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18 January 1977
SUPERSEDING
MIL-C-28781A(EC)
9 January 1976

MILITARY SPECIFICATION

CABLE, ELECTRICAL, SPECIAL PURPOSE SHORE USE

This specification is approved for use by Naval Electronic 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 specification describes twisted pair multiconductor shielded cables for use within shore communication stations and facilities.

1.2 Classification. Cables shall be of the following number of pairs as specified in the invitation for bids, or order (see 6.2):

1 pair
3 pairs
6 pairs
16 pairs
26 pairs
52 pairs
104 pairs

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

MIL-C-12000	Cable, Cord, and Wire, Electric Packaging of
MIL-W-16878	Wire, Electrical, Insulated, High Temperature
MIL-W-16878/1	Wire, Electrical, Type B, 105°C., 600 Volts (Insulated, High Temperature)

STANDARDS

FEDERAL

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

MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection
MIL-STD-129	Marking for Shipment and Storage

(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 shall apply.

American Society for Testing and Materials

ASTM B33-63	Tinned Soft or Annealed Copper Wire for Electrical Purposes.
ASTM D470-64T	Testing Rubber and Thermoplastic Insulated Wire and Cable.
ASTN D2240-64T	Methods of Testing for Indentation Hardness of Rubber and Plastics by means of a Durometer.

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

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, D.C. 20360 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

Insulated Power Cable Engineering Association

S61-402 Insulation Striping

(Application for copies should be addressed to Insulation Power Cable Engineering Association, 192 Washington Street, Belmont, Massachusetts, 02178).

Munsell Color Charts for Plastic Cable and Wire

(Application for copies should be addressed to the Munsell Color Company, Inc., 2441 N. Calvert Street, Baltimore, Maryland 21218).

3. REQUIREMENTS

3.1 First article sample. Prior to beginning production, a sample shall be tested as specified in 4.3 (see 6.2).

3.2 Material.

3.2.1 Conductors. The conductors shall be number 24 American Wire Gage (AWG) (nominal diameter 0.510540 millimeters (0.0201 inches)) tinned solid copper wire in accordance with ASTM B33.

3.2.1.1 Joining conductors. Joints made in conductors may be brazed using a silver alloy solder and a non-acid flux, or welded. Joints shall be butted and shall be free from lumps and sharp projections. The tensile strength of any section of a conductor joint which was brazed or welded, shall be not less than 85 percent of the tensile strength of an adjacent section without a joint.

3.2.1.2 Conductor resistance. The direct current (DC) resistance of each conductor shall not exceed 30 ohms per 304.8 meters (1,000 foot) length when measured at or corrected at 68° Fahrenheit (F).

3.2.2 Insulation material. The insulation material shall be 0.254 ±0.05080 millimeters (0.010 ± 0.002 inches) thick polyvinylchloride in accordance with Type B wire of MIL-W-16878/1. A jacket of polyamide material 0.5080 ± 0.0254 millimeters (0.002 ± 0.001 inches) thick shall be put over the insulation. The outside diameter of the conductor, including insulation and polyamide material, is to be not greater than 1.27508 millimeters (0.0502 inches) to permit application of commercially available cable connector devices. The water tank test of MIL-W-16878 is not required. Heat resistance test and solder test shall be performed on the finished insulated conductor.

3.2.2.1 Insulation defects. The insulation shall be smooth and free from holes, splits, blisters and other imperfections.

3.2.2.2 Cold bend. The finished conductor insulation shall show no evidence of cracking or fracturing when tested in accordance with 4.5.4

3.2.2.3 Color coding of insulation. The color coding shall be as shown in TABLE I to identify each pair in the completed cable.

3.2.2.4 Color standards. The colored insulation shall match the centroid colors of TABLE II, within the limits of standards for colors as defined in Munsell Color Charts for Plastic Cable and Wire. The color pigments shall be chosen to yield uniform dielectric constant between colors and shall have no injurious effects on the insulation.

3.2.2.4.1 Insulation striping. Striping shall be such as to provide readily discernible stripes on the conductor insulation. These stripes may be integral of the insulation or the striping may be provided as in internal plastic coating. Striping shall firmly adhere to the insulation and remain intact through the life of the conductor insulation. Insulation striping in accordance with Method 1 of IPCEA Specification No. S61-402 is acceptable.

