UL 1693

Underwriters Laboratories Inc.

Standard for Safety

Electric Radiant Heating Panels and Heating Panel Sets

UL Standard for Safety for Electric Radiant Heating Panels and Heating Panel Sets, UL 1693

Third Edition, Dated September 13, 2010

SUMMARY OF TOPICS:

These revisions to UL 1693 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that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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UL 1693

Standard for Electric Radiant Heating Panels and Heating Panel Sets

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Second Edition – July, 2002

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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INTRODUCTION

1 Scope

1.1 These requirements cover radiant heating panels and heating panel sets, for use on ac supply system voltages not exceeding 600 V, designed for installation indoors in nonhazardous locations in household, commercial, and industrial applications, in accordance with Article 424, Part IX , of the National Electrical Code, ANSI/NFPA 70.

1.1 revised October 14, 2011

1.2 These requirements cover products designed to be permanently connected to a supply circuit, and that are intended to form an integral part of the building construction after on-site assembly, installation, and connection.

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

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

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

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

f) Electric Space Heating Cables, UL 1673;

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

h) Electric Heating Appliances, UL 499.

1.3 revised October 14, 2011

1.4 These requirements do not cover the following:

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

b) Heating equipment that is movable after installation;

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

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

e) Heating equipment exceeding 355 W/m^2(33 W/ft^2) when installed in concrete or poured masonry;

f) Electric Space-Heating Cables of Article 424 Part V of the National Electrical Code, ANSI/NFPA 70;

g) Heating panels and panel sets for mounted directly underfloor coverings in accordance with 424.99 of the National Electrical Code, ANSI/NFPA 70; and

h) Radiant heating panels intended to be installed in a dropped or suspended ceiling.

1.4 added 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 heating panels 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 added 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 References

4.1 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.

5 Glossary

5.1 For the purpose of this standard, the following definitions apply.

5.2 ACTIVE AREA – That part of a heating product forming a plane area bounded by the perimeter of the heating element and its non-heating components.

5.3 ASSOCIATE PART – A nonintegral part of a heating product essential for the correct operation, installation, or both, of the product.

5.3.1 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.

5.3.1 added October 14, 2011

5.4 FLEXIBLE HEATING PRODUCT – A heating product of nonrigid construction, composed of thin flexible sheets of electrical insulating material enclosing a heating element, which is intended for installation in contact with normal building construction materials.

5.5 HEATING ELEMENT – That portion of a heating panel or heating panel set that is the actual electrical conducting medium, including a continuously applied or patterned conductive film, intended to be heated by an electric current.

5.6 HEATING PANEL – A complete assembly provided with a junction box or a length of flexible conduit for connection to a branch circuit.

5.7 HEATING PANEL SET – An assembly provided with nonheating leads or a terminal junction assembly identified as being suitable for connection to a wiring system. It may be of fixed dimension, or of continuous form where the final product dimension is determined during installation.

5.8 HEATING PRODUCT – A collective term used to refer to heating panels and heating panel sets.

5.9 NONHEATING COMPONENT – A component of a heating product that carries current or is conductively coupled to a supply circuit, and that is not primarily intended to produce heat.

5.10 NONHEATING LEADS – Lead wires provided to facilitate connection of a heating product directly to branch circuit conductors. Also known as “cold leads.”

5.11 RIGID HEATING PRODUCT – A heating product of fixed construction designed to be mounted on or above a ceiling, forming all or part of a ceiling, or mounted below a subfloor.

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

5.11.1 added October 14, 2011

5.12 TERMINAL BOX – A box or enclosure, inside which connections between branch circuit conductors and cold leads or terminals are made.

CONSTRUCTION

6 General

6.1 A heating product shall be provided with means for mounting in the intended manner. Any fittings – such as brackets, hangers, or the like – necessary for mounting shall be furnished with the heating product.

6.2 A heating product intended to be installed in contact with combustible building construction materials, such as furring, nailing strips or joists shall be provided with an integral means to facilitate securement during installation.

6.3 A heating product shall be installed in accordance with the manufacturer’s installation instructions provided with the heating product. See Details, Section 36.

6.4 A component of a product covered by this standard shall:

a) Comply with the requirements for that component as indicated in 6A – 6D;

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 6A – 6D is acceptable if:

a) The component also complies with the applicable component standard of 6A – 6D; 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.

6.4 added October 14, 2011

6.5 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.

6.5 added October 14, 2011

6.6 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of 6A – 6D, 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 6.4(b) – (e).

6.6 added October 14, 2011

6.7 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.

6.7 added October 14, 2011

6A Insulated Wire, Cable and Nonheating Leads

6A.1 Unless specified elsewhere, insulated conductors, nonheating leads, and sensor wire shall comply with one of the following:

a) The Standard for Appliance Wiring Material, UL 758;

b) The Standard for Thermoset-Insulated Wires and Cables, UL 44;

c) The Standard for Thermoplastic-Insulated Wires and Cables, UL 83; or

d) other types specified in Chapter 3 of the National Electrical Code (NEC), ANSI/NFPA 70 complying with the appropriate standard.

6A.1 added October 14, 2011

6B Connectors

6B.1 Multi-pole connectors shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459.

6B.1 added October 14, 2011

6B.2 Splices complying with one of the following are considered to fulfill the requirement of 10.1 – 10.5:

a) the Standard for Wire Connectors, UL 486A-486B, provided with supplemental insulation complying with 6C.1 and 11.1 – 11.3;

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, provided with supplemental insulation complying with 11.1 – 11.3 provided with supplemental insulation complying with 6C.1 and 11.1 – 11.3.

6B.2 added October 14, 2011

6C Supplemental Insulation, Insulating Bushings and Assembly Aids

6C.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 10.2. 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.

6C.1 added October 14, 2011

6D Boxes and Raceways

6D.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 and Section 7, Enclosure, are considered to fulfill the requirements of this Standard.

6D.1 added October 14, 2011

7 Enclosure

7.1 The enclosure of a heating product shall be so formed and assembled that it will have the strength and rigidity necessary to resist the abuses likely to be encountered during its intended service. The degree of resistance inherent in the heating product shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other serious defects which alone or in combination constitute a risk of fire, electric shock, explosion, or injury to persons.

Exception: A heating product need not be rigid if, when installed per the manufacturer's instructions, the building construction materials completely enclose the product except for the nonheating leads.

7.2 Among the factors taken into consideration if an enclosure is being judged for acceptability are its mechanical strength, resistance to impact, moisture-absorption properties, flammability, resistance to corrosion, and resistance to distortion and or delamination at temperatures to which the enclosure may be subjected under conditions of intended or abnormal use.

7.3 Cast- and sheet-metal portions of the enclosure shall not be thinner than indicated in Table 7.1 unless the enclosure is found to be acceptable when judged under considerations such as are mentioned in 7.4.

7.4 An enclosure of sheet metal is to be judged with respect to its size and shape, the thickness of metal, and its acceptability for the particular application, considering the intended use of the heating product.

