INCH-POUND
MIL-DTL-915G
22 August 2002
SUPERSEDING
MIL-C-915F
14 March 1988

DETAIL SPECIFICATION

CABLE, ELECTRICAL, FOR SHIPBOARD USE, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers electrical cable for Navy shipboard applications.

1.2 Classification. Cables covered by this specification will be classified as watertight with circuit integrity and non-watertight constructions, and further classified for flexing and nonflexing service for power, lighting, control, communications, instrumentation and electronic applications, as specified in 1.2.1 through 1.2.4 (see 6.2).

1.2.1 Watertight, nonflexing service. Cable types for watertight, nonflexing service are as follows:

Electronic, communication and instrumentation:

Type	MSPW	59 conductors (8 shielded pairs, 3 shielded triads, 34 shielded singles)	
	TSP	11 and 31 pairs	300 V

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6145

1.2.2 Watertight, flexing service. Cable types for watertight, flexing service are as follows:

Power:

Type	DSWS	Two conductors shielded	
	MCSF	Four conductors (2-#6 600 and 2-#1 AWG)	

Control:

Type	MWF	Seven through 37 conductors	600 V

Electronic, communication and instrumentation:

Type	DSS	Two conductors with overall shield	600 V
	FSS	Four conductors with overall shield	600 V
	TSS	Three conductors with overall shield	600 V
	1SWF	Two shielded singles	
	2SWF	Three, 4 and 7 shielded pairs	
	7SS	Seven conductors with overall shield	600 V

1.2.3 Non-watertight, nonflexing service. Cable types for nonwatertight, nonflexing service are as follows:

Electronic, communication and instrumentation:

Type	MSP	59 conductors (8 shielded pairs, 3 shielded triads, 34 shielded singles)
	IPR-A20E	One twisted pair

1.2.4 Non-watertight, flexing service. Cable types for non-watertight, flexing service are as follows:

Power and lighting:

Type	CVSF	Four conductors (3-#3 and 1-#5 AWG)	600 V
	JAS	Four conductors (2-250 and 2-#12 AWG)	600 V
	THOF	Three conductors, sizes 3 through 600 AWG	600 V

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-PRF-17331 - Lubricating Oil, Steam Turbine and Gear, Moderate Service.
MIL-W-81381 - Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy.

(See supplement 1 for list of applicable specification sheets.)

STANDARDS

FEDERAL

FED-STD-228 - Cable and Wire, Insulated; Methods of Testing.
FED-STD-595 - Colors Used in Government Procurement.

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

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

B 3 - Copper Wire, Soft or Annealed
B 8 - Conductors, Copper, Concentric-Lay-Stranded, Hard, Medium-Hard, or Soft
B 33 - Wire, Tinned Soft or Annealed Copper, For Electrical Purposes
B 172 - Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded

Members, for Electrical Conductors. (DoD adopted)
B 173 - Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors. (DoD adopted)
B 174 - Copper Conductors, Bunch-Stranded For Electrical Conductors
B 193 - Conductor Materials, Electrical, Resistivity of. (DoD adopted)
B 228 - Steel Conductors, Concentric-Lay-Stranded Copper-Clad. (DoD adopted)
B 258 - Wires, Solid Round, Used as Electrical Conductors, AWG Sizes of, Standard Nominal Diameters and Cross-Sectional Areas of
B 286 - Copper Conductors for Use in Hookup Wire for Electronic Equipment. (DoD adopted)
B 298 - Wire, Copper, Silver-Coated Soft or Annealed. (DoD adopted)
B 344 - Alloys for Electrical Heating Elements, Nickel-Chromium and Nickel-Chromium-Iron, Drawn or Rolled
D 297 - Rubber Products-Chemical Analysis. (DoD adopted)
D 2240 - Rubber Property-Durometer Hardness. (DoD adopted)
G 21 - Standard Recommended Practice for Determining the Resistance of Synthetic Polymeric Materials to Fungi.

(Application for copies should be addressed to the America Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)
B46.1 - Surface Texture, Surface Roughness, Waviness and Lay. (DoD adopted)

(Application for copies should be addressed to American National Standards Institute, Inc., 11 West 42nd Street, 13th Floor, NY, NY 10036.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, (NEMA)
WC 26 - Binational Wire and Cable Packaging Standard.
FI 4 - Film, Flexible Composites

(Application for copies should be addressed to National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.)

UNDERWRITERS' LABORATORIES, INC. (UL)
1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords

(Application for copies of publications should be addressed to Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specifications sheets), the text of this document will take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

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

3.2 Qualification. Cables furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award. (see 4.2 and 6.5).

3.3. Materials. Materials used in the construction of those cables furnished under this specification shall be in accordance with the requirements shown in the applicable specification sheets and as follows.

3.3.1 Conductors.

3.3.1.1 Copper conductors. Copper conductors shall be composed of soft or annealed copper strands in accordance with ASTM B 3.

3.3.1.2 High strength conductors. Unless otherwise specified on the specification sheet, high strength conductors shall be composed of 30 percent conductivity, high strength, copper-covered steel strands in accordance with ASTM B 228.

3.3.1.3 Tin coating. Tin coating shall be in accordance with ASTM B 33.

3.3.1.4 Silver coating. Silver coating shall be in accordance with ASTM B 298.

3.3.2 Insulation. Insulation shall be as specified on the applicable specification sheet. All physical and electrical properties shall be as specified by the specification sheets.

3.3.3 Jackets. The material used for jackets over insulated conductors and groups of insulated conductors, and for the cable jacket, shall have the physical and electrical properties as required by the applicable specification sheet.

3.3.3.1 Thermoplastic jackets. Thermoplastic jackets shall be polyvinyl chloride. Unless otherwise specified on the specification sheet, thermoplastic cable jackets shall be gray.

3.3.4 Shields. The materials and constructions for shields of insulated conductors, groups of insulated conductors and overall cable shall be as specified in the specification sheet. When AWG sizes are specified for wire shields, they shall be in accordance with ASTM B 258.

3.3.5 Fillers. Unless otherwise specified in the applicable specification sheet, fillers for cables, which are not required to be watertight, may be fibrous. Fillers for cables, which are required to be watertight, shall be nonfibrous or a combination of nonfibrous and fibrous as specified in the specification sheet.

3.3.5.1 Fibrous fillers. Fibrous fillers shall consist of cotton, jute, synthetic fibers or glass fibers. The material shall be treated for flame or moisture resistance, or a combination of both, to meet

the requirements for the particular type of cable.

3.3.5.2 Nonfibrous fillers. Nonfibrous fillers shall consist of elastomeric material that is readily removable from insulation of conductors and insulating tapes over shields without the aid of solvents, cleansers or tools. The acceptability of the material shall be in accordance with 4.5.3 and 4.5.4, as applicable.

3.3.6 Tapes. Unless otherwise specified (see 3.1), tapes shall be polyester, in accordance with NEMA FI 4. Tapes applied over shield braids for singles, twisted pairs and triads shall be sealed or set to prevent unwinding freely, but shall be easily removable for wire or shield termination.

3.3.7 Separators. Unless otherwise specified (see 3.1), separators, when required, shall consist of a winding of glass fibers, synthetic fibers or cotton. They may also be of a tape of cotton, synthetic fiber, paper or polyester. Separators shall be opaque.

3.3.8 Reinforcement. Reinforcing binders or reinforcement for a single or double layer jacket shall be a size 3 nylon seine twine having a minimum breaking strength of 15 pounds or of a material approved by NAVSEA.

3.3.9 Binders. Binders shall be of a material compatible with other cable materials. The compatibility of the material shall be as specified in 3.1.

3.3.10 Fungus resistance. All nonmetallic materials shall be fungus inert and shall be certified that they meet the requirements of ASTM G 21.

3.3.11 Hazardous items and toxic materials. The material shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the contracting activity to the appropriate department medical service that will act as an advisor to the contracting agency. Regardless of any other requirements, materials and parts containing asbestos, mercury or mercury compounds shall not be used (see 4.3.7).

3.3.12 Materials control. All materials included in the construction of the cable shall be examined and tested to ensure conformance to this specification and applicable specification sheet. Once a cable construction has been fully qualified, no materials may be added, deleted or modified. Any addition, deletion or modification of materials within a cable construction shall require requalification.

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

3.4 Design and construction.

3.4.1 Conductor stranding. The size and quantity of individual conductor strands and the total circular-mil area of the conductor shall be in accordance with ASTM B 8, B 286, B 172, B 173, or B 174 as specified in the specification sheets. Navy standard sized conductors shall be in accordance with table I. Other strand construction employing the same or greater total number of wires are acceptable if approved by NAVSEA.

TABLE I. Navy standard sizes.

Conductor size Navy standard	Number of strands (minimum)	Strand diameter nominal (inch)	Conductor diameter nominal (inches)	Conductor cross-sectional area (circular mils)		Maximum conductor resistance (dc) per 1000 feet at 25°C		Weight per 1000 feet approximate (pounds)
				Nominal[1]	Minimum	Bare (ohms)	Coated (ohms)	
Concentric-lay-stranded:								
400 (127)	127	0.057	0.742	413,600	405,400	0.0268	0.0273	1,300
Bunch-lay-stranded:								
9 (90)	90	0.010	0.120	9,045	8,864	1.22	1.28	28
14 (140)	140	0.010	0.145	14,070	13,790	0.786	0.823	43
Rope-lay-stranded:								
23 (228)	228	0.010	0.190	22,910	22,460	0.499	0.523	73
42 (209)	209	0.014	0.260	42,100	41,280	0.272	0.284	130
60 (304)	304	0.014	0.310	61,260	60,040	0.187	0.196	190
83 (418)	418	0.014	0.380	84,230	82,560	0.136	0.142	270
133 (684)	684	0.014	0.480	137,800	135,100	0.0830	0.0867	440
150 (760)	760	0.014	0.510	153,100	150,100	0.0747	0.0780	490
200 (988)	988	0.014	0.580	199,100	195,100	0.0575	0.0600	630
250 (1254)	1254	0.014	0.680	252,700	247,700	0.0453	0.0472	800
400 (2052)	2052	0.014	0.850	413,500	405,300	0.0277	0.0289	1,300
800 (4033)	4033	0.014	1.150	812,700	796,500	0.0141	0.0148	2,600

[1] Values are for information only.

3.4.1.1 Concentric-lay-stranded. The length and direction of lay and the type and number of joints in concentric-lay-stranded conductors shall be in accordance with ASTM B 8 or B 286, as applicable.

3.4.1.2 Bunch-stranded. The length and direction of lay and the type and number of joints in bunch-stranded conductors shall be in accordance with ASTM B 174.

3.4.1.3 Rope-lay-stranded. The length and direction of lay and the type and number of joints in rope-lay-stranded conductors shall be in accordance with ASTM B 172 or B 173, as applicable.

3.4.2 Separators. Separators employed directly over conductors shall be applied to give not less than 100 percent coverage to the conductors.

3.4.3 Insulation. The insulation shall be as specified in the applicable specification sheet. Conductor insulation shall be readily removable by conventional wire stripping devices without damage to the conductor.

3.4.3.1 Extruded insulation. Extruded insulation shall be applied concentrically to the dimensions required by the specification sheet.

3.4.3.2 Taped insulation. Tapes used as insulation shall be applied in such a manner that they lie smoothly and free from wrinkles. The tape width shall be proper for the diameter over which it is applied so as to minimize splits, creases and edge tears when the completed cable is subjected to bending.

3.4.4 Fillers. Fillers and binders shall be used, where required, to provide firmness and roundness of completed cables and to provide watertightness when required by the specification sheet. Filler and binder material shall be compatible with all other cable components. Compatibility of components shall be determined in accordance with 4.5.4 and 4.5.18.

3.4.5 Shields. Shields, when specified in the applicable specification sheet, shall be of the push back type and shall be constructed to conform to the physical and electrical requirements specified in the applicable specification sheet. The shield shall be of a close fitting braid construction and shall be free from irregularities and discontinuities. Individual wire strands may be spliced, but not more than one carrier may be spliced at any one point. When the braided shield is cut, it shall be capable of sliding back not less than 4 inches on an exposed 24 inch length of component wire or cable with the opposite end clamped.

3.4.5.1 Braided wire shield. Braided wire shield shall have the angle of application and the percent coverage as required in the specification sheet. The percent coverage and the angle of application shall be determined by the following formula:

$$\text{Percent coverage } (k) = 100\,(2F - F^2)$$

Where $F = NPd/\sin a$

$\tan a = 2 \times 3.14159\ DP/C$

a = acute angle of braid with axis of cable
d = diameter (inch) of individual braid wires
D = diameter (inch) of cable under braid
N = number of wires per carrier
C = number of carriers P = picks per inch of cable length.

3.4.5.2 Double shield. Double shields shall have the angle of application and the percent coverage as required in the specification sheet. The percent coverage and the angle of application shall be determined by the formula specified in 3.4.5.1. The material and percent of separator tape coverage between double shields shall be as required by the applicable specification sheet.

3.4.6 Identification codes and methods. Individual conductors and groups of conductors shall be separately identified. The applicable identification code and the method by which the code is applied shall be as specified in the specification sheet.

3.4.6.1 Identification codes.

3.4.6.1.1 Standard identification code. Standard identification code shall be in accordance with table II.

TABLE II. Standard identification code.

Color, conductor or group number	Background or base color	First tracer color	Second tracer color
1	Black	---	---
2	White	---	---
3	Red	---	---
4	Green	---	---
5	Orange	---	---
6	Blue	---	---
7	White	Black	---
8	Red	Black	---
9	Green	Black	---
10	Orange	Black	---
11	Blue	Black	---
12	Black	White	---
13	Red	White	---
14	Green	White	---
15	Blue	White	---
16	Black	Red	---
17	White	Red	---
18	Orange	Red	---
19	Blue	Red	---
20	Red	Green	---
21	Orange	Green	
22	Black	White	Red
23	White	Black	Red
24	Red	Black	White
25	Green	Black	White
26	Orange	Black	White
27	Blue	Black	White
28	Black	Red	Green
29	White	Red	Green
30	Red	Black	Green
31	Green	Black	Orange
32	Orange	Black	Green
33	Blue	White	Orange
34	Black	White	Orange
35	White	Red	Orange

TABLE II. Standard identification code. (Cont'd)

Color, conductor or group number	Background or base color	First tracer color	Second tracer color
36	Orange	White	Blue
37	White	Red	Blue
38	Brown	---	---
39	Brown	Black	---
40	Brown	White	---
41	Brown	Red	---
42	Brown	Green	---
43	Brown	Orange	---
44	Brown	Blue	---
45	White	Black	Blue
46	Red	White	Blue
47	Green	Orange	Red
48	Orange	Red	Blue
49	Blue	Red	Orange
50	Black	Orange	Red
51	White	Black	Orange
52	Red	Orange	Black
53	Green	Red	Blue
54	Orange	Black	Blue
55	Blue	Black	Orange
56	Black	Orange	Green
57	White	Orange	Green
58	Red	Orange	Green
59	Green	Black	Blue
60	Orange	Green	Blue
61	Blue	Green	Orange
62	Black	Red	Blue
63	White	Orange	Blue
64	Red	Black	Blue
65	Green	Orange	Blue
66	Orange	White	Red
67	Blue	White	Red
68	Black	Green	Blue
69	White	Green	Blue
70	Red	Green	Blue

TABLE II. Standard identification code. (Cont'd)

Color, conductor or group number	Background or base color	First tracer color	Second tracer color
71	Green	White	Red
72	Orange	Red	Black
73	Blue	Red	Black
74	Black	Orange	Blue
75	Red	Orange	Blue
76	Green	Red	Black
77	Orange	White	Green
78	Blue	White	Green
79	Red	White	Orange
80	Green	White	Orange
81	Blue	Black	Green
82	Orange	White	---
83	Green	Red	---
84	Black	Green	---
85	White	Green	---
86	Blue	Green	---
87	Black	Orange	---
88	White	Orange	---
89	Red	Orange	---
90	Green	Orange	---
91	Blue	Orange	---
92	Black	Blue	---
93	White	Blue	---
94	Red	Blue	---
95	Green	Blue	---
96	Orange	Blue	---
97	Yellow	---	---
98	Yellow	Black	---
99	Yellow	White	---
100	Yellow	Red	---
101	Yellow	Green	---
102	Yellow	Orange	---
103	Yellow	Blue	---
104	Black	Yellow	---
105	White	Yellow	

TABLE II. Standard identification code. (Cont'd)

Color, conductor or group number	Background or base color	First tracer color	Second tracer color
106	Red	Yellow	---
107	Green	Yellow	---
108	Orange	Yellow	---
109	Blue	Yellow	---
110	Black	Yellow	Red
111	White	Yellow	Red
112	Green	Yellow	Red
113	Orange	Yellow	Red
114	Blue	Yellow	Red
115	Black	Yellow	White
116	Red	Yellow	White
117	Green	Yellow	White
118	Orange	Yellow	White
119	Blue	Yellow	White
120	Black	Yellow	Green
121	White	Yellow	Green
122	Red	Yellow	Green
123	Orange	Yellow	Green
124	Blue	Yellow	Green
125	Black	Yellow	Blue
126	White	Yellow	Blue
127	Red	Yellow	Blue

3.4.6.1.2 Telephone identification code. Conductor identification code for telephone cables shall be as follows:

Color or conductor no.	Color	Color or conductor no.	Color
1	Black	7	Brown
2	White	8	Gray
3	Red	9	Yellow
4	Green	10	Purple
5	Orange	11	Tan
6	Blue	12	Pink

The pairing of conductors for forming pairs shall be as follows:

No. 1 paired with nos. 2 thru 12 for first 11 pairs
No. 2 paired with nos. 3 thru 12 for next 10 pairs
No. 3 paired with nos. 4 thru 12 for next 9 pairs
No. 4 paired with nos. S thru 12 for next 8 pairs
No. 5 paired with nos. 6 thru 12 for next 7 pairs
No. 6 paired with nos. 7 thru 12 for next 6 pairs
No. 7 paired with nos. 8 thru 12 for next 5 pairs
No. 8 paired with nos. 9 thru 12 for next 4 pairs
No. 9 paired with nos. 10 thru 12 for next 3 pairs
No. 10 paired with nos. 11 thru 12 for next 2 pairs
No. 11 paired with no. 12

3.4.6.1.3 Special identification code. Special identification code shall be in accordance with the following:

Color or conductor No.	Color	Color or conductor No.	Color
1	Black	7	Brown
2	White	8	Gray
3	Red	9	Yellow
4	Green	10	Purple
5	Orange	11	Tan
6	Blue	12	Pink

3.4.6.1.4 Letter identification code. Letter identification code shall consist of the letters A, B, C and D printed in block type and with black, white, red and green ink, respectively.