3.2.2.5 Twisting of pairs. The insulated conductors shall be twisted into pairs. In order to provide sufficiently high crosstalk losses at voice and carrier frequencies, the pair twists shall be designed to enable the cable to conform to the pair-to-pair capacitance unbalance requirements of 4.5.3 and the crosstalk requirements of 3.2.2.5.1. The average length of pair twists in any pair in the finished cable, when measured on any 3.05 meters (10-foot) length, shall not exceed 152.4 millimeters (six inches).

TABLE I. Color coding.

Pair number	Color	Pair number	Color
1	Blue and white (or natural)	27	Orange-white (stripe) and white (or natural)
2	Orange and white (or natural)	28	Green-white (stripe) and white (or natural)
3	Green and white (or natural)	29	Brown-white (stripe) and white (or natural)
4	Brown and white (or natural)	30	Slate-white (stripe) and white (or natural)
5	Slate and white (or natural)	31	Blue-white (stripe) and red
6	Blue and red	32	Orange-white (stripe) and red
7	Orange and red	33	Green-white (stripe) and red
8	Green and red	34	Brown-white (stripe) and red
9	Brown and red	35	Slate-white (stripe) and red
10	Slate and red	36	Blue-white (stripe) and black
11	Blue and black	37	Orange-white (stripe) and black
12	Orange and black	38	Green-white (stripe) and black
13	Green and black	39	Brown-white (stripe) and black
14	Brown and black	40	Slate-white (stripe) and black
15	Slate and black	41	Blue-white (stripe) and yellow
16	Blue and yellow	42	Orange-white (stripe) and yellow
17	Orange and yellow	43	Green-white (stripe) and yellow
18	Green and yellow	44	Brown-white (stripe) and yellow
19	Brown and yellow	45	Slate-white (stripe) and yellow
20	Slate and yellow	46 1/	Blue-white (stripe) and violet
21	Blue and violet	47	Orange-white (stripe) and violet
22	Orange and violet	48	Green-white (stripe) and violet
23	Green and violet	49	Brown-white (stripe) and violet
24	Brown and violet	50	Slate-white (stripe) and violet
25	Slate and violet	51	Red and white (or natural)
26	Blue-white (stripe) and white (or natural)	Spare 1/ (For 52 or 104 pair)	Red and black

1/ At the manufacturer's option, pair number 46 and the Spare pair may be used to assure the required number of (non-defective) pairs.

TABLE II. Munsell centroid colors.

COLOR	CENTROID	TOLERANCE LIMITS					
		HUE		VALUE		CHROMA	
		H-	H+	V-	V+	C-	C+
Red	2.5R 4/12	1.25R 4/12	3.75R 4/12	2.5R 3/12	2.5R 4.5/12	2.5R 4/10	None
Orange	2.5YR 6/14	1.25R 6/14	3.75YR 6/14	2.5YR 5/14	2.5YR 6.5/14	2.5YR 6/12	None
Brown	2.5YR 3.5/6	10R 3.5/6	5YR 3.5/6	2.5YR 3/6	2.5YR 4/6	2.5YR 3.5/4	2.5YR 3.5/7
Yellow	5Y 8.5/12	2.5Y 8.5/12	7.5Y 8.5/12	5Y 8/12	None	5Y 8.5/10	None
Green	2.5G 5/12	1.25 G5/12	3.75G 5/12	2.5G 4/10	2.5G 5.5/12	2.5G 5/9	None
Blue	2.5PB 4/10	10B 4/10	5PB 4/10	2.5PB 3.5/10	2.5PB 4.5/10	2.5PB 4/9	None
Violet	2.5P 4/10	1.25P 4/10	3.75P 4/10	2.5P 3/10	2.5P 4.5/10	2.5P 4/8	None
White	N 9/	Value Tolerances: V- is N 8.75 no V+ limit. Chromaticity Tolerances: 5R 9/1 5G 9/0.5 5YR 9/1 5B 9/0.5 5Y 9/1 5P 9/0.5					
Slate	N 5/	Value Tolerances: V- is N 4.5/; V+ is N 5.5/ Chromaticity Tolerances: 5R 5/0.5 5B 5/0.5 5Y 5/0.5 5P 5/0.5 5G 5/0.5					
Black	N 2/	Value Tolerances: No V- limit; V+ is N 2.3 Chromaticity Tolerances: 5R 2/0.5 5B 2/0.5 5Y 2/0.5 5P 2/0.5 5G 2/0.5					

