UL 814

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Gas-Tube-Sign and Ignition Cable

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Gas-Tube-Sign and Ignition Cable, UL 814

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Revisions: This Standard contains revisions through and including April 17, 2001.

Announcement Bulletin(s): This Standard contains the announcement bulletin(s) dated August 27, 1999.

Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The new and/or revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated October 13, 2000 and March 29, 1999. The bulletin(s) is now obsolete and may be discarded.

The revisions dated April 17, 2001 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-3	April 17, 2001
4	October 31, 1995
5	December 1, 2000
6-12	April 17, 2001
13	March 19, 1999
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Gas-Tube-Sign and Ignition Cable

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Second Edition – February, 1943
Third Edition – October, 1948
Fourth Edition – January, 1966
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Tenth Edition

October 31, 1995

The most recent designation of ANSI/UL 814 as an American National Standard occurred on June 28, 2000.

This ANSI/UL Standard for Safety is under periodic maintenance, whereby the ANSI approval is updated approximately every five years. The Tenth edition (and revisions dated December 1, 2000) is ANSI approved, other revisions are not part of the ANSI designated text. To obtain a copy of the originally approved ANSI version of the Standard, contact *comm 2000* at www.comm-2000.com.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc and is not part of the ANSI approved standard.

Approved as ANSI/UL 814-2000, June 28, 2000

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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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 which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, 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.

INTRODUCTION

1 Scope

1.1 These requirements cover single-conductor, Nos. 18 - 10 AWG, gas-tube-sign and ignition cable with temperature ratings of 105°C – 250°C (221°F – 482°F), and ratings of 5000 volts, 10000 volts, or 15000 volts;

a) For use with gas-tube systems for signs, outline lighting, and interior lighting in accordance with the National Electrical Code and the Standard for Electrical Signs (UL 48), and

b) For use with oil-burning equipment in accordance with the National Electrical Code and the Standard for Oil Burners (UL 296).

Revised 1.1 effective August 1, 1999

1.2 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.2 revised December 1, 2000

2 References

2.1 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.

2.2 Wherever the designation ″UL 1581 ″ is used in this wire standard, reference is to be made to the designated parts(s) of the Reference Standard for Electrical Wires, Cables, and Flexible Cords (UL 1581).

3 Units of Measurement

3.1 In addition to being stated in the inch/pound units that are customary in the USA, each of the requirements in this standard is also stated in units that make the requirement conveniently usable in countries employing the various metric systems (practical SI and customary). Equivalent– although not necessary exactly identical – results are to be expected from applying a requirement in USA or in metric terms. Equipment calibrated in metric units is to be used when a requirement is applied in metric terms.

4 Materials

4.1 Each material used in a cable shall be compatible with all of the other materials used in the cable.

5 Conductors

5.1 Materials and sizes

5.1.1 The conductor shall be of soft-annealed copper or of semi-annealed (1/2 – 3/4 hard) aluminum or copper-clad aluminum. Copper-clad aluminum conductors shall be drawn from copper-clad aluminum rod. The copper shall be metallurgically bonded to the aluminum core, shall occupy 10 percent or more of the cross section of each strand of a stranded conductor, and shall be concentric with the aluminum. The thickness of the copper shall not be less than 2.56 percent of the conductor or strand diameter as determined by microscopic examination of a polished right cross section of the round strand or round solid conductor. Semi-annealed (1/2 – 3/4 hard) aluminum and fully annealed copper-clad aluminum shall have a tensile strength of 18,500 ±3,500 lbf/in^2 or 128±24 MN/m^2 or 12,755 ±2,413 N/cm^2 or 13.0 ±2.5 kgf/mm^2. The conductor shall be stranded and built up from at least 19 wires, each not smaller than No. 36 AWG (25 cmil or 0.0127 mm^2) if of copper and No. 27 AWG (202 cmil or 0.102 mm^2) if of aluminum or copper-clad aluminum. The conductor shall be Nos. 18 – 10 AWG in size. The conductor shall not be smaller in area than indicated in Table 5.1 and shall be continuous throughout without joints in the conductor as a whole.

5.1.1A The size of a conductor shall be verified either by determination of the d-c resistance or by determination of the cross-sectional area as described in 5.1.1C. Measurement of the d-c resistance is to be as described in D-C Resistance, Section 220 of UL 1581. Determination of the conductor size by measurement of the direct-current resistance is the referee method in all cases. The d-c resistance shall not be higher than the maximum indicated for the size in Table 5.2 or 5.3, as applicable.

5.1.1A added April 17, 2001

5.1.1B The resistance of a copper conductor measured at a temperature other than 20 or 25°C is to be adjusted to the resistance at 20 or 25°C by means of the applicable multiplying factor from Table 220.1 of UL 1581.

