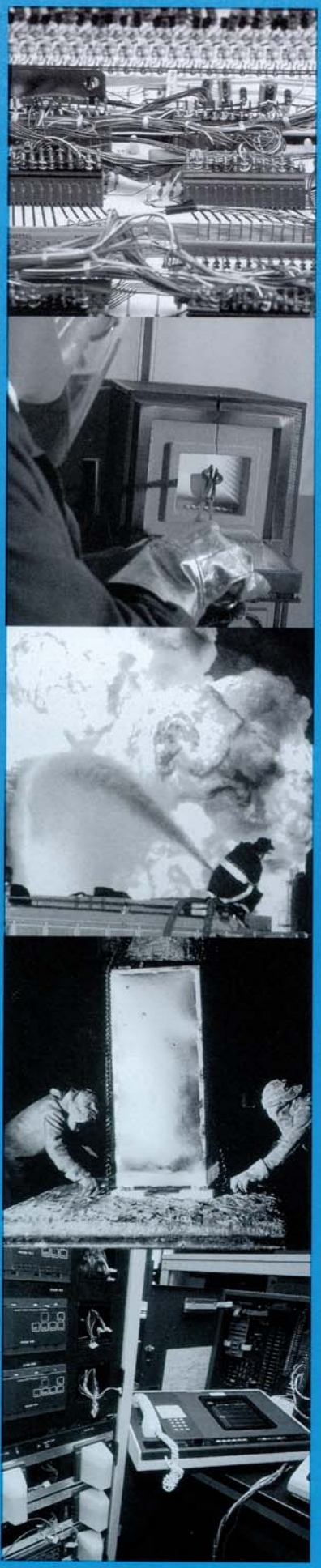
UL 1673

Underwriters Laboratories Inc.

Standard for Safety

Electric Space Heating Cables



UL Standard for Safety for Electric Space Heating Cables, UL 1673

Third Edition, Dated September 13, 2010

SUMMARY OF TOPICS:

These revisions to UL 1673 are being issued to incorporate the addition and revision of requirements to relocate component Standard references from Appendix A into the body of the Standard as component requirements.

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. 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 revised requirements are substantially in accordance with Proposal(s) on this subject dated July 29, 2011.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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SEPTEMBER 13, 2010
(Title Page Reprinted: October 14, 2011)

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UL 1673

Standard for Electric Space Heating Cables

First Edition – November, 1990
Second Edition – May, 1996

Third Edition

September 13, 2010

This UL Standard for Safety consists of the Third Edition including revisions through October 14, 2011.

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 http://csds.ul.com.

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INTRODUCTIONS

1 Scope

1.1 These requirements cover electric space heating cables intended for space heating purposes, rated for 480 V or less, for installation in unclassified locations in accordance with Article 424 Part V of the National Electrical Code (NEC), ANSI/NFPA 70.

1.1 revised October 14, 2011

1.2 These requirements apply to space heating cables intended for installation in ceilings of enclosed structures or within or beneath floors of enclosed structures where the floor is constructed of noncombustible material, concrete, or asphalt.

1.3 These requirements do not cover electric heating equipment or appliances that are covered by individual requirements that are separate from this Standard. Other related standards include:

a) Electrical Resistance Heat Tracing for Commercial and Industrial Applications, UL 515;

b) Movable and Wall- or Ceiling-Hung Electric Room Heaters, UL 1278;

c) Outline of Investigation for Mobile Home Pipe Heating Cables, Subject 1462;

d) Outline of Investigation for Roof and Gutter De-Icing Cable Units, Subject 1588;

e) Electric Radiant Heating Panels and Heating Panel Sets, UL 1693;

f) Outline of Investigation for Residential Pipe Heating Cables, Subject 2049;

g) Fixed and Location-Dedicated Electric Room Heaters, UL 2021; and

h) Electric Heating Appliances, UL 499.

1.3 revised October 14, 2011

1.4 These requirements do not cover the following:

a) Heating cable intended to be installed in a dropped or suspended ceiling;

b) Heating cable connected to the supply by use of a flexible cord with attachment plug;

c) Heating cable equipment that is movable after installation;

d) Heating equipment with integral means of producing air flow;

e) Heating equipment manufactured and sold as an integral part of a floor covering materials such as heated floor tiles, heated carpet, and heated laminate floor;

f) Heating equipment intended for installation on dry board or plaster, when heating equipment exceeds 2-3/4 W/ft (9 W/m) and/or with adjacent runs intended to be installed less than 1.5 inches (38 mm) on center;

g) Constant wattage heating cable intended for installation in concrete or poured masonry floors with heating leads rated greater than 16-1/2 W/ft (54 W/m); and

h) Heating panels and panel sets of Article Part IX of the National Electrical Code (NEC), ANSI/NFPA 70; and

i) Heating cables for installation directly below floor coverings in accordance with 424.99 of the National Electrical Code (NEC), ANSI/NFPA 70.

