UL 1426

STANDARD FOR SAFETY

Electrical Cables for Boats

UL Standard for Safety for Electrical Cables for Boats, UL 1426

Fifth Edition, Dated December 6, 2010

Summary of Topics

This revision of ANSI/UL 1426 dated February 7, 2020 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated November 1, 2019.

No Text on This Page

DECEMBER 6, 2010
(Title Page Reprinted: February 7, 2020)

ANSI/UL 1426-2010 (R2020)

UL 1426

Standard for Electrical Cables for Boats

First Edition – December, 1986
Second Edition – April, 1994
Third Edition – April, 1999
Fourth Edition – December, 2001

Fifth Edition

December 6, 2010

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through February 7, 2020.

The most recent designation of ANSI/UL 1426 as a Reaffirmed American National Standard (ANS) occurred on January 10, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover electrical 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: 600 V; 60°C (140°F), 75°C (167°F), or 90°C (194°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 is for use where exposed to oil at 60°C (140°F) and lower temperatures. Boat cables employ stranded copper conductors that are 18 – 4/0 AWG for multiple conductors and 16 – 4/0 AWG for single conductors.

1.2 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.

2 Units of Measurement

2.1 In addition to being stated in inch/pound units, each numerical requirement in this standard is also stated in units that make the requirement conveniently usable in the metric system (practical SI). Equivalent – although not necessarily exactly identical – results are to be expected from applying a requirement in inch/pound or metric terms. Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

3 References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

CONSTRUCTION

4 Conductors

4.1 The conductors shall be of stranded soft-annealed copper that complies with the American Society for Testing and Materials Standard Specification for Soft or Annealed Copper Wire, ASTM B 3. Conductors shall be 18 – 4/0 AWG. The 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. An 18 or 16 AWG conductor shall comply with the requirements for conductors in the Standard for Fixture Wire, UL 66. A 14 AWG or larger conductor shall comply with the requirements for copper conductors in the Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

5 Insulation

5.1 The insulation shall be any of the PVC insulation materials 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 5.1 or Table 5.2. Insulated conductors employing other insulation, wall thicknesses, or temperature ratings may be investigated.

Table 5.1
Insulation thicknesses – PVC without a nylon jacket

AWG Conductor size	Minimum average thickness		Minimum thickness at any point	
	mils	mm	mils	mm
18 – 10	30	0.76	27	0.69
8	45	1.14	40	1.02
6 – 2	60	1.52	54	1.37
1 – 4/0	80	2.03	72	1.83

Table 5.2
Insulation thicknesses – PVC with a nylon jacket

AWG conductor size	Minimum average thickness		Minimum thickness at any point		Minimum thickness at any point of nylon jacket	
	mils	mm	mils	mm	mils	mm
18 – 12	15	0.38	13	0.33	4	0.10
10	20	0.51	18	0.46	4	0.10
8	30	0.76	27	0.69	5	0.13
6	30	0.76	27	0.69	5	0.13
4, 3, 2	40	1.02	36	0.91	6	0.15
1 – 4/0	50	1.27	45	1.14	7	0.18

6 Grounding Conductor

6.1 A grounding conductor, if provided, shall be bare or fully insulated and shall not be smaller than indicated in Table 6.1.

Table 6.1
Smallest 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

7 Color Coding

7.1 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, if any, in the other category.

8 Conductor Assembly

8.1 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.

9 Shield(s)

9.1 A shield is not required but is acceptable over an individual insulated conductor, over one or several groups of conductors, or over the entire cable assembly, in a cable with a nonmetallic jacket only. Several shields may be used in a given cable.

10 Nonmetallic Jacket (Optional)

10.1 A jacket of any PVC jacketing material (60°C or 140°F oil-resistant PVC if the cable is marked as being oil-resistant) mentioned in the Standard for Flexible Cords and Cables, 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 10.1.

Table 10.1
Minimum thicknesses of jacket

Calculated diameter of assembly under cable jacket or calculated length of major axis of flat assembly under 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

11 Physical Properties of Insulation and Jacket

11.1 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 Cords and Cables, UL 62, for the jacket.

12 Conductor Corrosion

12.1 Conductors shall not show any evidence of pitting or corrosion after being tested in accordance with Conductor Corrosion – General, Section 500 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581. Bare copper conductors without a metal covering are required to be tested. One specimen is to be conditioned with the conductor in place, in an air oven mentioned in 11.1.

12.2 A specimen not showing any evidence of pitting or corrosion compounds in a close visual examination with normal or corrected vision without magnification is determined to be in compliance. Normal discoloration not induced by the insulation is to be disregarded.