7.5 Sheet metal to which a wiring system is to be connected in the field shall have an average thickness not less than 0.81 mm (0.032 inch) if uncoated steel, not less than 0.86 mm (0.034 inch) if galvanized steel, and not less than 1.14 mm (0.045 inch) if nonferrous.

7.6 An electrical part of a heating product, installed in accordance with the manufacturer's installation instructions, shall be so located or enclosed to provide protection against unintentional contact with uninsulated live parts.

7.7 Determination of the acceptability of a polymeric material used as an enclosure of a rigid heating product shall be made based on the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.8 The flexible enclosure material of a flexible heating product shall have a relative thermal index and adhesive bond strength suitable for the temperatures to which it is exposed during the Normal and Abnormal Temperature Tests and shall comply with the requirements in Flammability, Section 13. Determination of the acceptability of a polymeric material used as an enclosure of a flexible heating product with respect to its relative thermal index and adhesive bond strength shall be made based on the requirements of UL 746C.

Table 7.1
Minimum acceptable thickness of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing and the like (or are otherwise of a shape and/or size) to provide mechanical strength		At relatively-large unreinforced flat surfaces	
	Millimeters	(Inches)	Millimeters	(Inches)
Die-cast	1.2	(3/64)	2.0	(5/64)
Cast malleable	1.6	(1/16)	2.4	(3/32)
Other cast metal	2.4	(3/32)	3.2	(1/8)
Uncoated sheet steel	0.66[a]	(0.026)[a]	–	–
Galvanized sheet steel	0.74[a]	(0.029)[a]	–	–
Nonferrous sheet metal	0.91[a]	(0.036)[a]	–	–

[a] Thinner sheet metal may be employed if found to be acceptable when the enclosure is judged under considerations such as those mentioned in 7.4.

7.9 See Wire Connectors, Section 10, for requirements for insulating covers for wire connectors and pre-insulated wire connectors.

7.10 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part, an opening in an enclosure shall comply with one of the following:

a) For an opening that has a minor dimension (see 7.12) less than 25.4 mm (1 inch), such a part or wire shall not be contacted by the probe illustrated in Figure 7.1.

b) For an opening that has a minor dimension of 25.4 mm (1 inch) or more, such a part or wire shall be spaced from the opening as specified in Table 7.2.

Table 7.2
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

Minor dimension of opening[a]		Minimum distance from opening to part	
Millimeters[b]	(Inches)[b]	Millimeters[b]	(Inches)[b]
19.1	(3/4)	114.0	(4-1/2)
25.4	(1)	165.0	(6-1/2)
31.8	(1-1/4)	190.0	(7-1/2)
38.1	(1-1/2)	318.0	(12-1/2)
47.6	(1-7/8)	394.0	(15-1/2)
54.0	(2-1/8)	444.0	(17-1/2)
c	c	762.0	(30)

[a] See 7.12.

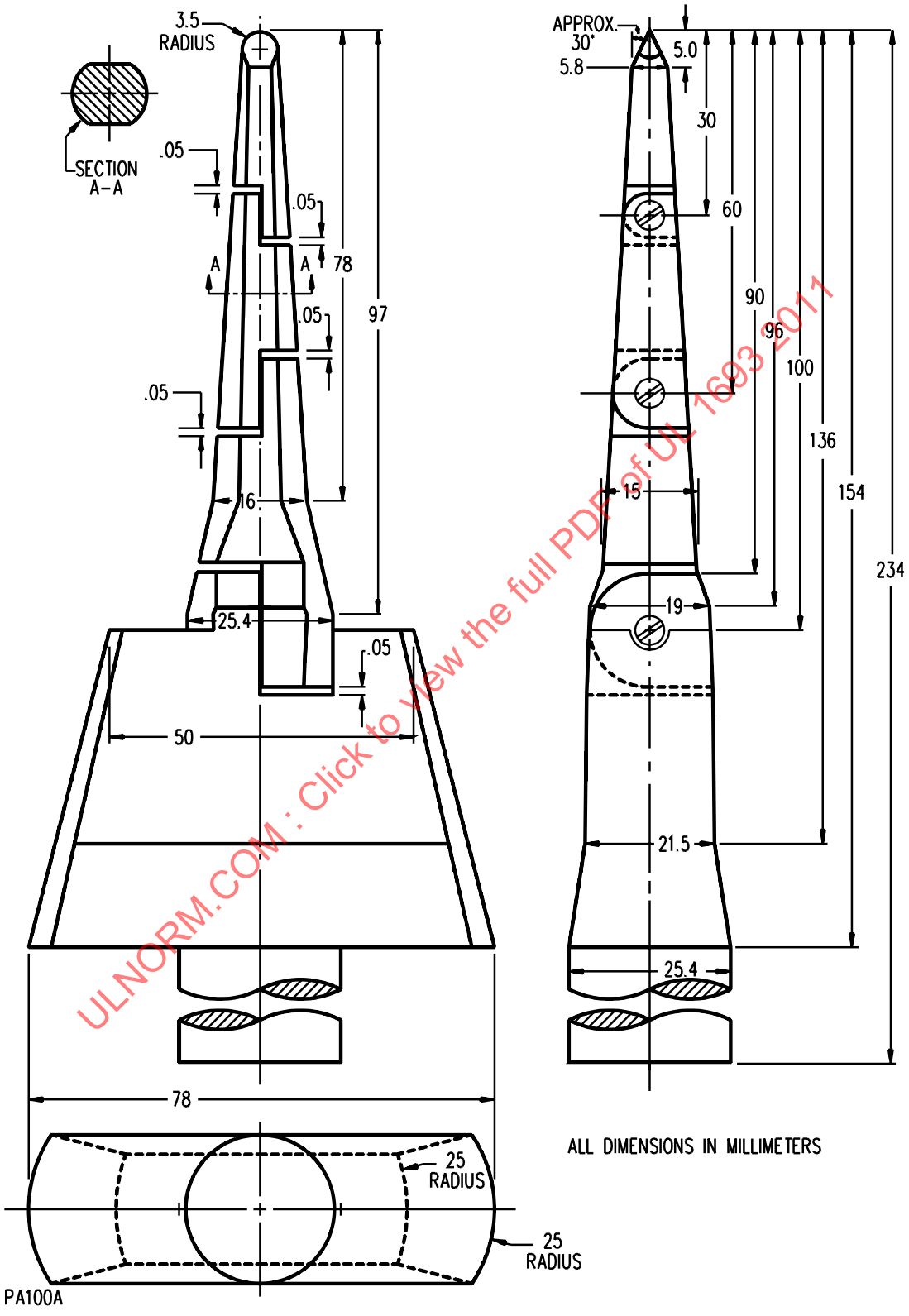
[b] Between 19.1 mm (3/4 inch) and 54 mm (2-1/8 inches), interpolation is to be used to determine a value between values specified in the table.

[c] More than 54 mm (2-1/8 inches), but not more than 152 mm (6 inches).

7.11 The probe illustrated in Figure 7.1 shall be used as a measuring instrument to judge the accessibility provided by an opening, and not as an instrument to judge the strength of a material; it shall be applied with the minimum force necessary to determine accessibility.

