

September 20, 2013

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UL 1683

**Outline of Investigation for Electric Heating Products For Installation Under
Floor Coverings**

ISSUE NO: 2

September 20, 2013

Summary of Topics

This is the second issue of the Outline of Investigation for Electric Heating Products For Installation Under Floor Coverings, UL 1683. Wet location requirements are being added to the Outline.

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INTRODUCTION

1 Scope

1.1 These requirements cover fixed electric heating products for installation under floor coverings and above a subfloor, in accordance with the National Electrical Code, NFPA 70, Article 424, for use on system voltages not exceeding 600 V.

1.2 These requirements cover electric heating products of the type specified in 1.3, only when installed per 1.4.

1.3 These requirements cover the following product types:

- a) Electric heating cables and cables on carriers;
- b) Flexible and rigid electric heating panels, mats, and heating panel sets;
- c) Electric flexible heating products, including carbon film-type constructions; and
- d) Any combination of the above.

1.4 These requirements cover one or more of the following installation types:

- a) Above a subfloor, the subfloor being constructed of wood, concrete, or other material;
- b) Directly underneath a floor covering such as tile, carpet, wood, laminate, sheet vinyl, decorative concrete, or other floor covering;
- c) Embedded in and covered with a layer of thinset, mortar, or the like under a floor covering;
- d) Not embedded, and in direct contact with combustible or combustion resistant material subfloor or floor covering, except as noted in 1.7(j);
- e) In dry or damp locations per the National Electrical Code, NFPA 70; and
- f) Any combination of the above.

1.5 These requirements do not cover electric space, floor, or ceiling heating products that are fully addressed by individual requirements that are separate from this Outline, including:

- a) Electric heating cables that are within the scope of the Standard for Electric Space Heating Cables, UL 1673; and
- b) Electric heating panels and heating panel sets that are within the scope of the Standard for Electric Heating Panels and Heating Panel Sets, UL 1693.

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1.6 These requirements do not cover electric heating products that are covered by individual requirements that are separate from this Outline. 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, UL 1462;
- d) Outline of Investigation for Roof and Gutter De-Icing Cable Units, UL 1588;
- e) Outline of Investigation for Residential Pipe Heating Cables, UL 2049;
- f) Fixed and Location-Dedicated Electric Room Heaters, UL 2021; and
- g) Electric Heating Appliances, UL 499.

1.7 These requirements do not cover the following:

- a) Heating products connected to the supply by use of a flexible cord with attachment plug;
- b) Heating products that are movable after installation;
- c) Heating products with integral means of producing air flow;
- d) Heating products manufactured and sold as an integral part of a floor covering materials such as heated floor tiles, heated carpet, and heated laminate floor;
- e) Heating products intended for use outdoors;
- f) Heating products intended for installation on, in, or above a ceiling;
- g) Heating products intended for installation in or under a concrete subfloor;
- h) Heating products intended for installation under a wood subfloor;
- i) Heating products employing self-regulating or positive temperature coefficient (PTC) heater design; and
- j) Flexible film-type products not embedded, and installed directly in contact with rigid or flexible floor coverings.

1.8 These requirements do not cover additional grounding or shielding that may be required during installation in accordance with local or national codes.

1.9 These requirements do not cover switches, transformers, power supplies, controls (i.e. temperature) or protective devices (i.e. ground fault protection) that are installed separate from the heating equipment as part of the complete heating system installation, unless inherent to the heating product. Those devices are covered by individual requirements that are separate from this Outline.

2 Units of Measurement

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

3 References

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

4 Glossary

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

4.2 **CARBON FILM-TYPE HEATING PRODUCT** – A flexible film-type heating product that utilizes carbon conductive material as the resistive heating element. A carbon dispersion heater is one type of carbon film-type product.

4.3 **CARRIER** – Part of a cable-based product, such as a mesh, fabric, or similar material, used to bind or arrange the cable in preset configuration. Serves to maintain spacing of heating cable between adjacent runs and to provide ease of installation. Also known as a Scrim or Mesh. A carrier may provide some mechanical protection for the product, but does not serve as an electrical or fire enclosure. Applied to one or both sides of the product. The heating cable is either visible or fully covered after mated with the carrier.