5.1.1B added April 17, 2001

5.1.1C Where measured as the means of size verification (see 5.1.1A), the cross-sectional area of the conductor shall not be smaller than the minimum area indicated for the size in Table 5.1. The cross-sectional area of the conductor is to be determined as the sum of the areas of its component round strands, with the individual strands measured as described in 5.1.2. Where the sum of the strand areas does not comply, the conductor area is to be determined by the weight method outlined in Conductor Cross-Sectional Area by the Weight Method, Section 210 of UL 1581. The area determined by the weight method is to be taken as conclusive.

5.1.1C added April 17, 2001

Table 5.1
Minimum cross-sectional area of conductor

Table 5.1 revised April 17, 2001

AWG size of copper conductor	cmil (0.98 x nominal area)	mm^2
18	1,588	0.807
17	2,009	1.02

Table 5.1 Continued on Next Page

Table 5.1 Continued

AWG size of copper conductor	cmil (0.98 x nominal area)	mm^2
16	2,528	1.28
15	3,195	1.62
14	4,028	2.04
13	5,076	2.58
12	6,399	3.24
11	8,065	4.04
10	10,172	5.16

5.1.2 The diameter of each individual strand is to be measured over the tin or other metal coating by means of a micrometer caliper having flat surfaces on both the anvil and the end of the spindle and calibrated to read directly to at least 0.001 inch or 0.01 mm. It is to be assumed that any one strand is practically constant in diameter throughout its length.

5.1.2 revised April 17, 2001

5.1.3 No particular combination of the individual strands of a conductor is required; however, simple bunching (untwisted strands) shall not be used.

5.1.3 revised April 17, 2001

5.1.4 The individual wires strands used in making up a conductor are usually drawn to a specified diameter that does or does not correspond to the diameter of an established gauge number. The individual strands are not required to be all of the same diameter.

5.1.4 revised April 17, 2001

5.1.5 The length of lay of the strands in every layer of a concentric-lay-stranded conductor shall be 8 – 16 times the outside diameter of that layer. The direction of lay of the outer layer shall be left-hand.

5.1.5 added April 17, 2001

5.1.6 The length of lay of the strands in a single-bunch bunch-stranded conductor shall not be greater than indicated in Table 5A. The direction of lay shall be left-hand.

5.1.6 added April 17, 2001

Table 5A
Maximum length of lay of strands in a single-bunch bunch-stranded conductor

Table 5A added April 17, 2001

AWG size of conductor	Inches	mm
18, 17	1–1/4	32
16, 15	1–1/2	38
14, 13	1–3/4	44
12, 11	2	51
10	2–1/2	64

Table 5.2
Maximum direct-current resistance of copper conductors
ASTM Class C 19–strand concentric-lay conductors assumed

Table 5.2 added April 17, 2001

AWG size of conductor	Uncoated				Coated			
	20°C (68°F)		25°C (77°F)		20°C (68°F)		25°C (77°F)	
	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter	Ohms per 1000 feet	Ohms per kilo-meter
18	6.66	21.8	6.79	22.2	7.06	23.2	7.19	23.6
17	5.27	17.3	5.37	17.6	5.59	18.3	5.70	18.7
16	4.18	13.7	4.26	14.0	4.45	14.6	4.53	14.9
15	3.31	10.9	3.37	11.1	3.44	11.3	3.51	11.5
14	2.62	8.62	2.68	8.78	2.73	8.96	2.78	9.14
13	2.08	6.82	2.12	6.97	2.21	7.10	2.20	7.24
12	1.65	5.43	1.68	5.53	1.72	5.64	1.75	5.75
11	1.32	4.30	1.34	4.39	1.37	4.48	1.39	4.56
10	1.039	3.409	1.060	3.476	1.080	3.546	1.102	3.615

Table 5.3
Maximum direct-current resistance of single-bunch bunch-stranded copper conductors

Table 5.3 added April 17, 2001

AWG size of conductor	Uncoated				Coated			
	20°C (68°F)		25°C (77°F)		20°C (68°F)		25°C (77°F)	
	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer	Ohms per 1000 feet	Ohms per kilometer
18	6.72	22.1	6.85	22.5	7.23	23.7	7.36	24.6
17	5.29	17.4	5.40	17.7	5.47	17.9	5.57	18.3
16	4.18	13.7	4.26	14.0	4.54	14.9	4.58	15.0
15	3.30	10.8	3.37	11.1	3.44	11.3	3.50	11.5
14	2.63	8.64	2.67	8.76	2.82	9.25	2.89	9.48
13	2.08	6.82	2.12	6.96	2.16	7.09	2.20	7.22
12	1.65	5.42	1.69	5.55	1.78	5.84	1.81	5.94
11	1.32	4.33	1.35	4.43	1.37	4.49	1.40	4.59
10	1.040	3.420	1.063	3.380	1.120	3.680	1.140	3.740

5.2 Metal coating

5.2.1 The individual strands of a copper or copper-clad aluminum conductor shall each have a continuous coating of tin or other metal or alloy if the conductor is insulated with a material that is capable of corroding unprotected copper.