7.12 With reference to the requirements in 7.10, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

Figure 7.1
Articulate probe with web stop



8 Protection Against Corrosion

8.1 Except as noted in 8.2, iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if the deterioration of such unprotected parts would be likely to result in risk of fire, electric shock, explosion, or personal injury.

8.2 In certain equipment where the oxidation of steel is not likely to be accelerated due to the exposure of metal to air and moisture or other oxidizing influence – thickness of metal and temperature also being factors – surfaces of sheet steel within an enclosure may not be required to be protected against corrosion. Cast-iron parts are not required to be protected against corrosion. A sheath employed on a heating element operating in air and terminal parts attached directly to the heating element need not be protected against corrosion.

8.3 The aging characteristics of plating or other finish used in a heating product shall be such that deterioration of the finish will not result in unacceptable performance of the heating product.

9 Supply Connections

9.1 Each heating product shall have provision for permanent connection to a supply circuit.

9.2 For a heating product with supply connections concealed by building construction materials after installation, the means of supply circuit connection shall be one of the following:

a) Integral nonheating leads complying with the requirements of 9.4;

b) Field assembled nonheating leads complying with the requirements of 9.4, including the means of connection to the heating product complying with the requirements of Wire Connectors, Section 10; or

c) Terminal fittings complying with the requirements of Wire Connectors, Section 10.

9.3 For a surface mounted heating product, and a heating product intended for installation in which the supply conductors are not intended to be concealed by building construction materials after installation, the means of supply circuit connection shall be one of the following:

a) Terminals suitable for connection of branch circuit conductors, marked to indicate the intended supply circuit connection, and located inside a terminal box; or

b) Pigtail leads, marked to indicate the intended supply circuit connection, and located inside a terminal box or as part of a length of flexible conduit.

9.4 Nonheating leads of heating products shall be suitable for the applied voltage, temperature, and conditions of service to which they are subjected under normal and abnormal operating conditions, and shall be one of the following:

a) Nonmetallic sheathed cable (Types NM-B and NMC-B) or the equivalent complying with the Standard for Nonmetallic-Sheathed Cables, UL 719, if:

1) Not enclosed in a terminal box or enclosure; or

2) Intended to be installed in direct contact with combustible building materials;

b) Appliance wiring material complying with 6A.1 if the wiring is internal to the product such as conductors used for making supply connections inside a terminal box;

c) Underground feeder and branch circuit cable (Type UF) or mineral insulated, metal sheathed cable (Type MI) complying with the Standard for Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables, UL 493 when used in applications as specified in (a);

d) Mineral insulated, metal sheathed cable (Type MI) complying with the Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581, for single conductor applications as specified in (a); or

e) Other type equivalent to the above and acceptable for the application with respect to use, exposure, and physical properties in accordance with the National Electrical Code (NEC), ANSI/NFPA 70.

9.4 revised October 14, 2011

9.5 Factory-assembled nonheating leads shall be one of the following:

a) Not less than 1 m (3 ft) long, for heating products designed to have supply circuit connections located remote from the product;

b) Not less than 152 mm (6 inches) long, for heating panels where supply circuit connections are made in an integral terminal box.

9.6 The location of a terminal box or compartment, if provided, in which power-supply connections are to be made shall be such that these connections may be inspected after the heating product is installed as intended, before the surface finishing material (floor or ceiling) is applied.

9.7 A terminal box or compartment shall not be permitted to rotate such that wiring and connections are subjected to stress or mechanical abuse.

9.8 The surface of an insulated lead intended for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

10 Wire Connectors

10.1 Wire connectors, recommended by a heating product manufacturer for the attachment of nonheating leads to a heating product, shall be of a nonreusable type, and shall comply with the requirements of 6B.

10.1 revised October 14, 2011

10.2 Wire connectors not intended to be enclosed in a terminal box shall be provided with an insulating cover to reduce the likelihood of contact with uninsulated live parts after correct assembly.

10.3 Insulating covers as described in 10.2 shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: Small parts, measuring a maximum of 60 mm long, 25 mm wide and 15 mm thick need not comply with the flammability requirements of UL 746C provided that the insulating material has a minimum flame class rating of V-0 in accordance with the requirements of the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

10.4 Insulating covers shall be free of sharp edges at all points of contact with an element.

10.5 When a special tool is required for the installation of wire connectors to connect nonheating leads to a heating product, the tool shall be identified by manufacturer name or trade name, part number and any limitations (number of wires to be connected, AWG size, and the like) in the heating product installation instructions. See 36.2(i).

11 Electrical Insulation

11.1 Insulating washers, bushings, and the like, that are integral parts of a heating product, and bases or supports for the mounting of live parts shall be of a moisture-resistant material that will not be damaged by the temperatures to which they will be subjected under conditions of actual use. Molded parts shall be constructed so that they will have the mechanical strength and rigidity necessary to withstand the stresses of actual service.

11.2 Insulating material employed in a heating product is to be judged with respect to its particular application. Other materials that are not for general use, such as magnesium oxide, may be acceptable if used in conjunction with other less hygroscopic insulating materials or if located and protected so that they are not subjected to mechanical damage and are resistant to the absorption of moisture. When 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 qualities, the degree to which it is enclosed or protected and any other features having a bearing on the likelihood that a risk of fire, electric shock, or injury to persons may occur, under conditions of actual service. All of these factors are considered with respect to thermal aging.

11.2 revised October 14, 2011

11.3 In the mounting or supporting of small, fragile, insulating parts, screws or other fastenings shall not be tight enough to cause cracking or breaking of these parts with expansion and contraction. Generally, such parts should be slightly loose.

12 Thermal Insulation

12.1 Thermal insulation shall be of such nature and located and mounted or supported so that it will not be adversely affected by any intended operation of the heating product.

12.2 Thermal insulation that is not rigid shall be mounted or supported so that it will not sag. Adhesive material employed for mounting thermal insulation shall be acceptable for use at the temperature to which it may be subjected.

12.3 Determination of the acceptability of an adhesive may be omitted if the thermal insulation is mechanically supported by at least 11 rivets or the equivalent per square meter of material (at least one rivet or the equivalent per square foot of material).

12.4 Flammable or electrically conductive thermal insulation shall not contact uninsulated live parts of a heating product.

12.5 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag that make its use unacceptable if in contact with uninsulated live parts.

13 Flammability

13.1 General

13.1.1 These requirements apply to:

a) All flexible heating products; and

b) All rigid heating products having polymeric enclosures.