4.4 **COMBUSTIBLE MATERIAL** – A material not resistant to ignition and flame spread used in buildings and structures for floors, subfloors, floor coverings, shared ceilings, and adjacent walls. For the purpose of these requirements, examples include wood, gypsum board, carpet, and underlayment padding.

4.5 **COMBUSTION RESISTANT MATERIAL** – A material known to be resistant to ignition and flame spread used in buildings and structures for floors, subfloors, floor coverings, shared ceilings, and adjacent walls. Examples of combustion resistant materials include metal, concrete, masonry, cement board, thinset, floor leveler, etc.

4.6 **ELECTRIC HEATING CABLE** – An assembly consisting of a heating lead and a non-heating lead or leads intended for installation in the field, provided in predefined lengths or on a spool. Also known as Heating Cable. Power output is provided in watts per specific length or in watts per unit length.

4.7 **ELECTRIC HEATING PRODUCT** – An electric resistive heating device which provides conductive, radiant, and/or convective heat to the floor surface and room. Comprises a complete product including heating components and means of connection to building power. Also referred to as Heating Product, and Heating Equipment.

4.8 **EMBEDDED** – Having all parts of the heating device fully covered on top and bottom with combustion resistant building material, such as thinset, mortar, concrete, etc. A product not covered on the top surface, is not considered embedded.

4.9 **FLEXIBLE FILM-TYPE HEATING PRODUCT** – An electric heating panel 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.

4.10 FLOOR COVERING – A finished top surface or layer of a floor exposed to the room, such as hardwood, tile, linoleum, laminate, decorative concrete, or carpet. A solid-surface floor covering is one that is rigid and generally hard, including tile, laminate flooring, hardwood, marble, etc.

4.11 HEATING LEAD – That portion of the electric heating cable that, by means of electrical resistance, is provided for the intent of heating. Power output is provided in watts per specific length or in watts per unit length.

4.12 HEATING PANEL – A flexible film-type or rigid complete assembly, provided in preset configuration or dimensions, and provided with a junction box or length of flexible conduit or cable for connection to the branch circuit. Power output is provided in total watts or watts per area.

4.13 HEATING PANEL, PARALLEL TYPE – A heating panel constructed of a heating element medium with parallel bus bars or conductors. Voltage is applied to the bus conductors and heat is generated by current flowing through the resistive heating element medium.

4.14 HEATING PANEL SET – A combination of heating panels to be interconnected to one another, such that the final product dimension is determined during installation.

4.15 INTEGRAL COMPONENT – Factory-fabricated or field-installed terminations and/or connections, such as, end seals and splices, which can be exposed to the same environments as the heating device.

4.16 LEADS, FREE NON-HEATING – The portion of non-heating leads of an electric heating product that are located in concealed areas, without a supplemental raceway and not embedded within combustion resistant materials, and that are intended to be spliced to electrical power supply leads at a junction box.

4.17 LEADS, NON-HEATING – The leads or cable of an electric heating product that are not intended to consume electrical energy for the purpose of heating. Intended to be connected to free non-heating leads, or spliced directly to branch circuit conductors. Also includes connections to controls and other external devices.

4.18 MEMBRANE – A layer of material used installation to separate other layers (i.e. heating product, thinset, tile, subfloor, etc.). Often provided to serve as a Vapor Barrier, but also used for mechanical protection, crack prevention, and sound reducer in some cases.

4.19 PERM VALUE – A measure of the ability of a material to pass water vapor through it. Usually used in conjunction with building materials, such as a vapor barrier, membrane, or plywood. A lower perm value allows less moisture to pass through, thus providing better resistance to moisture. A perm at 73.4°F (23°C) is a measure of the number of grains of water vapor passing through a square foot of material per hour at a differential vapor pressure equal to one inch of mercury (1" W.C.). Any material with a perm rating of less than 1.0 is considered a vapor retarder.

4.20 R VALUE – The degree of thermal resistance of a material, expressed in the U.S. as $R = \text{ft}^2 \cdot \text{°F} \cdot \text{h} / \text{Btu}$. Commonly used with reference to building materials (insulation, wood, floor coverings, etc.), where materials with a higher R value provide a higher insulating value.