3.2.2.5.1 Crosstalk loss. The root mean square (rms) output-to-output far-end crosstalk loss, as measured on the completed cable at a test frequency of 150 kiloHertz (kHz), shall not be less than 70 dB per 304.8 meters (1,000 feet). The rms calculation shall be based on the combined total of all adjacent and alternate pair combinations within the same layer and center-to-first layer pair combinations. The rms crosstalk loss and dB is the number of dB corresponding to the rms crosstalk voltage ratio. If the crosstalk loss is K_o dB at a frequency f_o for a length L_o, it can be determined for any other length or frequency by:

$$K_{f/L} \text{ loss} = K_o - 20 \log_{10} f/f_o - 10 \log_{10} L/L_o$$

3.2.3 Cable forming. The twisted pairs shall be assembled to form a substantially cylindrical core. Adjacent layers may be stranded in the same direction or in opposite directions. For 104-pair cable, the cable shall be formed in two 52-pair concentric units or four 26-pair units.

3.2.3.1 Binder A colored binder shall be applied around the units for separation. The colors shall be readily recognizable. Bindings shall be applied with a lay of not more than four inches. The binder may be either a nonhygroscopic thread or tape.

3.2.3.2 Binder colors. The colors for each unit binder shall be as follows:

Unit	Color of Binding
1	Blue-White
2	Orange-White
3	Green-White
4	Brown-White
5	Slate-White

3.2.4 Core covering. The core covering shall be completely covered with mylar, polyethylene, or mylar-backed SBR or equivalent, which shall be non-hygroscopic and shall be applied with an overlap. The core covering shall provide a sufficient heat barrier to prevent visible evidence of conductor insulation deformation or adhesion between conductors caused by adverse heat transfer during the jacketing operation.

3.2.4.1 Dielectric. In each length of completed cable, the insulation between conductors and between conductors and shield shall withstand the dielectric DC potential for three seconds as follows:

	DC volts
Between conductors	3,600
Between conductors and shield	1,800

3.2.5 Shield. An overall tinned copper braid shield shall be applied over the core covering. The shield shall cover 90 percent of the cable core.

3.2.5.1 Shield resistance. The DC resistance of the shield for a 304.8 meters (1,000 foot) length of completed cable shall not exceed the values shown below:

No. of pairs	DC resistance of shield 304.8 meters (1000 foot)
1	5.75 ohms
3	4.00 ohms
6	3.50 ohms
26	2.10 ohms

3.2.6 Jacket material. The jacket material shall be polyvinylchloride, colored black, which shall conform to the physical (finished cable) requirements outlined in 3.2.6.1 and 3.2.6.2. The cable jacket shall have a hardness of 80 ±5 as determined on a shore durometer, Type A, test specified in ASTM D2240-64T. The jacketing material shall contain a minimum of one percent of carbon black or similar material to resist ultraviolet light.

3.2.6.1 Tensile strength. The cable jacket shall have a minimum tensile strength of 2000 pounds per square inch (PSI) when tested in accordance with FED-STD-228, Method 3021, or ASTM D470-64T.

3.2.6.2 Elongation. The cable jacket shall have a minimum elongation of 250 percent when tested in accordance with FED-STD-228, Method 3031, or ASTM D470-64T.

3.2.6.3 Jacket thickness and outside cable diameters. The jacket thickness and outside cable diameter shall be as specified in TABLE III. The minimum spot thickness of the jacket shall not be less than 70 percent of the specified thickness. The average thickness at any cross-section of the jacket material shall be not less than 90 percent of the specified thickness.

TABLE III. Jacket thickness and outside diameters (OD).