13.2 Flexible heating products

13.2.1 A flexible heating product intended to be installed in direct contact with combustible building construction materials and forming an integral part of the building construction shall have a minimum flame rating of HB in accordance with the requirements of the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

13.3 Rigid heating products with polymeric enclosures

13.3.1 A polymeric enclosure of a rigid heating product shall have a flame rating of 5V in accordance with the requirements of the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

14 Spacings

14.1 The spacings in a heating product shall be in accordance with Tables 14.1 and 14.2.

Table 14.1
Minimum acceptable spacings at field-wiring terminals[a,b]

Parts involved	Potential involved	Through air		Over surface	
		mm	(Inch)	mm	(Inch)
Between live parts of opposite polarity; and between a live part and a noncurrent carrying metal part, which may be grounded	0 – 250 volts	6.4	(1/4)	9.5	(3/8)
	251 – 600	9.5	(3/8)	12.7	(1/2)

[a] The spacings do not apply to connecting straps or busses extending away from wiring terminals. Such spacings are to be judged under 14.2.

[b] Applies to the sum of the spacings involved where an isolated noncurrent carrying part is interposed.

Table 14.2
Minimum acceptable spacings through air or over surface at points other than field-wiring terminals[a]

Parts involved	Potential involved, volts	Millimeters	(Inch)
Between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part and a noncurrent-carrying metal part that either is exposed for persons to contact or may be grounded.	0 – 250	1.6	(1/16)
	251 – 600	6.4[b]	(1/4)[b]

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

[b] A spacing of 1.6 mm (1/16 inch) is permissible at the heating element support and terminals only in a heating product rated for 300 volts or less.

14.2 Except as indicated in 14.3, an insulating lining or barrier of fiber or similar material employed where spacings would otherwise be less than the required values shall not be less than 0.8 mm (1/32 inch) thick and shall be so located or of such material that it will not be affected adversely by arcing; except that fiber not less than 0.4 mm (1/64 inch) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

14.3 Insulating material having a thickness less than that specified in 14.2 may be used if, upon investigation, it is found to be acceptable for the application.

14.4 Unless protected from physical abuse during assembly and operation of the heating product, a barrier of mica shall be at least 0.25 mm (0.01 inch) thick.

15 Grounding

15.1 In a heating product, all exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair) and that are likely to become energized shall be electrically connected to the equipment-grounding terminal or lead or be conductively connected to the point of attachment of the wiring system.

15.2 In a heating product required to be grounded and intended for permanent connection to the power supply by means other than a metal-enclosed wiring system (such as nonmetallic-sheathed cable):

a) An equipment-grounding terminal or lead shall be provided (see 9.8), and

b) All exposed noncurrent-carrying metal parts and all noncurrent-carrying metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair) and that are likely to become energized shall be conductively connected to such terminal or lead.

15.2.1 The nonheating lead(s) serving as an equipment-grounding conductor shall be:

a) Identified per 9.8, and

b) Of a size acceptable for the application in accordance with Table 250.122 of National Electrical Code (NEC), ANSI/NFPA 70, but shall not be required to be larger than the circuit conductors or leads supplying the equipment.

15.2.1 added October 14, 2011

15.3 The resistance of the grounding path between a dead metal part and the equipment-grounding terminal and point of attachment of the wiring system shall not be more than 0.1 ohm.

15.4 With reference to 15.3, the resistance may be determined by any convenient method except that if unacceptable results are recorded, either a direct or alternating current equal to the current rating of the maximum-current-rated branch-circuit overcurrent-protective device that may be employed with the heating product is to be passed from the equipment grounding terminal or the point of attachment of the wiring system to the dead metal part, and the resulting drop in potential is measured between these two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

PERFORMANCE

GENERAL

16 Details

16.1 See Table 16.1 for a list of tests applicable to flexible and rigid heating products.

Table 16.1
Performance tests

Performance test	Section no.	
	Flexible heating products	Rigid heating products
Power Input	17	17
Normal Temperature	19	19
Abnormal Temperature	20	20
Contact Loss	21	21
Dielectric Voltage-Withstand (Dry)	22	29
Dielectric Voltage-Withstand (In-Water)	23	30
Cold Bend	24	-
Mechanical Abuse Test	25	-
Scratch	26	-
Concrete Slab Cracking	27	-
Nonheating Conductor Overload	28	-
Impact	-	31
Drop	-	32

16.2 Each representative heating product is to be subjected to the sequence of heat cycling described in 16.3 until the change in resistance, between consecutive heating cycles as noted, is determined to be less than 0.5% as determined in accordance with 16.4.

16.3 Each representative flexible heating product, cut to size in accordance with the requirements for the Normal Temperature Test, 19.1.1, is to be placed in an air-circulating oven which is initially maintained at a temperature of 20 ±2°C. The total element resistance of each heating product is to be measured after an initial temperature stabilization period. The temperature in the oven is then to be raised for approximately 20 minutes to 85°C and maintained within ±5°C for 10 minutes. The heating product is then to be allowed to cool down for 20 minutes, forced cooling is permitted, to a temperature of 30 ±2°C and maintained within ±2°C for 10 minutes.

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16.4 The resistance of each heating product is to be measured after the 25th cycle. If the change in resistance between the initial measurement and after the 25th cycle is not less than 0.5%, the resistance measurement is to be repeated after the 400th cycle, and again after every additional 100 cycles until the resistance measured after the current cycle interval differs from the previous cycle interval by less than 0.5%.

16.5 Whenever cheesecloth is mentioned, the cloth is to be bleached, 914 mm (36 inches) wide, running 20 – 30 m/Kg (14 – 15 yards per pound mass) and having what is known to the trade as a ″count of 32 x 28″, that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 threads in the other direction).

ALL HEATING PRODUCTS

17 Power Input Test

17.1 When a heating product is tested as described in 17.2, the measured power input or current input (or both) shall not vary from the marked rating of the product by more than +5% and -10%.

17.2 The product under investigation, a flexible heating product previously conditioned as described in 16.2 or a previously untested rigid heating product, is to be installed in accordance with the instructions specified for the Normal Temperature Test, based on the type of installation, 19.3 – 19.5. The product is to be operated in accordance with the test procedure of the Normal Temperature Test, described in 19.7, except for the supply voltage, which is to be adjusted to the rated voltage of the product. When thermal equilibrium is reached, the input power or current (or both) of the product is to be measured according to the parameters used to rate the product.

18 General Test Conditions

18.1 The supply voltage feeding the representative heating products during the Normal and Abnormal Temperature Tests is to be adjusted to produce a power input in accordance with the following formula:

$$W_t = 1.05 W_m \left(\frac{V_{n\ max}}{V_r} \right)^2$$

in which:

1.05 = upper limit tolerance of rated power; see 17.1

W_t = test power (in watts)

W_m = marked power rating of product (at rated voltage); replace with calculated wattage (rated voltage multiplied by rated current) if heating product is rated in amperes

$V_{n\ max}$ = upper limit of voltage range for the nominal supply system on which the product is intended to be used; see 34.3

V_r = rated voltage marked on the product under investigation

18.2 Power adjustment is to be made, if necessary, after the addition of a load to simulate full heating product length as described in 18.3.

18.3 When the length of a representative parallel heating product is less than the maximum length specified by the manufacturer, an additional load is to be connected to the heating product to simulate the maximum specified product length. The additional load is to be connected so that the total load current (product plus added load) flows through the internal nonheating conductors of the product. When a temperature test involves more than one heating product, each product used for the test is to be loaded to simulate maximum length.