12.3 Specimens of wire that do not comply with the conductor corrosion test are required to use tinning or other protective metal coating.

13 Heat-Shock Test

13.1 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 13.2.

13.2 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 13.1 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 13.1
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	180-degree U bend
3/0	1.294	33	180-degree U bend
4/0	1.410	36	180-degree U bend

14 Flexibility Test

14.1 Within 16 – 96 hours after oven treatment under the conditions described in 11.1, the insulation shall not show any cracks on its inside or outside surfaces when a specimen of finished cable at room temperature is wound onto a mandrel using the method described in 16.2 and 16.2. The mandrel diameter shall be as specified in Table 16.1.

15 Deformation Test

15.1 Neither the insulation nor the jacket from finished cable shall decrease more than 50 percent in thickness while at a temperature of 121.0 ±1.0° C (249.8 ±1.8° F) under the pressure indicated in Table 15.1. The test is to be conducted as described under Deformation Test, Section 560 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

Table 15.1
Specimen loading

Size of specimen	Load 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.

16 Cold-Bend Test

16.1 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 16.2 and 16.3.

16.2 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 ±2.0°C (–13.0 ±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 16.1. In the case of a 3/0 AWG or smaller conductor, four adjacent turns are to be tightly wound around the mandrel. In the case of a 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.

16.3 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 16.1
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

Table 16.1 Continued on Next Page

Table 16.1 Continued

Size of conductor	Diameter	
	inches	mm
1	2.688	68
1/0	2.875	73
2/0	3.000	76
3/0	3.250	83
4/0	3.500	89

17 Vertical Flame Test (Insulated Conductors)

17.1 A vertical specimen of the insulated conductors removed from the finished cable shall comply with the Vertical Flame Test and FT1 Tests, Section 1060 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

18 Cable Flame Test (Completed Cable)

18.1 A vertical specimen of the finished cable shall comply with the Cable Flame Test, Section 1061 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

19 VW-1 Flame Test

19.1 To be eligible to be durably marked “VW-1” on the surface of the wire or cable, finished single-conductor wires and cables specimens shall separately comply with the Horizontal-Specimen/FT2 Flame Test, Section 1100 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581 and with the VW-1 (Vertical-Specimen) Flame Test, Section 1080 of UL 1581.

19.2 As a result of the VW-1 test, if any specimen shows more than 25 percent of the indicator flag burned away or charred (soot that can be removed with a cloth or the fingers and brown scorching are to be ignored) after any of the five applications of flame, the wire or cable is to be judged capable of conveying flame along its length. Where any specimen emits flaming or glowing particles or flaming drops at any time that ignite the cotton on the burner, wedge, or testing surface (flameless charring of the cotton is to be ignored), or continues to flame longer than 60 s after any application of the gas flame, the wire or cable is to be judged capable of conveying flame to combustible materials in its vicinity.

20 Capacitance and Relative Permittivity Test

20.1 The insulation on the individual conductors shall be such that the capacitance and relative permittivity of the insulation, when specimens are tested in accordance with the Capacitance and Relative Permittivity Test, Section 1020 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581, comply with each of the following:

a) The relative permittivity (dielectric constant) determined after 24 hours shall not be more than 8.00 for 60°C wet rated conductors, and 10.00 for 75°C and 90°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 hours immersion.

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

21 Dielectric Voltage-Withstand Test and Alternatives

21.1 The insulation on the conductors in full-length coils or reels of finished cable shall withstand a 60-second application of the 48 – 62 Hertz essentially sinusoidal potential indicated in Table 21.1. The equipment and the method of test are to be as indicated in Dielectric Voltage-Withstand Test of Coils and Reels in Water, Section 820 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581, but the cable is not to be immersed in water.

21.2 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 21.1, 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 Spark Test – Method, Section 900 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

Table 21.1
Dielectric voltage-withstand and spark-test potentials

Size of conductor	Dielectric voltage-withstand test potential	Spark-test potential
18 – 10 AWG	1500 volts	7,500 volts
8 – 2	2000	10,000
1 – 4/0	2500	10,000

22 Insulation Resistance Test at 15°C

22.1 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 22.1 when the cable is tested under the following conditions. The cable shall be immersed in tap water at 15°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. The equipment and the method of test are to be as indicated in Insulation-Resistance Test in Water, Section 920 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

Table 22.1
Minimum insulation resistance in megohms at 15°C

AWG conductor	Based on 1000 conductor feet			AWG conductor	Based on a conductor kilometer		
	Construction				Construction		
	60°C PVC Table 5.1	75 or 90°C PVC Table 5.1	75 or 90°C PVC with nylon Table 5.2		60°C PVC Table 5.1	75 or 90°C PVC Table 5.1	75 or 90°C PVC with nylon Table 5.2
18	195	785	970	18	60	240	300
16	170	680	815	16	55	210	250
14	140	570	665	14	45	175	205
12	120	485	560	12	40	150	175

