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By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

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ANSI
UL 1426

UL 1426

STANDARD for SAFETY

CABLES FOR BOATS

UNDERWRITERS LABORATORIES INC.®

UNDERWRITERS LABORATORIES INC.®

an independent, not-for-profit organization testing for public safety

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Reprinted title page for

STANDARD FOR
ELECTRIC CABLES FOR BOATS

UL 1426, FIRST EDITION

Attached is a reprinted title page for the first edition of UL 1426.

As indicated on the reprinted title page, this standard as revised is an American National Standard.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 1426—1987.

Revised and/or additional pages may be issued from time to time.

UL 1426

STANDARD FOR ELECTRIC CABLES FOR BOATS

FIRST EDITION

December 1, 1986

Approval as an American National Standard covers the numbered paragraphs on pages dated December 1, 1986. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the approved test. Revisions of this standard will be made by issuing revised or additional pages bearing their dates of issue.

Approved as ANSI/UL 1426—1987, October 19, 1987

(1—12/1/86)

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

GENERAL

1. Scope

1.1 These requirements cover electric cables for boats. The cables are intended for use in marine pleasure craft and consist of a single insulated conductor without a jacket or of two or more insulated conductors with or without an overall nonmetallic jacket. Each boat cable is rated as follows: 50 or 600 V; 60°C (140°F) or 75°C (167°F°) wet; and 60°C (140°F), 75°C (167°F), 90°C (194°F), or 105°C (221°F) dry. Boat cable dry-rated 125°C (257°F) or 200°C (392°F) may be investigated. A boat cable so marked has insulation (and jacket if a jacket is used) that are for use where exposed to oil at 60°C (140°F) and lower temperatures. Boat cables employ stranded copper conductors that are Nos. 18—4/0 AWG for multiple conductors and Nos. 16—4/0 AWG for single conductors.

1.2 The construction and performance details of single-conductor 50-volt cables are outlined in the Society of Automotive Engineers, Inc. Standard for Battery Cable (SAE J1127), Low-Tension Primary Cable (SAE J1128), and Recommended Practice for Marine-Engine Wiring (SAE J378b). The marking and optional jacket requirements for 50-volt cables, and the complete construction, performance, and marking requirements for single- and multiple-conductor boat cables rated 600 volts are stated in these requirements.

1.3 The ampacity of a boat cable shall be as stated in the US Coast Guard regulations Title 33, Chapter I, Parts 183.430 and 183.435 of the CFR.

CONSTRUCTION

2. Conductors

2.1 The conductors shall be stranded annealed copper, Nos. 18—4/0 AWG. The No. 18 AWG size is limited to a jacketed multiple-conductor cable and shall employ 16 or more strands. All other conductor sizes shall employ 19 or more strands. Conductors may be coated with tin or a tin/lead alloy.

3. Insulation

3.1 The insulation shall be any of the types having a wet rating in the Standard for Thermoplastic-Insulated Wires and Cables (UL 83). In addition, the insulation in a cable that is marked as being oil-resistant shall comply with the requirements for 60°C (140°F) oil resistance in UL 83. The average and minimum-at-any-point thicknesses shall comply with one of the constructions in Table 3.1 or 3.2. Insulated conductors employing other insulation, wall thicknesses, or temperature ratings may be investigated.

TABLE 3.1
INSULATION THICKNESS

Conductor Size	Construction A 75°C (167°F) dry 60°C (140°F) wet		Construction B 90°C (194°F) dry 75°C (167°F) wet		Construction C 90°C (194°F) dry 75°C (167°F) wet	
	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at Any Point	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at Any Point	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at Any Point
	Mils mm	Mils mm	Mils mm	Mils mm	Mils mm	Mils mm
18—10 AWG	30 0.76	27 0.69	30 0.76	27 0.69	45 1.14	40 1.02
8	45 1.14	40 1.02	45 1.14	40 1.02	60 1.52	54 1.37
6—2	60 1.52	54 1.37	60 1.52	54 1.37	60 1.52	54 1.37
1—4/0	80 2.03	72 1.83	80 2.03	72 1.83	80 2.03	72 1.83

TABLE 3.2
INSULATION THICKNESSES

Conductor Size	Construction D 105°C (221°F) dry 75°C (167°F) wet		Construction E 105°C (221°F) dry 75°C (167°F) wet		
	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at Any Point	Minimum Acceptable Average Thickness	Minimum Acceptable Thickness at Any Point	Minimum Acceptable Thickness at Any Point of Nylon Jacket
	Mils mm	Mils mm	Mils mm	Mils mm	Mils mm
18—12 AWG	30 0.76	27 0.69	15 0.38	13 0.33	4 0.10
10	30 0.76	27 0.69	20 0.51	18 0.46	4 0.10
8	45 1.14	40 1.02	30 0.76	27 0.69	5 0.13
6	60 1.52	54 1.37	30 0.76	27 0.69	5 0.13
4—2	60 1.52	54 1.37	40 1.02	36 0.91	6 0.15
1—4/0	80 2.03	72 1.83	50 1.27	45 1.14	7 0.18