5.3 Separator

5.3.1 A separator between the conductor and the insulation is not required but, if provided, shall consist of a close wind or braid of material such as fine cotton, or a close wind or wrap of a material such as paper or cellophane. A separator shall be colored or opaque to make the separator clearly distinguishable from the conductor once the insulation is removed. The color shall be other than green or green and yellow and may be solid, striped, or in some other pattern.

5.3.1 revised April 17, 2001

6 Insulation

6.1 The conductor shall be insulated or integrally insulated and jacketed for its entire length with one or more of the insulation or insulation/jacket materials for which physical-properties limits are tabulated in Specific Materials, Section 50, of UL 1581 or with another such material evaluated for the use. The insulation or integral insulation/jacket material shall have a temperature rating of 105°C (221°F), 150°C (302°F), 200°C (392°F), or 250°C (482°F). The insulation shall be applied directly to the surface of the conductor or to the separator, if one is used, and shall comply with the requirements in Sections 9 – 17.

Revised 6.1 effective August 1, 1999

6.2 The applied insulation or integral insulation and jacket shall provide a circular cross section for the insulated or insulated/jacketed conductor, and the conductor itself shall be centered in the applied material so that, when determined by the pin-gauge or optical method, the minimum thickness at any point of the applied material is not less than 90 percent of the average thickness of the material as determined by the difference method. The average thickness of the insulation or integral insulation/jacket is not specified.

6.3 An insulation or jacket that is of material generically different from any insulation or jacket material referenced in 7.1.2 (new material), or that is as referenced in 6.1 or 7.1.2 yet does not comply with the short-term tests applicable to the material, shall be of a material and in thicknesses and with the temperature rating appropriate for the gas-tube-sign and ignition cable construction. The material shall be evaluated for the requested temperature rating as described in Long-Term Aging, Section 481 of UL 1581. Investigation of the electrical, mechanical, and physical characteristics of the cable using either material shall show the material to be comparable in performance to the insulation or jacket materials referenced in 6.1 or 7.1.2. The investigation shall include tests such as crushing, abrasion, deformation, heat shock, insulation resistance, and dielectric voltage-withstand.

6.3 added May 5, 1998

7 Jacket

7.1 General

7.1.1 Cable shall be provided – over the insulation – with a jacket that enables the cables to comply with the requirements in Sections 9 – 17. The jacket shall be integral with the insulation (see 6.1 and 6.2) or shall be applied as a separate layer (see 7.1.2 and 7.1.3).

7.1.2 A jacket consisting of a separate layer shall be of one of the jacketing materials for which physical-properties limits are tabulated in Specific Materials, Section 50, of UL 1581 or of another jacketing material evaluated for the use as indicated in 6.3. The temperature rating of the cables is the temperature rating of the insulation or the jacket, whichever is lowest.

7.1.2 revised May 5, 1998

7.1.3 The thickness of a separate jacket shall not be less than 0.015 inch or 0.38 mm, without any minus tolerance.

7.2 Additional – metal

7.2.1 Overall copper-wire braid

7.2.1.1 An overall copper-wire braid may be applied over the nonmetallic covering mentioned in 7.1.1 – 7.1.3.

7.2.2 Overall lead sheath

7.2.2.1 An overall lead sheath may be applied over the nonmetallic covering mentioned in 7.1.1 – 7.1.3. The lead content of a lead covering shall not be less than 99.85 percent. A lead covering shall be tight on the core formed by the insulated conductor. The average thickness of the lead shall not be less than 45 mils or 1.14 mm, and the minimum thickness at any point of the lead shall not be less than 41 mils or 1.04 mm.

7.2.2.2 Compliance of a lead covering with the thickness requirement in 7.2.2.1 is to be determined by means of a micrometer caliper having a rounded anvil. The average of five measurements is to be taken and none of the measurements is to be less than 41 mils or 1.04 mm.

PERFORMANCE

8 Physical Properties Tests

8.1 Specimens prepared from sample lengths of the insulation, integral insulation/jacket, or separate jacket shall have physical properties that comply with the applicable table referenced in 6.1 or 7.1.2 or with separately established values of physical properties. The samples are to be taken from the finished cable and the testing is to be conducted as indicated in 8.2.

8.2 The methods of preparation of samples, of selection and conditioning of specimens, and of making the measurements and calculations for ultimate elongation, tensile strength, and set shall be as indicated under the heading ″Physical Properties of Insulation and Jacket″ in UL 1581.

9 Routine Voltage Application Test

9.1 Finished cable shall be capable of withstanding without breakdown the application of a 48 – 62 Hz essentially sinusoidal potential after immersion in water at room temperature for 1 hour and under the following conditions. Starting near zero, the applied potential shall be increased at the rate of approximately 500 V/s until the test voltage is equal to the rated voltage of the cable, shall be held at that level, and then shall be reduced to zero. The total time for increasing, holding, and reducing the test voltage shall be 5 min.