Table 22.1 Continued on Next Page

Table 22.1 Continued

AWG conductor	Based on 1000 conductor feet			AWG conductor	Based on a conductor kilometer		
	Construction				Construction		
	60°C PVC Table 5.1	75 or 90°C PVC Table 5.1	75 or 90°C PVC with nylon Table 5.2		60°C PVC Table 5.1	75 or 90°C PVC Table 5.1	75 or 90°C PVC with nylon Table 5.2
10	100	405	580	10	35	125	180
8	105	415	595	8	35	130	185
6	105	435	495	6	35	135	155
4	90	360	505	4	30	115	155
3	80	325	465	3	25	110	145
2	75	295	415	2	25	90	130
1	85	340	455	1	30	105	140
1/0	75	310	415	1/0	25	95	130
2/0	70	280	370	2/0	25	85	115
3/0	60	250	330	3/0	20	80	105
4/0	55	225	300	4/0	20	70	95

23 Insulation Resistance Test at Elevated Temperature

23.1 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) or 60°C (140°F), for insulation rated 60°C wet, and at 75°C (167°F), for insulation rated 75°C wet, and at 90°C (194°F) for insulation rated 90°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 23.1, 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 23.1. An essentially sinusoidal rms potential of 600 volts at 48 – 62 Hertz shall be applied to the insulation at all times other than while readings of insulation resistance are being taken. See also 23.3 covering the maximum acceptable rate of decrease of the insulation resistance.

23.2 The values in Table 23.1 apply only to the construction with insulations of the materials and in the thickness indicated in Table 5.1 and Table 5.2. 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.

60°C PVC Table 5.1:

$$IR_{50°C} = K_{15°C} \times 6.63 \times 10^{-4} \times \log_{10} \frac{\text{DIA}}{\text{dia}}$$

75 or 90°C PVC Table 5.1:

$$IR_{75°C} = K_{15°C} \times 6.63 \times 10^{-4} \times \log_{10} \frac{\text{DIA}}{\text{dia}}$$

75 or 90°C PVC with nylon Table 5.2:

$$IR_{75°C} = K_{15°C} \times 1.74 \times 10^{-4} \times \log_{10}\frac{\text{DIA}}{\text{dia}}$$

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), 60°C (140°F), or 75°C (167°F),

K is the constant for the insulation material at 15° C in megohms based on 1000 conductor feet; $6.63x10^{-4}$ is the multiplier necessary for reducing K at 15° C to the value it would have at 50° C (122° F), 60° C (140° F), or 75° C (167° F) for 60, 75, or 90° C PVC Table 5.1; $1.74x10^{-4}$ is the multiplier necessary for reducing K at 15°C to the value it would have at 75°C (167°F) for 75 or 90° C PVC with nylon Table 5.2.

DIA is the diameter over the insulation in inches,

dia is the diameter of the metal conductor in inches.

60°C PVC Table 5.1:

$$IR_{50°C} = K_{15°C} \times 2.02 \times 10^{-4} \times \log_{10}\frac{\text{DIA}}{\text{dia}}$$

75 or 90°C PVC Table 5.1:

$$IR_{75°C} = K_{15°C} \times 2.02 \times 10^{-4} \times \log_{10}\frac{\text{DIA}}{\text{dia}}$$

75 or 90°C PVC with nylon Table 5.2:

$$IR_{75°C} = K_{15°C} \times 5.30 \times 10^{-4} \times \log_{10}\frac{\text{DIA}}{\text{dia}}$$

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), 60°C (140°F), or 75°C (167°F),

K is the constant for the insulation material at 15° C in megohms based on 1000 conductor feet; $2.02x10^{-4}$ is the multiplier necessary for reducing K at 15°C in megohms based on 1000 conductor feet to the value it would have at 50°C (122°F), 60°C (140°F), or 75°C (167°F) for 60, 75, or 90°C PVC Table 5.1; $5.30x10^{-5}$ is the multiplier necessary for reducing K at 15°C in megohms based on 1000 conductor feet to the value it would have at 75°C (167°F) based on a conductor kilometer for 75 or 90°C PVC with nylon Table 5.2.

DIA is the diameter over the insulation in millimeters, and

dia is the diameter of the metal conductor in millimeters.

For example, the insulation resistance of an 8 AWG wire with an 0.060-inch average thickness of 60° C PVC insulation would be calculated as follows:

dia of 8 AWG conductor = 0.146 inch