4. Grounding Conductor

4.1 A grounding conductor, if provided, shall not be smaller than indicated in Table 4.1.

TABLE 4.1
SMALLEST ACCEPTABLE SIZE OF GROUNDING CONDUCTOR

Size of Largest Circuit Conductor	Minimum Size of Grounding Conductor
18 AWG	18 AWG
16	16
14	14
12	12
10—8	10
6—3	8
2—2/0	6
3/0—4/0	3

5. Color Coding

5.1 Color coding of conductors is not specified, but boat cable that is also for use as a type of wire other than boat cable shall comply with the color code requirements in the other category.

6. Conductor Assembly

6.1 Conductors of different sizes may be used in the same cable. The length of lay of the cabled conductors is not specified. The conductors in a 2-, 3-, or 4-conductor cable may be laid parallel to form a flat cable. The use of fillers is optional. The cabled assembly may be enclosed in a braid, tape, or other binder.

7. Nonmetallic Jacket (Optional)

7.1 A jacket of any PVC material (60°C or 140°F oil-resistant PVC if the cable is marked as being oil-resistant) mentioned in the Standard for Flexible Cord and Fixture Wire (UL 62) may be employed over the flat or cabled conductor assembly in a multiple-conductor cable. Single-conductor cable shall not be jacketed. If the conductor insulation is rated for 60°C (140°F) or 75°C (167°F), the jacket shall be of a material having a rating of at least 60°C (140°F). If the conductor insulation is rated for 90°C (194°F) or a higher temperature, the jacket may be of a material having a temperature rating 15°C or 27°F lower than the dry temperature rating of the conductor insulation. The thicknesses of the jacket shall comply with Table 7.1.

TABLE 7.1
MINIMUM ACCEPTABLE THICKNESSES OF JACKET

Calculated Diameter of Assembly under Cable Jacket		Minimum Average Thickness		Minimum Thickness at Any Point	
Inches	mm	Mils	mm	Mils	mm
0—0.700	0—17.78	30	0.76	24	0.61
0.701—1.500	17.79—38.10	45	1.14	36	0.91
1.501—2.500	38.11—63.50	60	1.52	48	1.22
2.501 and larger	63.51 and larger	80	2.03	64	1.63

PERFORMANCE

8. Physical Properties of Insulation and Jacket

8.1 The physical properties of the insulation and jacket taken from finished cable and tested as described in sections 400—480 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords (UL 1581) shall make unaged and aged specimens perform in accordance with the Standard for Thermoplastic-Insulated Wires and Cables (UL 83) for the insulation and in accordance with the Standard for Flexible Cord and Fixture Wire (UL 62) for the jacket.

9. Conductor Corrosion

9.1 Insulation on the conductors shall not corrode the conductors when the cable is subjected to the aging mentioned in paragraph 8.1. See paragraph 500.1 of UL 1581.

10. Heat-Shock Test

10.1 Neither the insulation nor the jacket shall crack or check as a result of being wound onto a mandrel and then heated in air as indicated in paragraph 10.2.

10.2 Specimens of finished cable and of the insulated conductors taken from finished cable are to be wound tightly, with adjacent turns touching, onto metal mandrels. The size of the mandrels and number of turns wound are to be as indicated in Table 10.1 for the test of the individual conductors. For the test of the complete cable, a mandrel five times the measured overall diameter of the complete cable or the length of the minor axis of a flat cable shall be used. The cable is to be wrapped for not less than 180° around the mandrel. The ends of each specimen are to be secured to the mandrels and the assemblies placed in a full-draft circulating-air oven operating at a temperature of 121.0 ± 1.0°C (249.8 ± 1.8°F) for one hour.