9.1 revised April 17, 2001

9.2 Compliance of cable with the requirement in 9.1 is to be determined by using a voltage supply that complies with 10.4. The test potential is to be applied between the conductor of the cable and an electrode immersed in the water. Throughout the test, including the 1-h period of immersion prior to the application of the test potential, the two ends of the coil are to be kept at least 2 ft or 610 mm out of the water. Breakdown usually can be determined by a current rush resulting from the decreased resistance of the circuit, and is to be indicated by the tripping of a circuit breaker or by the illumination of a bank of lamps connected in series with the test coil. In some instances, breakdown can be noted by observing the flash at the point on the cable at which the rupture takes place.

Revised 9.2 effective August 1, 1999

9A Voltage Application at Elevated Temperature

Added 9A effective August 1, 1999

9A.1 A 10 ft. coil of finished cable shall be capable of withstanding, without breakdown, the application of a 48 – 62 Hz essentially sinusoidal potential when the coil under test is placed in an oven at elevated temperature (as calculated in 481.3 of UL 1581) under the following conditions. Starting near zero, the applied potential shall be increased at the rate of approximately 500 V/s until the test voltage is equal to the rated voltage of the cable, shall be held at that level, and then shall be reduced to zero. The total time for increasing, holding, and reducing the test voltage shall be 12 hours.

9A.1 revised April 17, 2001

9A.2 Compliance of cable with the requirement in 9A.1 is to be determined by using a voltage supply that complies with 10.4. For shielded cables, the test potential is to be applied between the shield and conductor of the cable. For non-shielded cables, the test potential is to be applied between the conductor and either a metallic braid applied around the cable for test purposes, or a graphite powder that the cable is placed in. Breakdown usually can be determined by a current rush resulting from the decreased resistance of the circuit, and is to be indicated by the tripping of a circuit breaker or by the illumination of a bank of lamps connected in series with the test coil. In some instances, breakdown can be noted by observing the flash at the point on the cable at which the rupture takes place.

10 Extended Voltage Application Test

10.1 When a sample of cable with a nonmetallic covering intended as the finished outer covering or as the covering under a wire braid or lead sheath is wound on a metal mandrel, the insulation shall be capable of withstanding for 1 h without breakdown the application of a 48 – 62 Hz essentially sinusoidal potential as indicated in Table 10.1 and under the following conditions: starting near zero, the applied potential shall be increased at the rate of approximately 500 V/s until the required test value is reached. After an hour, the applied potential shall be reduced to zero.

10.1 revised April 17, 2001

Table 10.1
Test potential and mandrel diameter

Type of cable and maximum working potential in volts		Test potential in volts rms	Diameter of mandrel	
			inches	mm
GTO - 5	5,000	10,000	3/4	19
GTO - 10	10,000	20,000	1	25
GTO - 15	15,000	30,000	1-1/4	32

10.2 Finished cable with an overall copper-wire braid shall comply with the requirement in 10.1, but the mandrel need not be of metal.

10.3 Compliance of cable with the requirements of 10.1 and 10.2 is to be determined by means of:

a) A voltage supply that complies with 10.4, and

b) A rigid mandrel 24 inches or 610 mm in length and having the diameter indicated in Table 10.1.

For a sample with a nonmetallic covering, the mandrel is to be of metal and is to be covered at each end, for a distance of approximately 5-1/4 inches or 130 mm back from the end, with varnished-cloth tape and then friction tape to reduce the partial-discharge (corona) effect at the point at which the cable under test leaves the mandrel. The distance between the taped sections is to be approximately 13-1/2 inches or 340 mm. For a sample with an overall copper-wire braid, the mandrel need not be of metal but may be of wood or other rigid nonmetallic material.

10.4 The test potential is to be supplied by a 48 – 62 Hz supply whose potential is continuously variable from near zero to at least 50 kV rms at the rate of approximately 500 V rms/s. With a specimen in the circuit, the supply potential is to have a crest factor (peak voltage divided by rms voltage) equal to 95 – 105 percent of the crest factor of a pure sine wave over the upper half of the supply range. The supply voltage is to be monitored continuously by a voltmeter that, if of the analog rather than digital type, shall have a response time that does not introduce a lagging error greater than 1 percent of full scale at the specified rate of increase in voltage, and that has an overall accuracy that does not introduce an error exceeding 5 percent.

10.5 The cable is not to be twisted while being wound onto the mandrel. The free end of the cable is to adjust itself as the cable is being wound onto the mandrel. The ends of a test sample with a nonmetallic covering are to leave the metal mandrel at points near the centers of the taped sections at each end.