3.4.6.1.5 Twisted pair identification code. This code shall consist of numbers in sequence running from 1 through the number corresponding to the total quantity of twisted pairs in the cable. Both conductors in each pair shall be numbered the same, denoting the sequence number of the pair. Distinction between the two conductors is provided by different colored insulation. Conductors of a cable with a single pair need not be numbered.

3.4.6.1.6 Twisted triad identification code. This code shall consist of numbers in sequence running from l through the number corresponding to the total quantity of twisted triads in the cable. Three conductors shall be numbered the same, denoting the sequence number of the triad; distinction between the three conductors is provided by different colored insulation. Conductors of a cable with a single triad need not be numbered.

3.4.6.2 Identification methods.

3.4.6.2.1 Method 1. Identification method 1 shall be surface printing of both number and color designations. The legend shall be printed in contrasting color: preferably white ink on black or dark background or black ink on white or light background. The printing can be on the conductor insulation provided that the jacket is transparent or on the jacket if the jacket is not transparent. The

legend shall be repeated at intervals not exceeding 3 inches and alternate legends shall be inverted. For example: 10 ORANGE BLACK ⅃0 ORANGE BLACK. The character type shall be block and shall have a height in accordance with the diameter over which it is applied as follows:

Diameter range (inch)	Height of character approximate (inch)
0.045 to 0.095	0.025
0.096 to 0.120	0.047
0.121 to 0.175	0.063
0.176 to 0.330	0.094
0.331 and larger	0.125

3.4.6.2.2 Method 2. Identification method 2 shall be the use of translucent (opaque) polyester tapes that have been printed with both the number and color designation prior to application. The legend shall be printed with black ink and shall be repeated at intervals not exceeding 3 inches and alternate legends shall be inverted. The character type shall be block and shall be approximately 3/32-inch high.

3.4.6.2.3 Method 3. Identification method 3 shall be the use of solid base colors or solid base colors with tracers as required. The base color may be either the color of the insulation or the color of a coating applied to the insulation. The tracers shall be approximately 1/32 inch wide ink stripes of the required color applied helically with 1-1/2 ± 1/4-inch lay. If two tracers are required, the second tracer shall be half the width of the first tracer.

3.4.6.2.4 Method 4. Identification method 4 shall be the use of colored braids. Tracers shall consist of the required colors applied by three adjacent carriers. Where two tracers are required, they shall be applied with reverse lay.

3.4.6.2.5 Method 5. Identification method 5 shall be the use of the printed letter on the outermost insulating tape or the printed letter on a polyester binder tape over the insulating tapes. The letters shall be approximately 3/16-inch high and shall have been printed at intervals not exceeding 3 inches prior to the application of the tape to the conductor. If the insulating tapes are white, no printing is required on the B (white) conductor.

3.4.6.2.6 Method 6. Identification method 6 shall consist of numerals printed in ink on the conductor insulation. For conductors having a jacket directly over the insulation, the numerals may be printed in ink on the jacket, at the manufacturer's option. White ink shall be used for a red or black background; black ink shall be used for a white background. Numerals shall be perpendicular or parallel on the longitudinal axis of the conductor (see figure 1). Numeral width shall be proportional to conductor outside diameter (od) as shown in Method 1 (see 3.4.6.2.1).
Numeral width shall be 1/3 numeral height. Each numeric legend shall be underlined. Two-digit legends shall have the bottom numeral under-lined. Legends shall be alternately inverted and shall be repeated at intervals not greater than 1-1/2 inch.

3.4.7 Manufacturer's identification tape. Unless otherwise indicated on the specification sheet, all cables with a core diameter of 0.250 inches or greater, shall contain a continuous, thin, moisture-resistant marker tape, not less than 1/10-inch wide. Cables with core diameters less than 0.250 inches shall either contain a manufacturer’s identification tape, or a marker thread per 3.4.7.1.

The marker tape or threads shall be placed directly under the cable binder tape or jacket. The tape shall be printed to show the following information at intervals not greater than 1 foot:

- Name and location of manufacturer
- Year of manufacture
- Specification number (MIL-DTL-915)
- Progressive serial number.

The serial number is not necessarily a footage marker. A serial number shall not be repeated by a manufacturer in any one year for any one type and size of cable.

3.4.7.1 Marker threads. Marker threads may be used on cables as an alternative to a manufacturer's identification tape, as specified in 3.4.7, for cables with a core diameter of less than 0.250 inches.. The use of marker threads in lieu of the tape for all other size cables shall have the written approval of NAVSEA. Marker threads shall be in accordance with those assigned by Underwriters Laboratory (UL) Incorporated to indicate the manufacturer of the cable. When UL marker threads are used, yearly marker threads shall also be used to indicate the year of manufacture, as follows:

Color codes

Year	Thread 1 Color	Thread 2 Color
1998	Blue	Yellow
1999	Blue	Green
2000	Blue	Brown
2001	Blue	Black
2002	White	Green
2003	White	Brown
2004	White	Black
2005	White	Yellow
2006	Red	Green
2007	Red	Brown
2008	Red	Black

3.4.8 Cable or surface marking. Unless otherwise specified (see 3.1), ink marking shall be used for overall cable jacket surface marking. The legend shall be printed in contrasting color: preferably white ink on a black or dark background or black ink on a white or light background. The legend shall consist of the manufacturer's name, the cable type and size designation, when applicable, the type of jacket material and the year of manufacture. The legend shall be repeated at intervals not exceeding 1 foot and the year of manufacture need not be in line with the balance of the legend.

For example: "Manufacturer's name – MWF 24 M915/58 1989"

The character type shall be block and shall have a minimum height in accordance with the diameter over which it is applied as follows:

Diameter range (inch)	Height of character approximate (inch)

0.125 to 0.200	0.047
0.200 to 0.285	0.063
0.285 to 0.350	0.078
0.350 to 0.500	0.094
0.500 and larger	0.125

Jacket material names shall be abbreviated as follows:

Polychloroprene	- NEOP
Thermoplastic	- PVC
Chlorosulfonated polyethylene	- CSPE

3.4.9 Watertightness. Where watertight cable construction is specified (see 3.1), voids within the cable construction shall be filled to prevent the passage of water longitudinally through the cable.

3.4.10 Jacket reinforcement. Where a reinforced polychloroprene jacket is specified (see 3.1), the jacket shall be applied in two layers with a size 3 nylon cord applied as a braid or two reverse serves between the layers. The minimum thickness of the outer layer of jacket shall be 50 percent of the total. The reinforcement shall be applied with approximately four picks or crossovers per inch.

3.4.11 Dimensional tolerances. Where minimum or maximum dimensions, or both, are specified, no minus or plus tolerances, respectively, shall be permitted. Where a dimension is specified as nominal, the average dimension shall be not less than the specified nominal. Where no minimum overall cable diameter is specified, the minimum permissible diameter shall be not less than 92-1/2 percent of the specified maximum overall cable diameter.

3.4.11.1 Extruded insulation wall thickness. For conductor insulation wall thickness specified as nominal, the average thickness shall be not less than the specified nominal. The minimum thickness, measured at any cross section, shall be not less than 90 percent of the specified nominal.

3.4.11.2 Cable jacket thickness. The average thickness of a cable jacket measured at any cross section shall be not less than the specified nominal. In case of multiconductor cables, the jacket thickness shall be determined from the measurements made at the high point of each conductor taken on a line through the center of the cable and through the center of each conductor in the outer layer. The minimum thickness at any cross section shall be not less than 80 percent of the specified nominal.

3.4.12 Centering and circularity.

3.4.12.1 Insulation. The insulation on the individual conductors shall be uniform in diameter throughout the conductor length. At any cross section, the maximum wall thickness shall not exceed the minimum by more than 25 percent for specified thickness greater than 0.025 inch, nor by more than 40 percent for specified thickness of 0.025 inch and less.

3.4.12.2 Cable jacket. The cable jacket shall be applied concentrically to the cable core in a manner to maintain circularity in the completed cable. The maximum wall thickness of the jacket at any cross section shall not exceed the minimum by more than 66 percent.

3.4.13 Surface condition (cable jacket). The surface of the cable jacket shall be dry and free of any coating, film or treatment that would tend to interfere with the bonding to it of encapsulating or molding materials normally used in splicing and terminating.

3.5 Electrical properties. Electrical properties of the completed cable shall be as specified by the specification sheet.

3.6 Physical properties. Physical properties of the completed cable and cable components shall be as specified by the specification sheet.

3.7 Repair of insulation or cable jacket. Repair of cable jacket will not be permitted on cables that are required to pass the hydrostatic (open end) test. Repair of cable jacket will be permitted on cables, which are not required to pass the hydrostatic (open end) test, provided the materials and techniques used are such that the finished cable complies with all the requirements of this specification.

3.7.1 Conductor splices. Conductor splices in finished cable, shall be removed prior to preparation for shipment.

3.8 Workmanship. Cable shall be a uniform and consistent product and shall be delivered free of defects and surface contamination which will adversely affect the serviceability of the product.

3.9 Shipment of cables. Cables covered by this specification shall be shipped on reels, unless otherwise specified on the specification sheet.

3.9.1 Cable packaging. Cables shipped on reels shall be packaged in accordance with the requirements of NEMA WC 26.

3.9.1.1 Placement of cable on the reel. The cable on each reel shall be one continuous length and shall have both ends readily available for testing without re-reeling.

3.9.2 Year marking. In addition to any other required marking, reels shall be marked with a keyed series of colors to indicate the year of manufacture. The cycle of colors shall be repeated every fifth year. The reel marking shall consist of a stripe of one coat of commercial quality outside paint approximately 2 inches wide, colored to designate the particular year of manufacture as follows:

Year of manufacture	Identifying color
1998	Orange
1999	Blue
2000	White
2001	Red
2002	Green
2003	Orange
2004	Blue
2005	White
2006	Red
2007	Green
2008	Orange

3.9.3 Location of year marking. The colored stripe on reels shall be applied circumferentially over the lagging or the alternative to lagging and midway between the flanges. The stripe shall consist of one coat of commercial quality outside paint of the appropriate color. In addition to the stripe, both flanges of the reel shall be stenciled with 4-inch high figures to show the year of manufacture.

3.9.4 Standard reel markings. Each reel shall be plainly marked on both flanges with the following information:

(a) Reel number.
(b) Type and size of cable.
(c) Footage.
(d) Contract or order number.
(e) Contractor's name.
(f) Manufacturer's name (if other than contractor).
(g) Gross weight.
(h) One continuous length on the reel indicated in feet.

3.9.5 Coils. Coils shall contain one continuous length of cable or cord (standard length, see table III).

TABLE III. Cable or cord lengths.

				Remnant lengths price reduction		
Type of package	Nominal length (feet)	Standard lengths no price reduction (feet)	Random lengths no price reduction (feet)	5 percent (feet)	10 percent (feet)	Scrap lengths not accept-able (feet)
Coil	500	550 to 450	449 to 150	149 to 100	99 to 50	49 to 0
Coil	600	660 to 540	539 to 180	179 to 120	119 to 60	59 to 0
Reel	500	550 to 450	449 to 150	149 to 100	99 to 50	49 to 0
Reel	800	880 to 720	719 to 240	239 to 160	159 to 80	79 to 0
Reel	1000	1100 to 900	899 to 300	299 to 200	199 to 100	99 to 0
Reel	1500	1650 to 1350	1349 to 450	449 to 300	299 to 150	149 to 0
Reel	2000	2200 to 1800	1799 to 600	599 to 400	399 to 200	199 to 0
Reel	2500	2750 to 2250	2249 to 750	749 to 500	499 to 250	249 to 0
Reel	3000	3300 to 2700	2699 to 900	899 to 600	599 to 300	299 to 0

3.9.6 Year marking. In addition to any other required marking, coils shall be marked with a keyed series of colors to indicate the year of manufacture. This marking shall consist of a stripe approximately 2 inches wide and colored for the particular year of manufacture. The cycle of colors shall be the same as those used for year marking on reels (see 3.9.2).

3.9.7 Identification. Two shipping tags shall be securely attached to each coil, both inside and outside the wrapping, and marked with the following information.

(a) Type and size of cable
(b) Footage.
(c) Contract or order number.
(d) Contractor's name.
(e) Manufacturer's name (if other than contractor).
(f) Gross weight.

4. VERIFICATION

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

(a) Qualification inspection (see 4.2).
(b) Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall consist of the examination and tests specified in tables IV and V and in accordance with the applicable specification sheet.

TABLE IV. Qualification inspection.

Examination or test	Requirement paragraph	Test method paragraph
Cable aging and compatibility (95°C)	Specification sheet	4.5.3
Cold working (minus 20°C)	Specification sheet	4.5.6
Cold working (minus 54°C)	Specification sheet	4.5.7
Durometer hardness (jacket)	Specification sheet	4.5.9
Hydrostatic (open end)	Specification sheet	4.5.13
Stress endurance	Specification sheet	4.5.16
Weathering	Specification sheet	4.5.19
Fungus resistance	3.3.10	---

4.2.1 Qualification specimens. A manufacturer seeking qualified products listing (QPL) shall manufacture and be responsible for testing at least one specimen of cable of each type, size or group for which qualification is sought. The cable type and size required for group qualification shall be in accordance with table V. When a manufacturer desires qualification of an individual type or size, the selection of test specimens shall be subject to review by NAVSEA. A sufficient length of any test specimen shall be manufactured at one time. The groups are based on similar characteristics and requirements.

TABLE V. Qualification samples and groups.

Qualification test		
Group number	All tests specified in the applicable specification sheet (type and size)	Types comprising the group[1]
1	TPUM-6	TPUM
2	MCSF-4	MCSF
3	DSS-3	All sizes of DSS, TSS,
4		FSS, and 7SS
5	DSWS	DSWS
6	2SWF-7	All sizes of 1SWF and 2SWF
7	MSPW	MSP, MSPW
8	TSP-11	All sizes of TSP
9	CVSF-4	CVSF-4
10	1PR-A20E	1PR-A20E
	2SPR-16	1PR-16, 7PR-16, 2SPR-16, 3PR-16, 1Q-16, ITR-16, 7SPR-16 and 1SPR-16
11	MWF-24	All sizes of MWF

[1]Includes all sizes and variations of the cable type.

4.3 Conformance inspection. Conformance inspection shall be performed on all completed cable in accordance with the procedures specified herein. This inspection shall consist of basic electrical test plus groups A, B and C examination and tests specified in table VI and in accordance with the specification sheets.

TABLE VI. Conformance inspection.

Examination or test	Requirement paragraph	Test method
Basic electrical		
Conductor resistance	Specification sheet	4.6.4
Voltage withstand	Specification sheet	4.6.5
Insulation dielectric	Specification sheet	MIL-W-81381
Group A		
Hydrostatic (open end)	Specification sheet	4.5.13
Visual and dimensional	Specification sheet	4.5.17
Watertightness	Specification sheet	4.5.18
Capacitance	Specification sheet	4.6.2
Characteristic impedance	Specification sheet	4.6.3
Conductor tensile and elongation	Specification sheet	Method 3212, FED-STD-228
Group B		
Bending endurance	Specification sheet	4.5.1
Breaking strength	Specification sheet	4.5.2
Cold bending cable	Specification sheet	4.5.5
Drip	Specification sheet	4.5.8
Durometer hardness (insulation)	Specification sheet	4.5.9
Attenuation	Specification sheet	4.6.1
Group C		
Cable filler removability	Specification sheet	4.5.4
Flammability	Specification sheet	4.5.11
Heat distortion	Specification sheet	4.5.12
Permanence of printing		
Jacket	Specification sheet	4.5.13
Physical tests on insulation and jacket (aged)	Specification sheet	4.5.14

4.3.1 Inspection lot. An inspection lot shall consist of the total number of units of product of any one type, size, and construction manufactured under the same conditions.

4.3.2 Basic electrical tests. Basic electrical tests shall be in accordance with the applicable specification sheet and shall be performed on each length of completed cable. For electrical test purposes, length of completed cable shall be as defined in paragraph 6.7.1.1.

4.3.3 Sampling procedure. The required number of samples for groups A, B and C examination and tests shall be selected at random from the inspection lot. Nonconforming starting and finishing ends of completed cable shall be removed by the manufacturer prior to selecting samples.

4.3.3.1 Sampling for group A examination and tests. Samples for group A examination and tests shall be selected from each lot in accordance with table VII.

TABLE VII. Sampling for group A examination and tests.

Units of product in lot	Number of samples
1	1
2 thru 10	2
11 thru 30	3
31 thru 90	7
91 thru 210	15
211 and over	25

4.3.3.2. Sampling for group B examination and tests. Samples for group B examination and tests shall be selected from each lot in accordance with table VIII.

TABLE VIII. Sampling for group B examination and tests.

Units of products in lot	Number of samples
8 and under	1
9 thru 30	2
31 thru 90	3
91 thru 210	4
211 and over	5

4.3.3.3 Sampling for group C examination and tests. Samples for group C examination and tests shall be selected in accordance with table IX.

TABLE IX. Sampling for group C examination and tests.

Two months' production (units of product)	Number of samples
8 and under	1
9 thru 30	2
31 thru 90	3
91 thru 210	4
211 and over	5

4.3.3.4 Tightened sampling and accept-reject criteria. If the number of a defective units in a lot exceeds the acceptance number for group A examination and tests (see table VII), or if there are any failures in group B tests, the manufacturer shall have the option of reworking the lot and performing examination and tests on the tightened sampling basis in accordance with table X. If there are any failures on tests performed on the tightened sampling basis, if there are any failures in group C tests, or if the manufacturer chooses not to rework and retest, the lot shall be rejected.