No. of pairs	Nominal jacket thickness (millimeters)	(inches)	Approx. OD (millimeters)	(inches)
1	1.270	(0.05)	5.765	.227
3	1.270	(0.05)	8.001	.315
6	1.270	(0.05)	9.855	.388
16	1.5748	(0.062)	12.852	.506
26	1.5748	(0.062)	15.621	.615
52	1.5748	(0.062)	19.837	.781
104	1.778	(0.07)	28.900	1.137

3.2.6.4 Cold bend. A sample of the finished cable shall show no evidence of cracking or fracturing when tested in accordance with 4.5.4.

3.2.7 Cable marking. A tape shall be permanently marked and inserted between the jacket and shield, and the footage marked every 30.48 centimeters (12 inches). The tape shall be marked at least every 60.96 centimeters (24 inches) with the following:

(a) Manufacturer's name (or symbol designation).
(b) Date of manufacture.
(c) Contract number.
(d) Specification number.

3.3 Electrical requirements.

3.3.1 Mutual Capacitance. The average mutual capacitance of all pairs in a completed reel of cable of 3 or more pairs shall not exceed 0.152 microfarad (MF) per 1.609 kilometer (mile) and shall not exceed 0.160 MF per 1.609 kilometer (mile) for cables of less than 3 pairs. The mutual capacitance test shall be performed in accordance with 4.5.2. Note: The objective is the lowest practical average mutual capacitance with all individual pair mutual capacitances as close as practical to the average value for the reel.

3.3.2 Capacitance unbalance. The pair-to-pair and pair-to-shield unbalance tests shall be performed on the completed cable in accordance with 4.5.3 and 4.5.3.1.

3.3.3 Continuity. In each length of cable, the conductors shall be free from grounds (contacts between a conductor and shield) short circuits and open circuits. The shielding shall be free from open circuits.

3.3.4 Workmanship. Workmanship shall be such as to enable the cable to conform to all applicable requirements of this specification, when inspected in accordance with Section 4.

3.4 Cable put-up. Cable shall be put-up on reels in lengths-per-reel as specified in the solicitation or order.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 Government verification. All quality assurance operations performed by the supplier will be subject to Government verification at any time. Verification will consist of (a) surveillance of the operations to determine that practice, methods, and procedures of the written system are being properly applied (b) Government product inspection to measure quality of product to be offered for acceptance, and (c) Government inspection of delivered items to assure compliance with this specification and as specified in the contract or order (not excluding any requirement of the specification for which detailed tests are not specified herein).

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

(a) First article (see 4.3)
(b) Quality conformance inspection (see 4.4)
(c) Inspection of preparation for delivery (see 4.6)

4.3 First article inspection. First article samples shall be fabricated by the manufacturer with tools and methods that, as far as practicable, are the same as those which will be used for quantity production of the product. The manufacturer of the cable for a government contract, prior to approval of the first article sample, shall be at the manufacturer's risk. First article inspection shall be performed on 152.4 meters (500 foot) of cable of the number of pairs specified in the Invitation for Bids (IFB). Certification of compliance for the basic material may be obtained from the supplier of the material providing that such certification contains actual test, examination or other verifiable quality data (see 6.3).

4.3.1 The first article samples shall be subjected to the tests listed in TABLE IV. No failure will be permitted.

TABLE IV. First article inspection.

Examination and test	Requirement paragraph	Test method paragraph
Visual and dimensional	3.2.1, 3.2.1.1, 3.2.2, 3.2.2.1, 3.2.2.3, 3.2.2.4, 3.2.2.4.1, 3.2.2.5, 3.2.3, 3.2.3.1, 3.2.4, 3.2.5, 3.2.6, 3.2.6.3, 3.2.7, 3.3.4, 3.2.3.2	4.5.1
Continuity	3.3.3	4.4.2.2
Conductor resistance	3.2.1.2	4.5.7
Mutual capacitance	3.3.1	4.5.2
Capacitance unbalance	3.3.2	4.5.3
Insulation:		
Material	3.2.2 (Type B wire of MIL-W-16878/1)	4.4.2.2
Defects	3.2.2.1	4.5.1
Cold bend	3.2.2.2	4.5.4
Tensile and elongation	3.2.2 (MIL-W-16878/1)	4.5.5
Striping (if applicable)	3.2.2.4.1	4.5.1
Color coding	3.2.2.4.3	4.5.1
Color standards	3.2.2.4	4.5.1
Forming of pairs	3.2.2.5	4.5.3
Binder thread or tapes	3.2.3.1, 3.2.3.2	4.4.2.3
Core covering	3.2.4	4.5.1
Crosstalk	3.2.2.5.1	4.4.3.1
Shield:		
Resistance	3.2.5.1	4.5.7
Jacket:		
Cold bend	3.2.6.4	4.5.4
Tensile strength	3.2.6.1	4.5.5
Elongation	3.2.6.2	4.5.5
Dielectric	3.2.4.1	4.5.6