1.4 revised October 14, 2011

1.5 These requirements do not cover switches, transformers, power supplies, controls (e.g. temperature) or protective devices (e.g. ground fault protection) that are typically installed separate from the space heating cable but may be installed at the same time as part of the space heating system. Those devices are covered by individual requirements that are separate from this Standard.

1.5 revised October 14, 2011

2 Components

Section 2 deleted October 14, 2011

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Glossary

4.1 For the purpose of this standard, the definitions in this Section apply.

4.1.1 COMPONENT – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to the purpose. When incorporated in an appliance, equipment otherwise typically field installed (e.g. outlet box) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as thermoplastic or copper, are not considered components.

4.1.1 added October 14, 2011

4.2 ELECTRICAL CIRCUITS

a) High Voltage Circuit – A circuit involving a potential of not more than 480 V, and having circuit characteristics in excess of those of a low voltage circuit.

b) Low Voltage Circuit – A circuit involving a potential of not more than 30 V rms (42.4 V peak or direct-current) and supplied by a primary battery or by a Class 2 transformer, or by a combination of an isolating transformer and fixed impedance that, as a unit, complies with all of the performance requirements for a Class 2 transformer specified in the Standard for Low Voltage Transformers - Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3. A circuit derived from a source of supply classified as a line voltage circuit, using impedance in series with the supply circuit as a means of limiting the voltage and current, is not to be considered a low voltage circuit.

4.2 revised October 14, 2011

4.3 FIELD CONNECTION – Terminals or leads provided for connection of the space heating cable by an electrical installer to the branch circuit supply source.

4.4 HEATING LEAD – That portion of the electric space heating cable that, by means of electrical resistance, is provided for the intent of heating.

4.5 ELECTRIC SPACE HEATING CABLE – An assembly consisting of a heating lead and a nonheating lead or leads intended for installation in the field.

4.6 FREE NONHEATING LEADS – That portion of the factory installed nonheating leads of an electric space heating cable intended for installation in ceilings or within floors that are located behind concealed areas without a supplemental raceway and not embedded within noncombustible materials such as concrete and that are intended to be spliced to electrical power supply leads at a junction box.

4.6 revised October 14, 2011

4.7 NONHEATING LEAD – Factory installed wiring that is employed to connect the heating length of the space heating cable to the branch circuit supply source, and that is not intended to consume electrical energy for the purpose of heating.

4.7 revised October 14, 2011

4.7.1 SENSOR WIRE – Factory provided wiring intended for installation in ceilings or floors in proximity to heating lead(s) and for connection to a control and/or protective device installed as part of the space heating system.

4.7.1 added October 14, 2011

4.8 WATTS PER FOOT – The total power in watts of the heating lead length divided by its total linear length in feet.

CONSTRUCTION

4A General

4A.1 A component of a product covered by this standard shall:

a) Comply with the requirements for that component as indicated in 4B – 4E;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability;

d) Additionally comply with the applicable requirements of this end product standard; and

e) Not contain mercury.

Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

Exception No. 1: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product,

b) Is superseded by a requirement in this standard, or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

Exception No. 2: A component complying with a component standard other than those cited in 4B – 4E is acceptable if:

a) The component also complies with the applicable component standard of 4B – 4E; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements in the National Electrical Code (NEC), ANSI/NFPA 70, where appropriate;

2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, and;

3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.

4A.1 added October 14, 2011

4A.2 A component that is also intended to perform other functions, such as over current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

4A.2 added October 14, 2011

4A.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of 4B – 4E, and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable standard, and shall comply with 4A.1(b) – (e).

4A.3 added October 14, 2011

4A.4 With regard to a component being additionally investigated, reference to construction and performance requirements in another end product standard is appropriate where that standard anticipates normal and abnormal use conditions consistent with the application of this standard.

4A.4 added October 14, 2011

4B Insulated Wire, Cable and Heating Leads

4B.1 Unless specified otherwise, insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

Exception: Nonheating leads and sensor wire complying with the Standard for Thermoset-Insulated Wires and Cables, UL 44, Thermoplastic-Insulated Wires and Cables, UL 83, or other types specified in Chapter 3 of the National Electrical Code (NEC), ANSI/NFPA 70 complying with the appropriate standard, need not comply with UL 758.

4B.1 added October 14, 2011

4B.2 Free nonheating leads shall comply with 6.3.

4B.2 added October 14, 2011

4C Connectors

4C.1 Multi-pole connectors shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459.

