



UL 2683

STANDARD FOR SAFETY

Electric Heating Systems for Floor and Ceiling Installation

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UL Standard for Safety for Electric Heating Systems for Floor and Ceiling Installation, UL 2683

First Edition, Dated February 25, 2020

Summary of Topics

This First Edition of ANSI/UL 2683 dated February 25, 2020 covers indoor fixed electric heating systems for use on system voltages not exceeding 600 V.

The new requirements are substantially in accordance with Proposal(s) on this subject dated June 21, 2019 and November 29, 2019.

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UL 2683

Standard for Electric Heating Systems for Floor and Ceiling Installation

First Edition

February 25, 2020

This ANSI/UL Standard for Safety consists of the First Edition.

The most recent designation of ANSI/UL 2683 as an American National Standard (ANSI) occurred on February 25, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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PART 1 – ALL SYSTEMS

INTRODUCTION

1 Scope

1.1 These requirements cover indoor fixed electric heating systems for use on system voltages not exceeding 600 V.

1.2 The heating systems covered by this Standard are intended for installation in accordance with the National Electrical Code, NFPA 70, Article 424.

1.3 These requirements cover the following electric heating systems:

- a) Heating cable systems;
- b) Heating mat systems;
- c) Heating panel systems;
- d) Modular flooring heating systems; and
- e) Low voltage systems including power units.

With the following types of insulated heating elements:

- f) Heating cable elements;
- g) Laminate elements; and
- h) Flat strip elements.

Of the following types:

- i) Constant wattage elements;
- j) Self-regulating elements; and
- k) Low voltage elements.

1.4 These requirements cover electric heating systems permanently installed as follows:

- a) WOOD SUBFLOORS – Installed above (on top of) or under (adjacent to rafters or joists);
- b) CONCRETE SUBFLOORS – Installed above (on top of), inside (embedded), or under (in earth or sand bed);
- c) CEILINGS – Installed inside (embedded), above (attic or between floors of a building adjacent to ceiling rafters or joists), or under (room side);
- d) In WET LOCATIONS – Locations where the heating element may be subject to saturation with water after installation;
- e) Embedded systems;
- e) Underneath and in direct contact with floor coverings (non-embedded), while above wood or concrete subfloors;

- f) Modular flooring heating systems installed above wood or concrete subfloors; and
- g) Shower benches.

1.5 These requirements do not cover electric heating systems that are covered under the following standards:

- 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) Fixed and Location-Dedicated Electric Room Heaters, UL 2021; and
- d) Electric Heating Appliances, UL 499.

1.6 These requirements do not cover the following products:

- a) Heating systems connected to the supply by use of a flexible cord with attachment plug;
- b) Heating systems that are portable or easily moved after installation;
- c) Heating systems with integral means of producing air flow;
- d) Heating systems intended for snow melting/deicing or pipe maintenance;
- e) Heating systems intended to be installed outdoors; and
- f) Heating systems intended to be installed in a dropped or suspended ceiling.

1.7 These requirements do not cover the use of electrical heating systems installed in environmental air-handling spaces.

1.8 These requirements do not cover surface burning characteristics performance requirements that may be required by building codes.

2 Units of Measurement

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

3 Normative References

3.1 The following documents are referenced in this Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. References to UL standards are not included in this list and are referenced throughout this Standard.

ASTM International

ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
ASTM B193, *Standard Test Method for Resistivity of Electrical Conductor Materials*
ASTM B258, *Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors*
ASTM C665, *Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing*
ASTM C1396 / C1396M, *Standard Specification for Gypsum Board*

IEC 60695-2-11, *Standard for Fire hazard testing – Part 2-11: Glowing/hot wire based test methods – Glow-wire flammability test method for end-products*
IEC 60695-2-12, *Standard for Fire hazard testing – Part 2-12: Glowing/hot wire based test methods – Glow-wire flammability test method for materials*
IEC 60695-2-13, *Standard for Fire hazard testing – Part 2-13: Glowing/hot wire based test methods – Glow-wire ignitability test method for materials*
IEC 60335-2-96, Edition 1.2, *Standard for Household and similar electrical appliances – Safety – Part 2-96: Particular requirements for flexible sheet heating elements for room heating*
IEC 60335-2-106, Edition 1, *Standard for Household and similar electrical appliances – Safety – Part 2-106: Particular requirements for heated carpets and for heating units for room heating installed under removable floor coverings*
IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*
IEEE 515.1-2012, *IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications*
NFPA 70, *National Electrical Code (NEC), 2017 Edition*

4 Glossary

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

4.2 **ASSEMBLY KIT** – Part(s) needed in the field installation for assembly of a heating system provided by the heating system manufacturer. Common assembly kits include splice connection kit, end seal kit, securement hardware kit, etc.

4.3 **BONDING** – The joining of metallic parts to form an electrically conductive path that provides electrical continuity and the capacity to conduct any current likely to be imposed without a risk of electric shock, fire, or injury to persons.