4.21 RIGID – A heating product of fixed construction that is not flexible, and essentially retains its shape when held from its edges horizontally.

4.22 SECURED – A heating product positioned and held in place via mechanical means such as adhesive, thinset, mortar, or other mechanical fastening.

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

4.24 SUBFLOOR – A structural layer of a floor constructed to withstand the load placed upon it, on top of which a Floor Covering is commonly installed. Common subfloor materials include plywood, wood, concrete, or similar materials.

4.25 TEMPERATURE REGULATING DEVICE – A component, control, or device that regulates that temperature of the floor, the room, or both, and comprises a sensor, control, and actuator to turn the power on and off to the heating product when the area being monitored reaches a preset temperature set point. Typically separate from the heater, but installed at the same time as the heater installation.

4.26 VAPOR BARRIER – A layer of material used during installation to prevent or reduce moisture from passing through. Also known as a vapor diffusion retarder or water barrier.

CONSTRUCTION

5 General

5.1 A component of a product covered by this Outline shall:

- a) Comply with the requirements for that component as indicated in Sections 8 – 15;
- 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 Outline; 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 outline 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 Outline, 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 Sections 8 – 15 is acceptable if:

- a) The component also complies with the applicable component standard of Sections 8 – 15; or*
- b) The component standard:*

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- 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.*

5.2 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.

5.3 A component not anticipated by the requirements of this outline, not specifically covered by the component standards of Sections 8 – 15, 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 5.1(b) – (e).

5.4 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 outline.

6 Enclosure

6.1 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 non-heating leads.

6.2 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.

6.3 Cast- and sheet-metal portions of the enclosure shall not be thinner than indicated in Table 6.1 unless the enclosure is found to be acceptable when judged under considerations such as are mentioned in 6.4.

Table 6.1
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 6.4.

6.4 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.

6.5 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.

6.6 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.

6.7 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.

6.8 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 7. 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.

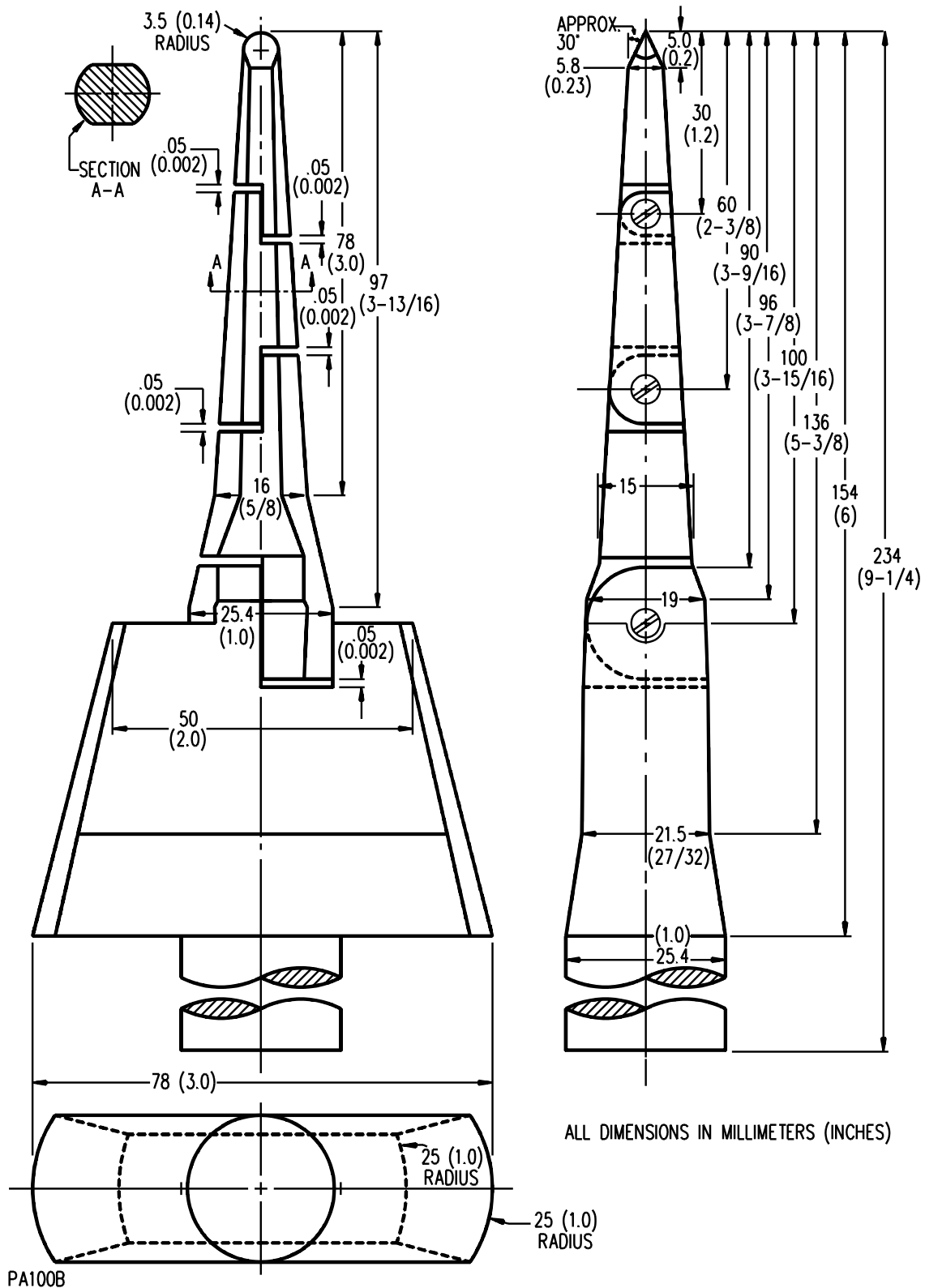
Exception No. 1: A flexible film-type heating product enclosure need not meet the adhesive requirements in when the product is embedded.