4C.1 added October 14, 2011

4C.2 Connectors complying with one of the following are considered acceptable to fulfill the requirement of 8.1:

a) the Standard for Wire Connectors, UL 486A-486B;

b) the Standard for Splicing Wire Connectors, UL 486C;

c) the Standard for Sealed Wire Connector Systems, UL 486D; or

d) the Standard for Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors, UL 486E.

When an insulated connector or splice is required for the application, the insulation provided shall comply with 9.1.

4C.2 added October 14, 2011

4D Supplemental Insulation, Insulating Bushings and Assembly Aids

4D.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 8.3 and/or 8.4. In such cases:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510 and be used within use limitations (e.g. adherence to itself).

b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441.

c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

4D.1 added October 14, 2011

4E Boxes and Raceways

4E.1 Electrical boxes and raceways of the types specified in Chapter 3 of National Electrical Code (NEC), ANSI/NFPA 70 and that comply with the relevant standard are considered to fulfill the requirements of this Standard.

4E.1 added October 14, 2011

5 Current-Carrying Parts

5.1 Metal employed for a current-carrying part shall consist of one of the following or shall provide equal corrosion protection:

a) Plated iron or steel, where the intended operating temperature of the part is higher than 100°C (212°F);

b) Stainless steel or other corrosion-resistant alloy, regardless of the intended operating temperature of the part;

c) Nichrome for heating lead; or

d) Other material determined to be equivalent to any of the above.

Plain (unplated) iron or steel shall not be used, regardless of the temperatures attained by the part.

5.1 revised October 14, 2011

6 Nonheating Leads

6.1 The nonheating leads of a space heating cable shall consist of wires of a size and type or types that are acceptable for the particular application when considered with respect to:

a) The temperature and voltage to which the leads are likely to be subjected,

b) Their exposure to oil or grease, and

c) Other conditions of service to which they are likely to be subjected.

Free nonheating leads shall comply with 6.3.

6.1.1 Nonheating leads, other than free nonheating leads in 6.3, shall comply with Insulated Wire, Cable and Heating Leads, Section 4B.

6.1.1 added October 14, 2011

6.2 For the purpose of these requirements, the nonheating leads are to be considered factory provided wiring connected to the heating lead and to the wiring terminals or leads intended for field connection.

6.3 Free nonheating leads shall consist of factory installed wiring of one of the following types:

a) Type underground feeder UF cable, complying with the Standard for Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables, UL 493.

b) Type mineral insulated MI cable complying with the Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581 or nonmetallic sheathed type NMC-B cable complying with the Standard for Nonmetallic-Sheathed Cables, UL 719.

c) Other cable found acceptable for the application with respect to use, exposure, and physical properties in accordance with the National Electrical Code, ANSI/NFPA 70.

6.3 revised October 14, 2011

6.4 The ampacity of the nonheating leads shall not be less than 125 percent of the current rating of the space heating cable. Reference should be made to Section 424.36 and the ampacity tables in Article 310 of the National Electrical Code, ANSI/NFPA 70. In no case shall the nonheating leads be smaller than 18 AWG (0.823 mm^2).

6.5 The length of each nonheating lead shall not be less than 7 ft (2.1 m).

7 Heating Leads

7.1 Heating leads of space heating cable shall consist of wires of a size and type or types that are acceptable for the particular application when considered with respect to:

a) The temperature and voltage to which the leads are likely to be subjected, and

b) Other conditions of service to which they are likely to be subjected, such as mechanical strength and resistance to deformation.

7.2 Space heating cables intended for installation on dry board, in plaster, and on concrete ceilings shall have heating leads rated for no more than 2-3/4 W/ft (9 W/m).

7.3 Constant wattage space heating cables intended for installation in concrete or poured masonry floors shall have heating leads rated for no more than 16-1/2 W/ft (54 W/m).

8 Splices and Connections

8.1 All splices and connections shall be mechanically secure and shall provide good electrical contact. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection can result in a risk of fire or of electric shock.

8.2 An insulated splice shall be provided with insulation equal to that on the wires involved.

8.3 Insulation consisting of two layers of friction tape, two layers of thermoplastic tape, or of one layer of friction tape wrapped over one layer of rubber tape is acceptable on a splice if the operating potential is not higher than 250 V. In determining whether splice insulation consisting of coated-fabric, thermoplastic, or other tubing is acceptable, consideration is to be given to such factors as the dielectric properties and the heat- and moisture-resistance characteristics of the tubing. Thermoplastic tape is not acceptable wrapped over a sharp edge.