TABLE X. Tightened sampling.

Units of product in lot	Number of samples
10 or under	3
11 thru 30	5
31 thru 90	9
91 thru 210	15

4.3.4 Group A examination and tests. Group A examination and tests as required by the specification sheet shall be performed on samples selected in accordance with 4.3.3.1.

4.3.5 Group B examination and tests. Group B examination and tests as required by the specification sheet shall be performed on specimens taken from samples selected in accordance with 4.3.3.2.

4.3.6 Group C examination and tests. Group C examination and tests as required by the specification sheet shall be performed on specimens taken from samples selected in accordance with 4.3.3.3.

4.3.7 Certified test reports. The contractor shall prepare test reports in accordance with the data ordering document (see 6.2.2). The test report shall contain the following information:

(a) Manufacturer's QPL number and date or serial number and date of NAVSEA letter of approval.
(b) A statement to the effect that the product was constructed from materials listed on the manufacturer's approved details of construction sheet.
(c) A statement that the product meets all of the requirements of this specification.
(d) Results of all conformance tests showing actual values obtained.
(e) Year and month cable was manufactured.
(f) Serial numbers of the marker tape taken from each end of each length cable .
(g) Customer's name and contract or order number.
(h) A statement that the product contains no metallic mercury or mercury compounds and are free from mercury contamination.
(i) The serial number of all NAVSEA letters approving deviations from the approved specification slash sheet.

4.4 Test conditions. Unless otherwise specified (see 3.1), the examination and tests specified in tables V and VI shall be made at standard ambient conditions as follows:

(a) Temperature: 23 ± 20°C
(b) Humidity: 50 ± 40 percent

4.5 Test methods (physical).

4.5.1 Bending endurance. The ability of completed cable to withstand repeated and smooth and continuous reversing bending motion while subjected to a specified temperature shall be determined.

4.5.1.1 Specimen. The specimen shall consist of a 30 plus 6, minus 0 inch length of completed cable. Specimen conductor ends shall be electrically interconnected such that a single series electrical circuit is formed by the conductors. The two end conductors of this series circuit shall be connected as specified in 4.5.1.3.

4.5.1.2 Special apparatus. Apparatus shall include the following:

(a) Flexing machine for suspending the specimen vertically and for automatically bending the upper portion of the specimen alternately to left and to right by 90 plus 5, minus 0 degrees from vertical, over rollers, as shown on figure 2 and as further described below.

(1) The specimen shall be suspended and bent by means of a rigid, motor driven arm, which shall initially be vertical, which shall be horizontally pivoted about its lower end, and which shall incorporate a clamp at its upper end for securing the upper portion of the specimen jacket. The distance between the upper and of the specimen jacket and the nearest edge of this clamp shall be not less than 1 inch. When its motor is turned on, the arm shall move at a rate of not more than 14, nor less than 12 cycles per minute, where a cycle is 180 plus 10, minus 0 degrees of clockwise arm travel plus 180 plus 10, minus 0 degrees of counterclockwise arm travel (360 plus 20, minus 0 degrees total travel). The specimen clamp shall be positioned such that when the arm is vertical (straight up), the longitudinal axis of the specimen shall intersect the pivoting axis, and the lower edge of the clamp shall be 8-1/2 ± 1/2 inches above a horizontal line drawn across the tops of the upper rollers.

(2) The specimen shall be bent over two solid steel cylindrical rollers (the upper rollers a shown on figure 2) of the diameter specified. Unless otherwise specified in the applicable specification sheet: For cables over 1 inch in diameter, the roller shall have a diameter four times the diameter of the specimen; for cables with a diameter between 0.75 inch and 1 inch, roller size shall be 3.5 times the maximum diameter of the cable; and for cables with a diameter less than 0.75 inch, roller size shall be 3 times the maximum diameter of the cable. Both rollers shall have a smooth surface finish on their curving surfaces, and shall be pivoted about their axes and capable of free rotation at all times. They shall be positioned such that their axes are horizontal and parallel and share a common horizontal centerline. The tops of the rollers shall be below the horizontal centerline of the flexing machine arm pivoting axis by a distance equal to one-half of the maximum specified overall cable diameter plus or minus 10 percent. The rollers shall be located equidistantly on opposite sides of the vertical centerline passing through the flexing machine arm pivoting axis. They shall be spaced apart such that their nearest edges are 1/8 ± 1/32 inch from the specimen passing between them when the flexing machine arm is vertical.

(3) Two cylindrical rollers (the lower rollers as shown on figure 2), of not less than 3/8-inch diameter, shall be provided to restrain lateral motion of the specimen. Both rollers shall be pivoted about their axes and capable of free rotation at all times. They shall be positioned such that their axes are horizontal centerline. The axes of these rollers shall be 7 ± 1 inch below the axes of the rollers over which the specimen is bent (the upper rollers as shown on figure 2) The lower rollers shall be located equidistantly on opposite sides of the vertical centerline passing through the flexing machine arm pivoting axis; they shall be spaced apart such that their nearest edges are 1/8 ± 1/32 inch from the specimen passing between them when the flexing machine arm is vertical.

(4) A weight shall be provided for applying tension to the specimen. This weight shall be attached to the specimen by means of a second clamp. The lower end of the specimen jacket shall be a distance of not less than 1 inch below the nearest edge of this clamp. The weight shall be chosen such that the:

Specimen tension produced by the clamp plus the weight in pounds = $10\ (3.14159)d^2 \pm (3.14159)\ d^2/2$

Where: d = specified maximum overall cable diameter, in inches.

The clamp and weight shall be attached such that specimen tension is applied vertically downward along the specimen axis.

(5) Both the specimen clamp on the flexing machine arm and the specimen clamp supporting the tensioning weight shall apply radial compression to the specimen that neither the specimen nor any of its internal components will slip in the clamping area during the test.

(6) An automatic counter shall be provided to total the number of bending cycles performed on the specimen during a test.

(7) The specimen shall not come into contact with any piece of machinery at any time during the test, except for the upper and lower rollers, the two specimen clamps, and the circuit continuity monitor.

(b) Circuit continuity monitor is a means for continuously monitoring the electrical continuity of the series through connected specimen conductors, which shall automatically stop the flexing machine arm (as by removing motor power) when a specimen conductor breaks.

(c) Test chambers are chambers for maintaining the specified air temperature within plus or minus 2°C for accommodating the flexible machine with specimen attached and for supporting the requirements as specified in 4.5.1.3. The chamber air temperature shall be measured in the immediate vicinity of the upper roller of the flexing machine. The chamber shall incorporate a viewing port for observing the specimen under test.

(d) Voltage withstand test apparatus is as specified in 4.6.5.2.

4.5.1.3 Procedure. The flexing machine shall be installed in the test chamber, and the specimen

installed in the flexing machine, as shown on figure 2. The circuit continuity monitor shall be connected between the two end conductors of the single series circuit within the specimen The test chamber doors shall then be closed, and the air temperature within the chamber shall be brought to the specified value within plus or minus 2°C. After the air temperature within the chamber has been maintained at this value for a period of not less than 1 hour, the automatic counter shall be set initially to zero, and the bending endurance test begun by turning on the motor driven flexing machine arm. The specified number of bending cycles shall be performed. At all times during the test, the air temperature within the chamber shall be maintained as specified within plus or minus 2°C, and the test chamber doors shall remain closed.

4.5.1.4 Observation. Either of the following shall constitute specimen failure, except that specimen damage within 2 inches of the location where either specimen clamp had been fastened shall not constitute specimen failure, but shall require a complete retest using a different specimen from the same length of cable:

(a) Stoppage of the flexing machine arm caused by the circuit continuity monitor (indicating specimen conductor breakage), prior to completion of the specified number of bending cycles. (Loss of conductor continuity from loss of connectors shall not be construed as failure. If this situation occurs, reconnect connectors and continue testing).

(b) Rupture of the specimen jacket prior to completion of the specified number of bending cycles.

4.5.1.5 Further procedure. If the specimen shows no failure, it shall be allowed to return to room temperature and shall be subjected to the voltage withstand test as specified in 4.6.5, using the specified voltages. Following this, that portion of the specimen, which had been repeatedly bent over the upper rollers of the flexing machine, shall be dissected, and each of its constituent components visually inspected for deterioration.

4.5.1.6 Further observation. Either of the following shall constitute specimen failure, except that specimen damage within 2 inches of the location where either specimen clamp had been fastened shall not constitute specimen failure, but shall require a complete retest of bending endurance using a different specimen from the same length of cable:

(a) Specimen fails the voltage withstand test (see 4.6.5.4).

(b) Specimen, upon dissection and inspection, exhibits visible distortion or cracking of any specimen component, including strand breakage on any conductor, or exhibits any other visible deterioration of such a nature or extent as to impair the performance of the cable in service.

4.5.2 Breaking strength. This test shall be to determine the axial tension necessary to break completed cable.

4.5.2.1 Specimen. The specimen shall consist of a piece of completed cable, which shall have sufficient length for use in the test as specified in 4.5.2.3. Additional specimens may be required in the event of invalid test results (see 4.5.2.3).

4.5.2.2 Special apparatus. Apparatus shall include a motor driven tensile machine, for applying increasing axial tension to the specimen, which shall automatically indicate within plus or minus 1 percent the maximum axial tension experienced by the specimen prior to rupture. This tensile machine shall incorporate two parallel and opposing, rigid and smooth cylindrical mandrels, between which the specimen can be secured, as specified in 4.5.2.3. The two mandrels shall increase their separation at the uniform rate of 1 ± 1/8 inch per minute during the test by means of the tensile machine motor.

4.5.2.3 Procedure. The ends of the specimen shall be attached to opposing tensile machine mandrels, such that each specimen end is tightly wrapped circumferentially around its mandrel for not fewer than two complete revolutions and then firmly secured, at its extremity, to that mandrel. This is to assure that neither the specimen nor any of its internal components shall slip during the test. Care shall be taken during specimen mounting to assure that the specimen shall be subjected only to axial forces, and not to lateral or torsional forces during the test. The specimen shall be mounted such that it has a free span of not less than 6 inches between its nearest points of contact on the opposing mandrels at all times during the test. The test shall be initiated by starting the tensile machine motor, thereby increasing the mandrel separation and applying increasing tension to the specimen. If specimen rapture occurs in a location other than in the free span between mandrels, then the test result shall be considered invalid, and the test shall be repeated using a different specimen.

4.5.2.4 Observation. Specimen failure shall be construed if the maximum recorded specimen tension is less than that specified (see 3.1).

4.5.3 Cable aging and compatibility (95°C). This test shall detect any significant degradation due to component incompatibility or prolonged overheating of completed cable containing thermoplastic insulation.

4.5.3.1 Specimens. Two specimens of completed cable shall be required: specimen number 1 shall have a length of 30 ± 3 feet, and specimen number 2 shall have a length of not less than the sum of 12 inches plus 20 times the maximum specified overall cable diameter (see 3.1). Both specimens shall be removed from the same length of cable.

4.5.3.2 Special apparatus. Apparatus shall include the following:

(a) A heating chamber shall support the requirements as specified in 4.5.3.3. The chamber air temperature shall be measured in the immediate vicinity of the specimen.
(b) The mandrel shall be rigid, smooth cylinder or partial cylinder with a continuous, curved surface of not less than 180 degrees, of proper length and construction for the specimen bending as specified in 4.5.3.3(b). The mandrel diameter shall be not more than 13 nor less than 11 times the specified maximum overall cable diameter (see 3.1).
(c) Watertightness test apparatus shall be as specified in 4.5.17.2.
(d) Voltage withstand test apparatus shall be as specified in 4.6.5.2.

4.5.3.3 Procedure. Both specimens shall be simultaneously subjected to heat aging within the heating chamber after preliminary procedure (a) and (b) have been completed. Heat aging shall be

exposed to a temperature of 95 ± 3°C for a continuous period of not less than 400 hours. The chamber air temperature shall be recorded at intervals of not more than 15 minutes during the first hour after attaining the heat aging temperature, at intervals of not more than 1 hour for the following 5 hours, and not less than twice daily thereafter for the duration of heat aging. The interval between consecutive temperature recordings shall not exceed 17 hours at any time during heat aging. The following additional details shall apply for each specimen:

(a) Prior to heat aging, specimen number 1 shall be subjected to the insulation resistance and voltage withstand tests as specified in 4.6.5, respectively. The voltage withstand test shall use the voltages specified (see 3.1). The specimen shall then be formed into the largest practicable horizontal coil within the heating chamber, and shall be subjected to heat aging. Following heat aging, the specimen shall be allowed to cool to room temperature, and shall again be subjected to the insulation resistance and voltage withstand test as specified in 4.6.5, respectively. The specimen shall then be cut into two samples: one sample (see 4.5.17.1) shall be subjected to the watertightness test as specified in 4.5.17; the other sample (see 4.5.4.1) shall be subjected to the cable filler removability test as specified in 4.5.4.

(b) Specimen number 2 shall be placed within the heating chamber, such that it is both straight and horizontal, and shall then be subjected to heat aging. Following heat aging, the specimen shall be allowed to cool to room temperature. The mandrel shall be secured to a fixed surface, and one end of the specimen shall be secured such that it is both in contact with the curved surface of the mandrel, and also perpendicular to the mandrel center of curvature axis. The opposite end of the specimen shall then be bent circumferentially around the curved mandrel surface through an arc of not less than 170 degrees; bending shall be accomplished at a rate of approximately 20 degrees per second. The specimen shall next be secured to maintain its bent shape (as with a piece of twine, stretched it and tied between each end of the specimen) and shall be removed from the mandrel. Not less than two-thirds of the bent portion of the specimen shall then be dissected, and each of its constituent components shall be visually inspected for deterioration.

4.5.3.4 Observation. Any of the following shall constitute specimen failure:

(a) The failing away of any material from either specimen during heat aging.
(b) Jacket sagging.
(c) Specimen number 1 fails either of the voltage withstand tests (see 4.6.5.4).
(d) The indicated sample from specimen number 1 fails the watertightness test (see 4.5.17.4).
(e) The indicated sample from specimen number 1 fails the cable filler removability test (see 4.5.4.3).
(f) Specimen number 2, upon dissection and inspection, exhibits visible deterioration of such a nature or extent as to impair the performance of the cable in service. Deterioration sufficient to constitute specimen failure shall include, but shall not be limited to: distortion or cracking of any constituent component, hardening of filler material, or any discoloration indicating material incompatibility.

4.5.4 Cable filler removability. This test shall determine whether or not nonfibrous filler materials can be readily removed from the constituent components of cable. This test shall not apply to filler material used to fill voids between either conductor strands or braid strands.

4.5.4.1 Specimen. The specimen shall be a 2 foot ± 2 inch length of completed cable.

4.5.4.2 Procedure. Overall specimen components (such as, jackets, overall binders or overall shields) shall be removed from one end of the specimen for a distance of not less than 10 inches, thereby exposing the cable core. Using fingers only, filler material shall then be removed from all exposed insulated conductors, or from all groupings of insulated conductors, which have a common covering (such as insulated conductor pairs or triads, which have an overall shield or binder) for a distance of not less than 8 inches. Tools, cloths or solvents shall not be used to assist with filler removal. The common covering and filler material shall then be removed from not less than one grouping of insulated conductors, on specimens incorporating such groupings, for a distance of not less than 5 inches. Fingers only shall be used for filler removal. If occasional particles of filler material remain on any constituent component of the cable core, then the removal of these particles shall be attempted by means of light brushing with the fingers or with a dry cloth.

4.5.4.3 Observation. Any of the following shall constitute specimen failure:

(a) Filler material, which is nonflexible.
(b) Filler material, which adheres to the finger or to any component of the cable core. The adherence of occasional small particles of filler material to cable core components is acceptable unless there are small particles of filler material which cannot be removed from core components by means of light brushing with the fingers or with a dry cloth.
(c) Filler material, which leaves a residue on cable core components.
(d) Filler material can not be removed in less than 5 minutes.

4.5.5 Cold bending cable. This test shall determine the ability of completed cable, which is not intended to be flexed during use, to withstand bending at a reduced temperature, such as might be encountered during ship-board construction or repair.

4.5.5.1 Specimen. The specimen shall consist of a piece of completed cable which shall have a length of not less than the sum of 12 inches plus 1.6 times the specified mandrel diameter (see 3.1).

4.5.5.2 Special apparatus. Apparatus shall include the following:

(a) Refrigeration chamber shall support the requirements as specified in 4.5.5.3. The chamber air temperature shall be measured in the immediate vicinity of the specimen.
(b) Unless otherwise specified (see 3.1), the mandrel diameter shall be approximately 12 times the diameter of the cable. Mandrel shall be rigid, smooth cylinder or partial cylinder, with a continuous, curved surface of not less than 180 degrees, of proper length and construction for the specimen bending of 4.5.5.3. The mandrel shall be provided with a clip for affixing one specimen end (see 4.5.5.3).

4.5.5.3 Procedure. The specimen shall be straightened. If it does not remain straight of itself, it shall be held straight by securing it (as with twine) to a straight wooden bar. The straightened specimen (including attached wooden bar, if applicable) shall be placed within the refrigeration chamber, and subjected to an air temperature of minus 20 ± 2°C (unless otherwise specified, see 3.1) for a continuous period of not less than 6 hours. Prior to any change of chamber temperature, the specimen shall be removed from the chamber (following detachment from the wooden bar, if applicable), and one specimen end shall be inserted into a clip which has been affixed to (or adjacent to) the mandrel, such that the specimen is both in contact with the curved surface of the mandrel and also perpendicular to the mandrel center of curvature axis. The opposite end of the specimen shall then be bent circumferentially around the curved mandrel surface through an arc of not less than 170 degrees. This bending shall be accomplished at a rate of not less than 10 degrees per second nor more than 20 degrees per second. The period of time between the removal from the refrigeration chamber and the completion of specimen bending shall be not greater than 40 seconds. Care shall be taken to avoid heating the specimen, as by excessive handling, during removal from the refrigeration chamber and during bending. Following bending, the specimen shall be secured to maintain Its bent shape (as with a piece of twine, stretched taut and tied between each end of the specimen) and shall be removed from the mandrel. Not less than two-thirds of the bent portion of the specimen shall then be dissected, and each of its constituent components visually inspected for deterioration.