TABLE 10.1
MANDREL DIAMETERS AND NUMBER OF TURNS

Size of Conductor	Mandrel Diameter		Number of Turns
	Inches	Millimeters	
18, 16 AWG	0.094	2	4
14	0.131	3	4
12	0.148	4	4
10	0.168	4	4
8	0.228	6	4
6	0.646	16	4
4	0.744	19	4
3	0.802	20	4
2	0.866	22	4
1	1.016	26	4
1/0	1.098	28	180-degree U bend
2/0	1.190	30	80-degree U bend
3/0	1.294	33	180-degree U bend
4/0	1.410	36	180-degree U bend

11. Flexibility Test

11.1 Within 16-96 hours after oven treatment under the conditions described in paragraph 8.1, insulation shall not show any cracks either on the surface or internally when a specimen of finished cable at room temperature is wound onto a mandrel using the method described in paragraphs 13.2 and 13.3. The mandrel diameter shall be as specified in Table 13.1.

12. Deformation Test

12.1 Neither the insulation nor the jacket from finished cable shall decrease more than 50 percent in thickness while at a temperature of $121.0 \pm 1.0°C$ ($249.8 \pm 1.8°F$) under the pressure indicated in Table 12.1.

12.2 One-inch or 25-mm specimens of the finished insulated conductor on which the thickness of insulation (T_1) has been determined by the difference method are to be used for tests of the insulation.

12.3 For tests of the jacket, specimens that are 1 inch by 9/16 inch wide or 25 by 14 mm are to be cut from an 8-inch or 200-mm sample of jacket taken from a length of finished cable, but, before the specimens are cut, the sample is to be buffed (1) to remove all traces of the impressions left by the assembly underlying the jacket, and (2) to make sure that the specimens cut from the sample have a uniform thickness. The thickness (T_1) of the buffed specimen is to be determined (with no weight added) by means of a dead-weight dial micrometer having a flat-faced presser foot 0.250 ± 0.010 inch or 6.4 ± 0.2 mm or 0.375 ± 0.010 inch or 9.5 ± 0.2 mm in diameter. The anvil of the instrument is to be at least 1.5 inches or 38 mm in diameter and is to be parallel to the face of the presser foot.

12.4 Weight is to be added to the spindle of the dial micrometer to make the presser foot exert the force indicated in Table 12.1 on a specimen if a specimen were in place between the foot and anvil. The micrometer, with the presser foot so loaded, is to be placed beside a test specimen in a full-draft circulating-air oven that has been preheated at full draft to a temperature of $121.0 \pm 1.0°C$ ($249.8 \pm 1.8°F$). The specimen and the micrometer are to remain in the oven for one hour of preheating at full draft.

12.5 At the end of one hour, the specimen is to be placed on the anvil directly under the weighted presser foot. The specimen and micrometer are to remain in the heated oven at full draft for an additional hour. At the end of the second hour, the thickness (T_2) is to be read from the dial micrometer. If T_2 is less than half of T_1, the insulation or the jacket is not acceptable.

TABLE 12.1
SPECIMEN LOADING

Size of Specimen	Loading Exerted on Specimen by Presser Foot[a]	
	Grams Force	Newtons
18, 16 AWG	400	3.92
14—8	500	4.90
6—1	750	7.36
1/0—4/0	1000	9.81
Cable jackets	2000	19.61

[a]The specified load is not the weight to be added to the spindle of the dead-weight dial micrometer but rather the total of the weight added and the weight of the spindle. Since the weight of the spindle varies from one dial micrometer to another, specifying the exact weight to be added to the spindle to achieve the specified load on the specimen is impractical in all cases except for an individual instrument.

13. Cold-Bend Test

13.1 Neither the insulation nor the jacket shall crack or check as a result of being cooled in air and then wound onto a mandrel as indicated in paragraphs 13.2 and 13.3.

13.2 Specimens of finished cable and of the insulated conductors taken from finished cable are to be cooled in air to a temperature of $-25.0 \pm 2.0°C$ ($-13.0 \pm 3.6°F$) for 4 hours. While at the low temperature, each insulated conductor is to be wound tightly, with adjacent turns touching, onto a metal mandrel of the diameter indicated in Table 13.1. In the case of a No. 3/0 AWG or smaller conductor, four adjacent turns are to be tightly wound around the mandrel. In the case of a No. 4/0 AWG conductor and the complete cable, a U bend is to be made around the mandrel for not less than 180°. The mandrel diameter used for the complete cable is to be five times the measured overall diameter of a round cable or five times the measured length of the minor axis of a flat cable.

13.3 The mandrels are to be cooled in the chamber with the specimens and for the same length of time. The winding is to be done at low temperature in the chamber if possible; if not, immediately upon removal and at the rate of about 4 seconds per turn. The assemblies of specimens and mandrels are to be removed from the cold chamber and the specimens are to be examined for cracks and checks. Checks are cracks in the inside surface of the insulation or jacket. Checks can show as circumferential depressions in the outer surface of the insulation or jacket.