8.4 Splices employed on space heating cables shall be tested as described in the Splice Test, Section 21.

9 Electrical Insulation

9.1 Insulating materials employed in a space heating cable and in its associated fittings and connectors shall be judged with respect to their acceptability for the particular application. Where it is necessary to investigate a material to determine whether or not it is acceptable, consideration is to be given to its mechanical strength, dielectric properties, insulation resistance, heat-resistant quality, the degree to which it is enclosed or protected, and any other features having a bearing on the likelihood that a risk of fire or a risk of electric shock or injury to persons may occur, under conditions of actual service. All of these factors are to be considered with respect to thermal aging.

9.1 revised October 14, 2011

10 Electrical Spacings

10.1 The electrical spacings shall be in accordance with Tables 10.1 and 10.2.

Table 10.1
Minimum acceptable spacings at field wiring terminals

Place(s) of measurement	Potential involved in volts	Spacings[a,b]			
		Through air		Over the surface	
		inch	(mm)	inch	(mm)
Between live parts of opposite polarity; and between a live part and a dead metal part, which may be grounded	0 – 250	1/4	(6.4)	3/8	(9.5)
	251 – 480	3/8	(9.5)	1/2	(12.7)

[a] These spacings do not apply to connecting straps or busses extending away from wiring terminals. Such spacings are to be judged under Table 10.2.

[b] These spacings apply to the sum of the spacings involved where an isolated dead part is interposed.

Table 10.2
Minimum acceptable spacings through air or over the surface

Table 10.2 revised October 14, 2011

Place(s) of measurement	Potential involved in volts	Spacing	
		inch	(mm)
Between uninsulated live metal parts of opposite polarity, and between a rigidly mounted uninsulated live metal part and a dead metal part that either is exposed for persons to contact or may be grounded	0 – 250	1/16	(1.6)
	251 – 480	1/4	(6.4)

[a] If an uninsulated live part is not rigidly supported, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum acceptable spacing of 1/16 inch (1.6 mm) is maintained under all operating conditions and under all normal conditions of handling.

11 Grounding

11.1 Electric space heating cables shall be provided with a grounding component over the heating length of the cable. The grounding component may be covered with an overall jacket. The construction shall comply with the city Test, Section 22.

11.1 revised October 14, 2011

11.2 The grounding component shall:

a) cover 50 percent or more of the surface area of the heating length,

b) have an ampacity at least equal to that of an 18 AWG (0.823 mm^2) copper conductor,

c) be corrosion resistant or protected by an outer jacket; and

d) terminate in one or more nonheating lead(s) of the same length as the adjacent nonheating lead carrying the heating load current.

11.2 revised October 14, 2011

11.3 The nonheating lead(s) connected to the grounding component shall be of a size acceptable for the application in accordance with Table 250.122 of ANSI/NFPA 70, but shall not be required to be larger than the circuit conductors or leads supplying the equipment.

11.3 added October 14, 2011

12 Accessories

12.1 A space heating cable having provision for the use of an electrical accessory intended to be attached in the field shall comply with the requirements in this standard, with and without the accessory installed.

12.2 The installation of an accessory by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals.

12.3 With reference to 12.2, an installation shall not require the cutting of wire or the soldering of connections by the installer.

12.4 As part of an investigation, an accessory is to be trial installed to determine that the installation is feasible, the instructions are detailed and correct, and the use of the accessory does not introduce a risk of fire or of electric shock or injury to persons.

PERFORMANCE

13 General

13.1 The performance of an electric space heating cable shall comply with the applicable requirements when the cable is tested as described herein. A copy of the manufacturer's instructions (see Details, Section 26) shall be furnished for the investigation. The instructions shall be trial tested, for the installation of the space heating cable, as described in Test Installation, Section 14. It shall be determined that the installation does not result in a risk of fire or electric shock and that the installation complies with the installation requirements for electric space heating cables in the National Electrical Code, ANSI/NFPA 70.

13.2 Unless otherwise specified, the space heating cable shall be installed and operated in accordance with the manufacturer's instructions.

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14 Test Installation

14.1 Cable intended for mounting in ceilings

14.1.1 Electric space heating cables intended for installation on dry board, in plaster, and on concrete ceilings shall be supported in the intended manner on the surface recommended in the manufacturer's instructions. The test surface shall be blanketed on top with conventional glass-fiber or mineral-wool insulation having an R factor of the maximum R value recommended by the manufacturer [(see 26.2(j)] but in no case less than 30. The ceiling shall have an area of 8 ft by 12 ft (2.4 m by 3.7 m). The ceiling is to be supported in the corner of black-painted walls consisting of plywood that is 3/8 inch (9.5 mm) thick and is fastened to both shorter sides of two-by-four (actual cross section measures 1-1/2 inches by 3-1/2 inches or 38 mm by 89 mm) vertical wooden studs on 16 inches (406 mm) centers. The height of the walls shall extend not less than 2 ft (610 mm) below the ceiling. The cables shall be secured at intervals not exceeding 16 inches (406 mm) by stapling, tape, or other means designated by the manufacturer. A spacing of 2-1/2 inches (64 mm) on centers from adjacent runs shall be provided except that adjacent runs of cable not exceeding 2-3/4 W/ft (9 W/m) may be on centers not less than 1-1/2 inches (38 mm) apart.