4.5.5.4 Observation. Specimen failure shall be construed if the specimen either during bending or upon dissection and inspection, exhibits distortion or cracking of any specimen component, or exhibits any other visible deterioration of such a nature or extent as to impair the performance of the cable in service.

4.5.6 Cold working (minus 20°C). This test shall determine the ability of completed cable, which is not intended to be flexed during use, to withstand a traveling bend at a reduced temperature, such as might be encountered during shipboard construction or repair.

4.5.6.1 Specimen. The specimen shall consist of a 20 ± 1 foot length of completed cable.

4.5.6.2 Special apparatus. Apparatus shall include the following:

(a) A refrigeration chamber for supporting the requirements as specified in 4.5.6.3. The chamber air temperature shall be measured in the immediate vicinity of the specimen.

(b) Bending apparatus shall consist of two identical sheaves, as shown on figures 3 and 4, which are attached to a fixed surface such that they are pivoted about their axes and at all times, their axes are both horizontal and parallel, the corresponding points on each sheave are located in the same vertical plane, their bending surfaces are separated by a distance of not more than four times the maximum specified cable diameter (see 3.1), and they support the requirements as specified in 4.5.6.3. Each sheave shall have a bending surface width of not more then three times the maximum specified overall cable diameter (see 3.1) and a beading surface diameter of not more than 13 nor less than 11 times the maximum specified overall cable diameter (see 3.1).

(c) Two pieces of rope or twine, each of which shall have a length of not less than 25 feet and which shall support the requirements as specified in 4.5.6.3.

4.5.6.3 Procedure. One end of one piece of rope or twine shall be firmly attached to either end of the specimen, and one end of the second piece of rope or twine shall be firmly attached to the opposite specimen end. Attachment may be made either with a cable grip or by directly tying the rope or twine onto the specimen. The specimen, with rope or twine attached, shall be placed within the refrigeration chamber, and shall be subjected to a temperature of minus 20 ± 2°C for a period of not less then 6 hours. Prior to any change of chamber temperature, the specimen (with rope or twine attached) shall be removed from the chamber, one rope or twine shall be wound through the bending apparatus into an S shape as shown a figure 3 and not more than 20 seconds after removing the specimen from the chamber, the specimen shall be subjected to cold working, as follows. The specimen shall be drawn completely through the bending apparatus, at a rate of 35 ±5 feet per minute by means of pulling on the rope or twine, which initially passes through the apparatus. Immediately thereafter, the specimen shall be drawn completely through the bending apparatus in the opposite direction, at the same rate, by means of pulling on the opposite rope or twine. At all times during cold working, both ropes or twine shall be directed such that the bending surface of each sheave (see figures 3 and 4) is in contact with either the specimen or with rope or twine for an arc of not less than 170 degrees. Following cold working, the specimen shall be dissected for a distance of not less than 3 feet, and each of its constituent components visually inspected for deterioration.

4.5.6.4 Observation. Specimen failure shall be construed if the specimen, either during cold working or upon dissection and inspection, exhibits distortion or cracking of any specimen component, or exhibits any other visible deterioration of such a nature or extent as to impair the performance of the cable In service.

4.5.7 Cold working (minus 54°C). This test shall determine the ability of completed cable, which is intended for in-sea flexing use external to the hull of a ship, to withstand a traveling bend at a reduced temperature, such as might be encountered during service in polar regions.

4.5.7.1 Specimen. The specimen shall consist of a 20 ± 1 foot length of completed cable.

4.5.7.2 Special apparatus. Apparatus shall include the following:

(a) A refrigeration chamber for accommodating the bending apparatus with specimen attached and for supporting the requirements as specified in 4.5.7.3. The chamber air temperature shall be measured in the immediate vicinity of the specimen.

(b) Bending apparatus shall consist of two identical, rigid and smooth cylindrical mandrels, as shown on figure 5, which shall have a diameter of 12 ± 1/4 inches and which shall be of proper length and construction for the specimen bending as specified in 4.5.7.3. Both mandrels shall be attached to a fixed surface such that they are pivoted about their axes, their axes are both horizontal and parallel, and the corresponding points on each mandrel are located in the same vertical plane. One mandrel (the idler mandrel shown on figure 5) shall be capable of free rotation at all times; the other mandrel (the drive mandrel as shown on figure 5) shall be attached to a motor (as by a drive chain), such that It can be rotated as specified in 4.5.7.3. The mandrel axes shall be separated by a distance of not more than 24 inches.

(c) Salt water tub (required for qualification only, see 3.2) shall be filled with a

uniform solution of salt water comprising 3 ± 1/4 percent salt by weight, for the specimen immersion as specified in 4.5.7.3(b). The salt water solution shall be maintained at a temperature of 22 ± 5°C during specimen immersion.

(d) Hydrostatic (open end) test apparatus (required for qualification only, see 3.2) shall be as specified in 4.5.13.2.

4.5.7.3 Procedure. Specimens not undergoing qualification shall be tested as specified in (a). Specimens undergoing qualification (see 3.2) shall be tested as specified in (b).

(a) The bending apparatus shall be installed in the refrigeration chamber, and the specimen shall be installed in the bending apparatus as shown on figure 5. One end of the specimen shall be secured to the curved surface of the drive mandrel with a clamp, such that the specimen end is perpendicular to the mandrel axis; the free portion of the specimen shall then be held perpendicularly to the mandrel axes, tautly wrapped once about the circumference of the idler mandrel, and then tautly wrapped as many times as the specimen length will allow about the circumference of the drive mandrel. The free end of the specimen shall then be secured to the drive mandrel with a clamp. Wrappings shall be such that the specimen is directed in an opposite sense around each mandrel (that is, the wrapping around the idler mandrel is clockwise, as shown on figure 5, then all wrappings around the drive mandrel shall be counterclockwise). The specimen will form a figure 5 about the mandrels when viewed parallel to the mandrel axes. Specimen wrappings around the drive mandrel shall be as close together as practicable. The refrigeration chamber doors shall then be closed, and the specimen subjected to a temperature of minus 54°C for a period of not less than 6 hours. Prior to any change of chamber temperature, the specimen shall be subjected to cold working. Cold working shall consist of operating the motor of the bending apparatus such that as much of the specimen length as practicable is drawn over the idler pulley at the rate of 50 ± 5 feet per second, the direction of motor rotation shall then be reversed and as much of the specimen length as practicable drawn over the idler pulley in the opposite direction at the same rate. This process shall then be repeated three more times (the specimen shall be drawn over the idler pulley a total of four times in each direction). Following cold working, the specimen shall be removed from the bending apparatus, and the approximate middle of the specimen shall be dissected for a distance of not less than 3 feet. Each of its constituent components shall then be visually inspected for deterioration.

(b) The entire specimen, except for its extreme ends (which shall remain exposed to the air) shall be submerged in the solution of the salt water tub for a period of not less than 21 days. The specimen shall then be removed from the salt water tub and immediately subjected to the procedure of (a), above, except for the following:

(1) The specimen shall be drawn over the idler pulley a total of 10 times in each direction instead of a total of four times in each direction.

(2) Following cold working, the specimen shall be allowed to return to room temperature, and 60 ± 2-inch piece shall be removed from the approximate middle of the specimen. This piece shall be subjected to

the hydrostatic (open end) test as specified in 4.5.13. Specimen dissection shall be performed on a cable section, which has not been subjected to this hydrostatic (open end) test.

4.5.7.4 Observation. Either of the following shall constitute specimen failure:

(a) The specimen, upon dissection and inspection, exhibits visible distortion or cracking of any specimen component, or exhibits any other visible deterioration of such a nature or extent as to impair the performance of the cable in service.
(b) (For specimens undergoing qualification only.) The specimen fails the hydrostatic (open end) test (see 4.5.13.4).

4.5.8 Drip. This test shall determine whether or not nonfibrous fillers will exude and drip from cable ends when cables containing these fillers are subjected to high temperatures. Such filler dripping may produce deleterious effects, such as the coating or bridging of underlying electrical contacts.

4.5.8.1 Specimen. The specimen shall consist of an 18 ± 1/2 inch length of completed cable.

4.5.8.2 Special apparatus. Apparatus shall include a heating chamber for supporting the requirements as specified in 4.5.8.3. The chamber air temperature shall be measured in the immediate vicinity of the specimen.

4.5.8.3 Procedure. The specimen shall be straightened, and shall be suspended from one end within the heating chamber, such that the specimen hangs freely downward. The temperature within the chamber shall then be raised to 95°C±1°C. This chamber temperature shall be maintained for a continuous period of not less than 18 hours. Provision shall be made to catch any material, which may fall away from the lower specimen end during this test.

4.5.8.4 Observation. Specimen failure shall be construed if any material falls away from the lower specimen end during the test.

4.5.9 Durometer hardness. This test shall determine whether or not semirigid polyvinylchloride insulation material, polyvinylchloride jacketing material and silicone rubber jacketing material exhibit sufficient hardness (see 4.5.9.4) for use in cable construction.

4.5.9.1 Specimen. The specimen shall consist of a block of material, of the dimensions specified in ASTM D 2240, which shall have be: cured in effectively the same manner as when used in cable manufacture.

4.5.9.2 Special apparatus. Apparatus shall include a type A or type D durometer, as specified (see 3.1), which shall be in accordance with ASTM D 2240.

4.5.9.3 Procedure. The specimen shall be tested in accordance with ASTM D 2240.

4.5.9.4 Observation. Specimen failure shall be construed if the specimen exhibits a durometer hardness other than that specified (see 3.1).

4.5.10 Flammability. This test shall determine the ability of a single length of completed cable

to resist ignition from the spatter of welding operations, and to self-extinguish should ignition occur.

4.5.10.1 Specimen. The specimen shall consist of an 18 ± 2-inch length of completed cable . (Two additional specimens (a total of three specimens) may be required, see 4.5.10.4 and 4.5.10.5.)

4.5.10.2 Special apparatus. Apparatus shall include the following:

(a) Flammability apparatus shall support the specimen vertically, and apply controlled sources of heat and ignition to the specimen as shown on figure 6 and as further described below.

(1) A cup shall be placed over the lower specimen end to direct any gases, which might emanate from this end upwards into the heating coil. The sides of this cup shall extend not less than 1 inch up the outside of the specimen from the specimen end, but shall not cover that portion of the specimen which lies beneath the heating coil. The cup shall be shaped from thin metal foil, or from any other fire-resistant material, which will not absorb a significant amount of heat from the heating coil, such that it forms an approximately conformal fit around the specimen. This fit shall be sufficiently loose that gases can easily pass out the specimen end, up between the cup and the specimen and out towards the heating coil.

(2) A specimen holder (such as a lathe chuck) shall support the specimen, by its lower end, in a vertical position. The specimen holder shall not deform the cup to an extent that the cup fails to perform its intended function.

(3) A heating coil shall furnish a controlled source of heat to the specimen when used with the current source (see 4.5.10.2 (b). The coil shall consist of a 7-turn helix of 10 AWG resistance wire, which is an 80 percent nickel and 20 percent chromium alloy in accordance with ASTM B 344. The coil shall exhibit a uniform axial spacing of 1/4 ± 1/32 inch between the centers of each adjacent turn, and shall have a and which shall be larger than the maximum measured specimen diameter by 0.55 ± 0.05 inch. The heating coil shall be placed over the specimen coaxially, such that the lower end of the coil is located 1-1/2 ± 1/8 inches above the top of the specimen holder.

(4) Two spark plugs shall furnish a source of ignition to the specimen when used with the voltage source (see 4.5.10.2(c)). These plugs shall be mounted such that they are on diametrically opposite sides of the specimen, their axes are horizontal and their electrode gaps are spaced both 1/8 ± 1/32 inch from the surface of the specimen and 1/2 ± 1/16 inch above the top of the heating coil. Means (such a handles) shall be provided whereby both spark plugs may be withdrawn from the specimen following ignition (see 4.5.10.3) to allow unimpeded flame travel and to prevent the collection of soot on spark plug electrodes.

(5) A scale shall be used to measure the height of flame travel (see 4.5.10.3) along the specimen above the heating coil. This scale shall be graduated at intervals of not more than 1/8 inch, and shall be affixed

near the specimen in a position, which will not significantly impede the progress of the flame.

(b) Current source shall be a adjustable source of 60 Hz single-phase ac, which shall maintain the current specified in table XI through the heating coil, a shown on figure 6.

(c) A source of voltage for producing continuous inter-electrode sparking on both spark plugs, a shown on figure 6.

(d) Enclosure shall be a chamber for enclosing the flammability apparatus with the specimen mounted. This enclosure shall incorporate an exhaust fan at its top, and shall incorporate apertures for admitting air along its sides, adjacent to its base. The exhaust fan shall be operated to produce no more suction than is necessary to carry off smoke and gases, and the enclosure shall be designed to minimize all interior air drafts to the greatest practicable extent. Shatterproof windows, which shall provide a clear and unobstructed view of the flammability apparatus and mounted specimen shall be provided in the walls of the enclosure. The means for withdrawing the spark plugs from the specimen shall be located outside of the enclosure (for example, withdrawal may be accomplished by means of handles passing through the enclosure walls).

TABLE XI. Current in heating coil.

Measured overall cable diameter, inches	Current, amps rms + 1/4 A
Less than 0.099	45
0.100 to 0.199	46
0.200 to 0.299	47
0.300 to 0.399	48
0.400 to 0.499	49
0.500 to 0.599	50
0.600 to 0.699	51
0.700 to 0.799	52
0.800 to 0.899	53
0.900 to 0.999	54
1.000 to 1.099	55
1.100 to 1.399	56
1.400 to 1.799	57
1.800 to 2.299	58
2.300 or greater	59

(e) A stop watch or equal, which shall resolve 1-second increments, and which shall support the requirements as specified in 4.5.10.3.

4.5.10.3 Procedure. The flammability apparatus shall be placed within the enclosure, and the specimen shall be mounted in the flammability apparatus. The enclosure door shall then be shut, the exhaust fan turned on, and the voltage source applied to the spark plugs. The current source shall next be applied to the heating coil and the stop watch started simultaneously. When specimen ignition

occurs, the ignition time (that is, elapsed since starting the stop watch) shall be recorded, the voltage source shall be removed from the spark plugs and the spark plugs shall be withdrawn from the specimen. (Ignition shall be considered to have occurred when flames transfer from: volatizing gases to the specimen surface and remain there. Flashes which may occur prior to sustained flame on the specimen surface shall be disregarded.)

The current source shall be removed from the heating coil in accordance with the following schedule:

a) The current source of the specimen shall be removed from the heating coil either when the stop watch shows 60 ± 3 seconds, or else when ignition occurs, whichever occurs later.

The burning time (that is, the number of seconds elapsing between the removal of the current source from the heating coil and the complete extinction of all flame) shall be recorded. The flame travel distance (that is, the maximum: height above the top of the heating coil that the base of the flame reaches on the specimen surface) shall be noted on the scale, prior to flame extinction, and shall also be recorded. If the specimen exhibits an ignition time of 250 seconds or more, the test shall be discontinued.

4.5.10.4 Observation. Any of the following shall constitute the need for farther testing, a specified in 4.5.11.5:

(a) Any specimen: a flame travel distance in excess of that specified (see 3.1).

(b) Any specimen: an ignition time of less than 30 seconds or a burning time of more than 120 seconds.

Any specimen not requiring further testing, including any specimen exhibiting an ignition time of 250 seconds or more shall be construed as having passed the flammability test.

4.5.10.5 Further procedure (may not be required, see 4.5.10.4). Two additional specimens shall be prepared from the same length of cable as was the original specimen. Each of these additional specimens shall be tested in accordance with 4.5.10.3. An average ignition time, average burning time and average flame travel distance shall be calculated from the results of the three tests (the original specimen test plus the test for each of the two additional specimens).

4.5.10.6 Further observation. Any of the following shall constitute specimen failure:

(a) All specimens: shall have an average flame travel distance in excess of that specified (see 3.1).

(b) Specimens: shall have a average ignition time of less than 30 seconds or an average burning time of more than 120 seconds.

4.5.11 Heat distortion. This test shall determine the ability of cross-linked thermosetting polyethylene insulation to resist physical deformation when subjected to an elevated temperature.

4.5.11.1 Specimen. Each specimen shall be removed from completed cable In accordance with (a) or (b), whichever is indicated. The number of specimens which shall be required shall he in accordance with (c), (d) or (e), as appropriate.

(a) Cables which incorporate conductors with cross sections of more than 190,000 circular mils: each specimen shall consist of a piece of insulation, which has been removed from a conductor and which has been cut to form a rectangular strip. This strip shall be not less than 7/8-inch long nor less than 9/16 ± 1/16-inch wide, and shall be ground and buffed to a thickness of 0.050 ± 0.010 inch with a grinding apparatus (see 4.5.11.2(c)). The thickness of this specimen shall be made a uniform as practicable.

(b) Cables which incorporate conductors with cross sections of 190,000 circular mils or less. Each specimen shall consist of a single insulated conductor of length not less than 7/8 inch.

(c) Cables containing four or fewer conductors: one specimen shall be prepared from each insulated conductor.

(d) Cables containing more than four but fewer than 21 conductors: one specimen shall be prepared from each of four different insulated conductors (a total of four specimens).

(e) Cables containing 21 or more conductors: the number of specimens prepared shall be equal to the square root (rounded, if necessary, to the nearest whole number) of the total number of conductors. Each specimen shall be prepared from a different insulated conductor.