4.4 Quality conformance inspection.

4.4.1 Sampling.

4.4.1.1 Inspection lot. Cable of the same size (number of pairs) and color coding, offered for delivery at one time, shall be considered a lot for purposes of sampling and inspection.

4.4.2 Group A inspection. The Group A inspection shall consist of the tests shown in TABLE V.

4.4.2.1 Sampling for visual and dimensional examination. Each reel shipping length shall be examined to verify conformance to 4.5.1, and the requirements in TABLE V. The number of pairs to be examined shall be as follows:

Pairs in the cable	Pairs to be examined
1	1
3	2
6	3
16	5
26	8
52	13
104	20

Any defect in a sample of 1 through 5 shall cause rejection of the shipping length. One defect is allowed in samples of 8 through 13 pairs; two or more defects cause rejection. In the event that defect or error is found at any inspected end, the other end of that length shall be examined for the same defect. The reel which contains the adjacent section of cable shall also be examined for the same defect.

4.4.2.2 Sampling for insulation and continuity tests. In each shipping length of cable, tests shall be performed on the number of pairs specified in 4.4.2.1. Each of the selected pairs shall be subjected to all of the tests necessary to verify conformance to 3.2.2, 3.2.2.1 and 3.3.3, respectively. If any pair fails in any test, the entire length of cable shall not be offered for delivery. The same pair on the adjacent reels shall be subjected to the same test in which failure occurred.

4.4.2.3 Sampling for measurement of colors. In each shipping length of cable, pairs shall be selected at random for verification of the color in accordance with 3.2.2.3 by comparison with Munsell color cards. The number of pairs so examined shall be the same as specified in 4.4.2.1. If any pair is found not having color as specified, every pair in that cable length shall be compared with the Munsell color card. Also, the reels of cable preceding and following shall be examined to determine the extent of the incorrect coloring. If the colored insulation does not conform to the requirements of 3.2.2.3, the lot shall not be offered for delivery.

4.4.3 Group B inspection. The Group B inspection shall consist of tests shown in TABLE VI.

4.4.3.1 Sampling for Group B tests. The sample size (number of reels) of each lot of prepared cable to be tested under Group B tests listed in TABLE VI shall be in accordance with MIL-STD-105, at the inspection and acceptance quality levels stated below for the cable construction (number of pairs) involved:

Number of pairs in assembled cable	Number of reels to be tested per TABLE VI (all pairs each sample reel are to be tested) to be in accordance with inspection level shown:	Acceptance quality level, based on the total number of tests to be made per sample reel as the sample size for each test in TABLE V.
1	II	2.5 (Sample size
3	II	2.5 for shield
6	II	4.0 resistance
16	II	4.0 to be based on
26	S-4	4.0 the number of
52	S-3	4.0 reels to be tested)
104	S-3	4.0

If test failures in any sample reel exceed the acceptance quality level (AQL) indicated for any type test listed in TABLE VI of this specification, shall be cause for rejection of the entire lot of the cable size represented by the sample reel under test on the basis of the parameter being tested (mutual capacitance, capacitance unbalance, conductor resistance, or crosstalk, as the case may be).

4.4.4 Rejected lots. If an inspection lot is rejected, the supplier may replace it with a new lot, rework it to correct the defects, or screen out the defective units, and reinspect the lot. Such lots shall be inspected using tightened inspection, as specified in either the Double Sampling Plan or the Multiple Sample Plan paragraph of MIL-STD-105, as necessary to meet the AQL stated above. Reinspected lots shall be kept separate from new lots and shall be clearly identified as reinspected lots.