14.2 Cable intended for installation in concrete or poured masonry floors

14.2.1 Electric space heating cables intended for mounting in concrete or poured masonry shall be installed in a concrete floor in accordance with the manufacturer's instructions. The floor shall have minimum dimensions of 3 feet (910 millimeters) square and 3-1/2 inches (89 mm) thick and shall have a control joint at least 1/8 inch (3 mm) deep across the width, and parallel and equally spaced between two sides of the floor. The concrete shall have a 1:2:4 mix (1 part cement, 2 parts sand, 4 parts stone). The flooring material shall be cured for approximately two weeks prior to conducting the tests. Any steel reinforcing means recommended by the manufacturer shall be omitted. The spacing between runs of cable shall not be less than 1 inch (25.4 mm) on centers.

14.3 Test voltage

14.3.1 The test voltage is to be that indicated in Table 14.1, except that, if the application of the indicated test voltage does not result in the measured wattage input to the heater being equal to or greater than the marked wattage rating, the test voltage is to be increased until the measured wattage input equals the marked wattage rating.

Table 14.1
Voltage for temperature test

Marked voltage rating	Test potential in volts
110 – 120	120
208	208
220 – 240	240
277	277
440 – 480	480
Value not within one of the above ranges	Rated voltage

15 Power Input Test

15.1 The power input to an electric space heating cable shall not be more than 105 percent of its marked rating.

15.2 To determine whether a space heating cable complies with the requirement in 15.1, the power input is to be measured with the cable installed as described in Test Installation, Section 14. The cable is to be at normal operating temperature under full-load conditions while energized by a supply circuit adjusted to the highest of the following:

a) The marked voltage rating, or

b) The highest voltage of the applicable range of voltages specified in 14.3 if the marked voltage is within one of the voltage ranges indicated in 14.3.

16 Normal-Temperature Test

16.1 General

16.1.1 A space heating cable, when tested under the conditions described in 16.3.1 and 16.3.2, shall not attain a temperature at any point high enough to constitute a risk of fire or of damage to any material employed in the space heating cable, nor shall temperature rises at specific points be greater than those indicated in Table 16.1.

16.1.2 In conducting a test to determine whether or not a space heating cable complies with the temperature requirements, the cable is to be mounted or supported as in service and is to be tested under conditions approximating those of normal operation, except as noted otherwise. Temperatures are to be measured on nearby surfaces, on the supporting surface, at points of support, and at other points as may be necessary, including any building wiring that may be located adjacent to or behind a space heating cable.

16.1.3 The space heating cable shall be installed in the test assembly for ceiling or floor installation as described in 14.1 – 14.2 in accordance with the manufacturer's installation instructions.

16.1.4 The test assembly shall include at least one point of cable crossover. The temperature at this location shall determine the effects of improper separation during installation.

Exception: One point of cable crossover is not required for a cable that is bound or arranged in an installation aid, such as a mesh or similar material that does not enclose the cable, and for which cable bunching or crossover is unlikely.

16.1.4 revised October 14, 2011

16.2 Temperature measurements

16.2.1 Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.205 mm^2) and not smaller than 30 AWG (0.0507 mm^2). The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements for Special Tolerances thermocouples as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

16.2.1 revised October 14, 2011

16.2.2 A temperature is to be considered constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but at intervals of not less than 5 min), indicate no change.

16.2.3 A thermocouple junction and the adjacent thermocouple lead wires are to be securely held in good thermal contact with the surface of the material whose temperature is being measured. In most cases, acceptable thermal contact results from securely taping or cementing the thermocouple in place.

16.3 Specific test conditions

16.3.1 All values in Table 16.1 are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

16.3.2 To determine whether a space heating cable complies with the requirement in 16.1, it is to be operated continuously until constant temperatures have been reached. The test voltage is to be as indicated in Table 14.1, except that, if the application of the indicated test voltage does not result in the measured wattage input to the space heating cable being equal to or greater than the marked wattage rating, the test voltage is to be increased until the measured wattage input equals the marked wattage rating.

Table 16.1
Maximum acceptable temperature rises[a]

	Materials and components	°C	°F
1.	Any point on a combustible surface adjacent to space heating cable, including the surface on which the heater is mounted	65	117
2.	Insulated wire or cable	25°C (77°F) less than its temperature rating	
3.	Fiber employed as electrical insulation	65	117
4.	Phenolic composition employed as electrical insulation or where the deterioration would result in a risk of fire or of electric shock or injury to persons[b]	125	225
5.	Sealing compound	c	

[a] Rated temperature limit of material minus test ambient temperature.