4.5.11.2 Special apparatus. Apparatus shall include the following:

(a) A self-standing thickness gauge, for supporting the requirements a specified in 4.5.11.3, which shall exhibit a measurement error of not more than plus or minus 0.001 inch. This gauge shall incorporate a flat horizontal platen upon which an entire specimen shall be laid flat during measurement, and shall incorporate a foot which rests upon the top of the specimen during measurement. This foot shall be attached to a plunger which moves freely in the vertical direction, and which is attached to a dial or other indicating device from which the specimen thickness may be read. The foot shall present a horizontal disk of 3/8 plus 0, minus 1/64 inch diameter to the specimen, shall bear down upon the specimen with a force of 85 plus 0, minus 4 grams and shall be loaded with weights (see 4.5.12.3) to present additional force to the specimen.

(b) A micrometer (required for insulated conductor specimens only) with flat, parallel measurement surfaces on both spindle and anvil, for the specimen thickness measurement a specified in 4.5.11.3(b)(1), which shall exhibit a measurement error of not more than plus or minus 0.001 inch.

(c) A motor driven grinding wheel and a motor driven buffing wheel, or their equal, for the specimen preparation as specified in 4.5.11.1(a). Guides shall be provided to assure that the specimen is pulled tangentially to the surface of each wheel during grinding and buffing.

(d) An oven, for accommodating the gage with specimen inserted and for

supporting the requirements as specified in 4.5.11.3. The oven air temperature shall be measured in the immediate vicinity of the specimen.

4.5.11.3 Procedure. The initial insulation thickness of each specimen (T in the following formula) shall be determined (see (a) (1) and (b)) and the oven shall be preheated to 121 ± 1°C. This oven temperature shall be maintained for the remainder of the test. The gauge foot shall then be loaded with weights (see (a) (2) and (b)(2)) and the gauge placed within the oven. Not less than 1 hour later, one specimen shall be selected and also placed within the oven. Not less than 1 hour after placing the specimen within the oven, the specimen shall be placed beneath the gauge foot such that the gage indicates the specimen thickness. Not less than 1 hour after placing the specimen beneath the gauge foot, the final specimen thickness or diameter (as appropriate) shall be read from the gauge and the final insulation thickness (t in the following formula) determined (see (a) (3) and (b)(3)). In an identical manner, the remaining specimens shall also be tested. The percentage heat distortion of the insulation shall then be calculated by using the following formula:

Percentage heat distortion = Median value of 100(T-t)/T for all tested specimens.

Where: T = Initial insulation thickness of the specimen, in thousandths of an inch (see (a) and (b)).
t = Final insulation thickness of the specimen, in thousandths of a inch (see (a) and (b)).

The following additional details apply:

(a) Rectangular strip specimens:
(1) The initial insulation thickness (T) shall be the initial specimen thickness, as measured with the gage, prior to loading the gauge with weights and prior to inserting either the gage or the specimen into the oven.
(2) The gage foot shall be loaded with 2000 ± 100 grams.
(3) The final insulation thickness (t) shall be the final specimen thickness, measured a specified.

(b) Insulated conductor specimen:
(1) The initial insulation thickness (T) shall be defined as 1/2 of the difference between the measured overall specimen diameter and the measured specimen conductor diameter. Measurements shall be made using the micrometer. The overall specimen diameter shall be measured in the same radial direction as will be measured when the final insulation thickness (t) (see (b)(3)) is determined.
(2) The gauge foot shall be loaded as follows:
a. Specimens with a conductor cross section of not more than 3999 circular mils nor less than 2700 circular mils: 400 ± 20 grams.
b. Specimens with a conductor cross section of not more than 21,999 circular mils nor less than 4000 circular mils: 500 ± 25 grams.
c. Specimens with a conductor cross section of not more than 94,999 circular mils nor less than 22,000 circular mils: 750 ±

35 grams.

d. Specimens with a conductor cross section of not more than 189,999 circular mils nor less than 95,000 circular mils: 1000 ± 50 grams.

(3) The final insulation thickness (t) shall be defined as 1/2 of the difference between the final specimen diameter, measured as specified, and the previously measured specimen conductor diameter.

4.5.11.4 Observation. The specimen shall be considered to have failed the test if the percentage heat distortion is greater than that specified (see 3.1).

4.5.12 Hydrostatic (open end). This test shall determine the ability of completed cable, which is intended to pass through watertight bulkheads on submersible vehicles, to prevent the longitudinal high-pressure water when properly installed in a bulkhead penetrator.

4.5.12.1 Specimen. The specimen shall consist of a 60 ± 2 inches length of completed cable.

4.5.12.2 Special apparatus. Apparatus shall include a tank, which can be filled with water, which can be internally pressurized to the specified value (see 3.1), and which is used for applying this water pressure to one specimen end, as specified in 4.5.12.3. An appropriate stuffing tube shall be welded into the tank wall to provide a means for sealing the one specimen end within the tank. An appropriate packing assembly shall be available to effect this sealing (see 4.5.12.3). A means shall be provided whereby the pressure within the tank can be measured within an accuracy of plus or minus 5 percent.

4.5.12.3 Procedure. One end of the specimen shall be installed through the tank stuffing tube, and shall be sealed in place by using a packing assembly. The opposite specimen end shall remain freely exposed to air for the remainder of the test. The tank shall then be closed and filled with water, such that the specimen end within the tank remains directly and entirely exposed to water for the remainder of the test. The water shall then be pressurized to a value of not less than that specified (see 3.1). This pressure shall be maintained for a continuous period of not less than that specified (see 3.1), unless specimen failure (see 4.5.12.4) occurs prior to the end of this period; the test may then be terminated prematurely. Following the test, the specimen shall be removed from the tank, and the end which had been exposed to water pressure shall be examined.

4.5.12.4 Observation. Either of the following shall constitute specimen failure:

(a) Any water leakage from the free end of the specimen in excess of that specified (see 3.1).

(b) Slippage of more than ¼ inch, with respect to the specimen jacket, of any specimen component at the end of the specimen, which had been exposed to water pressure.

4.5.13 Permanence of printing (jacket). This test shall determine the ability of printed information of jacketing material to remain legible in the presence of repeated abrasion. The test shall be performed in accordance with UL 1581 clause 1690.

4.5.14 Physical tests on insulation and jacket. This test shall determine whether or not various extruded insulating and extruded jacketing materials have been properly processed, by means of tension measurements. This test means provision for making tension measurements both before and after these materials have been artificially aged.

4.5.14.1 Specimens. Each specimen shall consist of a single piece of insulation or jacketing, which shall have sufficient length for use in the tests as specified in 4.5.14.4, as specified (see 3.1), and which shall have been prepared in accordance with (a) or (b), whichever is indicated. Specimens shall be removed from completed cable. The number of specimens which shall be required each time each test is performed shall be in accordance with (c), (d) or (e), as appropriate; it is recommended, however, that extra specimens be prepared to allow for possible invalid test results (see 4.5.14.4).

(a) For insulation (not jacketing) which has a cross-sectional area of 0.030 in^2 or less, and which can readily be pulled from its associated conductor, the outer diameter of a length of insulated conductor shall be measured with a micrometer (see 4.5.14.2(a)), in two perpendicular directions, at not fewer than three different longitudinal locations (not fewer than six measurements total); an average outer insulation diameter shall then be calculated from these measurements. Next, the maximum conductor diameter shall be measured with the micrometer, and the insulation then removed from the conductor by pulling. The insulation shall not be cut longitudinally or permanently distorted for pulling ease, since these might adversely affect test results. The pulled insulation shall constitute one specimen. The cross sectional area of the specimen shall be determined by the following formula:

Cross sectional area, in square inches = $0.7854 (D + d) (D - d)$

Where: D = Calculated average outer insulation diameter, in inches; accuracy of constituent measurements and calculations shall be within plus or minus 0.001 inch.

d = Measured maximum conductor diameter, in inches; measurement accuracy shall be within plus or minus 0.001 inch.

(b) For all jacketing, and for insulation which cannot readily be pulled from its associated conductor or which has a cross sectional area of greater than 0.030 in^2, longitudinal segment of insulation or jacketing shall be cut from a length of insulated conductor or cable, respectively. This segment shall have a reasonably constant cross sectional shape (such as a circular segment, a circular sector, a rectangle or any other cross sectional shape which may be conveniently produced). The segment shall then be ground and buffed with a grinding apparatus (see 4.5.14.2(b)), such that it has two smooth and parallel surfaces, which are as flat as practicable. Two straight, parallel and longitudinal cuts shall then be made in the middle of this segment. These cuts shall be perpendicular to the buffed surfaces, such that the cross sectional area between the two cuts shall be rectangular in shape and as large as practicable, except that this cross sectional area shall not exceed 0.030 in^2. Each of these cuts shall be longer than the benchmark spacing specified in 4.5.14.4. Material between

each cut and the nearest longitudinal edge of the segment shall then be removed and discarded; material which is longitudinally above or below the region of the cuts may be allowed to remain or may be cut into any configuration appropriate for use with the jaws of the tensile machine (see 4.5.14.2(f)). Care shall be taken at all times to prevent nicking the material, and to avoid cuts which intersect each other at a angle, rather than in a gradual, curving manner. These precautions are necessary to prevent a possible premature specimen failure during tensile strength and elongation testing (see 4.5.14.4(a)). The prepared segment shall constitute one specimen. The maximum width and maximum thickness of the specimen in the region between the two required parallel cuts shall be determined by measurement with a micrometer (see 4.5.14.2(a)), and the cross sectional area of the specimen shall be calculated by the following formula:

Cross sectional area in square inches = TW

Where: T = Measured maximum specimen thickness in region between the two required parallel cuts, in inches; measurement accuracy shall be within plus or minus 0.001 inch.

W = Measured maximum specimen width in region between the two required parallel cuts, in inches; measurement accuracy shall be within plus or minus 0.001 inch.

(c) Cables containing four or fewer conductors: not fewer than four specimens shall be required; not fewer than one of these specimens shall be removed from each insulated conductor.

(d) Cables containing more than four but fewer than 21 conductors: not fewer than four specimens shall be required; each specimen shall be removed from a different insulated conductor.

(e) Cables containing 21 or more conductors: the number of specimens required shall be not less than the square root (rounded, if necessary, to the nearest whole number) of the total number of conductors. Each specimen shall be removed from a different insulated conductor.

4.5.14.2 ~~Special apparatus~~. Apparatus shall include the following:

(a) A micrometer with flat, parallel measurement surfaces on both spindle and anvil, which is for the specimen measurement as specified in 4.5.14.1 and which exhibits a measurement error of not more than plus or minus 0.001 inch.

(b) Grinding apparatus (not required for insulation with a cross sectional area of 0.030 in^2 or less, a motor driven grinding wheel and a motor driven buffing wheel, or their equal, for the specimen preparation as specified in 4.5.14.1(b). Guides shall be provided to assure that the specimen is pulled tangentially to the surface of each wheel during grinding and buffing.

(c) A forced, fresh-air circulating oven (if required, see 4.5.14.3), for supporting the requirements as specified in 4.5.14.3(a). The oven air temperature shall be measured in the immediate vicinity of the specimen.

(d) A hermetic chamber (if required, see 4.5.14.3), which shall be filled and

internally pressurized with air and then internally heated, as specified in 4.5.14.3(b), as applicable. (For relative simplicity, it is suggested that a sealable, pressure-proof steel canister be used to contain the specimens, that this canister be pressurized from a regulated source of air, and that this canister be heated by means of immersion in a controlled temperature hot oil bath) pressure and temperature shall be automatically regulated, and an appropriate pressure-relief valve shall be provided on the hermetic chamber. These measures will reduce the possibility of spontaneous specimen combustion, and will augment the safety of personnel.

(e) A heated container (if required, see 4.5.14.3), which shall be filled with lubricating oil in accordance with symbol number 2190 TEP of MIL-PRF - 17331, and which shall be for the specimen immersion as specified in 4.5.14.3(c). The oil shall be maintained at a temperature of 121 ± 1°C during specimen immersion.

(f) A motor driven tensile machine which shall be for applying increasing axial tension to the specimen, and which shall automatically indicate within ± 1 percent the maximum axial tension experienced by the specimen prior to rupture. This tensile machine shall incorporate two parallel and opposing jaws, between which the specimen can be secured, as specified in 4.5.14.4(a). The two jaws shall increase their separation at the uniform rate of 20 ± 2 inches per minute by means of the tensile machine motor.

4.5.14.3 Procedure. Specimens shall be maintained at a temperature of 25 + 3°C for a period of not less than 30 minutes immediately prior to any accelerated aging or testing. Each of the specified physicals (aged) accelerated aging procedures, if any (see 3.1), shall be performed as follows, using the specified number of specimens (see 4.5.14.1) for each procedure. The same specimen shall not be used for more than one physicals (aged) procedure. Each of the specified physicals (unaged) tests, if any (see 3.1), shall be performed as specified in 4.5.14.4.

(a) Air oven accelerated aging: each specimen shall be freely suspended vertically, secured by one end, within the oven. The air temperature within the oven shall then be raised to the value specified in table XII, and shall be maintained at this value for a continuous period of not less then that specified in table XII. Each specimen shall then be removed from the oven and tested as specified in 4.5.14.4.

(b) Air-pressure-heat accelerated aging: each specimen shall be freely suspended vertically, secured by one end, within the heat-pressure chamber. The air pressure within the chamber shall then be raised to 80 ± 2 lb/in^2, and the air temperature within the chamber raised to the value specified in table XII. This pressure and temperature shall then be simultaneously maintained for a continuous period of not less than that specified in table XII. Following this, the pressure within the chamber shall be reduced, at a uniform rate, and over a period of not less than 5 minutes, to ambient atmospheric pressure. Each specimen shall then be removed from the chamber and tested as specified in 4.7.24.4.

(c) Hot-oil immersion accelerated aging: each specimen shall be submerged within the hot oil bath for a continuous period of not less than that specified in table XII. Each specimen shall then be removed from the hot oil bath, blotted lightly

to remove excessive oil and then suspended in air, to ambient room temperature, for 4 ± 112 hours. Each specimen shall then be tested as specified in 4.5.14.4.

4.5.14.4 Further procedure. Each of the specified physicals (unaged) tests (see 3.1) shall be performed as follows: the specified number of specimens (see 4.5.14.1) shall be required for each test. In addition, the specimens of each material aged in accordance with 4.5.14.3 shall be tested as specified in (a) below, to the extent specified (see 3.1). Specimens shall be maintained at a temperature of 25 ± 3°C for a period of not less than 30 minutes immediately prior to any testing. Two benchmarks shall be printed on the region of each specimen where the cross sectional area is known (see 4.6.14.1(a) and (b)): these two benchmarks shall be separated by a longitudinal distance of 1 plus 1/64 inch on specimens of polyethylene (thermoplastic) or polypropylene insulation; the two benchmarks shall be separated by a longitudinal distance of 2 ± 1/64 inches on all other specimens. The same specimen shall not be used for more then one test.

TABLE XII. Details for accelerated aging procedures.

Specimen material	Procedure	Temperature (°C)	Minimum period (hours)
Insulation specimens:			
Polyethylene (cross-linked)	Air oven	121 ± 2	168
Polyethylene (thermoplastic)	Air oven	100 ± 2	96
Rubber (butyl)	Air oven	100 ± 2	168
Rubber (ethylene propylene)	Air oven	121 ± 2	168
Rubber (synthetic)	Air oven	127 ± 2	20
Jacketing specimens:			
Polychloroprene	Hot-oil immersion	121 ± 1	18
Polyether polyurethane	Air oven	80 ± 1	168
Polyethylene (chloro-sulphonated)	Air oven	100 ± 2	96
	Hot-oil immersion	121 ± 1	18
Polyvinyl chloride	Air oven	127 ± 2	168
	Hot-oil immersion	121 ± 1	
Silicone rubber	Air oven	260 ± 2	24

(a) Tensile strength and elongation tests: one specimen shall be selected and secured between the jaws of the tensile machine, such that the region of the specimen which contains both benchmarks shall be suspended between the jaws, and such that the jaws are separated by a distance which shall be not greater than twice the benchmark separation. Care shall be taken during specimen mounting to assure that tension shall be uniformly distributed across the cross sectional area of the specimen during the test, and to assure that the specimen shall be subjected only to axial forces, and not to lateral or torsional forces during the test. The test shall be initiated by starting the tensile machine motor, thereby increasing jaw separation and applying increasing tension to the specimen. The distance between the specimen benchmarks shall be constantly monitored during the test, within an accuracy of ± 1/6 inch. The applied specimen tension and specimen benchmark separation existing immediately prior to specimen rupture shall be recorded if this rupture occurs between benchmarks; if specimen rupture does not occur between benchmarks, then the test results shall be considered invalid, and the test shall be repeated using a different specimen of the same material and aging history. This test shall be successfully repeated, using a different specimen of the same material and aging history each time, until the specified number of specimens (see 4.5.14.1) have been tested. The specimen tensile strength shall then be calculated by using the following formula:

Tensile strength, in lb/in^2 = Median value of F/A for all tested specimens.

Where: F = Measured tension in the specimen immediately prior to rupture, in pounds.

A = Measured cross sectional area (see 4.5.15.1) of the specimen, in square inches.

The specimen elongation shall be calculated by using the following formula:

Elongation, in percent = Median value of 100(D/K - 1) for all tested specimens.

where: D = Measured benchmark separation on the specimen immediately prior to rupture, in inches.
K = Initial benchmark separation (either 1 or 2 inches, as specified in 4.5.14.4).

(b) Set test: one specimen shall be selected and secured between the jaws of the tensile machine, such that the region of the specimen which contains both benchmarks shall be suspended between the jaws, and such that the jaws are separated by a distance which shall be not greater than 4 inches. Care shall be taken during specimen mounting to assure that tension shall be uniformly distributed across the cross sectional area of the specimen during the test, and to assure that the specimen shall be subjected only to axial forces, and not to lateral or torsional forces during the test. The tensile machine motor shall then be started, thereby increasing jaw separation and stretching the specimen until the specimen benchmarks are separated by a distance of 6 plus 3/8, minus 1/8 inches. The benchmarks shall be maintained at this separation for a period of 5 ± 2 seconds, after which the specimen shall be immediately released from the lower tensile machine jaw and permitted to contract naturally. Sixty ± 5 seconds after specimen release, the benchmark separation shall be measured, within an accuracy of ± 1/64 inch. This measured benchmark separation shall be recorded, and this test then repeated, using a different specimen of the same material each time, until the specified number of specimens (see 4.5.14.1) have been tested. The specimen set shall then be calculated by using the following formula:

Set, in inches Median value of (L - 2) for all tested specimens.