TABLE 13.1
MANDREL DIAMETER

Size of Conductor	Diameter	
	Inches	mm
18, 16 AWG	0.250	6
14	0.313	8
12	0.375	9
10	0.563	14
8	0.688	17
6	1.250	32
4	1.375	35
3	1.458	37
2	1.563	40
1	2.688	68
1/0	2.875	73
2/0	3.000	76
3/0	3.250	83
4/0	3.500	89

14. Vertical Flame Test (Insulated Conductors)

14.1 A vertical specimen of an insulated conductor shall not flame longer than 60 seconds following five 15-second applications of flame, the period between applications being 15 seconds. The cable shall not convey flame during, between, or after the five applications of flame. The test is to be made as described in section 1060 of UL 1581.

15. Vertical Flame Test (Completed Cable)

15.1 A vertical specimen of the finished cable shall not flame longer than 60 seconds following any of three 60-second applications of flame, the period between applications being 30 seconds. The cable shall not convey flame during, between, or after the three applications of flame. Other than the number and length of application of the flame noted in paragraph 14.1, the test is to be made as described in section 1060 of UL 1581.

16. Mechanical Water Absorption Test

16.1 The insulation on the individual conductors shall not absorb more than 25 milligrams per square inch of exposed surface or 3.8 milligrams per square centimeter of exposed surface for conductors rated 75°C wet, after 168 hours of immersion in tap water at 82.0 ± 1.0°C (179.6 ± 1.8°F), and shall not absorb more than 25 milligrams per square inch of exposed surface or 3.8 milligrams per square centimeter of exposed surface for conductors rated 60°C wet, after 168 hours of immersion in tap water at 70.0 ± 1.0°C (158.0 ± 1.8°F).

16.2 The test is to be made as described in section 1040 of UL 1581.

17. Specific Inductive Capacity Test

17.1 The insulation on the individual conductors shall be such that the capacity and SIC (specific inductive capacity or relative permittivity) of the insulation, when specimens are tested with 1000-hertz essentially sinusoidal current in accordance with paragraphs 17.2—17.4, comply with each of the following:

A. The SIC determined after 24 hours shall not be more than 8.00 for 60°C wet rated conductors, and 10.00 for 75°C wet rated conductors.

B. For all conductors, the capacitance determined after immersion for 14 days shall not be more than 10.0 percent higher than the capacitance after the 24-hour immersion.

C. For all conductors, the capacitance determined after the 14-day immersion shall not be more than 5.0 percent higher than the capacitance determined after immersion for 7 days.

17.2 The capacitance of insulation is to be determined as the average for three specimens after immersion of the specimens for 24 hours, 7 days, and 14 days, respectively, in water at 30.0 ± 1.0°C (86.0 ± 1.8°F) for insulation having a wet temperature rating of 60°C (140°F) and at 75.0 ± 1.0°C (167.0 ± 1.8°F) for insulation having a wet temperature rating of 75°C (167°F).

17.3 The capacitance of the insulation is to be determined at a frequency of 1000 hertz using a capacitance bridge. The potential impressed upon the insulation is not to exceed 10 volts.

17.4 The test is to be made on a 15-foot or 5-meter specimen of finished wire. The center 10-foot or 3048-mm section of the specimen is to be immersed in distilled water for 14 days, with a 30-inch or 762-mm portion at each end kept dry above the water as leakage insulation. The water temperature and the depth of immersion of the specimen are to be the same whenever readings are taken. The specific inductive capacity of the insulation is to be determined after 1, 7, and 14 days by means of the formula

$$SIC = 13{,}600\ C \log_{10} \frac{D}{d}$$

in which C is the capacitance in microfarads of the immersed 10-foot or 3048-mm specimen, D is the diameter over the insulation in inches or mm, and d is the diameter under the insulation in inches or mm.

18. Dielectric Voltage-Withstand Test and Alternatives

18.1 The insulation on the conductors in full-length coils or reels of finished cable shall withstand a 60-second application of the 48—62 Hz essentially sinusoidal potential indicated in Table 18.1. The potential shall be applied successively between each conductor and all of the other conductors connected together. The equipment and the method of test are to be as indicated in section 820 of UL 1581 but the cable is not to be immersed in water.

18.2 For routine production testing at the factory, 15-second rather than 60-second applications may be used, or a spark test may be substituted for the dielectric voltage-withstand test between conductors. If the spark test is used, the insulated conductors are to be spark tested at the voltage specified in Table 18.1, as single conductors before being assembled into the cable, or as twisted groups immediately after being cabled and before being assembled into the cable. The equipment and the method of spark testing are to be as indicated in section 900 of UL 1581.