TABLE V. Group A inspection.

Examination and tests	Requirement paragraph	Test method paragraph
Visual and dimensional	3.2.1, 3.2.1.1, 3.2.2.1, 3.2.2.3, 3.2.2.5, 3.2.3, 3.2.3.1 3.2.4, 3.2.5, 3.2.3.2	4.5.1
Continuity	3.3.3	4.4.2.2
Jacket thickness and OD	3.2.6.3	4.5.1
Insulation defects	3.2.2.1	4.5.1
Insulation striping	3.2.2.4.1	4.5.1
Insulation colors:		
Pre-mixed (mixed in plant)	3.2.2.4	
Mixed (mixed by material manufacturer)	3.2.2.4	
Dielectric	3.2.4.1	4.5.6

TABLE VI. Group B inspection.

Examination and tests	Requirement paragraph	Test method paragraph
Mutual capacitance	3.3.1	4.5.2
Capacitance unbalance	3.3.2	4.5.3, 4.5.3.1
Conductor resistance	3.2.1.2	4.5.7
Shield resistance	3.2.5.1	4.5.7
Crosstalk	3.2.2.5.1	

4.5 Test procedures.

4.5.1 Visual and dimensional examination. The color coding, shielding, core covering, binder marking, and jacket thickness shall be examined at the ends of the shipping length of cable on the reel. The cable shall be examined for jacket imperfections on all of the surface which is visible without unwinding the cable from the reel.

4.5.2 Mutual capacitance test. The mutual capacitance test shall be performed on the cable shipping length in place on the reel. Mutual capacitance is the effective capacitance between the two wires of a pair. Mutual capacitance may be measured on individual pairs, or the average mutual capacitance may be on a number of pairs in groups. The mutual capacitance shall be measured by using a suitable capacitance or impedance bridge with a test frequency of 1000 ±100 Hz. The cable shall conform to the requirement of 3.3.1. Where group measurements of mutual capacitance are performed with cables exceeding 26 pairs in size, these measurements should be made on individual groups rather than on all pairs of the cable grouped together for a single average measurement. In any reel of 12 pairs or more, the rms deviation of mutual capacitance of all the pairs tested from the average mutual capacitance of that reel shall not exceed four percent.

4.5.3 Capacitance unbalance. The capacitance unbalance test shall be performed on the cable shipping length in place on the reel. The pair-to-pair capacitance unbalance for 304.8 meters (1,000 foot) lengths of completed cable measured at 1,000 Hz ±100 Hz shall not exceed the following:

Less than 16 pair	100 pF max individual
16 or more pair	40 pF RMS

For lengths of cable other than 304.8 meters (1,000 foot), the value shall be converted to 304.8 meters (1,000 foot) values by dividing the unbalance of the length measured by the square root of the ratio of the length measured to 1,000. In cables with 52 pairs and less and in each group of multigroup cables, the unbalances to be considered shall be:

(a) Between pairs adjacent in a layer.
(b) Between pairs in centers of four pairs or less.
(c) Between pairs in adjacent layers, when the number of pairs in the inner (smaller) layer is six or less. In this, the center is counted as a layer.

The capacitance involved and test methods are as shown on Figure 1. One and two represent the two conductors of a pair. Three and four represent the two conductors of a second pair. The capacitances, namely C_{13}, C_{14}, C_{23}, C_{24}, C_{12}, and C_{34} are the direct capacitances between conductors. The capacitances C_{1g}, C_{2g}, and C_{4g} are the direct capacitances between wires 1 to 4, respectively, and all other conductors in the cable connected to the shield and grounded.

