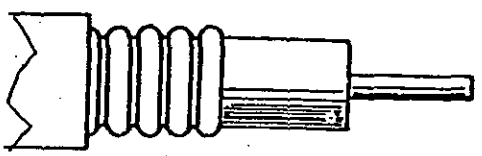


FIGURE 1. End view of test cable.

Removal of each layer shall be accomplished by an even cut perpendicular to the longitudinal axis of the cable; a razor blade, or equivalent, shall be used to cut the insulation. The specimen shall be formed into a loose coil with the largest convenient radius, and shall be laid on a screen for handling throughout the test. The length of exposed conductors and dielectric at each end of the specimen shall be measured to the nearest .031 inch.

The screen (with cable) shall be placed for a minimum of 4 hours in a preheated, aircirculating oven at the temperature of $80^{\circ} \pm 2^{\circ}C$. It shall then be removed from the oven and within 2 minutes be placed into a chamber maintained at $-55^{\circ} \pm 2^{\circ}C$. The specimen shall remain there for a minimum of 4 hours. It shall then be removed from the chamber and allowed to warm to room temperature. At the conclusion of this cycle, the length of the dielectric and of the inner conductor at each end of the cable shall be measured to the nearest 1/32 inch. This thermal shock and the measurements shall be repeated for an additional three cycles (a total of four cycles). Cables shall be examined for changes in length of their various exposed areas at both ends (see 3.5.14).

4.8.16 Continuous lengths. Unless otherwise specified by the contracting officer in the ordering data, the inspection requirements for continuous cable lengths shall be satisfied by the contractors certificate of conformity and the presence of the required piece length markings on the spools or reels (3.8). However, the Government reserves the right to examine such certified lots if deemed necessary to assure that the length actually conforms to the requirements. When the ordering data specifies examination of cable lengths, the Government representative shall examine the cable at his own discretion to determine conformity in this characteristic. In measuring continuous cable lengths where marking or stripping of jacket has been used in lieu of cutting the cable to identify dielectric test failures or areas not properly tested, such marking or stripping shall be considered equivalent to severance of the cable at the two ends of each marked or stripped area.

5. PACKAGING.

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-12000.

6. NOTES

6.1 Intended use. Cables covered by this specification are intended for use in radio frequency applications.

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 specification sheet, and the complete part number.
c. Levels of preservation, packaging, packing and applicable marking.
d. Total footage of cable.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualification Products List whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Naval Electronic Systems Command.

Preparing activity:
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