TABLE 18.1
DIELECTRIC VOLTAGE-WITHSTAND AND SPARK-TEST POTENTIALS

Size of Conductor	Dielectric Voltage-Withstand Test Potential	Spark-Test Potential
18—10	1500 volts	7,500 volts
8—2	2000	10,000
1—4/0	2500	10,000

19. Insulation Resistance Test at 60°F (15.6°C)

19.1 The insulation shall result in the finished cable having an insulation resistance of not less than the number of megohms, based on 1000 conductor feet, or not less than the number of megohms, based on a conductor kilometer, indicated in Table 19.1 when the cable is tested under the following conditions. The cable shall be immersed in tap water at 60.0°F (15.6°C) for not less than 6 hours, following which it shall be tested for insulation resistance while still immersed. This test is to be conducted immediately following the dielectric voltage-withstand test. The coil or coils shall be earth-grounded and completely discharged previous to the measurement of insulation resistance.

19.2 The insulation-resistance test equipment and procedures shall be acceptable and applicable but otherwise are not specified. A megohm bridge used for this purpose shall be of applicable range and calibration, shall present readings that are accurate to 3 percent or less of full scale, and shall have a 125-volt or higher open-circuit potential.

19.3 The sample for the room-temperature test is to be brought out well above the water level in the tank. It is acceptable to dip the bared insulation at the ends in melted paraffin to keep moisture from forming a conductive path from the conductor metal across the surfaces of the insulation and to the water. The coil or reel is then to remain immersed in water for not less than 6 hours before the test is conducted. The water temperature is to be maintained within ±1.0°C (±1.8°F) of being constant at any temperature in the range of 10.0—26.7°C (50.0—80.0°F) for the entire 6-hour or longer immersion previous to the measurement of the insulation resistance (see paragraph 20.1 and note [a] to Table 19.2).

19.4 The temperature of the water in which the coil is immersed has a marked effect upon the insulation resistance and, if the temperature at which the readings are taken (see paragraph 19.3) is other than 60.0°F (15.6°C), the readings are to be multiplied by the applicable correction factor from Table 19.2. One of the four columns in the table is assigned to all PVC insulation compounds. If a compound cannot be made to fit into any of the four patterns (columns), applicable temperature-correction factors are to be determined.

TABLE 19.1
MINIMUM ACCEPTABLE INSULATION RESISTANCE
IN MEGOHMS AT 60.0°F (15.6°C)

Conductor	Based on 1000 Conductor Feet					Based on a Conductor Kilometer				
	Construction					Construction				
	A	B	C	D	E	A	B	C	D	E
18 AWG	195	785	1025	1590	970	65	240	315	485	300
16	170	680	890	1360	815	55	210	275	415	250
14	140	575	765	1150	665	45	180	235	355	205
12	120	485	650	970	560	40	150	200	300	175
10	100	400	550	805	580	35	125	170	250	180
8	105	415	520	835	595	35	130	160	255	185
6	105	435	435	870	495	35	135	135	265	155
4	90	360	360	725	505	30	115	115	225	155
3	80	325	325	655	465	25	100	100	205	145
2	75	295	295	595	415	25	95	95	185	130
1	85	340	340	680	455	30	105	105	210	140
1/0	75	310	310	620	415	25	95	95	190	130
2/0	70	280	280	560	370	25	85	85	175	115
3/0	60	250	250	505	330	20	80	80	155	105
4/0	55	225	225	455	300	20	70	70	140	95

TABLE 19.2
FACTORS FOR CORRECTING INSULATION
RESISTANCE TO 60.0°F (15.6°C)

Temperature[a]		Correction Factor			
°F	°C	I	II	III	IV
50	10.0	0.35	0.42	0.46	0.56
51	10.6	0.39	0.46	0.50	0.59
52	11.1	0.43	0.50	0.54	0.63
53	11.7	0.48	0.55	0.58	0.67
54	12.2	0.54	0.60	0.63	0.70
55	12.8	0.60	0.65	0.68	0.75
56	13.3	0.66	0.71	0.74	0.76
57	13.9	0.73	0.78	0.80	0.84
58	14.4	0.82	0.85	0.86	0.90
59	15.0	0.90	0.92	0.93	0.95
60	15.6	1.00	1.00	1.00	1.00
61	16.1	1.11	1.09	1.08	1.06
62	16.7	1.24	1.19	1.17	1.13
63	17.2	1.38	1.30	1.26	1.19
64	17.8	1.53	1.41	1.36	1.26
65	18.3	1.70	1.54	1.47	1.34
66	18.9	1.88	1.69	1.59	1.42
67	19.4	2.09	1.84	1.72	1.51
68	20.0	2.31	1.99	1.85	1.60
69	20.6	2.57	2.18	2.00	1.69
70	21.1	2.85	2.38	2.17	1.79
71	21.7	3.17	2.59	2.34	1.90
72	22.2	3.52	2.82	2.53	2.02
73	22.8	3.90	3.08	2.72	2.14
74	23.3	4.31	3.35	2.94	2.27
75	23.9	4.78	3.65	3.18	2.40
76	24.4	5.30	3.98	3.43	2.54
77	25.0	5.88	4.34	3.70	2.70
78	25.6	6.51	4.73	4.00	2.86
79	26.1	7.27	5.16	4.33	3.03
80	26.7	8.07	5.61	4.67	3.21
81	27.2	8.98	6.12	5.04	3.40
82	27.8	9.92	6.69	5.45	3.60
83	28.3	11.0	7.28	5.89	3.82
84	28.9	12.2	7.92	6.35	4.05
85	29.4	13.5	8.67	6.84	4.30