The pair-to-pair capacitance unbalance is:

$$(C_{14} + C_{23}) - (C_{13} + C_{24})$$

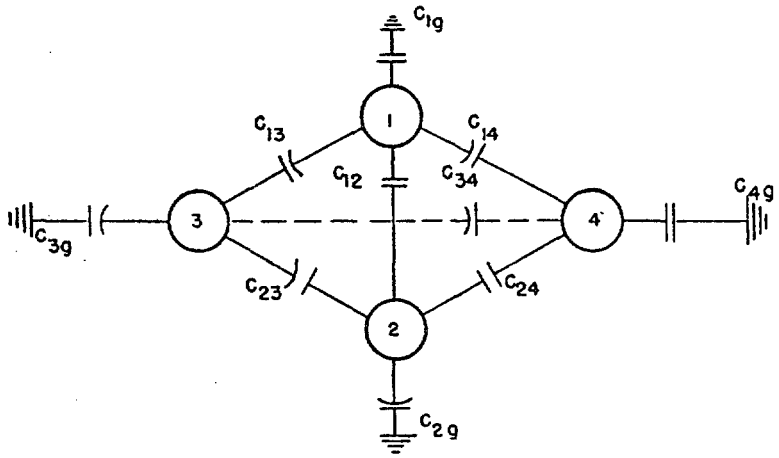

Figure 1. Test method for determining capacitance unbalance of pair to pair.

4.5.3.1 Capacitance unbalance, pair-to-shield. The pair-to-shield direct capacitance unbalance for 304.8 meters (1,000 foot) lengths of completed cable, when measured at 1,000 Hz ±100 Hz, shall conform to the following: (a) The capacitances-to-shield of the two conductors of the pair under test shall balance within 6 percent of the value of the lowest conductor-to-shield capacitance of the pair; (b) The maximum deviation of any pair difference shall not exceed the average of the differences of all pairs of the cable by more than 500 picofarads. Note: "Pair difference" is the difference between the conductor-to-shield capacitances of the two conductors of the pair. In Figure 2, S indicates all wires (except conductors 1 and 2) bunched together. Wires 1 and 2 have a direct capacitance between them as well as a direct capacitance to the shield. Wires 1 and 2 also have direct capacitance to S, and S has a direct capacitance to the shield.

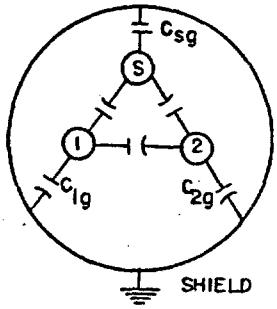

Figure 2. Test method for determining capacitance unbalance of pair-to-shield.

The pair-to-shield direct capacitance unbalance for pair 1-2 is $C_{1g} - C_{2g}$. The measurement of this difference shall be made in such a way that the measured value is not appreciably affected by the direct capacitances of wires 1 and 2 to other wires. A schematic of a form of measuring bridge often used to measure $C_{1g} - C_{2g}$ at 1,000 Hz, is shown on Figure 3.

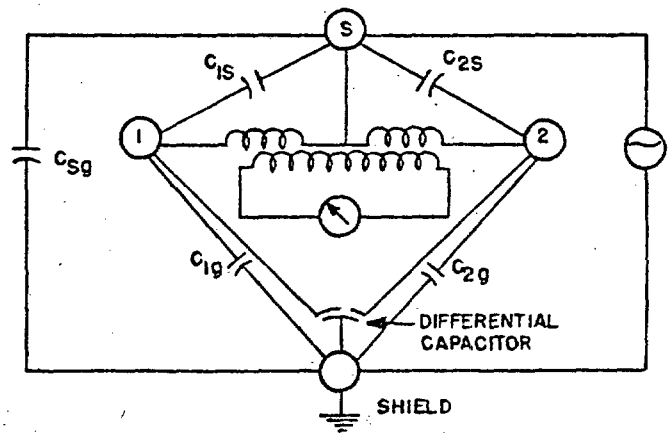

Figure 3. Test method for determining capacitance unbalance of pair-to-shield.

S indicates all wires (except conductors 1 and 2) bunched together.

If a group or subgroup is always separated from the shield (by other groups or subgroups) the wires of a pair in the separated group have very small direct capacitances to the shield and their difference is negligible.