Where: L = Measured benchmark separation on the specimen following contraction, in inches.

4.5.15 Stress endurance. This test shall determine the ability of completed cable, which is intended for use by divers, to withstand repeated traveling bends, such as might be encountered during in-service cable payout and retrieval.

4.5.15.1 Specimen. The specimen shall consist of a piece of completed cable, which shall have sufficient length for use in the test as specified in 4.5.15.3.

4.5.15.2 Special apparatus. Apparatus shall include the following:

(a) Test apparatus: mechanism for drawing the specimen alternately back and forth, for a distance of not less than 18 inches in each direction, around a pulley,

while maintaining the specimen under tension. The pulley shall have a diameter of not more than 3 inches, and the specimen shall seat within the pulley periphery over an arc of not less than 90 degrees at all times during the test. Specimen tension shall be maintained by means of freely suspended weights attached to the specimen end opposite that being drawn. A 490 ± 5 pound weight shall be used alternately with a 180 ± 5 pound weight as specified in 4.5.15.3.

(b) Voltage withstand test apparatus shall be as specified in 4.6.5.2.

4.5.15.3 Procedure. The specimen shall be drawn alternately back and forth in the test apparatus for a total of not fewer than 500 cycles (where each cycle shall consist of not less than 18 inches of specimen travel in each direction, a total travel per cycle of not less than 36 inches). The 490 ± 5 pound weight shall be attached to the specimen end during each even numbered cycle. The specimen shall be draw through the pulley at the same constant rate and for the same distance in each direction during each cycle. Following this cycling, the specimen shall be removed from the test apparatus.

4.5.15.4 Observation. Specimen failure shall be construed if the specimen exhibits visible distortion or jacket cracking. If the specimen exhibits no visible distortion or jacket cracking, it shall be further tested as specified in 4.5.15.5.

4.5.15.5 Further procedure (may not be required, see 4.5.15.4). The specimen shall be subjected to the voltage withstand test as specified in 4.6.5. Following this, the region of the specimen, which had been drawn back and forth across the pulley of the test apparatus, shall be dissected, and each of its components visually inspected for deterioration.

4.5.15.6 Further observation. Any of the following shall constitute specimen failure:

(a) Specimen fails the voltage withstand test (see 4.6.5.4).

(b) Specimen, upon dissection and inspection, exhibits visible distortion or cracking of any specimen component, including strand breakage on the steel strength member or on any conductor, or exhibits any other visible deterioration of such a nature or extent as to impair the performance of the cable in service.

4.5.16 Visual and dimensional examination. This test shall be to determine whether or not completed cable is assembled in accordance with the requirements of this specification.

4.5.16.1 Specimen. The specimen shall consist of an entire and continuous ordered length of completed cable.

4.5.16.2 Procedure. The specimen shall be examined and measured, as required, to determine conformance with overall jacket dimension, jacket color, surface marking, surface condition, and jacket repair requirements, as applicable (see 3.1, 3.3, 3.4 and 3.7). A portion of the specimen shall then be dissected, and each of its constituent components counted, examined and measured, as required, to determine conformance with all constructional, dimensional, material, and identification, color, and insulation repair requirements as applicable (see 3.1, 3.3, 3.4 and 3.7). Following this, and following installation of end seals on the specimen, these end seals shall be examined to determine conformance with materials.

4.5.16.3 Observation. Specimen failure shall be construed if the specimen, its assembly or any of its constituent components is not as specified (see 3.1, 3.3, 3.4 and 3.7).

4.5.17 Watertightness. This test shall determine the ability of completed cable, which is intended to pass through watertight bulkheads, to prevent the longitudinal flow of low-pressure water.

4.5.17.1 Specimen. The specimen shall consist of a 60 ± 2 inch length of completed cable. The specimen shall be cut to length using a scissors-action cable cutter. (Saws shall not be used.)

4.5.17.2 Special apparatus. Apparatus shall include the following:

(a) A source of pressurized water, which shall be provided at a regulated pressure of 25 ± 1/2 lb/in^2 and which shall be for use with the terminal fitting (see (b)) as specified in 4.5.18.3.

(b) A metal terminal fitting which applies the source of pressurized water to one end of the specimen, which supports the requirements as specified in 4.5.18.3, and which shall be fabricated as specified in the following. Figure 7 shows one possible arrangement for the terminal fitting. The fitting shall admit the specimen end for the distance specified in 4.5.18.3, and shall have an id, where it fits over the specimen of not greater than the measured overall specimen diameter plus 1/2 inch. The fitting shall have a means for introducing the source of pressurized water to the specimen end, and a means for bleeding off any air, which might be trapped between the specimen end and the source of pressurized water. The fitting shall also have an aperture for introducing a hardening sealant (see (c)), to produce a pressure-tight bond between the fitting and the specimen jacket. A plug (such as a thick wrapping of rubber tape around the specimen) shall be provided at the place where the specimen enters the fitting, to prevent sealant loss and to approximately center the specimen within the fitting.

(c) A liquid hardening sealant, which shall be for producing a pressure-tight bond between the fitting and the specimen jacket, when applied as specified (see 4.5.17.3) and allowed to harden. The sealant shall be at a temperature of not greater than 100°C when poured into the terminal fitting, and shall not expand in volume while hardening. An appropriate metal alloy is recommended as a sealant since it can be remelted and reused. Any metal alloy used shall have a melting point of not greater than 88°C.

4.5.17.3 Procedure. The specimen shall be secured in a vertical position, the terminal fitting (including the plug) shall be fitted over its upper end, and the hardening sealant shall be poured through the appropriate terminal fitting aperture to bond the fitting to the specimen. This shall be done such that the specimen is approximately centered within the terminal fitting, such that not more than a 6-inch length of specimen jacket is exposed to the sealant, such that the end face of the specimen is located a distance of not more than 1 inch above the sealant surface and itself contains no sealant, and such that the aperture through which the sealant was introduced is itself made pressure-tight. The sealant shall be allowed to harden, following which the terminal fitting plug shall be removed or cut away to the extent that it exerts no radial compression on the specimen. The specimen shall then be positioned such that it is straight, and such that no portion of the specimen is at a greater elevation than the specimen end within the terminal fitting. The fitting shall then be connected to the source of pressurized water, and

excess air within the fitting shall be bled off until it can be certain that the entire enclosed specimen end face is exposed to the pressurized water for the remainder of the test. The source of pressurized water shall remain connected to the fitting for a continuous period of 6 plus 1/4, minus 0 hours. During this test period, water (if any) 1eaking from the specimen end opposite the terminal fitting shall be collected into an initially dry container. Following the test period, the volume of this collected water shall be measured.

4.5.17.4 Observation. Specimen failure shall be construed if the collected water volume exceeds that shown on table XIII.

TABLE XIII. Limits for water leakage.

Sum of specified cross sections of all specimen conductors (see 3.1) (circular mils)	Collected water volume, (in^3) (maximum)
Less than 9,001	4
9,001 to 15,000	5
15 ,001 to 25,000	6
25,001 to 50,000	8
50,001 to 100,000	9
100,001 to 200,000	10
200,001 to 500,000	11
500,001 to 800,000	12
800,001 or greater	13

4.5.18 Weathering. Jacket material shall be subjected to 720 hours of the xenon arc lamp weathering resistance test in accordance with Section 1200 of UL standard 1581.

4.6 Tests methods (electrical).

4.6.1 Attenuation. This test shall determine the ability of completed cable, which is intended for the transmission of data, voice or control information, to propagate a signal at a specific frequency without causing an unacceptable reduction of signal amplitude.

4.6.1.1 Specimen. The specimen shall consist of a piece of completed cable, which shall have sufficient length to exhibit an electrical attenuation of not less than 3 decibels (dB) at the specified test frequency (see 3.1). Individual transmission lines within this specimen (where each single insulated conductor plus surrounding shield or each insulated conductor pair plus surrounding shield is considered to be a transmission line) shall be selected for testing as follows:

(a) Specimens containing four or fewer transmission lines: every transmission line shall be tested.

(b) Specimens containing more than four but fewer than 21 transmission lines: four different transmission lines shall be tested. Not fewer than one of these transmission lines shall be selected from each concentric cabling layer within the specimen.

(c) Specimens containing 21 or more transmission lines: the number of transmission lines tested shall be equal to the square root (rounded, if necessary,

to the nearest whole number) of the total number of transmission lines. Not fewer than one of these transmission lines shall be selected from each concentric cabling layer within the specimen.

An electrical connector, which shall be designed for use at the specified test frequency (see 3.1), and which shall be appropriate for use with the specimen, shall be attached to each end of each transmission line selected for testing.

4.6.1.2 ~~Special apparatus~~. Apparatus shall include the following, and shall be used at the specified test frequency (see 3.1), and shall be chosen such that all electrical interconnections (see 4.6.1.3) shall be of the same nominal characteristic impedance throughout (except that connectors and specimens in which a single conductor plus surrounding shield is tested may be of a different impedance than this apparatus, if necessary).

(a) A sinusoidal signal generator, which shall produce an unchanging signal of the specified test frequency (see 3.1) within a frequency accuracy of 0.25 percent. The signal generator may be amplitude modulated in a constant and unchanging manner if the detector (see (b)), requires an amplitude modulated signal for proper operation. The signal generator shall generate power to produce a reasonable indication on the detector when used as specified in 4.6.1.3, however, the signal generator shall not generate so much power that the specimen or any piece of test apparatus will consequently experience a significant temperature rise.

(b) A crystal diode, bolometer or other detector, with its associated indicating device, which shall be used as specified in 4.6.1.3.

(c) A calibrated variable attenuator, which shall produce a maximum attenuation greater than that exhibited by the specimen, and which shall resolve attenuation within an accuracy of ± 0.25 dB.

(d) Two fixed attenuators, each of which shall exhibit an attenuation of not less than 10 dB.

(e) Impedance matching transformers (required only when testing a conductor pair plus surrounding shield): two, two-winding transformers; one winding of each transformer shall have an impedance equal to the nominal impedance of the fixed attenuators; the second winding of each transformer shall be center-tapped, and shall have an impedance equal to the specified impedance of the specimen (see 3.1). When testing a single conductor plus surrounding shield, impedance matching transformers may be used, if necessary, to match the nominal unbalanced impedance of each fixed attenuator (see (d)), to the specified unbalanced impedance of the specimen (see 3.1), as show on figure 8.

(f) An adapter connector (may not be required, see 4.6.1.3) for joining the two fixed attenuators directly together. This adapter connector shall exhibit an attenuation, which shall be not greater than 2 percent of the specimen attenuation. If desired, the adapter connector may be fabricated in the same manner and of the same components as the specimen, except that the shortest practicable length of completed cable shall be used to join the two connectors.

4.6.1.3 Procedure. The test apparatus shall be electrically interconnected as shown on figure 8 (when the transmission line to be tested is a single insulated conductor plus surrounding shield) or as

shown on figure 9 (when the transmission line to be tested is an insulated conductor pair plus surrounding shield), as applicable; one of the selected transmission lines shall then be connected where shown. Following this, the calibrated variable attenuator shall be adjusted to a low value, and the signal generator adjusted to produce a test signal of sufficient amplitude to produce a reasonable indication on the detector. The setting on the calibrated variable attenuator and the indication on the detector shall then be noted. Next, the transmission line shall be disconnected from the test apparatus, and the two fixed attenuators shall be connected together either directly, or, if necessary, by means of an adapter connector. The signal generator shall not be readjusted. The calibrated variable attenuator shall then be readjusted until the detector produces the same indication as was noted when the transmission line was connected to the test apparatus. The new setting on the calibrated variable attenuator shall then be noted, and the transmission line attenuation shall be calculated by using the following formula:

Attenuation, in dB per 100 feet $= 100\,(A_2 - A_1)/L$

Where: A_1 = Initial setting of the calibrated variable attenuator (when the transmission line is connected to the test apparatus), in dB.
A_2 = Final setting of the calibrated variable attenuator (following transmission line removal from the test apparatus), in dB.
L = Measured specimen length, in feet; measurement accuracy shall be within $\pm$ 1 percent.

In an identical manner, the remaining selected transmission lines shall also be tested.

4.6.1.4 Observation. Specimen failure shall be construed if any transmission line exhibits an attenuation which is greater than that specified (see 3.1).

4.6.2 Capacitance. This test shall determine the capacitive characteristics of completed cable

4.6.2.1 Specimen. The specimen shall consist of a 122 $\pm$ 1/2 inch length of completed cable, which shall have overall components (such as jackets or overall binders) removed from each and for a distance of 2 plus 1/2, minus 0 inches, thereby exposing the insulated conductors (and shields, if applicable) at each end of the cable core. Each exposed shield (if any) at each cable end shall he unwrapped from the end of its enclosed insulated conductor(s) for a distance of 1 $\pm$ 1/8 inch; the unwrapped portion of each shield shall then be tightly twisted to form a pigtail for electrical connection. The insulation shall next be stripped from each end of each insulated conductor for a distance of 1/2 $\pm$ 1/8 inch. If the characteristic impedance test is not required (see 3.1), then the insulation may be stripped, for the specified distance from all of the insulated conductors at one specimen end only.

4.6.2.2 Special apparatus. Apparatus shall include an instrument for measuring capacitance (such as a capacitance bridge, Q-meter or other instrument), which shall be for supporting the requirements as specified in 4.6.2.3. This apparatus shall have a two-terminal measurement port, which shall use a sinusoidal wave of the specified frequency (see 3.1) for making measurements, and shall make measurements within an accuracy of $\pm$ 1 percent.

4.6.2.3 Procedure. The appropriate capacitance test method shall be selected and performed from the following:

(a) Specimens incorporating any number of individually shielded, insulated-

conductor transmission lines: one line shall be selected for measurement, and each end shall be positioned such that its conductor and shield shall not come into mutual electrical contact, nor into electrical contact with any other conductor or shield which may be within the specimen. One end of this selected transmission line shall then be appropriately connected electrically to the capacitance measuring instrument, and its capacitance shall be measured. In an identical manner, the capacitance of every other transmission line within the specimen shall also be measured. The capacitance per foot of each transmission line shall then be calculated by using the following formula:

Capacitance in picofarads per foot = C/10

Where: C = Measured capacitance of the transmission line, in picofarads.

(b) Specimens incorporating any number of individually shielded, insulated-conductor-pair transmission lines: one transmission line shall be selected for measurement, and each end shall be positioned such that neither its conductors nor its shield come into mutual electrical contact, or into electrical contact with any other conductor or shield which may be within the specimen. Three capacitances shall then be measured at one end of this transmission line as follows, where one conductor of this line has been designated as conductor number 1 and the other conductor of this line has been designated as conductor number 2 as follows:

(l) Conductor number 1 and the shield shall both be electrically connected to one terminal of the capacitance measuring instrument, and conductor number 2 shall be electrically connected to the other instrument terminal. The capacitance shall then be measured and designated as C_a.

(2) Conductor number 2 and the shield shall next be electrically connected to one terminal of the capacitance measuring instrument, and conductor number 1 shall be electrically a connected to the other instrument terminal. The capacitance shall then be measured and designated by C_b.

(3) Both conductor number 1 and conductor number 2 shall then be electrically connected to one terminal of the capacitance measuring instrument, and the shield shall be electrically connected to the other instrument terminal. The capacitance shall then be measured and designated as C_c.

The mutual capacitance per foot and, if specified (see 3.1), the capacitance unbalance (sometimes called the coefficient of asymmetry) shall then be calculated by using the following approximate formulas:

Mutual capacitance, in picofarads per foot = $(C_a + C_b)/20 - C_c/40$

Capacitance unbalance, in percent = $10/C_a - C_b/C_m$

Where: C_a, C_b and C_c are as defined in (1), (2) and (3) respectively, in picofarads.
C_m = Calculated mutual capacitance, in picofarads per foot.

In an identical manner, the mutual capacitance and, if specified (see 3.1), the capacitance unbalance of every other transmission line shall also be measured and calculated.

(c) Specimens incorporating multiple, unshielded, insulated-conductor-pair transmission lines: the mutual capacitance and, if specified (see 3.1), the capacitance unbalance of every transmission line shall be determined, using the same method as used for specimens incorporating individually-shielded, insulated-conductor-pair transmission lines, with the following change: the overall specimen braid (if any) and all specimen conductors except the conductor pair under test shall be connected together electrically and considered to be the shield of the transmission line under test.

(d) Specimens incorporating any number of individually shielded, insulated-conductor-triad transmission lines: one transmission line shall be selected for measurement, and each end shall be positioned such that none of its conductors, nor its shield, come into mutual electrical contact, nor into electrical contact with any other conductor or shield which may be within the specimen. Four capacitances shall then be measured at one end of this transmission line as follows, where one conductor of this line has been designated as conductor number 1, another conductor of this line has been designated as conductor number 2, and the remaining conductor of this line has been designated as conductor number 3 as follows:

(1) Conductors number 2 and 3 and the shield shall be electrically connected to one terminal of the capacitance measuring instrument, and conductor number 1 shall be electrically connected to the other instrument terminal. The capacitance shall then be measured and designated as C_a.

(2) Conductors number 1 and 3 and the shield shall next be electrically connected to one terminal of the capacitance measuring instrument, and conductor number 2 shall be electrically connected to the other instrument terminal. The capacitance shall then be measured and designated as C_b.

(3) Conductors number 1 and 2 and the shield shall next be electrically connected to one terminal of the capacitance measuring instrument and conductor number 3 shall be electrically connected to the other instrument terminal. The capacitance shall then be measured and designated as C_c.

(4) Conductors number 1, 2 and 3 shall then be electrically connected to one terminal of the capacitance measuring instrument, and the shield shall be electrically connected to the other instrument terminal. The capacitance shall then be measured and designated as C_d.