10.6 The spacing between centers of adjacent convolutions is to be 1-1/2 inches or 38 mm, and nine turns of the conductor are to be made around the mandrel. The conductor is to be held in position at the ends by means of one or two turns of tape around the mandrel and conductor. For a sample with a nonmetallic covering, the metal mandrel is to serve as one electrode and the conductor in the cable is to serve as the other electrode. For a sample with an overall copper-wire braid, the braid is to serve as one electrode and the conductor in the cable is to serve as the other electrode.

10.7 After preparation as indicated in 10.8, the insulation in a sample of finished lead-sheathed cable shall be capable of withstanding for 1 h without breakdown the application of a 48 – 62 Hz essentially sinusoidal potential as indicated in Table 10.1 and under the following conditions: starting near zero, the applied potential is to be increased at the rate of approximately 500 V/s until the required test value is reached. After an hour, the applied potential is to be reduced to near zero at the rate of approximately 500 V/s.

10.8 A straight sample 4 – 5 ft or 1.2– 1.5 m long is to be bent through an arc of 180° at its center, the diameter of the arc being eight times the overall diameter of the finished cable. The sample is to be straightened, bent through an arc of 180° in the reverse direction, and then straightened again. The straightened sample is then to be subjected to the test potential applied between the lead sheath and the conductor in the cable.

11 Extended Voltage Application After Immersion Test

11.1 After cable with a nonmetallic covering intended as the finished outer covering or as the covering under a wire braid or lead sheath is immersed in water for 1 h, the insulation shall be capable of withstanding for a period of 4 h without breakdown the application of a 48 – 62 Hz essentially sinusoidal potential of 150 percent of the rated voltage of the cable. Starting near zero, the applied potential is to be increased at the rate of approximately 500 V/s until the required test value is reached. After 4 h, the applied potential is to be reduced to zero.

11.1 revised April 17, 2001

11.2 Compliance of cable with the requirement in 11.1 is to be determined by means of:

a) A voltage supply that complies with 10.4, and

b) A 5-ft or 1.5-m length of 1/2 inch rigid metal conduit having square-cut ends and standard conduit bushings threaded in place.

11.3 A 9-ft or 2.7-m sample of cable is to be immersed for all but about 6 inches or 150 mm at each end in water at 25.0±5.0°C (77.0 ±9.0°F) for 1 h, after which the sample is to be removed and the surface moisture is to be wiped off with a clean, dry cloth. A 7-ft or 2.1-m specimen is then to be cut from the immersed part of the 9-ft or 2.7-m sample, and 1 inch or 25 mm of the insulation is to be removed from each end. This specimen is then to be centered lengthwise in the conduit so that approximately 10 inches or 250 mm of the insulation extends beyond the conduit at each end. By means of electrical connections to one end of the conductor and to the metal conduit, the sample is to be subjected to the test potential for 4 h. During this test, any breakdown of the insulation or charring of the nonmetallic covering is unacceptable.

12 Surface Leakage Test

12.1 After cable with a nonmetallic covering intended as the finished outer covering or as the covering under a wire braid or lead sheath is immersed in water for 30 min, the nonmetallic covering shall be capable of withstanding for 1 min without smoking, flaming, or flashover the application of a 48 – 62 Hz essentially sinusoidal potential as indicated in Table 12.1. Starting near zero, the applied potential is to be increased at the rate of approximately 500 V/s until the required test value is reached. After 1 minute, the applied potential is to be reduced to zero.

12.1 revised April 17, 2001

12.2 Compliance of cable with the requirements in 12.1 is to be determined by using a voltage supply that complies with 10.4.

12.3 A length of the cable is to be immersed, except at the ends, in tap water at 24.0 ±3.0°C (75.2 ±5.4°F) for 30 min. After removal from the water, surface moisture is to be wiped off with a clean, dry cloth, and then two bands of No. 18 AWG bare, solid wire are to be wrapped tightly around the surface of the nonmetallic covering, with a spacing between them as indicated in Table 12.1. Electrical connections are to be made to the two wire bands and the potential is then to be applied for 1 min.

Revised 12.3 effective August 1, 1999

Table 12.1
Length, spacing, and test potential

Type of cable	Length of sample		Spacings between bands		Test potential in volts rms
	inches	mm	inches	mm	
GTO-5	12	305	5	127	10,000
GTO-10	24	610	10	254	20,000
GTO-15	36	914	15	381	30,000

13 Test for Dripping of Compounds

13.1 The compounds used for the saturation and coating of a fibrous covering(s) in or on a cable shall not drip when a sample of the fibrous-covered cable is conditioned for 1 h in air at a temperature of 10 ±1°C (18 ±1.8°F) above its rated temperature.

Revised 13.1 effective August 1, 1999

13.2 Compliance of the cable with the requirement in 13.1 is to be determined by suspending a 10-inch or 250-mm sample of the fibrous covered cable in a vertical position in an oven. A clean sheet of paper or of metal foil is to be placed beneath the sample to catch any compound that softens to the extent of dripping.