4.5.4 Cold bend test. The cold bend test shall be performed as specified in 4.5.4.1. and 4.5.4.2.

4.5.4.1 Specimens. For cables with an overall diameter of less than 12.70 millimeters (0.500 inch), the test specified in 4.5.4.2 shall be conducted on three specimens of cable; the length of each specimen shall be at least 150 times the diameter. For cable of 12.70 millimeters (0.500 inch) and greater nominal diameter, the test specified in 4.5.4.2 shall be conducted on two specimens of cable; the length of each specimen shall be at least 120 times the diameter of the cable.

4.5.4.2 Procedure. One end of the test specimen shall be clamped circumferientially at two points, approximately 45 degrees apart, to a mandrel whose diameter is 10 times that of the test specimen. The specimen shall then be conditioned for 20 hours at -40° ±2°C except for cable 6.35 millimeters (0.250 inch) overall nominal diameter and smaller which shall be conditioned for 20 hours at -50° ±2°C. During this conditioning period, the specimens shall be kept reasonably straight. After this conditioning, but while the specimens are still in the cold chamber at the conditioning temperature, the specimens shall be wrapped for three close turns (two close turns for cables having a diameter 12.70 millimeters (0.500 inch) and greater) around the mandrel at a uniform rate of 15 ±3 revolutions per minute, preferably by means of an electrically driven motor. The cable shall be guided by a free moving sheave or transversing device in intimate contact with the cable at the initial point of bend. The cable shall be removed from the cold chamber and shall satisfactorily meet the dielectric withstanding voltage requirement of 3.2.4.1. The cable shall then be visually examined for evidence of cracks or flaws in the insulation material or jacket.

4.5.5 Tensile and elongation test. Samples of the conductor insulation or the jacket material, removed from the finished cable or conductor, shall be tested in accordance with standard ASTMD-470-64T to determine conformance with 3.2.2 for the conductor insulation, and 3.2.6.1 and 3.2.6.2 for the jacket material.

4.5.6 Dielectric. The cable shall be subjected to a dielectric test to determine conformance with 3.2.4.1.

4.5.7 Resistance. The resistance of the conductors and shield shall be measured to determine conformance with 3.2.1.2 and 3.2.5.1.

4.6 Inspection of preparation for delivery. Inspections shall be performed to ensure conformance to the requirements of Section 5.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in Section 2 do not apply unless specifically stated in contract or order. Preparation for delivery requirements for products procured by contractors shall be specified in the individual order.)

5.1 Preservation packaging, and packing. Preparation for delivery shall be in accordance with MIL-C-12000, at the level specified herein and in the contract or order.

5.1.1 Reels. Cables shall be furnished on non-returnable reels which shall contain lengths as specified in 3.4. The cable lengths shall have both ends brought out so that cable can be readily tested without unreeling. The reels shall be constructed with flanges of sufficient thickness to protect the cable from damage during handling, shipment, and storage. The diameter of the reel core shall be not less than 20 times the diameter of the cable.

5.2 Marking. In addition to any special marking required by the contract or order, both flanges of each reel shall be marked in accordance with MIL-STD-129 and with the following information:

(a) Reel number
(b) Number of pairs in cable
(c) Length and location of each piece in feet for reels of multi-lengths
(d) Specific defective pair and cable length (if applicable)

5.2.1 Where practicable, metal tags, stencil, or paper labels containing the information specified in 5.2 shall be securely attached to the reels. Where paper labels are used, they shall be securely attached and protected by a transparent compound to prevent deterioration of the markings.

6. NOTES

6.1 Intended use. The cable described in this specification is intended for use in shore stations and facilities.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Number of pairs in cable (see 1.2).
(c) Number of feet of cable required on each reel (see 3.4).
(d) Number of first article samples if other than specification 4.3.
(e) Packaging, packing and marking requirements other than those required by 5.1 and 5.2.

6.3 First article. Invitations for bids should provide that the Government reserves the right to waive the requirement for first article samples for those bidders offering a product which has been previously procured 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 procurement (see 4.2).

The invitations for bids should specify the size (No. of pairs) of cable to be tested under First Article test requirements. (If all constructions are procured, the 26 pair construction should normally be specified.)

6.4 CHANGES FROM PREVIOUS ISSUE. THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, AND SO FORTH) PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

Preparing activity:
Navy - EC
(Project 6145-N275)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/ vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?

   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*

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