4.4 **CARRIER (SCRIM OR MESH)** – Part of a cable-based mat product, such as a mesh, fabric, or similar material, used to bind or arrange the cable in a preset configuration at the factory. Serves to maintain spacing of heating cable between adjacent runs and to facilitate installation. 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 being mated with the carrier.

4.5 **COMBUSTIBLE MATERIAL** – A material used under the conditions anticipated, will ignite and burn or will add appreciable heat to an ambient fire. A material that is not inherently resistant to ignition and flame spread, used in buildings for subfloors and ceiling. Includes gypsum board, wood, adhesives, etc. May include underlayment, floor coverings, carrier, etc.

4.6 **COMBUSTION RESISTANT MATERIAL** – A material used and under the conditions anticipated, will not ignite and burn or add appreciable heat to an ambient fire. A material known to be resistant to ignition and flame spread used in buildings for subfloors, floor coverings, ceilings, and adjacent walls. Includes metal, concrete, masonry, cement board, thinset, floor leveler, etc.

4.7 **CONDUCTORS, EXPOSED** – With reference to a low voltage heating system. Current carrying wire, bus bars, and heating elements that are located in an occupied space, located at least 2.2 m (7 ft) above a floor, and are connected to a power unit that is provided with integral protection against shorting and overloading, and that complies with the Exposed current carrying parts test, [74.8](#).

4.8 **CONSTANT WATTAGE HEATING ELEMENT** – A heating element that has approximately the same power consumption over a temperature range of a typical heating system installation. The element has thermal coefficient of resistance less than or equal to copper as per ASTM B193. Examples include elements made with resistance wire.

4.9 EMBEDDED – Fully covered on top and bottom with combustion resistant material used for the installation of a heating system, such as thinset, mortar, sand, concrete, etc. A heating system not covered on all surfaces is not considered embedded. This does not pertain to metal and metal foil layers that are provided with or as part of a heating system.

4.10 ENCLOSURE – The part of a heating system that does one or more of the following:

- a) Renders inaccessible all or any part(s) of the heating system that may present a risk of electric shock.
- b) Retards propagation of flame initiated by electrical disturbances occurring within the heating system.

4.11 FLOOR COVERING – A finished top surface of a floor exposed to the room, such as hardwood, tile, stone, linoleum, laminate, decorative concrete, or carpet. Intended to be a permanent part of the building.

4.12 FLOATING (FLOOR COVERING) – A finished top surface of a floor exposed to the room, that does not need to be nailed, adhered, or otherwise secured to the subfloor. Often consist of panels of tile, stone, laminate, wood, vinyl, or the like. The panels may incorporate an underlayment. The panels are mechanically secured together by interlocking or adhesive.

4.13 GROUND (GROUNDING) – A connection (conductor) between an electrical circuit or accessible metal part of a heating system and the earth. A direct physical conducting connection to the earth.

4.14 GROUND-FAULT CIRCUIT-INTERRUPTER (GFCI) – A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. For further information, see UL 943, Standard for Ground-Fault Circuit Interrupters. These devices are intended for use on alternating current (AC) circuits of 120 V, 208Y/120 V, 120/240 V, 127 V, or 220Y/127 V, 60 Hz circuits.

4.15 GROUNDING COMPONENT – A metal covering, sheath, or braid that is to be connected to protective earth ground and intended to operate a circuit protection device in the event live parts are short circuited to the grounding component. Intended to reduce the risk of electric shock.

4.16 HEATING CABLE ELEMENTS (HEATING CABLE) – A insulated cable that is intended to heat by means of electrical resistance.

4.17 HEATING CABLE SYSTEM – A complete system that may consist of non-heating leads, heating cable, integral components, mounting hardware, power unit (for a low voltage heating system), installation instructions, and marking labels. The system can be provided on a spool or attached to a carrier. A heating cable system is considered a heating panel system when it is installed in a rigid or non-rigid enclosure.

4.18 HEATING ELEMENT – The portion of the electric heating system that, by means of electrical resistance, is provided for the intent of heating. Can be a heating cable, flat strip, heating ribbon, or laminate heating element.

4.19 HEATING PANEL SYSTEM – A rigid or non-rigid heating panel assembly employing a heating element and non-heating leads or a terminal junction assembly identified as being suitable for connection to a wiring system. A complete system that consists of non-heating leads, heating cable, integral components, mounting hardware, power unit (for a low voltage heating system), installation instructions, and marking labels.

4.20 HEATING SYSTEM – A complete system may consist of non-heating leads, heating element, integral components, a power unit (for a low voltage heating system), installation instructions, and marking labels. The system may be provided with any associated controls, protective devices, and installation hardware or materials. Can employ heating cable elements or laminate heating elements.

4.21 INTEGRAL COMPONENT – Assemblies such as end seals and splices which may be exposed to the same environments as the rest of the heating system. The assemblies typically consist of connectors, and insulation, such as shrink tubing enclosure or a molded enclosure. May be assembled at a factory or in the field.

4.22 ISOLATED – Electrically separated from line voltage via an isolating transformer such that no common ground reference is shared between the primary and secondary side of the isolating device. An isolating transformer has the primary and secondary windings galvanically / electrically separated with basic insulation, and also includes a protective partition between primary and all secondary circuits.