The mutual capacitance per foot and, if specified (see 3.1), the capacitance unbalance (sometimes called the coefficient of asymmetry) shall then be

calculated by using the following approximate formulas:

a. $$C_m = \frac{C_a + C_b + C_c}{40} - \frac{C_d}{120}$$

b. The capacitance unbalance or coefficient of asymmetry (K) of a shielded triad, expressed in percent shall be the greatest of K_1, K_2 or K_3 and shall be determined by the formula:

$$K_1 = \frac{200(C_a - C_b)}{(C_a + C_b)}$$

$$K_2 = \frac{200(C_a - C_c)}{(C_a + C_c)}$$

$$K_3 = \frac{200(C_b - C_c)}{(C_b + C_c)}$$

Where: K_1 = The percent of capacitance unbalance of conductor No. 1 in relation to conductor No. 2.
K_2 = The percent of capacitance unbalance of conductor No. 2 in relation to conductor No. 3.
K_3 = The percent of capacitance unbalance of conductor No. 3 in relation to conductor No. 1.

Note: In the formula, the relative positions of C_a, C_b and C_c may be transposed as necessary to avoid negative values.

In an identical manner, the mutual capacitance and, if specified (see 3.1), the capacitance unbalance of every other transmission line shall also be measured and calculated.

(e) Specimens incorporating multiple unshielded insulated conductor triad lines: the mutual capacitance and, if specified (see 3.1), the capacitance unbalance of every transmission line shall be determined, using the same method as used in (d), with the following change: the overall specimen braid (if any) and all specimen conductors except the conductor triad under test shall be connected together electrically and considered to be the shield of the transmission line under test.

4.6.2.4 Observation. Specimen failure shall be construed if the specimen exhibits a mutual capacitance or capacitance unbalance which is greater than that specified (see 3.1).

4.6.2.5 If the characteristic impedance test is specified (see 3.1), then the specimen shall be retained for use in that test.

4.6.3 Characteristic impedance. This test shall determine the characteristic impedance encountered by signals propagating along the completed cable. The mutual capacitance (see 4.6.2) shall be calculated for each transmission line within the completed cable prior to performing the characteristic impedance test. This is necessary since values of mutual capacitance are used to calculate values of characteristic impedance.

4.6.3.1 Specimen. The specimen shall be that which was previously used to determine capacitance characteristics (see 4.6.2.1).

4.6.3.2 Special apparatus. Apparatus shall include an instrument for measuring inductance (such as an inductance bridge, Q-meter or other instrument), which shall support the requirements as specified in 4.6.3.3. This apparatus shall have a two-terminal measurement port, which shall use a sinusoidal wave of the specified frequency (see 3.1) for making measurements, and shall make measurements within an accuracy of ± 1 percent.

4.6.3.3 Procedure. Select and perform the appropriate characteristic impedance test method from the following:

(a) Specimens incorporating any number of individually shielded, insulated-conductor transmission lines shall be laid straight. At one specimen end, the exposed conductor of each transmission line shall be electrically connected to the pigtail of its associated shield by tightly twisting both together. At the opposite specimen end, one transmission line shall be selected for measurement, which shall then be connected to the inductance measuring instrument. The inductance of this transmission line shall then be measured. In an identical manner, the inductance of every other transmission line within the specimen shall also be measured. The characteristic impedance of each transmission line shall then be calculated by using the following formula:

$$\text{Characteristic impedance, in ohms} = (10^5 L/C_m)^{1/2}$$

Where: C_m = Mutual capacitance, in picofarads per foot, as calculated in 4.6.2.3.
L = Measured inductance, in microhenries/10 feet.

(b) Specimens incorporating any number of individually shielded or unshielded, insulated-conductor-pair transmission lines shall be laid straight. At one specimen end, the two exposed insulated conductors of each transmission line shall be laid adjacent to each other (to minimize superfluous inductance), and electrically connected by tightly twisting both together. At the opposite specimen end, one transmission line shall be selected for measurement, and its two conductors shall be connected electrically to the inductance measuring instrument. Its shield (if any) shall remain disconnected. The inductance of this transmission line shall then be measured. In an identical manner, the inductance of every other transmission line within the specimen shall also be measured. The characteristic impedance of each insulated conductor pair shall then be calculated by using the formula shown in (a).

4.6.3.4 Observation. Specimen failure shall be construed if the specimen exhibits a characteristic impedance other than that specified (see 3.1).

4.6.4 Conductor resistance. This test shall determine whether or not conductors within the completed cable are fabricated from the specified material.

4.6.4.1 Specimen. The specimen shall consist of a piece of completed cable which shall have length to assure that the test as specified in 4.6.4.3 shall be performed with the specified accuracy (see 4.6.4.2). Individual conductors within the specimen shall be selected for testing as follows:

(a) Conductors with cross sections of less than 1400 circular mils shall all be tested.

(b) Conductors with cross sections of 1400 circular mils or more - conductors shall be selected for testing as follows:

(1) Specimens containing four or fewer such conductors: every such conductor shall be tested.

(2) Specimens containing more than four but fewer than 21 such conductors: not fewer than four such conductors shall be tested.

(3) Specimens containing 21 or more such conductors: the number of such conductors tested shall be equal to the square root (rounded, if necessary, to the nearest whole number) of the total number of such conductors.

4.6.4.2 Special apparatus. Apparatus shall include an instrument for measuring resistance (such as a Kelvin-type double bridge, a milliohmmeter or a Wheatstone bridge), which shall support the requirements as specified in 4.6.4.3, and which shall make measurements within an accuracy of ± 1 percent.

4.6.4.3 Procedure. Each selected specimen conductor shall be tested in accordance with ASTM B 193 (except as otherwise specified herein).

4.6.4.4 Observation. Specimen failure shall be construed if any specimen conductor exhibits a conductor resistance in excess of that specified (see 3.1).

4.6.5 Voltage withstand. This test shall determine the ability of the completed cable to withstand overvoltages without exhibiting electrical discharge through insulation or jacketing material, either between conductors, or between these conductors and any conducting material, which may be in contact with the surface of the cable during in-service use.

4.6.5.1 Specimen. The specimen shall consist of an entire and continuous ordered length of completed cable.

4.6.5.2 Special apparatus. Apparatus shall include the following:

(a) An adjustable voltage source, which shall be in accordance with either of the following, (see 3.1).

(1) An ac voltage source which shall produce a single-phase, approximately sinusoidal voltage under all test conditions, which shall have a frequency of not more than 100 Hz, and which can be adjusted to the specified rms magnitude (see 3.1). This source shall have the capacity to provide an effective power of not less than 5 kVA, and shall incorporate an overload relay which shall reduce the source voltage to zero whenever an applied load (that is, the specimen, see 4.6.5.3) attempts to draw electrical current to exceed this effective power capacity.

(2) A source of dc voltage which can be adjusted to the specified magnitude (see 3.1), and which shall have the capacity to provide an electrical current of not less than 1/4 A. This source shall incorporate an overload relay, which shall reduce the source voltage to zero whenever an applied load (that is, the specimen, see 4.6.5.3) attempts to draw electrical current to exceed this current capacity.

(b) When required, a water tank, filled with water, of sufficient size to contain the specimen, shall be used as specified in 4.6.5.3(d) (may not be required, see 4.6.5.3(d).

4.6.5.3 Procedure. The voltage source shall be electrically connected to the specimen as specified (see (a), (b), (c) and (d)). For each connection, the test voltage from the voltage source shall be increased, in a uniform manner, from 0 V to the specified voltage (see 3.1) during a period of not more than 60 seconds nor less than 10 seconds, except that specified voltages of less than 600 V may be applied instantaneously. (This gradual voltage application is generally necessary to prevent a current in rush, and the consequent tripping of the voltage source overload relay caused by specimen capacitance.) This specified voltage shall then be maintained for a period of 1 plus 1/2, minus 0 minute (unless the voltage source overload relay trips, see 4.6.5.4), following which the test voltage shall be reduced to zero at approximately the same rate as which it was applied.

(a) Specimens incorporating one or more individually shielded, insulated-conductor transmission lines: one transmission line shall be selected for measurement. One conductor of this transmission line shall be electrically connected to one terminal of the voltage source, and the shield and all other conductor(s) (if any) of this transmission line shall be electrically connected to the other voltage source terminal. The voltage withstand test shall then be performed as specified. In a similar manner, the voltage withstand test shall be performed between each remaining conductor in this transmission line (if any) and the short circuited combination of all other conductors (if any) plus the shield in this transmission line. Following this, and in an identical manner, the voltage withstand test shall be performed on all remaining transmission lines with the specimen. (Additional measurements may be required, see (c) and (d).)

(b) Specimens incorporating multiple insulated conductors without individual shields: one insulated conductor shall be selected and electrically connected to one terminal of the voltage source. Other specimen conductors, including the overall shield (if any) shall be electrically connected to the other voltage source terminal. The voltage withstand test shall then be performed as specified. In a

similar manner, the voltage withstand test shall be performed between each remaining conductor within the specimen and the short-circuited combination of all other conductors plus the overall shield (if any). If the specimen incorporates an overall shield, then the voltage withstand test shall additionally be performed between the shield and the short-circuited combination of all remaining conductors. (Additional measurements may be required, see (d).)

(c) Specimens incorporating one or more individually shielded insulated-conductor transmission lines (these measurements shall be required only when shield-to-shield measurements are specified, see 3.1): one shield shall be selected and electrically connected to one terminal of the voltage source. Other specimen shields shall be electrically connected to the other voltage source terminal, and the voltage withstand test shall then be performed as specified. In a similar manner, the voltage withstand test shall be performed between each remaining shield within the specimen and the short-circuited combination of all other shields.

(d) All specimens (these measurements shall be required only when measurements to water or to ground are specified, see 3.1) the specimen shall be submerged, except for its extreme ends (which shall remain exposed to the air), in the water tank for a period of not less than 1 hour. Following this, and while the specimen is still submerged, the specimen shall be tested as follows. The overall specimen shield (if any), or if there is no overall shield, all individual shields which are outermost in the specimen core plus all unshielded conductors which are outermost in the specimen core, shall be electrically connected to one terminal of the voltage source. The other voltage source terminal shall be electrically connected to the water surrounding the specimen (as by means of a bare metal wire which is both connected to the voltage source terminal and suspended within the water surrounding the specimen). The voltage withstand test shall then be performed as specified.

(e) Specimens incorporating single or multiple insulated conductors without shield shall be tested to water. The specimen shall be submerged, except for its extreme ends (which shall remain exposed to the air), in the water tank for a period of not less than 1 hour. While the specimen is still submerged, the specimen shall be tested as follows. For single conductors, the conductor shall be electrically connected to one terminal of the voltage source. The other voltage source terminal shall be electrically connected to the water surrounding the specimen (as by means of a bare metal wire, which is both connected to the water surrounding the specimen). For multiple conductor cables on insulated conductor shall be selected and electrically connected to one terminal of the voltage source. Other specimen conductors shall be electrically connected to the other voltage source terminal. The voltage withstand test shall then be performed sequentially on each conductor as specified.

4.6.5.4 Observation. Specimen failure shall be construed if the voltage source overload relay trips prior to removal of the test voltage from any specimen connection. If the insulation resistance test is specified (see 3.1), then the specimen shall be retained for use in that test.

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. Cables and specified herein are intended for use in various applications involving naval ships and shore stations.

6.2. Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.
b. Military part number (see 6.8).
c. Type and size of cable or cord required with reference to applicable specification sheet (see 3.1).
d. Packaging (see 5.1)
e. Quantity required (see 6.2.3).

6.2.1 Associated data item descriptions (DIDs). This specification is cited in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), as the source document for the following DIDs. When it is necessary to obtain the data, the applicable DIDs must be listed on the Contract Data Requirements List (DD Form 1423), except where the DoD Federal Acquisition Regulation Supplement exempts the requirement for a DD Form 1423.

DID Number	DID Title
Certification/data report	UDI-A-23264
Inspection system program plan	DI-R-4803
Reports/test	DI-T-2072

The above DIDs were current as of the date of this specification. The current issue of the AMSDL must be researched to ensure that only current and approved DIDs are cited on the DD Form 1423.

6.2.2 Certified test reports. The contractor may prepare test reports in accordance with the data-ordering document (see 6.2). The test report contains the following information:

(a) Manufacturer's QPL number and date or serial number and date of NAVSEA letter of approval.

(b) A statement to the effect that the product was constructed from materials listed on the manufacturer's approved details of construction sheet.

(c) A statement that the product meets all of the requirements of this specification.

(d) Results of all conformance tests showing actual values obtained.

(e) Year and month cable was manufactured.

(f) Serial numbers of the marker tape taken from each end of each length of cable.

(g) Customer's name and contract or order number.

(h) A statement that the product contains no metallic mercury or mercury compounds and are free from mercury contamination.

(i) The serial number of all NAVSEA letters approving deviations from the approved specification slash sheets.

6.2.3 Quantity. The quantity of each type and size on a contract or order should be specified as an integral multiple of the unit ordering length shown by the specification sheet.

6.2.4 Lengths. The range of standard, random, remnant and scrap lengths for each nominal length is shown in table III. In order to compensate for handling and probable loss on issue, remnant lengths are subject to the price reductions specified in table III. Scrap lengths are not acceptable. It is not intended that items being acquired in exact lengths for a specific job or ship will necessarily be shipped in lengths which are integral multiples of the unit ordering length or that price reductions will apply in the event that exact footages or fractional lengths are required and so indicated in acquisition of cable other than stock purposes.

6.3 Special clause. Except when small quantities are to be purchased, invitations for bid and contracts or orders should specify the following:

"In order to compensate for handling and probable loss on issue, remnant lengths will be subject to the price reductions specified in table III. In order that the number of lengths be kept to a minimum consistent with good manufacturing practices, for each type end size of cable on the contract or order, not less than 70 percent of the total footage to be shipped will be in standard lengths, and not more than 30 percent may be in any combination of random and remnant lengths. When the total quantity of any one item is six nominal lengths or less, a footage approximately two nominal lengths (in lieu of 30 percent) may be in any combination of random and remnant lengths. When the total quantity of any one item is two nominal lengths or less, the total footage may be in any combination of random lengths."

6.4 Time delay. Comparison inspection will normally require 40 calendar days from the date the sample is sent to the government designated laboratory to the date the inspection results are received by the manufacturer. This time delay should be taken into consideration by a contractor when estimating delivery time.

6.5 Qualification. With respect to products requiring qualification, awards will be made only for products, which are, at the time of award of contract, qualified for inclusion in Qualified Products List

QPL-915 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 the 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 purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, Attn: SEA 05Q, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard DC 20376-5160.

6.6 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate and identity when the equipment is shipped.

6.7 Definitions. For the purpose of the conformance inspection, the sampling terms specified in 6.7.1 through 6.7.4 will apply.

6.7.1 Defective unit. A defective unit is a unit of product from which a specimen that failed to meet one or more requirements was taken.

6.7.2 Sample. A sample is one unit of product selected from an inspection lot.

6.7.3 Specimen. A specimen is an individual length of cable or an individual length of a part of cable which has been taken from a sample.

6.7.4 Unit of product. A unit of product is the unit ordering length as specified on the specification sheet, except that when the unit ordering length is 500 feet, two such lengths will constitute a unit of product. Random and remnant lengths or special order lengths may be added together to equal a unit ordering length. Length tolerances, as given for standard lengths, will apply (see 6.2.4).

6.7.4.1 For electrical test purposes, a unit of product is defined as an electrically continuous splice-free length. This will allow for longer production lengths to be tested electrically prior to preparation for shipment.

6.7.4.2 Lengths longer than the unit ordering lengths (see 3.1) may be supplied when the end user and manufacturer agree. These lengths are as specified in 6.7.4.1.

6.8 Part or identifying number (PIN). The PINs to be used for electrical cable acquired to this specification are created as follows:

M	**915**	**/XX-**	**X-X**
Prefix for Military Specification	Specification Number	Specification Sheet Number	Type and Size (See individual Specification Sheets)

Example: M915/8-DSS-2

6.9 Subject term (key word) listing.

Binder
Conductor
Filler
Insulation
Jacket
Separator
Shield
Strand

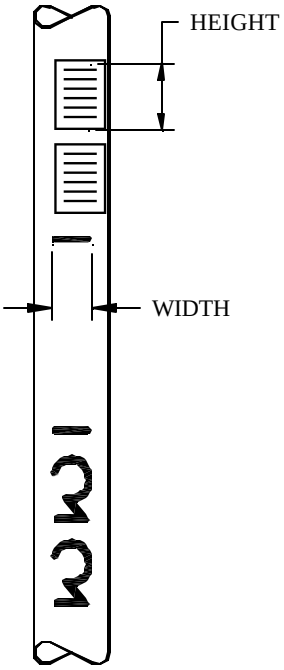

FIGURE 1. Conductor of pair number 33.