[a]The temperature of the water in which the coil or coils are immersed at the time that the insulation-resistance readings are taken is the basis for selection of the temperature-correction factor. If, because of hot or cold weather or local conditions, the temperature of the insulation to be tested differs by more than 5.0°F (2.8°C) from the temperature of the water in which the insulation is to be immersed, the test results after a 6-hour immersion are not accurate unless one of the following is accomplished before insulation-resistance readings are taken:

A. The cable is to be left in the water long enough to attain the same temperature as the water. The water and the cable immersed in it are to be considered to be at the same temperature when three successive measurements of the d-c resistance of the conductor made at 30-minute intervals show no change.

B. The water is to be heated or cooled, as necessary, to within 5.0°F (2.8°C) of the temperature of the cable before the cable is immersed for at least 6 hours.

20. Insulation Resistance Test at Elevated Temperature

20.1 The insulation on the individual conductors of boat cable shall result in the finished cable having an insulation resistance in tap water at 50°C (122°F), for insulation rated 60°C wet, and at 75°C (167°F), for insulation rated 75°C wet, that is not less than the number of megohms based on 1000 conductor feet, or the number of megohms based on a conductor kilometer, specified in Table 20.1, at any time during immersion under the following conditions. The period of immersion shall be 12 weeks or more if the insulation resistance throughout the last 6 weeks of the period is higher than 10 megohms based on 1000 conductor feet or is higher than 3 megohms based on a conductor kilometer. The period of immersion shall be 24—36 weeks if the insulation resistance is less than 10 megohms based on 1000 conductor feet or 3 megohms based on a conductor kilometer but more than the value indicated in Table 20.1. An essentially sinusoidal rms potential of 600 volts at 48—62 Hz shall be applied to the insulation at all times other than while readings of insulation resistance are being taken. See also paragraph 20.3 covering the maximum acceptable rate of decrease of the insulation resistance.

20.2 The values in Table 20.1 apply only to the construction with insulations of the materials and in the thickness indicated in Tables 3.1 and 3.2. For other thicknesses of the same materials, and for other materials in any thickness, the insulation-resistance values are to be calculated by means of whichever of the following formulas is applicable.

Construction A:

$$IR_{50°C} = K_{15.6°C} \times 6.63 \times 10^{-4} \times \log_{10} \frac{D}{d}$$

Construction B and C:

$$IR_{75°C} = K_{15.6°C} \times 6.63 \times 10^{-4} \times \log_{10} \frac{D}{d}$$

Construction D and E:

$$IR_{75°C} = K_{15.6°C} \times 1.74 \times 10^{-4} \times \log_{10} \frac{D}{d}$$

in which IR at 50°C (122°F) or 75°C (167°F) is the insulation resistance in megohms based on 1000 conductor feet at 50°C (122°F) or 75°C (167°F), K is the constant for the insulation material at 15.6°C (60.0°F) in megohms based on 1000 conductor feet, 6.63×10^{-4} is the multiplier necessary for reducing K at 15.6°C (60.0°F) to the value it would have at 50°C (122°F) or 75°C (167°F) for constructions A and B and C, 1.74×10^{-4} is the multiplier necessary for reducing K at 15.6°C to the value it would have at 75°C (167°F) for constructions D and E, D is the diameter over the insulation in inches, and d is the diameter of the metal conductor in inches; or

Construction A:

$$IR_{50°C} = K_{15.6°C} \times 2.02 \times 10^{-4} \times \log_{10} \frac{D}{d}$$

Construction B and C:

$$IR_{75°C} = K_{15.6°C} \times 2.02 \times 10^{-4} \times \log_{10} \frac{D}{d}$$