[b] The limitation on phenolic does not apply to a compound that has been investigated and found to have acceptable heat-resistant properties.

[c] The maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined by the American Society for Testing and Materials Standard Test Methods for Softening Point of Resins Derived form Naval Stores by Ring-and-Ball Apparatus, ASTM E 28).

17 Dielectric Voltage-Withstand Test

17.1 The space heating cable shall withstand for one minute without breakdown a 60 Hz essentially sinusoidal rms potential applied between live parts and non-current-carrying metal parts, with the space heating cable at its maximum normal operating temperature. The rms test potential shall be 1,000 V for a space heating cable rated for 250 V or less and 1,000 V plus twice rated voltage for a space heating cable rated for more than 250 V.

17.2 To determine whether or not a space heating cable complies with the requirement in 17.1, it is to be tested by means of a 500 VA or larger capacity transformer, the output voltage of which can be regulated and is essentially sinusoidal. The increase in the applied potential is to be at a substantially uniform rate and is to be as rapid as is consistent with its value being correctly indicated by a voltmeter.

18 Insulation Resistance Test

18.1 A space heating cable, when tested as described in 18.2, shall have an insulation resistance that is not less than 0.1 megohm based on 1,000 conductor feet of heated length (304,800 ohms based on 1000 meters of heated length).

18.2 The space heating cable is to be immersed in a salt water solution consisting of 1 gram of sodium chloride (NaCl) per liter of distilled water, maintained at a uniform temperature of 75.0 ±1.0°C (167.0 ±1.8°F). The ends of the nonheating leads are to be brought well above the water level of the tank. After 24 h, the insulation resistance is to be measured between the leads of the space heating cable and a probe inserted in the salt water solution.

19 Abnormal-Operation Tests

19.1 When a space heating cable intended for installation in a poured concrete slab is tested as described in 19.2, the electrical insulation in the space heating cable shall have an insulation resistance that is not less than 50,000 ohms. The cable may be damaged but current-carrying parts shall not be exposed.

Exception: Mineral insulated (MI) cable is exempt from this test.

19.2 One end of the concrete slab is to be raised and a crack is to be created in the concrete by hitting the slab on the control joint with a sledge hammer. The separated concrete sections are to be separated farther by means of a pry bar. The sections of the concrete slab are to be separated until the continuity of the space heating cable, which is to be continuously monitored by means of an ohmmeter, is interrupted or the gap between the slabs exceeds 12.7 mm (1/2 inch). After the slab is separated, the salt water solution described in 18.2 is to be poured continuously into the crack while the insulation resistance is measured. The salt water solution is to be added until it submerges the space heating cable in the crack. The insulation resistance is to be measured between the leads of the space heating cable and a probe inserted through the crack in the concrete slab. The probe is to be inserted into the solution and placed close to the cable but not touching it.

20 Physical Properties Tests

20.1 Space heating cables with an outer jacket intended for direct contact with asphalt shall comply with 20.2 – 20.4.

20.2 When tested as described in 20.3 and 20.4, the average tensile strength and elongation of space heating cable with an outer jacket and intended for direct contact with asphalt shall not be less than 50 percent of the unconditioned value.

20.3 Cable in the as-received condition and cable conditioned as described in 20.4 are to be employed for this test. The average tensile strength and elongation (in percent) of the jacket shall be as tabulated for the material in Specific Materials, Section 50 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

Exception: Mineral insulated (MI) cable is exempt from this test.

20.4 Space heating cables with an overall jacket intended for direct contact with asphalt are to be immersed in ASTM fuel oil Grade No. 6 for 60 days at a temperature of 82.0 ±1.0°C (179.6 ±1.8°F). This oil is used to represent asphalt. It is of a petroleum base and is a high-viscosity, residual fuel oil that sometimes is referred to as ″Bunker C″. This oil is described in the American Society for Testing and Materials Standard Specification for Fuel Oils, ANSI/ASTM D 396.

21 Splice Test

21.1 General

21.1.1 Three of the completed splice assemblies intended for use in concrete or beneath asphalt are to be tested. After having been conditioned as described in Table 21.2, the splice assemblies are to be subjected to the following test. The assemblies are to be flexed 12 times on a mandrel of the diameter indicated in Table 21.1. Each cycle is to consist of flexing the assembly 90° in one direction, 180° in the opposite (reverse) direction, and then returning to the starting point. The assemblies are then to be immersed for 30 min in a salt water solution maintained at a temperature of 35.0 ±2.0°C (95.0 ±3.6°F). The splices are then to be placed in tap water at room temperature for 7 min. This procedure (cycle) is to be repeated for a total of 8 cycles. The insulation resistance is to be measured at the end of each cycle. Following this, the splice assemblies are to be immersed in a salt water solution maintained at 75.0 ±1.0°C (167.0 ±1.8°F) for 7 h. The insulation resistance is then to be measured and shall comply with 18.1.