14 Flame Test

14.1 Type GTO cable shall comply with the requirements of the VW-1 flame test described in Section 1080 of UL 1581.

Revised 14.1 effective August 1, 1999

14.2 Deleted effective August 1, 1999

14.3 Deleted effective August 1, 1999

Figure 14.1
Essential dimensions in inches (millimeters) for horizontal-specimen flame test

Figure 14.1 deleted effective August 1, 1999

14.4 Deleted effective August 1, 1999

Figure 14.2
Acceptable dimensions of wedge in inches (millimeters)

Figure 14.2 deleted effective August 1, 1999

14.5 Deleted effective August 1, 1999

14.6 Deleted effective August 1, 1999

14.7 Deleted effective August 1, 1999

14.8 Deleted effective August 1, 1999

14A Sunlight Resistance

Added 14A effective August 1, 1999

14A.1 Specimens of the jacket or integral insulation and jacket taken from Type GTO cable shall comply with the requirements outlined in Section 1200 of UL 1581 for the 720 hour exposure.

14B Cold Bend

Added 14B effective August 1, 1999

14B.1 Type GTO cable shall not crack when tested in accordance with Section 580 of UL 1581 at -25°C and using the mandrel diameters shown in Table 14B.1 and 14B.2.

Table 14B.1
Mandrel diameter (inches)

Diameter of cable (inches)	Diameter of mandrel (inches)
0 – 0.125	0.250
0.126 – 0.250	0.500
0.251 – 0.375	0.750
0.376 – 0.500	1.000
0.501 – 0.625	1.250

Table 14B.2
Mandrel diameter (mm)

Diameter of cable (mm)	Diameter of mandrel (mm)
0 – 3.12	6.35
3.20 – 6.35	12.70
6.38 – 9.53	19.05
9.55 – 12.70	25.40
12.73 – 15.88	31.75

14C Ozone Exposure Test

Added 14C effective August 1, 1999

14C.1 General

14C.1.1 The ozone test is to be conducted on samples of finished Type GTO cable.

14C.2 Specimens

14C.2.1 The test specimens are to be 25 ft. coils of cable.

14C.3 Apparatus

14C.3.1 The test chamber is to be of any convenient and suitable size in order to fit three 25 foot coils.

14C.4 Method

14C.4.1 Three specimens are to be mounted in the looped position. The mounted specimens are to be subjected to an ozone partial pressure of 10,000 – 15,000 mPa and a temperature of 40.0 ±2.0°C (104.0 ±3.6°F) for 70 h. After the test exposure, the specimens are to be removed and the test in Section 9 conducted. The samples shall withstand the voltage application without breakdown.

14D U-Bend Test

Added 14D effective August 1, 1999

14D.1 General

14D.1.1 Finished cable shall not break down electrically and shall not crack, erode, or track on its outside surface when a specimen of the cable is prepared and tested as described in 14D.2 – 14D.4.

14D.2 Apparatus

14D.2.1 A smooth, flat metal plate, approximately square in shape, is required.

14D.3 Specimen

14D.3.1 A specimen of the wire or cable shall be bent, in the form of a ″U ″, around a mandrel having a diameter of 4 times the outside diameter of the specimen.

14D.4 Procedure

14D.4.1 The specimen shall be positioned over the horizontally supported plate, the bend of the ″U ″ just touching the plate, the legs of the ″U ″ being vertical. After not less than 30 or more than 45 min following the bending of the specimen, an ac voltage stress of 0.1 kV per mil (3.9 kV per millimeter) of nominal insulation thickness shall be applied and maintained for 6 h between the specimen conductor and the plate.

14D.5 Examination

14D.5.1 The cable is acceptable if there is no electrical breakdown and there is no visible cracking, erosion, or tracking of the outside surface. A change in color or glossiness or other appearance is not cause for rejection. If the specimen breaks down or shows cracking, erosion, or tracking, the test is to be repeated on each of two additional specimens. The cable is not acceptable if any of the two additional specimens break down or show cracking, erosion, or tracking. Visual examination is to be made with the unaided eye.

MARKINGS

15 Details for Conductors

15.1 If the conductor of a cable is of aluminum, the AWG size of the conductor, wherever it appears (on tags, reels, or the surface of the product), shall be followed by the word ″aluminum ″ or the letters ″AL ″.