Exception No. 2: Not applicable to a carrier.

6.9 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 6.12) less than 25.4 mm (1 inch), such a part or wire shall not be contacted by the probe illustrated in Figure 6.1.
- 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 6.2.

Figure 6.1
Articulate probe with web stop



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Table 6.2
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 6.11.
^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).

6.10 The probe illustrated in Figure 6.1 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.

6.11 With reference to the requirements in 6.9, 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.

6.12 A cable product provided on a spool or attached to carrier, and that complies with the remainder of the applicable parts of this Outline, is considered to comply with this section without further evaluation.

7 Flammability

7.1 Flexible heating products, heating cables, and cables with carrier

7.1.1 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.

Exception No. 1: Not applicable to a carrier used with a heating cable.

Exception No. 2: In lieu of the HB flame rating, a polymeric part may be subjected to the 12 mm or 20 mm end-product flame test in accordance with UL 746C.

7.2 Rigid heating products with polymeric enclosures

7.2.1 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.

Exception: In lieu of the 5V flame rating, a polymeric part may be subjected to the 127 mm end-product flame test in accordance with UL 746C.

7.3 Heating products directly in contact with carpet

7.3.1 Any heating product intended for installation directly in contact with carpet shall additionally comply with the Flame Retardant Test, Section 59.

8 Connectors

8.1 Connectors shall be suitable for use with regards to wire sizes, crimp methods, use temperatures, conductor material, and insulation. Such connector(s) shall be evaluated as part of the end-product covered by this Outline.

8.2 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.
- e) For multi-pole connectors, the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459.

When a connector or splice is required to be insulated for the application, the insulation provided shall comply with 15.1.

8.3 When a special tool is required for the field installation of wire connectors to connect non-heating leads to a heating product, the tool shall be identified by the 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 69.6(i).

9 Supplemental Insulation, Insulating Bushings and Assembly Aids

9.1 The requirements for supplemental insulation, bushings, and assembly aids (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 14.3. 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.

10 Current-Carrying Parts

10.1 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.

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

11 Non-Heating Leads

11.1 Non-heating leads of 4.16 shall comply with 11.2 – 11.6 below. Free non-heating leads of 4.15 shall comply with Section 12.

11.2 The non-heating leads of a 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.

11.3 Unless specified otherwise, insulated conductors 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.