Construction D and E:

$$IR_{75°C} = K_{15.6°C} \times 5.30 \times 10^{-5} \times \log_{10} \frac{D}{d}$$

in which IR at 50°C (122°F) or 75°C (167°F) is the insulation resistance in megohms based on a conductor kilometer at 50°C (122°F) or 75°C (167°F), K is the constant for the insulation material at 15.6°C (60.0°F) in megohms based on 1000 conductor feet, 2.02×10^{-4} is the multiplier necessary for reducing K at 15.6°C (60.0°F) in megohms based on 1000 conductor feet to the value it would have at 50°C (122°F) or 75°C (167°F) for constructions A and B and C, 5.30×10^{-5} is the multiplier necessary for reducing K at 15.6°C (60.0°F) in megohms based on 1000 conductor feet to the value it would have at 75°C (167°F) based on a conductor kilometer for constructions D and E, D is the diameter over the insulation in millimeters, and d is the diameter of the metal conductor in millimeters. For example, the insulation resistance of a No. 8 AWG wire of construction A with an average thickness of insulation of 0.060 inch would be calculated as follows:

d of No. 8 AWG conductor = 0.146 inch
D = d + 2 x (insulation thickness)
= 0.146 + 2 x (.060) = 0.266 inch

Construction A:

$$IR_{50°C} = K_{15.6°C} \times 6.63 \times 10^{-4} \times \log_{10} \frac{D}{d}$$

$$= 500 \times 6.63 \times 10^{-4} \times \log_{10} \frac{0.266}{0.146}$$

= 0.086 megohm based on 1000 conductor feet

This value rounded down to 0.085 megohms based on 1000 conductor feet would be the requirement for insulation resistance at 50°C (122°F).

20.3 The insulation mentioned in paragraph 20.1 shall also have the effect that, during the extended immersion at 50°C (122°F) or 75°C (167°F), the maximum decrease in insulation resistance per week, as determined from a curve (drawn to represent the average of actual values), for every continuous period of 3 weeks during the latter half of the specified immersion time is not more than 4 percent if and while the insulation resistance on the basis of 1000 conductor feet is 10 megohms or more (3 megohms or more based on a conductor kilometer); and is not more than 2 percent if and while the insulation resistance is less than 10 megohms based on 1000 conductor feet (less than 3 megohms based on a conductor kilometer) but more than the value indicated in Table 20.1.

20.4 To determine whether or not the insulation complies with the requirements in paragraph 20.1 and 20.3, the insulation is to be tested with the apparatus and according to the methods described in paragraphs 19.2—19.4. The ends of a specimen are to be brought well away from the tank, and the temperature of the water is to be maintained at 50.0 ± 1.0°C (122.0 ± 1.8°F) or 75.0 ± 1.0°C (167.0 ± 1.8°F). A coil that shows a greater percent decrease in insulation resistance during the extended immersion than specified in paragraph 20.3 may be tested for additional 1-week immersion periods and judged on the basis of the results for every continuous period of 3 weeks, during the last 12 weeks of immersion, provided that the final insulation resistance is not less than specified in Table 20.1.

TABLE 20.1
MINIMUM ACCEPTABLE INSULATION RESISTANCE IN MEGOHMS

AWG Conductor Size	Based on 1000 Conductor Feet					Based on a Conductor Kilometer				
	Construction					Construction				
	A	B	C	D	E	A	B	C	D	E
18	0.130	0.520	0.680	0.275	0.165	0.015	0.050	0.065	0.030	0.020
16	0.110	0.450	0.590	0.235	0.140	0.015	0.045	0.055	0.025	0.015
14	0.095	0.380	0.505	0.200	0.115	0.010	0.040	0.050	0.020	0.015
12	0.080	0.320	0.430	0.165	0.095	0.010	0.030	0.040	0.020	0.010
10	0.065	0.265	0.365	0.140	0.100	0.010	0.025	0.035	0.015	0.010
8	0.070	0.275	0.345	0.145	0.100	0.010	0.030	0.035	0.015	0.010
6	0.070	0.285	0.285	0.150	0.085	0.010	0.030	0.030	0.015	0.010
4	0.060	0.240	0.240	0.125	0.085	0.010	0.025	0.025	0.015	0.010
3	0.050	0.215	0.215	0.110	0.080	0.010	0.020	0.020	0.015	0.010
2	0.050	0.195	0.195	0.100	0.070	0.010	0.020	0.020	0.010	0.010
1	0.055	0.225	0.225	0.115	0.075	0.010	0.025	0.025	0.015	0.010
1/0	0.050	0.205	0.205	0.105	0.070	0.010	0.020	0.020	0.010	0.010
2/0	0.045	0.185	0.185	0.095	0.065	0.010	0.020	0.020	0.010	0.010
3/0	0.040	0.165	0.165	0.085	0.055	0.010	0.020	0.020	0.010	0.010
4/0	0.035	0.150	0.150	0.075	0.050	0.010	0.015	0.015	0.010	0.010