Exception: Mineral insulated (MI) cable is exempt from this test.

21.1.2 Three additional splice assemblies of space heating cables intended for direct contact with asphalt are to be immersed in ASTM fuel oil Grade No. 6 (see 20.4) for 60 days at a temperature of 82.0 ±1.0°C (179.6 ±1.8°F). Following this, insulation resistance and dielectric voltage withstand tests are to be conducted and the splice assemblies shall comply with 17.1 and 18.1.

Exception: Mineral insulated (MI) cable is exempt from this test.

21.1.3 Three splice assemblies intended for use in concrete or beneath asphalt are to be subjected to this test. Each ″as received″ assembly is to be flexed 12 times (cycles) over a mandrel of the diameter indicated in Table 21.1. Each cycle is to consist of flexing the splice 90° in one direction, 180° in the opposite (reverse) direction, and then returning to the starting point. The splice is then to be immersed in tap water at a temperature of 75.0 ±1.0°C (167.0 ±1.8°F) for 1 h. The insulation resistance is to be measured with the splice immersed in the water. The insulation resistance shall not be less than indicated in 18.1.

Exception: Mineral insulated (MI) cable is exempt from this test.

Table 21.1
Mandrel diameter

AWG size of nonheating lead	Mandrel diameter for types NMC and UF		Mandrel diameter for type MI		Mandrel diameter for other cables	
	inch[a]	(mm)[b]	inch[a]	(mm)[b]	inch[a]	(mm)[b]
18	–	–	–	–	–	–
16	–	–	–	–	–	–
14	0.313	(8.0)	2	(50.8)	0.313	(8.0)
12	0.375	(9.5)	3	(76.2)	0.375	(9.5)
10	0.563	(14.5)	4	(101.6)	0.563	(14.5)
8	0.688	(17.5)	6	(152.4)	0.688	(17.5)

[a] Tolerances of ±0.001 inch apply.
[b] Tolerances of ±0.1 mm apply.

Table 21.2
Conditioning for splice test

Temperature	Duration of conditioning of sets of three assemblies each
−10.0 ±2.0°C(+14.0 ±3.6°F)	1 hour
87.0 ±1.0°C(188.6±1.8°F)	30 days, 60 days, 90 days
97.0 ±1.0°C(206.6 ±1.8°F)	30 days, 60 days, 90 days
113.0 ±1.0°C(235.4 ±1.8°F)	7 days, 14 days, 21 days, 28 days

21.2 Thermal stress test

21.2.1 The splice assembly is to be conditioned for 15 min in a full-draft circulating-air oven that is maintained at a temperature of 121.0 ±1.0°C (249.8 ±1.8°F). Following this, the assembly is to be visually examined to determine that there is no exposure of uninsulated live parts.

21.3 Heat shock test

21.3.1 When tested as described in 21.3.2, there shall be no cracking of the splice tubing that results in exposure of live parts.

21.3.2 Three splice assemblies are to be wrapped around a mandrel of the diameter indicated in Table 21.1 and then are to be conditioned for 60 min in a full-draft circulating-air oven that is maintained at a temperature of 121.0 ±1.0°C (249.8 ±1.8°F). Following this, the assemblies are to be visually examined to determine that there is no cracking of the tubing that forms part of the splice.

22 Grounding Component Ampacity Test

22.1 The grounding component shall not open when carrying a low-voltage current equal to twice the current setting of the overcurrent protective device in the branch circuit to which the heating cable is intended to be connected.

22.2 The grounding component is to be connected to the isolated low-voltage secondary winding of a step-down transformer and is to be made to carry current that is gradually increased to twice the value of the intended branch-circuit protective device. The grounding component shall not open following 2 minutes of operation under this condition. The heating cable is to be as received and is to be tested in still air at a temperature of 24.0 ±8.0°C (75.2 ±14.4°F).

MANUFACTURING AND PRODUCTION TESTS

23 Production-Line Dielectric Voltage-Withstand Test

23.1 Each fully assembled, heated or unheated space heating cable shall withstand, without electrical breakdown, as a routine production-line test, a 40 – 70 Hz essentially sinusoidal rms test potential applied between live parts and the grounding component.

23.2 The manufacturer has the option of conducting the production-line test in accordance with condition A or B as described in Table 23.1.