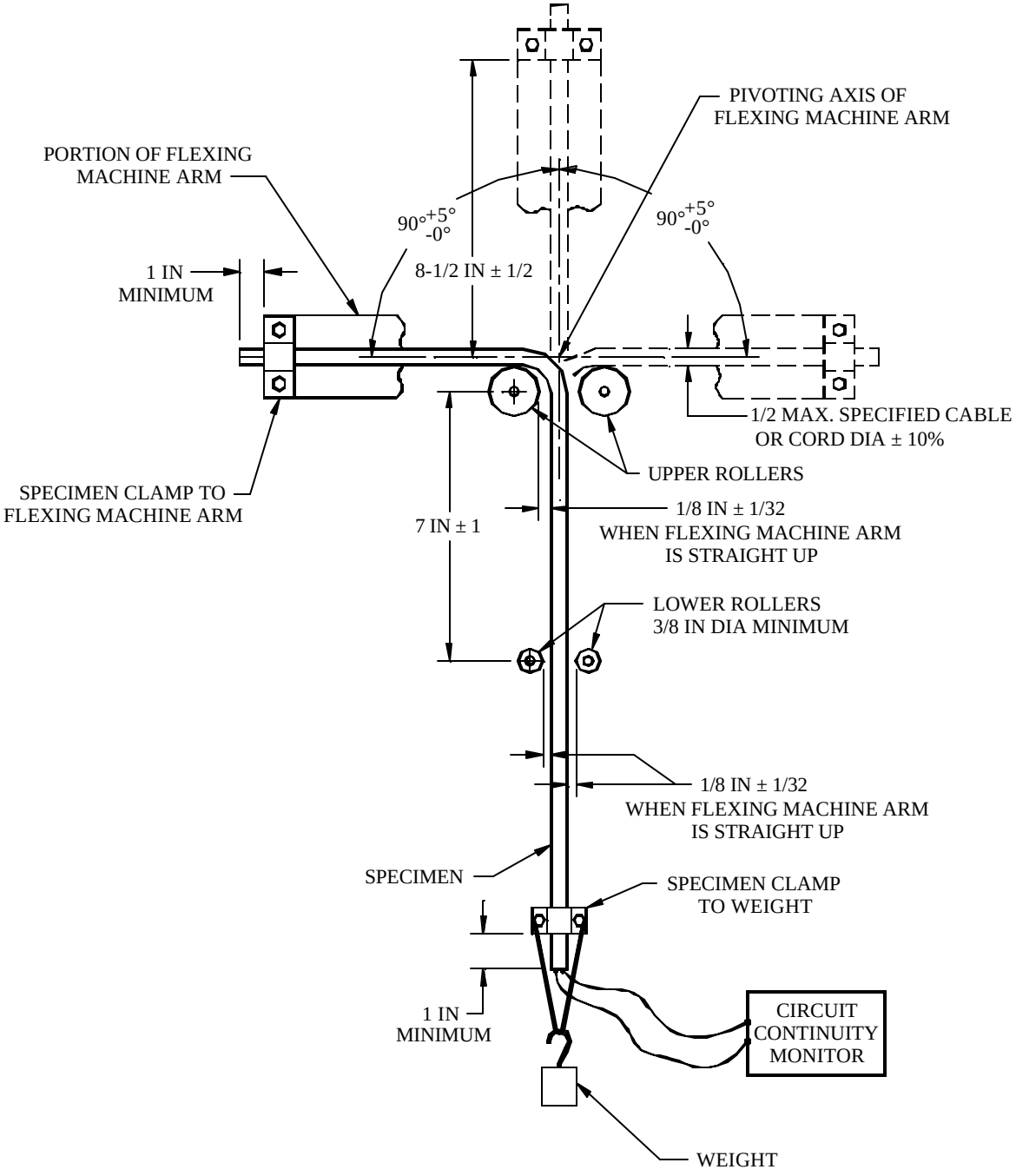

FIGURE 2. Diagram of flexing machine for the bending endurance test.

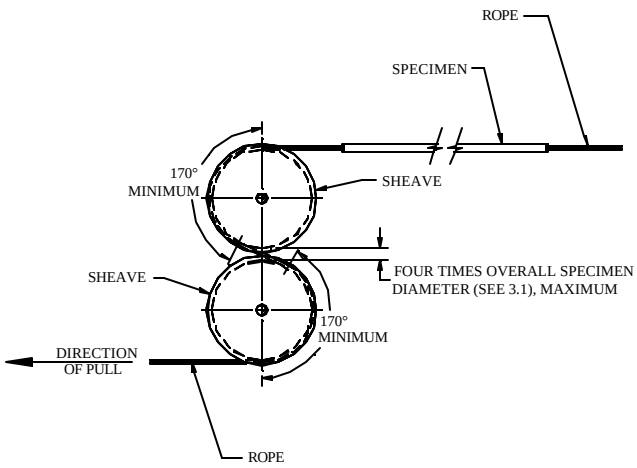

FIGURE 3. Diagram of bending apparatus for the cold working (minus 20°C) test.

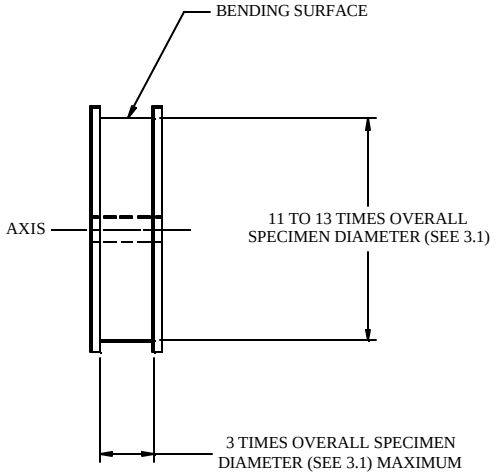

FIGURE 4. Edge view of either sheave for the bending apparatus of the cold working (minus 20°C) test.

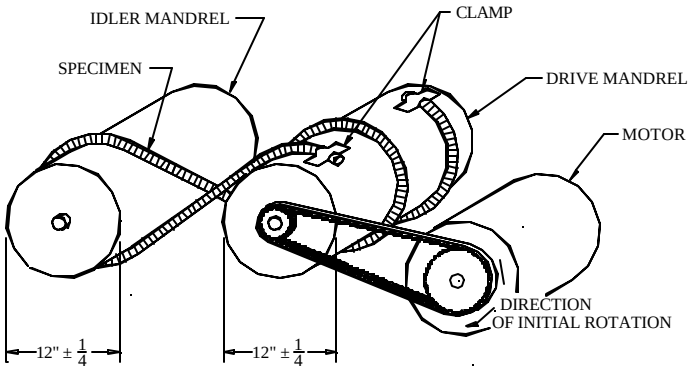

FIGURE 5. Diagram of bending apparatus for the cold working (minus 54°C) test.

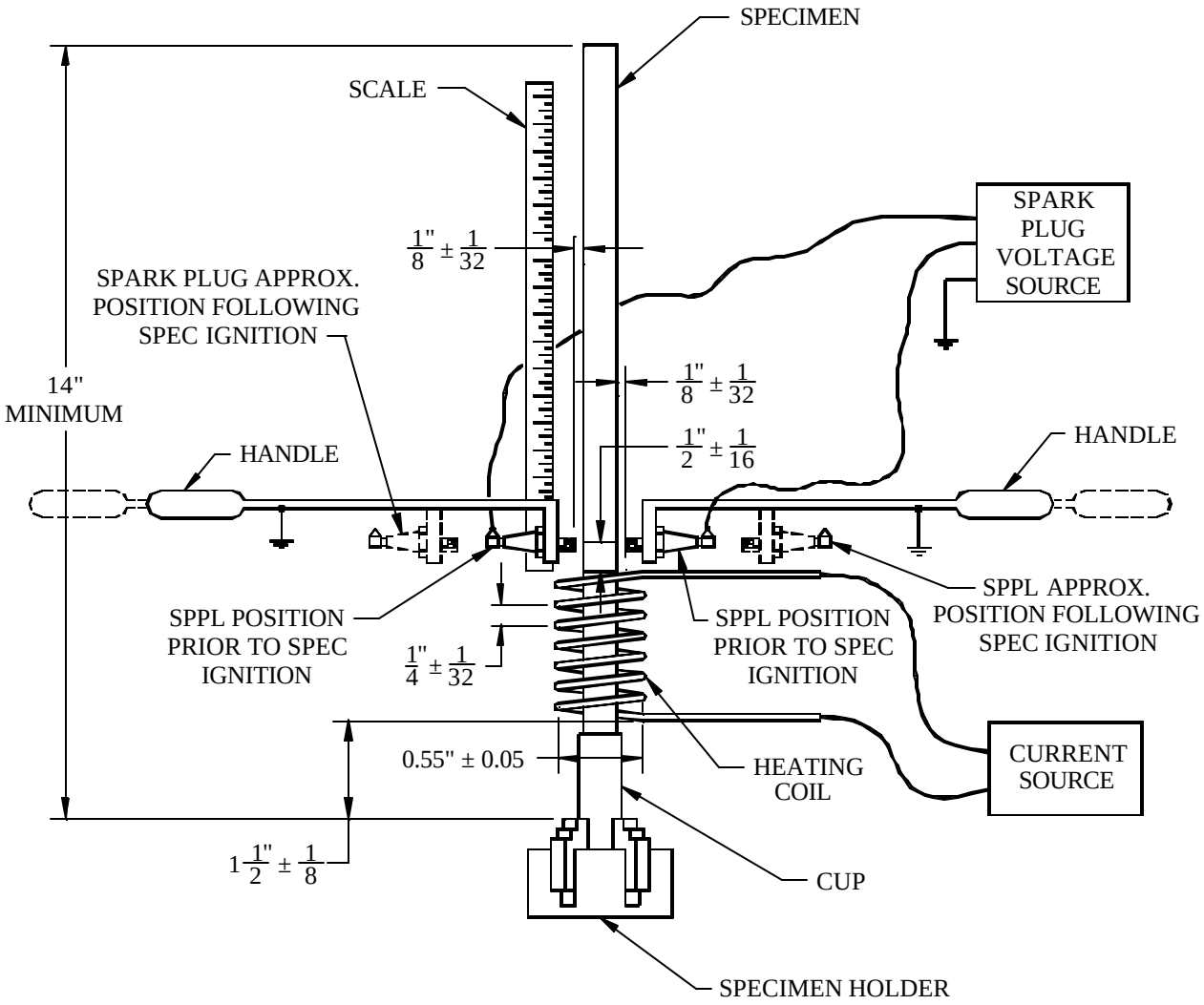

FIGURE 6. Diagram of flammability apparatus for flammability test.

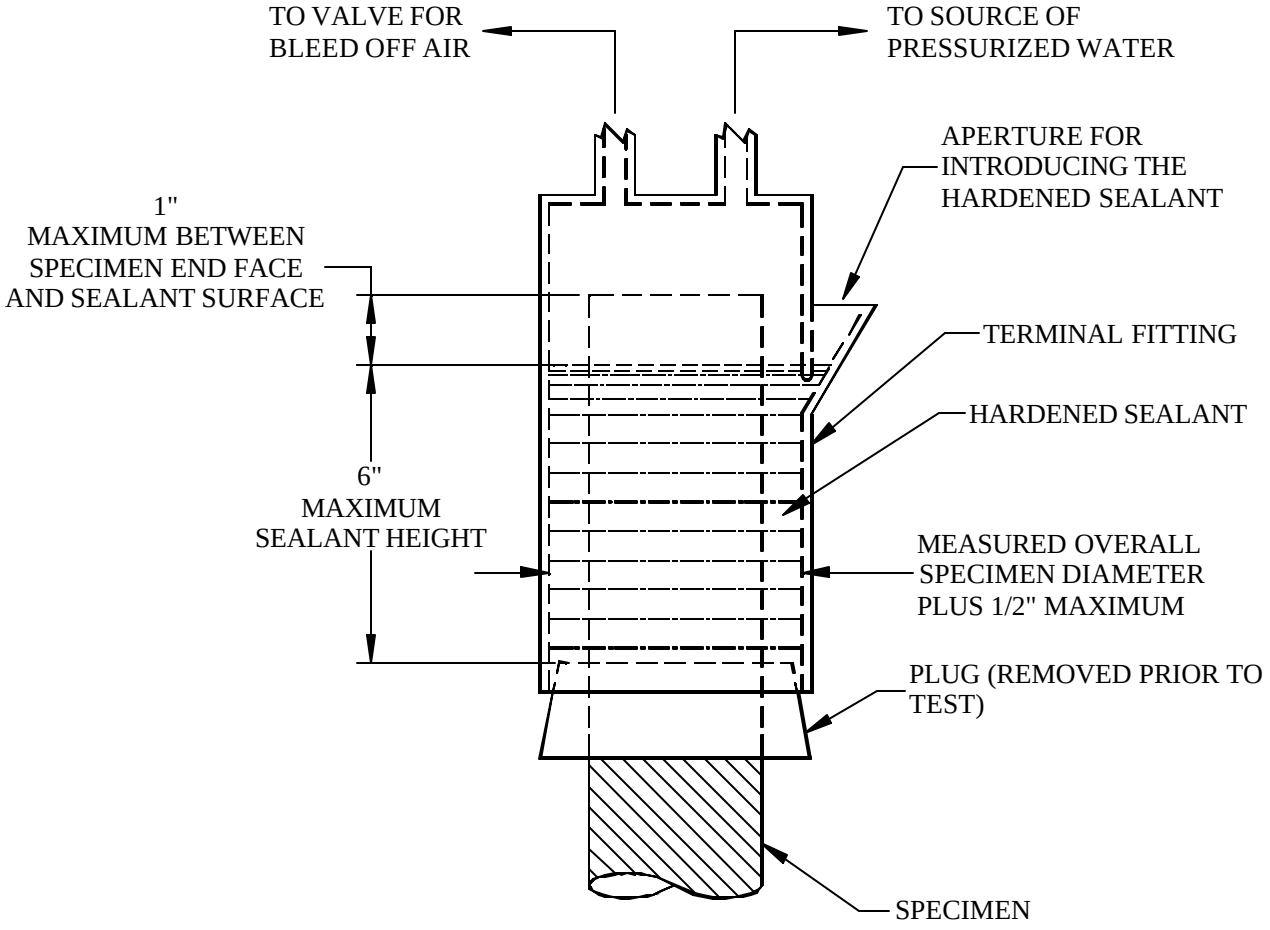

FIGURE 7. Diagram of terminal fitting, showing internal details, for the watertightness test.

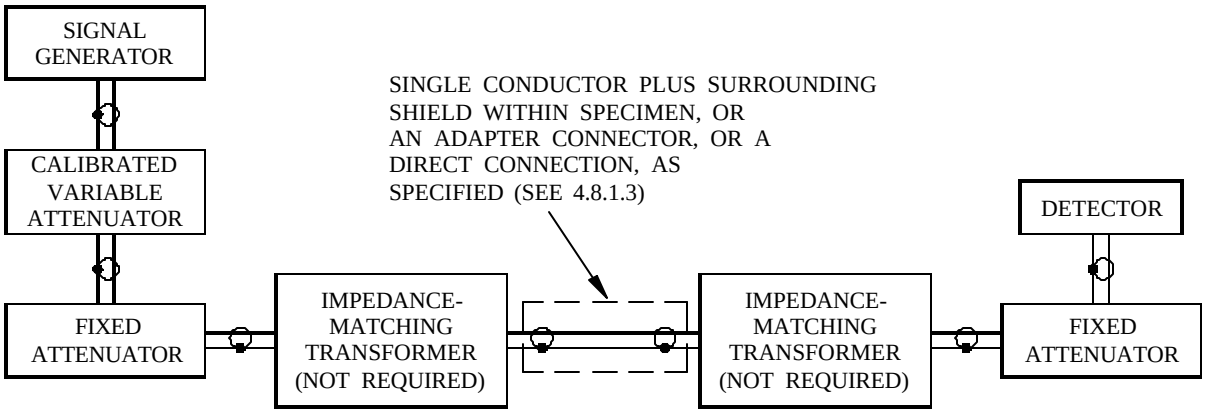

FIGURE 8. Block diagram of electrical connections for the attenuation test when testing a single conductor plus surrounding shield.

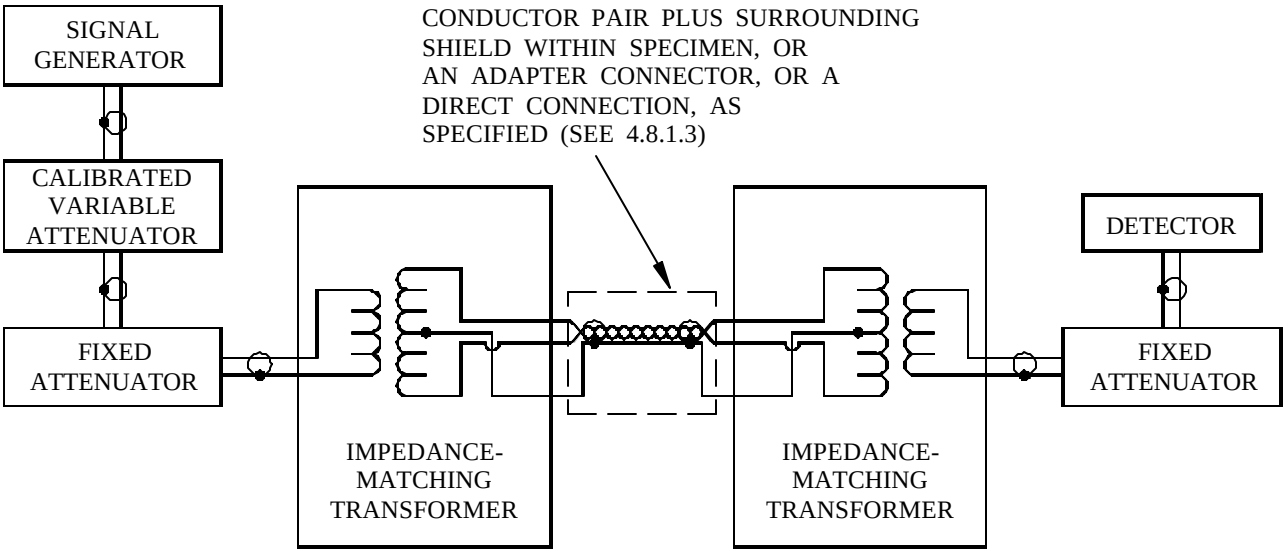

FIGURE 9. Block diagram of electrical connections for the attenuation test when testing a conductor pair plus surrounding shield.

Custodians:
Army – MI
Navy – SH

Review activities:
Army – AR, CR
Navy - CG, EC
DLA - CC

Preparing activity:
Navy - SH
(Project 6145-2317-000)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4,5,6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of this form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. 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.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-DTL-915G	2. DOCUMENT DATE *(YYMMDD)* 22 AUGUST 2002

3. DOCUMENT TITLE

Cable, Electrical, for Shipboard Use, General Specification for

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last. First. Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(if applicable)*	7. DATE SUBMITTED *(YYMMDD)*

8. PREPARING ACTIVITY

a. NAME SEA 05Q	b. TELEPHONE *(Include Area Code)* (1) Commercial 202-781-3726	(2) AUTOVON 326-3726
c. ADDRESS *(Include Zip Code)* Commander, Naval Sea Systems Command ATTN: SEA 05Q 1333 Isaac Hull Avenue, SE, Stop 5160 Washington Navy Yard DC 20376-5160	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	