15.2 If a copper-clad aluminum conductor is used, the AWG size of the conductor – wherever the size appears (on the tag, reel, or carton, or on the surface of the cable) – shall be followed by one of the designations ″AL (CU-CLAD)″ ″ALUMINUM (COPPER-CLAD)″ ″CU-CLAD AL″, or ″COPPER-CLAD ALUMINUM.″ Tags, reels, and cartons for copper-clad aluminum cable shall have both of the following markings:

a) ″Copper-clad aluminum shall be used only with equipment marked to indicate that it is for use with aluminum conductors. Terminate copper-clad aluminum with pressure wire connectors marked ’AL-CU’ or ’CU-CU’ ″.

b) ″Where physical contact between any combination of copper-clad aluminum, copper, and aluminum conductors occurs in a wire connector, the connector shall be of a type marked as being for such intermixed use and the connection shall be limited to dry locations only.″

15.3 The outer surface of the insulation or covering over the insulation on a copper-clad aluminum conductor shall be durably and legibly in printed, indent printed, or embossed at intervals no longer than 6 inch or 150 mm throughout the entire length of the cable with one of the designations ″AL (CU-CLAD)″ ″ALUMINUM (COPPER-CLAD)″, ″CU-CLAD AL″, or ″COPPER-CLAD ALUMINUM″.

No Text on This Page

16 Information on the Cable

16.1 The following information (the sequence of the items is not specified) shall appear on the outer surface of all cable in accordance with 16.2. See 18.1 for date marking:

a) The maximum voltage for which the cable is rated, 5000 V, 10000 V, or 15000 V, shall be indicated by marking the cable ″GTO ″ followed by the numerical suffix ″-5 ″, ″-10 ″, or ″-15 ″ as applicable.

b) The maximum temperature for which the cable is intended (see 6.1 and 7.1.2). The temperature rating shall be stated as ″____°C ″ or ″____C ″ or ″____″ (____ °F) ″ or ″____C (____F)″. Degrees F shall not appear in any manner other than as shown.

c) The name of the cable manufacturer, that manufacturer's trade name for the cable, or both, or any other appropriate distinctive marking by means of which the organization that is responsible for the cable is readily identifiable. Where 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 appropriate 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 by the organization responsible for the cable. It is appropriate also to identify a private labeler; the means is not specified.

d) The AWG size of the cable. It is appropriate to add the nominal metric cross-sectional area in square millimeters as shown in UL 1581, Table 20.1, before or after the required size designation, with either the required or metric size in parentheses – for example, ″8 AWG (8.367 mm^2) ″ or ″8.367 mm^2(8 AWG) ″. The abbreviation ″sq mm ″, ″SQ MM ″, or ″MM2″ is appropriate in place of ″mm^2″. It is appropriate to round the metric size in accordance with ASTM E 29-93a to at least three significant figures.

16.1 revised April 17, 2001

16.2 The markings required in 15.1, 15.2, and 16.1 shall consist of readily visible, legible, permanent printing in words on the outer surface of the jacket. The printing shall be repeated throughout the length of the cable at the following intervals:

a) Size shall be repeated at intervals that are not longer than a nominal 24 inches or 610 mm (maximum 25 inches or 635 mm).

b) The marking in 15.3 for identification of copper-clad aluminum shall be repeated at intervals that are not longer than 6 inches or 150 mm.

c) All information other than size and the identification of copper-clad aluminum shall be repeated at intervals that are not longer than 40 inches or 1.02 m.

d) The temperature rating of the cable shall be stated in accordance with 16.1 (b).

Indent printing shall not reduce the thickness of the jacket below the minimum indicated in 7.1.3. Ink printing is acceptable only if the printing on specimens remains legible after being rubbed repeatedly as described in Test, Section 1690, of UL 1581.

16.3 Deleted effective August 1, 1999

17 Information on the Tag, Reel, or Carton

17.1 A tag on which the following information is indicated plainly (the sequence of the items is not specified) shall be tied to every shipping length of finished cable. However, where the cable is wound on a reel or coiled in a carton, it is appropriate for the tag to be glued, tied, stapled, or otherwise attached to the reel or carton instead of to the cable or for the tag to be eliminated and the information printed or stenciled directly onto the reel or carton. Other information, where added, shall not confuse or mislead and shall not conflict with these requirements. See 18.1 for date marking:

a) The cable-surface information as required in 16.1

b) The maximum working voltage for which the cable is rated:

″____volts maximum″, ″____volts max. ″, ″____V maximum ″, or ″____V max.″

c) Deleted

d) The ply and material, the color, and the number of the thread(s) assigned to identify the organization responsible for the cable where such thread(s) are used in the cable.

17.1 revised April 17, 2001

18 Date of Manufacture

18.1 The date of manufacture by month and year (or in the sequence month, day, and year) shall be included among the tag, reel, or carton markings described in 17.1, or shall be included among the table markings described in 16.1 where legible on the outer surface of the cable. The date shall be shown in plain language, not in code.

18.1 and heading added April 17, 2001

Subject 814

1285 Walt Whitman Road
Melville, L.I., NY 11747
August 27, 1999

**TO: Technical Advisory Panel of UL for Power Wires and Cables,
Electrical Council of Underwriters Laboratories Inc.,
Subscribers to UL's Standards Service for
Gas-Tube Sign and Ignition Cable, UL 814**

SUBJECT: Announced Acceptance of GTO Cable Employing Integral Sleeving

UL announces that it is prepared to accept submittals of Type GTO cable employing integral sleeving, which insulates the cable against mechanical abuse such that it will not need the sleeving required by UL 48, the Standard for Electric Signs, when installed on a Listed sign. Please see Appendix A for the program.