18.4 The supply voltage for the Contact Loss Test, Section 21, and the Mechanical Abuse Tests, Section 25, is to be the rated voltage or the upper limit of the voltage range of the nominal supply system on which the product is intended to be used, whichever is greater. See 34.3.

19 Normal Temperature Test

19.1 General

19.1.1 Each heating product is to be provided in the maximum length or branch circuit size specified by the manufacturer.

Exception: A combination of heating product and supplemental load in accordance with 18.2 may be provided.

19.1.2 Unless otherwise specified by the manufacturer, the heating product is to be connected to a 20 A branch circuit using 12 AWG (3.3 mm^2), two conductor nonmetallic sheathed cable, Type NM, nonheating leads. See 36.2(f).

19.1.3 Each heating product is to be installed as close to the corner of the test alcove as construction and product installation instructions permit.

Exception: Heating products intended to be installed in concrete or poured masonry are not required to be installed in a test alcove.

19.1.4 Each heating product is to be installed with a vapor barrier in accordance with the manufacturer's installation instructions. If the position of a vapor barrier is not specified in the instructions, the product shall be installed with a vapor barrier in the most adverse position with respect to temperature.

19.2 Test alcove construction

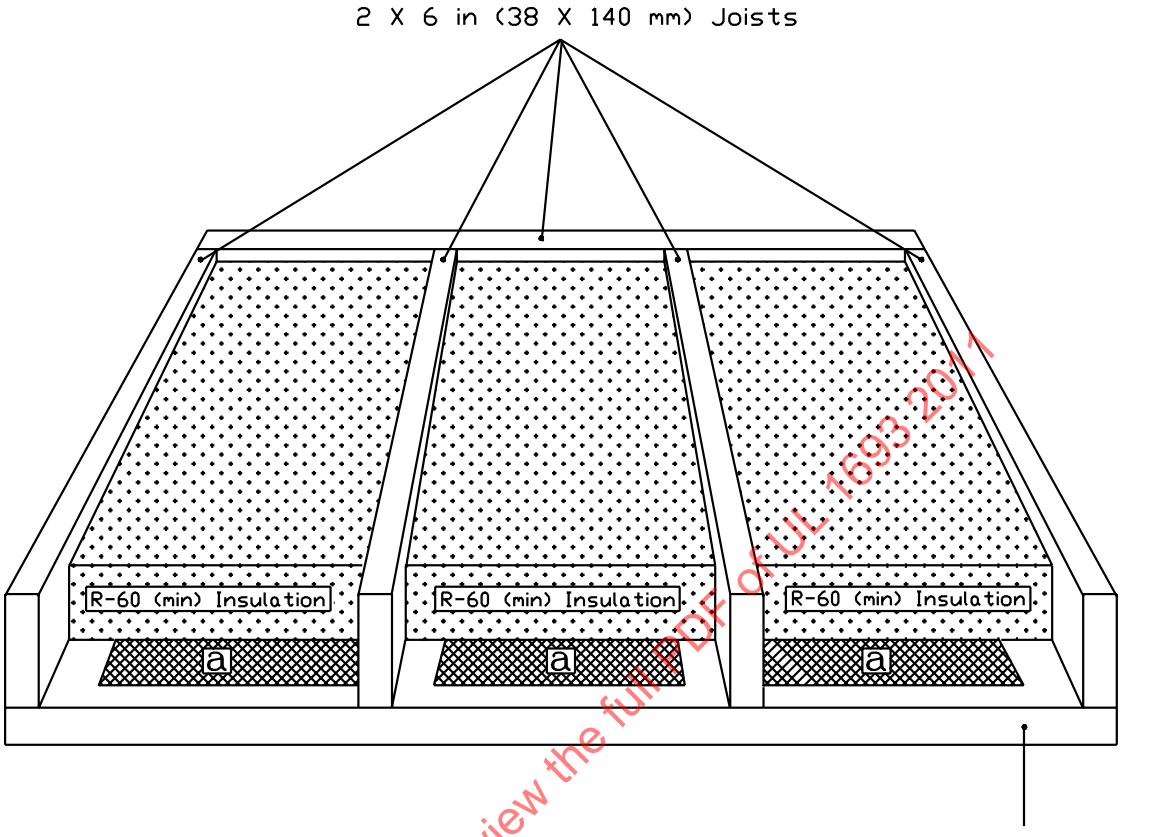
19.2.1 For heating products intended to be installed in the ceiling, a test alcove is to be constructed as follows:

a) The ceiling is to be constructed from nominal 2- by 6-inch trade size (38- by 140-mm) softwood lumber, arranged horizontally, with nominal 16 inches (406 mm) on center spacing unless otherwise specified by the heating product manufacturer. See Figure 19.1. If the manufacturer's instructions permit installation of heating products in sloped ceilings, an additional test ceiling with a pitch of 1/2 shall be constructed in accordance with the manufacturer's instructions; and

Exception: An additional test with a sloped ceiling is not required if, during the Normal Temperature Test of a horizontal ceiling installation, the maximum temperatures of Table 19.1 are not exceeded and the maximum temperature of wood (item 4 of Table 19.1) does not exceed 85°C (185°F)

b) The wall sections are to be a minimum of 1.5 m (4.9 ft) high, of wood frame construction, consisting of nominal 2- by 4-inch trade size (38- by 89-mm) softwood lumber located on nominal 16 inch (406 mm) centers suitable to support the test ceiling, and covered with 3/8 inch (9.5 mm) thick plywood painted flat black.

Figure 19.1
Test alcove ceiling construction



Notes:
"a" - Ceiling Heating Product Samples

Not to Scale
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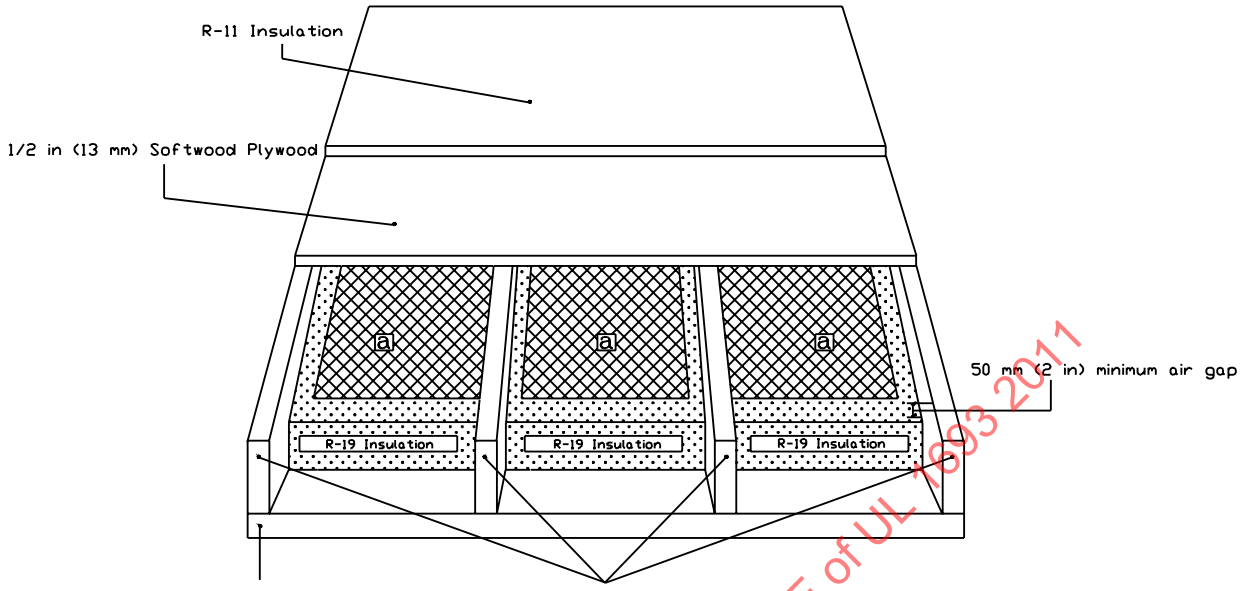
19.2.2 For heating products intended to be installed in the floor, a test alcove is to be constructed as follows:

a) The floor is to be constructed from nominal 2- by 8-inch trade size (38- by 184-mm) softwood lumber, with nominal 16 inches (406 mm) on center spacing unless otherwise specified by the manufacturer. A subfloor of 1/2 inch (13 mm) thick plywood is to be provided on the upper surface of the floor construction. The underside of the floor construction shall be covered by 1/2 inch (13 mm) thick gypsum board. Both the floor joists and the subfloor are to be painted flat black. See Figure 19.2; and

b) The wall sections are to be constructed as described in 19.2.1(b).

Figure 19.2
Test alcove floor construction test



Note "a" - Floor Heating Product Samples

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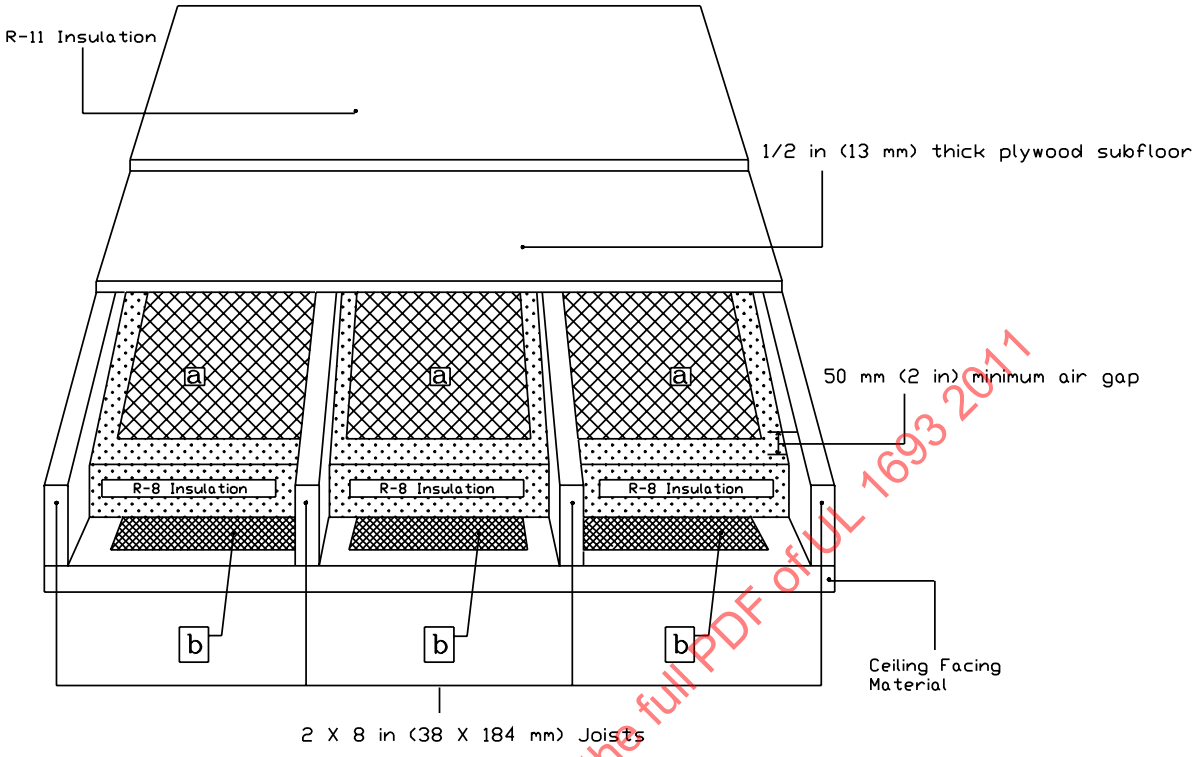
19.2.3 For heating products intended to be installed in a common ceiling/floor section, the test alcove is to be constructed as described for the floor construction in 19.2.2, except that the underside is to be covered with a material as specified by the manufacturer. The upper wall section in the test alcove is to be positioned directly above the lower wall section and all wall surfaces facing the inside of the test alcove are to be painted flat black. See Figure 19.3.

Figure 19.3
Test alcove common ceiling/floor construction



Notes:
"a" - Floor Heating Product Samples
"b" - Ceiling Heating Product Samples

Not to Scale

SM962D

19.2.4 For products intended to be installed on furring or nailing strips, the 2- by 6-inch (38- by 140-mm) joist spacing is to be a nominal 16 inches (406 mm) on center. Joists are to be of suitable length to accommodate representative heating products.

19.3 Ceiling installation

19.3.1 When evaluating heating panels, three representative heating panels are to be installed in the ceiling of the test alcove, separated by the minimum distance specified by the product manufacturer, without alteration of the product dimensions. If no separation distance is specified by the product manufacturer, the heating panel sets are to be positioned adjacent to each other.

19.3.2 When evaluating heating panel sets, three lengths of representative heating panel sets are to be installed in the ceiling of the test alcove, separated by the minimum distance specified by the product manufacturer, and are to have an area of at least 4 m^2 (43.1 ft^2) with no lengthwise dimension less than 1.5 m (4.9 ft). If no separation distance is specified by the product manufacturer, the heating panels are to be positioned adjacent to each other.

19.3.3 The heating products are to be covered from below with ceiling facing materials as recommended by the manufacturer of the product under test. Where more than one type of ceiling facing material is recommended, the material having the maximum overall thermal resistance is to be used.

19.3.4 The installed heating products are to be covered from above with thermal insulation at the maximum thermal resistance rating recommended by the product manufacturer, but not less than R-60. Additional insulation shall be provided between furring or nailing strips as recommended by the heating product manufacturer. Unless otherwise specified by the manufacturer, fiberglass batt insulation is to be used.

19.3.5 For surface mounted ceiling installations, the heating products are to be mounted to the underside of the ceiling of the test alcove. Thermal insulation having not less than R-60 rating is to be placed on top of the total finished ceiling area in order to cover the total alcove area, according to the instructions provided by the manufacturer.