Table 23.1
Production-line test conditions

Voltage rating of space heating cable	Condition A		Condition B	
	Potential in volts	Time in seconds	Potential in volts	Time in seconds
0 – 250	1,000	60	1,200	1
251 – 480	1,000 + 2V[a]	60	1,200 + 2.4V[a]	1

[a] Maximum marked voltage but not less than 250 V.

23.3 The test equipment is to include a transformer having an essentially sinusoidal output, a means of indicating the rms test potential, an audible or visible indicator of electrical breakdown, and either a manual reset device to restore the equipment after electrical breakdown or an automatic reject feature activated by a dielectric breakdown.

23.4 If the output of the test equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the rms test potential.

23.5 If the output of the test equipment transformer is 500 VA or is larger, the test potential may be indicated:

a) By a voltmeter in the primary circuit or in a tertiary winding circuit,

b) By a selector switch marked to indicate the test potential, or

c) In the case of equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential.

When a marking is used without an indicating voltmeter, the equipment is to include a positive means, such as an indicator lamp, to indicate that the manual-reset switch has been reset following a dielectric breakdown.

23.6 Test equipment other than that described in 23.3 – 23.5 may be used if it is found by an engineering evaluation to accomplish the intended factory control.

RATINGS

24 Details

24.1 A space heating cable shall be rated in watts or amperes and also in volts. The voltage rating shall be any appropriate single voltage or voltage range such as 100 – 120, 208, 220 – 240, 254 – 277, or 440 – 480.

MARKINGS

25 Details

25.1 Each space heating cable shall be permanently marked with:

a) The manufacturer's name, trade name, or trademark;

b) The catalog number or a similar designation; and

c) The electrical ratings in accordance with 24.1.

25.2 Each unit length of heating cable shall have a permanent, legible marking on each nonheating lead located within 3 inches (76 mm) of the terminal end. The lead wire shall have the following color identification to indicate the circuit voltage on which it is to be used:

a) 120 V nominal – yellow

b) 208 V nominal – blue

c) 240 V nominal – red

d) 277 V nominal – brown

e) 480 V nominal – orange

25.3 If a manufacturer produces or assembles space heating cables at more than one factory, each finished space heating cable shall have a distinctive marking, which may be in code, to identify it as the product of a particular factory.

25.4 The marking required in 25.1 shall be on a tag permanently affixed to the nonheating leads, no more than 3 inches (76 mm) from the terminal end. The tag shall be made of substantial material (cardboard, cloth, plastic, or the equal) to provide mechanical strength and to resist easy removal. The tag shall be of a size that facilitates legibility of the required markings, and all exposed surfaces shall have a clear plastic overlay or other protection for the markings. The tag shall be in one of the following forms:

a) A flat tag having a hole to facilitate securing of the tag to the nonheating leads by a means such as a plastic strap. The strap is not to be removable without cutting.

b) A flag-type tag with an adhesive back. The tag is to be wrapped tightly once around and is to adhere to the nonheated length. The ends of the tag are to adhere to one another and are to project as a flag. The required markings are to be positioned on the projecting (flag) portion of the tag.

INSTALLATION AND OPERATING INSTRUCTIONS

26 Details

26.1 An instruction manual, sheet(s), or the like shall be provided with each space heating cable. The manual shall specifically warn the user against the potential risks of fire and of electric shock and injury to persons and shall state that caution should be taken to guard against each such risk.

26.2 The instructions shall include the directions and information that the manufacturer considers necessary for installation, maintenance, and use of the space heating cable, and shall include the following information:

a) Where the space heating cable is to be installed – ceiling or floor.

b) The type of materials to be used for the installation.

c) That the space heating cable shall not extend beyond the room or area in which it originates.

d) That the space heating cable shall not be installed in closets, over walls or partitions that extend to the ceiling, or over cabinets whose clearance from the ceiling is less than the minimum horizontal dimension of the cabinet to the nearest cabinet edge that is open to the room or area.

Exception: The instructions may state that isolated single runs of cable may pass over partitions where they are embedded.

e) If the space heating cable is recommended by the manufacturer for installation in closet ceilings as a low temperature heat source to control relative humidity, the instructions shall specify that it is intended for use only in those portions of the ceiling that are unobstructed to the floor by shelves or other permanent fixtures.

f) The cable is not to be installed in walls.

g) The minimum distance between adjacent runs shall be as specified.

h) The instructions shall advise the installer of the need to inspect and remove damaged or defective cables before they are covered or concealed.

i) Instructions shall specify the need to mark the appropriate circuit breaker reference label indicating which branch circuit supplies the circuits to those electric space heating cables.

j) For cable intended for mounting in ceilings, the maximum R factor of insulation that may be blanketed above the ceiling.

APPENDIX A

Appendix A deleted October 14, 2011

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