4.23 LAMINATE HEATING ELEMENT (LAMINATE ELEMENT) – An insulated electric heating panel composed of layers of electrical insulating material (as required) enclosing a metallic or carbon-based heating material and is intended to provide heat. Examples of heating material include carbon ink, extruded carbon polymer, carbon nanotube, and carbon fiber.

4.24 LOW VOLTAGE – For the purpose of this standard, low voltage is limited to 25 amperes and operates at or below the risk of electric shock voltages. May still present a risk of fire. See RISK OF ELECTRIC SHOCK, [4.35](#), [Table 4.1](#). See RISK OF FIRE, [4.36](#).

4.25 LOW VOLTAGE HEATING SYSTEM – See Heating System. Additionally, limited to 25 amperes, operates at or below the risk of electric shock voltage and is intended to be powered by a low voltage supply. The system may be provided with associated controls, protective devices, and installation hardware or materials. The power source may consist of a means for connecting to building supply power, together with a power unit to convert from line voltage to low voltage, or by a direct dc low voltage source (e.g. solar, battery, etc.). Low voltage heating systems may still present a risk of fire. See RISK OF ELECTRIC SHOCK, [4.35](#), [Table 4.1](#). See RISK OF FIRE, [4.36](#).

4.26 MEMBRANE – A layer of material used in the installation of a heating system. Often provided to serve as a vapor barrier, cushioning, flame barrier, to provide mechanical protection, crack prevention, or as a sound reducer.

4.27 MODULAR FLOORING HEATING PANEL SYSTEM (MODULAR FLOORING SYSTEM) – A solid-surface panel intended to be a floor covering that incorporates a heating element. The materials used can provide mechanical protection to electrical components and may consist of tile, stone, wood laminate, wood, vinyl, or the like. The panels are mechanically secured together by interlocking or adhesive.

4.28 NON-HEATING LEADS – The leads of a heating system that are not intended to consume electrical energy for the purpose of heating, usually used to connect the heated portion to the source of power.

4.29 OCCUPIED SPACE – For the purpose of this standard, a room or enclosed space designed for human occupancy or use (i.e. kitchens, bedrooms, bathrooms, rooms, hallways, etc.).

4.30 PARALLEL HEATING ELEMENT (SERIES/PARALLEL ELEMENT) – A heating element that is constructed electrically in parallel; or in discrete zones of series heating elements (series/parallel element).

4.31 PERM VALUE – A measure of the ability to pass water vapor through a specific material. Usually used for 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 is a measure at 23°C 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.). 1.0 US perm = 1.0 grain/square-foot·hour·inch of mercury \approx 57 SI perm = 57 ng/s·m²·Pa. Any material with a perm rating of less than 1.0 is considered to be impermeable.

4.32 POWER UNIT – The equipment that powers low voltage heating systems. For the purpose of this standard, a power unit has all of the following characteristics:

- a) An isolating transformer or isolating electronic power supply of output voltage not exceeding the risk of electric shock voltage; and
- b) Employs a suitable enclosure; and
- c) Is intended for field installation; and
- d) Each secondary circuit is limited to 25 amperes under described loading conditions.

NOTE: Reference; NEC NFPA 70, Section 424.101(A).

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

4.34 RIGID AND SEMI-RIGID FLOORING – For the purpose of this standard, decorative floor coverings having a solid or multiple layer product structure that provide some level of mechanical protection for a heating system. Can be plank or tile format. Can be floating, nailed, or adhered to the subfloor. Can incorporate an underlayment. Intended to be mechanically secured together by interlocking or adhesive. Does not include carpet.

4.35 RISK OF ELECTRIC SHOCK – A risk of shock exists between any two uninsulated conductive parts, or between an uninsulated conductive part and earth ground, if the continuous current flow through a 1500 ohm resistor in parallel with a 0.015 μF capacitor connected between the two points exceeds 0.5 mA and if the open circuit voltage exceeds the following limits in [Table 4.1](#) under normal use and abnormal use conditions.

Table 4.1
Risk of electric shock voltage limits

Waveform type ^a	Maximum voltage, dry locations
Sinusoidal ac	30 V rms
Non-sinusoidal ac	42.4 V peak
Continuous dc ^b	60 V
10 – 200 Hz interrupted dc ^c	24.8 V

^a For a combined ac + dc waveform, the dry and damp location voltage limit shall be the non-sinusoidal ac limit where the dc voltage is no more than 20.9 V, and shall be $(33 + 0.45 \text{ Vdc})$ where the dc voltage is greater than 20.9 V.

^b If the peak-to-peak ripple voltage on a dc waveform exceeds 10% of the dc voltage, the waveform shall be considered a combined waveform per footnote a above.

^c Contact with interrupted dc at a lower or higher frequency shall be permitted only after a special investigation based on the specific waveform parameters.

4.36 RISK OF FIRE – A risk of fire is considered to exist between any two points in a circuit where the open circuit voltage is more than risk of electric shock values and the energy available to the circuit under any condition of load including short circuit, results in a current of 8 A or more after one minute of operation.