19.4 Floor installation

19.4.1 The number and relative positioning of the representative heating products installed in the floor of the test alcove is to be the same as described for ceiling installations described in 19.3.1 and 19.3.2.

19.4.2 Thermal insulation of the maximum thermal resistance value specified by the manufacturer, but not less than R-19 is to be installed below the heating products. Floor finishing materials of the maximum thermal resistance value specified by the product manufacturer, but in no case less than R-11 (excluding the subfloor), are to be installed above the subfloor for a portion of the test procedure. The floor finishing material shall provide complete coverage of the joist cavities containing heating panels with the exception of a maximum 406 mm (16 inch) border permitted along the alcove walls. See 19.7.4.

19.4.3 The air gap between the subfloor and the heating products is to be adjusted as specified by the manufacturer, but shall not be less than 50 mm (2 inches).

19.5 Common ceiling/floor section installation

19.5.1 Three representative ceiling heating products and three floor heating products are to be installed to concurrently heat the common ceiling/floor section of the test alcove. The heating products are to be separated horizontally by the minimum distance and vertically by the minimum distance using insulating materials specified by the product manufacturer, without altering the product dimensions. If no separation distances or materials are specified by the product manufacturer, the heating products are to be installed in a common joist space.

19.5.2 Heating products intended for use with other products in the same joist space are to be tested with products of equal power density ratings (watts per unit area) in the floor and ceiling heating positions, unless complimentary products of different power density rating (greater or lower) are specified in the installation instructions provided by the heating product manufacturer. When a heating product manufacturer provides specifications for complimentary heating products, representative heating products of the highest power density are to be used.

19.5.3 Thermal insulation is to be placed in between the ceiling heating products and the floor heating products according to the installation instructions specified by the manufacturer but shall not have more than a R-8 rating.

19.5.4 The ceiling heating products are to be covered from below with ceiling facing materials as recommended by the manufacturer for the product under test. Where more than one type of facing material is recommended, the material type having the maximum overall thermal resistance is to be used.

19.5.5 The floor heating products are to be installed according to the manufacturer's instructions for the air gap between the heating product and the underside of the subfloor, but the gap shall not be less than 50 mm (2 inches).

19.6 Concrete or poured masonry installations

19.6.1 A representative heating product shall be installed in or beneath a concrete floor slab in accordance with the manufacturer's instructions. The slab shall have nominal dimensions of 610- by 1220-mm (2- by 4-ft) by 89 mm (3-1/2 inches) thick.

19.6.2 If the installation is beneath the slab, the heating product shall be placed on a sand base and vapor barrier as specified by the manufacturer.

19.6.3 If the installation is in the slab, a double-pour installation, the heating product shall be installed on a concrete base with a nominal 51 mm (2 inches) of concrete poured over the product. The manufacturer's instructions concerning concrete reinforcement shall be followed. A control joint of nominal 3 mm (1/8 inch) depth shall be formed across the width of the slab, equally spaced between the two ends of the slab. The manufacturer's recommendations regarding slab perimeter insulation shall be followed.

19.7 Test procedure

19.7.1 The maximum ambient-adjusted temperature at each sensing location shall not exceed the limits specified in Table 19.1. Temperatures measured in the active area of the heating product shall not vary from each other by more than 5°C (9°F).

Table 19.1
Maximum temperatures of heating products

Item	Location	Maximum temperature	
		°C	°F
1	Any point within a terminal box or wiring compartment of a heating product in which field-installed conductors are to be connected(including such conductors themselves)	60	140
2	On a heating product surface, intended to be installed in contact with combustible building materials	90	194
3	On internal product components not intended to be in contact with combustible building materials	or the temperature rating of the product, whichever is lower The limiting temperature for the materials used	
4	On wood	90	194
5	On gypsum board used as a facing material when specified by the manufacturer	60	140
6	On the subfloor top surface with floor finishing material removed	40	104

19.7.2 At least three adjacent joist spaces are to be heated simultaneously during the tests. The products under test are to be operated continuously, in accordance with the General Test Conditions described in Section 18, in a test ambient of 20 - 2°/+6°C (68 - 3.6°/+10.8°F), until thermal equilibrium is reached. 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.

19.7.2 revised October 14, 2011

19.7.3 Maximum temperatures on the representative heating products and construction materials used to construct the test alcove ceiling, walls, and floor are to be determined. Ambient temperature variation below 20°C (68°F) is to be added to the measured temperature, and the resultant adjusted temperature used to determine compliance.

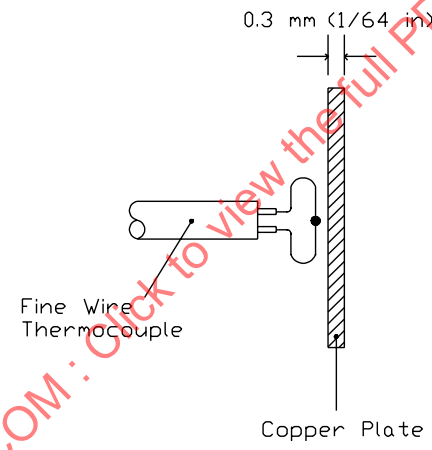
19.7.4 For a floor installation, including a common ceiling/floor section installation, the test is to be conducted both with and without the minimum R-11 floor finishing materials.

19.7.5 Temperatures of ceiling facing materials, thermal insulating material in direct contact with the representative heating products, and heating surfaces of the heating products are to be measured by means of fine wire thermocouples brazed to 0.3 mm (1/64 inch) thick circular or square copper plates having a nominal area of 177 mm^2(0.3 $inch^2$), as illustrated in Figure 19.4. Thermocouple leads are to be routed through small holes in the ceiling facing material to the interior of the test alcove. Each copper plate is to be secured in position so that it is flush and in full contact with both the heating product and the ceiling facing material.

19.7.6 Temperature measurements at locations other than those for determining product element and building material surface temperatures are to be made by means of fine wire thermocouples. 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.

19.7.6 revised October 14, 2011

Figure 19.4
Temperature sensor



Notes:
i) This figure illustrates the construction of a temperature sensor used for measurement of all product heating surface and facing material surface temperatures.
ii) Temperatures of internal product components shall be made with fine wire thermocouples.

Not to Scale

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20 Abnormal Temperature Test

20.1 Ceiling installation

20.1.1 A representative ceiling heating product installation is to be tested as described in 20.1.2, during which the maximum temperature shall not exceed 90°C (194°F). Upon completion of this test, there shall not be any evidence of cracking, deformation or delamination based on visual inspection.

20.1.2 Following the Normal Temperature Test, Section 19, one additional layer of 19.1 mm (3/4 inch) thick fir plywood is to be secured to the underside of the ceiling of the test alcove. The heating products are to be then operated in accordance with the test procedure of the Normal Temperature Test, described in 19.7, until thermal equilibrium is reached.

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21 Contact Loss Test

21.1 Parallel type heating products

21.1.1 Upon completion of this test, there shall not be any evidence of arcing or fire such as that indicated by severe discoloration, burning or charring of the cheesecloth.