This bulletin should be kept with your copy of the standard.

Questions regarding interpretation of requirements should be directed to the responsible UL Staff. Please see Appendix B of this bulletin regarding designated responsibility for the subject product category.

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APPENDIX A

ANNOUNCED TEST PROGRAM FOR GTO CABLE

WITH INTEGRAL SLEEVE

GENERAL:

This program assumes that the construction under test already complies with all of the tests required in UL 814.

SAMPLES REQUIRED:

1. 100 ft. of finished cable with integral sleeve.

2. 4 boots which are intended for use with the cable; the boot is to be identified by Manufacturer and Cat. No.

TESTS: (Per UL 814 or as modified below)

1. Detailed Examination

2. Physical Properties – Tensile strength and elongation

Samples are subjected to the 7 day oven aging required for the desired temperature rating.

Tensile strength and elongation measurements taken before and after the aging shall comply with the requirements for the class.

3. Extended Voltage Application –

The test described in Section 10 of UL 814 shall be conducted on samples which have been conditioned (two separate samples for each conditioning) as described below, except that the test voltage shown in Table 10.1 shall be increased by 6000 volts.

a) 720 hours Xenon arc and water-spray as described in Section 1200 of UL 1581

b) Ozone Exposure, as described in Section 14C of UL 814, except as modified above

c) 7 days immersion in 75°C water, immersed as described in Section 920 of UL 1581

d) 4 hours at -25°C (samples wound around the mandrel specified in Section 14B of UL 814 while at the low temperature)

4. Retention Test –

One sample of a polymeric boot and one sample of a 10 inch (254 mm) length of Type GTO with integral sleeving, when installed in accordance with the manufacturer's installation instructions, shall be subjected to a pulling force of 3 lbs (13.34 N) applied between the polymeric boot and GTO cable with integral sleeving.

The samples are to be tested while installed on an assembly consisting of a 15 kV, 30 mA transformer with GTO cable routed to a length of neon tubing having a diameter in accordance with the polymeric boot manufacturer's installation instructions. The total length of neon tubing is to be in accordance with the transformer manufacturer's instructions for proper loading of the transformer. Each GTO cable lead from the transformer is to be connected to the electrode leads at each end of the neon tubing load. An electrode to GTO cable splice shall consist of leads being twisted together by three full twists, with the excess lead length trimmed to a maximum of 1/2 inch (12.7 mm) length and bent back on the twists. A sample polymeric boot is to be installed over each GTO cable to electrode connection according to the manufacturer's installation instructions. The assembly is to be operated for 7 hours.

Following the conditioning, the samples are to be retained under conditions of ambient room temperature and atmospheric pressure for not less than 16 hours, and not more than 96 hours, before being subjected to a pulling force.

The 3 lb (13.34 N) force is to be applied uniformly to the GTO cable with integral sleeving to pull the cable out from in or around the polymeric boot. The force is to be maintained for one minute. After the force has been applied and removed and not while the force is being applied, there shall not be access to electrode lead wires, GTO cable conductor, or GTO cable that was originally within the polymeric boot.

MARKING:

Surface – In addition to the marking required by UL 814, Section 16, cable which complies with this program is surface marked ″Integral Sleeve″.

Tag – In addition to the marking required by UL 814, Section 17, the boot(s) which, by means of the Retention Test, have demonstrated compatibility with the cable, shall be identified by the statement ″Use (XYZ Co.) Cat. No.____ Boot″, or the like.

APPENDIX B

DESIGNATED RESPONSIBILITY FOR UL PRODUCT CATEGORY

ZJQX, GAS TUBE SIGN AND IGNITION CABLE

The individuals shown in the following table are involved with the investigation of products covered under the subject category. The Primary Designated Engineer (shown in UPPERCASE letters) coordinates the establishment and uniform interpretation of UL requirements applicable to the product category. The Designated Engineers (shown in lowercase letters) work with the Primary Designated Engineer to interpret requirements and maintain standards.

Should you have questions regarding the interpretation of the requirements proposed in this bulletin or any adopted requirements that affect your product, you are encouraged to contact the individual at the office to which you normally submit your products.

The Technical Advisory Panel (TAP) Chairman for Power Wires and Cables is George Fechtmann at UL's Melville office. The TAP Chairman oversees the significant interpretations made by the Primary Designated Engineer and arbitrates any differences regarding interpretation of UL requirements.

CCN	Office/Subsidiary	Responsible Engineer	Extension
ZJQX	Melville	AUSTIN D. WETHERELL	22818
	Santa Clara	Carl Huang	32810
	Camas	Roger Herb	55657