MARKINGS

21. Tag Marking

21.1 A tag on which the following information is indicated plainly shall be tied to every shipping length of finished cable. However, if the cable is coiled on a reel or is in a carton, the tag may be glued, tied, stapled, or otherwise attached to the reel or carton instead of to the cable, or the tag may be eliminated and the information printed or stenciled directly onto the reel or carton. Other information may be added if it does not confuse or mislead.

A. The name of the cable manufacturer, that manufacturer's trade name for the cable, or both, or any other distinctive marking by means of which the organization responsible for the cable can readily be identified. If the organization that is responsible for the cable is different from the actual manufacturer, both the responsible organization and the actual manufacturer shall be identified by name or by coding such as by trade name, trademark, the assigned electrical reference number, or the assigned combination of colored marker threads. The meaning of any coded identification shall be made available. A private labeler may also be identified.

B. The date of manufacture by month and year.

C. The voltage rating of the cable: "50 volts" or "600 volts". "V" is acceptable in place of "volts".

D. A description of the colored marker threads assigned to identify the organization responsible for the cable if the threads are used in the cable.

E. The temperature rating in degrees C and, if used on the cable, the temperature rating code (see item F of paragraph 22.1).

F. "Boat Cable", "oil resistant", "oil res", or "Oil Resistant I", may be added in the case of cable that complies with the requirements for 60°C (140°F) oil resistance. The temperature rating for the oil resistance shall not be included. Cable that complies with the requirements for oil resistance but is not marked to so indicate is not acceptable for oil-resistant use.

G. The SAE type-letter designation of the cable if the cable is rated for 50 volts (Types SGT, SGR, SGX, GPT, HDT, GPB, HDB, STS, HTS, and SXL).

H. The number and size of conductors if the cable is a multiple-conductor cable.

I. Size of conductor if a single-conductor cable.

22. Cable Marking

22.1 The following information shall be surface-marked (ink, embossing, or indent printing is acceptable) on the surface of a single-conductor cable, individual conductors of a multiple-conductor cable and, where noted, on the overall jacket of a multiple-conductor cable, repeated at least every 24 inches or 610 mm. The embossing or indent printing shall not reduce the wall at any point below the minimum acceptable thickness. Cables that cannot be surface-marked because of the configuration of conductors or the nature of the jacket material employed shall have a marker tape under the jacket indicating the required information. Marker threads are also required for surface-marked cable unless the surface marking is durable when evaluated as described in section 1690 of UL 1581.

A. The name of the cable manufacturer, that manufacturer's trade name for the cable, or both, or any other distinctive marking by means of which the organization responsible for the cable can readily be identified. Also required on the cable jacket of a multiple-conductor cable.

B. AWG size of conductors.

C. The voltage rating of the cable: "50 volts" or "600 volts". "V" is acceptable in place of "volts". Also required on the cable jacket of a multiple-conductor cable.

D. "Boat Cable" or the boat-cable temperature-rating code (see item F). "Oil resistant", "oil res", "Oil Resistant I", or "oil res I" may be added in the case of cable that complies with the requirements for 60°C (140°F) oil resistance. The temperature rating for the oil resistance shall not be included. Cable that complies with the requirements for oil resistance but is not marked to so indicate is not acceptable for oil-resistant use. Also required on the cable jacket of a multiple-conductor cable.

E. The SAE type-letter designation of the cable, if rated for 50 volts (Types SGT, SGR, SGX, GPT, HDT, GPB, HDB, STS, HTS, and SXL).

F. The temperature rating of the cable in accordance with one of the following (boat cable that is additionally acceptable for a use covered by the National Electrical Code must use the temperature-rating code form of temperature marking):

Boat-Cable Temperature Rating	or	Boat-Cable Temperature-Rating Code
60°C dry 60°C wet		BC-1W1
75°C dry 60°C wet		BC-2W1
75°C dry 75°C wet		BC-2W2
80°C dry 60°C wet		BC-3W1
80°C dry 75°C wet		BC-3W2
90°C dry 60°C wet		BC-4W1
90°C dry 75°C wet		BC-4W2
105°C dry 60°C wet		BC-5W1
105°C dry 75°C wet		BC-5W2