21.1.2 A representative parallel type heating product is to be modified by the manufacturer to include an insulating shim between an internal nonheating bus conductor and the element so as to produce a loss of contact between the nonheating conductor and the heating material.

21.1.3 The insulating shim is to be one half the length of the nonheating conductor supplying one section of active element area, up to a maximum of 200 mm (8 inches). The insulator is inserted under only one of the internal bus conductors.

21.1.4 The insulating shim is to be as thin as practical while effectively breaking the contact between the nonheating conductor and the active heating area.

21.1.5 The heating product shall be compensated for maximum panel length and operated in accordance with the test procedure of the Normal Temperature Test, described in 19.7, with a single layer of cheesecloth placed over and under the representative heating product.

FLEXIBLE HEATING PRODUCTS

22 Dielectric Voltage-Withstand Test (Dry)

22.1 A representative flexible heating product is to be subjected to three complete cycles of the following conditioning sequence:

a) Conditioned for 7 hours in an air circulating oven maintained at the maximum temperature observed during the Normal Temperature Test, Section 19;

b) Cooled to room temperature, then energized at marked rated voltage (see 34.1(c)) for 1 hour; and

c) Conditioned for 24 hours at 20 ±2°C (68 ±3.6°F) and a minimum of 96% relative humidity.

22.2 Following three complete conditioning cycles, there shall not be any evidence of delamination.

22.3 Immediately following the conditioning described in 22.1, the flexible heating product shall withstand for 1 minute without breakdown the application of a 40 – 70 Hz essentially sinusoidal potential between live parts and non-current-carrying metal parts. The test voltage is to be 1000 V plus twice the maximum rated voltage of the heating product.

22.4 The test voltage is to be applied between two metal foil electrodes connected together, and the supply terminals or leads of the product under test connected together. The foil electrodes are to be a maximum of 100- by 200-mm (4- by 8-inch) in overall dimension and are to be positioned on opposite sides of the heating product, in direct alignment with each other. The test electrodes are to be pressed against the heating product surface by means of a block of insulating material having a uniform thickness and a mass of 5 kg (11 lbs). Two 25 mm (1 inch) thick sponge rubber pads are to be interposed between the blocks and the foil electrodes.

22.5 The dielectric voltage is to be applied at locations chosen at random over the heating product surface, including bus bar locations and the ends of heating panel sets. When the test voltage is applied to the ends of a heating panel set, dielectric tape or other insulating material specified and/or provided by the manufacturer is to be used. The applied voltage is to be increased gradually at a uniform rate until the required test value is reached.

23 Dielectric Voltage-Withstand Test (In Water)

23.1 A representative flexible heating product having a nominal length of 2 – 3 m (6-1/2 – 10 ft), is to be subjected to the conditioning described in 22.1.

23.2 Immediately following the conditioning described in 22.1, the flexible heating product is to be immersed at 500 mm (20 inches) maximum length increments, in a saline test solution having a maximum resistivity of 50 ohm·cm, with both ends of the heating product out of the water. The test voltage specified in 22.3 is to be applied between current-carrying parts of the heating product and the test solution for 1 minute. There shall be no dielectric breakdown. The test is to be repeated in increments over the entire length of the heating product excluding the ends.

24 Cold Bend Test

24.1 Upon completion of the test described in 24.2, the heating product is to be examined for visual evidence of cracking, deformation or delamination and shall not break down when subjected to the Dielectric Voltage-Withstand Test procedure, excluding conditioning, described in 22.3 – 22.5.

24.2 The test procedure is to be performed as follows:

a) A previously untested heating product is to be wrapped on a cylinder of cardboard or similar material with a diameter of 55 mm (2 inches) or of the minimum diameter used by the manufacturer for shipping the product, whichever is less;

b) The wrapped heating product and cylinder is to be stored for 4 hours at -15 ±2°C (5 ±3.6°F) or the minimum handling temperature specified by the manufacturer's instructions [see 36.2(m)], whichever is lower. At the end of the conditioning period, the heating product is then to be unwrapped and rewrapped in the reverse direction. This procedure is to be repeated six times within 30 minutes; and

c) At the end of the forward and reverse wrapping procedure, the heating product is to be removed from the cold chamber and allowed to return to 25 ±1°C (77 ±1.8°F).

25 Mechanical Abuse Tests

25.1 General

25.1.1 Upon completion of the conditioning described in 25.2, the heating product is to be examined for visual evidence of cracking, deformation or delamination and shall not break down when subjected to the Dielectric Voltage-Withstand Test procedure, excluding conditioning, described in 22.3 – 22.5.

25.1.2 The heating product is to then be installed in accordance with the instructions specified for the Normal Temperature Test, 19.3 – 19.5, with a single layer of cheesecloth placed above and below the heating product, and operated under the General Test Conditions, Section 18. Temperatures are to be measured using the temperature sensors constructed as shown in Figure 19.4, positioned along the location of element crease or flexing, and shall not exceed 90°C (194°F) on the heating product surface. The cheesecloth shall neither glow nor flame during the test.

25.2 Conditioning

25.2.1 The representative flexible heating product used for the Cold Bend Test, Section 24, is to be further conditioned for 4 hours at -15° ±2°C (+5 ±3.6°F) or the minimum handling temperature marked in the manufacturer's instructions [see 36.2(m)] whichever is lower, and is to be subjected to the mechanical abuse conditions described in 25.2.2 and 25.2.3.

25.2.2 Following the conditioning specified in 25.2.1, the representative flexible heating product is to be creased by positioning the heating product on a smooth flat surface, folding the heating product along a longitudinal axis, and applying a force of 900 N (202 lbf). The force is to be applied by means of a rigid test block positioned to contact the heating product over an area not less than a 100 mm x 100 mm (4 inches x 4 inches) adjacent to the line of the fold. The force is to be applied so that the block overlaps the fold and contacts the heating product over the prescribed area. The heating product is to be creased in two locations, the first along the midpoint of the product parallel to the longitudinal axis of symmetry; and the second, parallel to the same longitudinal axis, but within 15 mm (1/2 inch) of the edge of a nonheating conductor.

25.2.3 Following the cold crease conditioning described in 25.2.2, the representative flexible heating product is to be clamped between two 1 mm (3/64 inch) thick rectangular steel plates having smooth rounded edges. The two test plates are to be aligned, and are to be rigidly clamped within 3 mm (1/8 inch) of the plate edges. The heating product is to be positioned so that the longer edges of the plates are perpendicular to the longitudinal axis of the heating product. The heating product clamped between the plates is to be conditioned for 4 hours, at a temperature of -15 ±2°C (+5 ±3.6°F) or minimum handling temperature marked in the manufacturer's instructions [see 36.2(m)], whichever is lower. At the end of the conditioning period, the free end of the heating product is to be bent back over the plates, in an alternating motion, as far as the construction of the clamps and plates permit, using an applied force of 50 N (11 lbf). The heating product is to be flexed for three complete cycles.