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Electric Heating Pads

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

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

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover electric heating pads for use in accordance with the National Electrical Code on either direct-current or single-phase alternating-current nominal 120 V supply circuits.

1.2 Pads are made in a variety of shapes and sizes for direct or indirect application to persons. A pad of unusual size or odd shape is to be judged on its compliance with the requirements in this standard and on further examination and tests to determine its acceptability for the intended use and possible misuses.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 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.

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.

CONSTRUCTION

5 General

5.1 Each pad shall be provided with a means to limit temperatures, be cord-connected, and have a moisture-resistant construction. A household pad shall also be supplied with a switch, and a vinyl envelope with a supplementary cover or a treated fabric envelope with or without a supplementary cover, and shall be single- or multiple-heat. A hospital pad shall be only single-heat.

5.2 Any supplementary cover, when provided, shall be easily removable to make the heating pad envelope readily accessible for inspection.

6 Envelope

6.1 The envelope shall be of materials acceptable for the application and shall enclose all electrical parts of the pad without any ventilation or other openings.

6.2 An envelope of unsupported vinyl sheeting on a household pad shall not be thinner than 0.012 inch (0.3 mm). An envelope of unsupported vinyl sheeting on a hospital pad shall not be thinner than 0.020 inch (0.5 mm). See 6.3 and 6.4 for the method of measurement.

6.3 The average thickness of a rectangular specimen measuring approximately 1 by 4 inches (25 by 102 mm) is to be determined from measurements made by means of a dead-weight dial micrometer having a flat anvil and a flat-faced cylindrical presser foot that is 0.25 ± 0.01 inch (6.35 ± 0.25 mm) in diameter and exerts 85 ± 3 gf (0.83 ± 0.03 N) on the specimen. The calibration of the dial on the micrometer is to facilitate estimation of each measurement to 0.0001 inch (0.0025 mm).

6.4 The thickness of a specimen is to be measured midway across the width of the specimen at the center of its length and at points 1/2 inch (13 mm) from each end. Each measurement is to be estimated at the nearest 0.0001 inch (0.0025 mm) and recorded. The smallest of the three recorded thicknesses is to be rounded off to the nearest 0.001 inch (0.025 mm).

6.5 A heating pad provided with a treated fabric envelope and no supplementary cover shall comply with the flammability tests specified in 18.2.1 – 18.6.17 and the Ease of Ignition Test, Section 19.

6.6 All seams in a treated-fabric envelope shall be strongly stitched or otherwise equivalently secured and shall be positioned where they are not unduly subject to stress during actual use.

7 Insulation

7.1 Electrical insulation is to be judged with respect to its usability for the particular application. If an investigation is required to determine whether or not a material is usable, the key factors to be examined are 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 risk of fire, electric shock or injury to persons in conjunction with conditions of service. All of these factors are to be investigated with respect to thermal aging.

7.2 Vulcanized fiber is a usable material for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated current-carrying parts where shrinkage, leakage current, or warpage introduce a potential risk of fire or electric shock. Thermoplastic materials generally are not determined to be able to serve as the sole support of uninsulated current-carrying parts, but are capable of being used if found to have the physical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric properties, and other properties that serve the purpose of the application. All of these factors are to be investigated with respect to thermal aging.

7.3 Vulcanized fiber or a similar material employed where spacings otherwise do not meet specification shall be 1/32 inch (0.8 mm) thick or thicker and shall be so located or of such material that it cannot be adversely affected by arcing. However, 1/64 inch (0.4 mm) or thicker vulcanized fiber used in conjunction with an additional air spacing of 50 percent or more of the spacing required for air alone meets the intent of the requirement. Barriers shall be held in place by a means more secure than friction between surfaces. The elasticity of tubing shall not be depended upon to hold the tubing in place, but dilated or heat-shrunk tubing are capable of performing as intended.

7.4 The heating element shall be electrically insulated for its entire length so that it is not in contact with the envelope at any point. The insulated heating element shall be held in position and shall be so located that its heat is not concentrated in less than half of the area of the pad.

7.5 Current-carrying metal parts within a pad shall be electrically insulated with material capable of withstanding the temperatures to which they are able to be subjected. The thickness (not including the envelope or padding material) of insulation applied directly to the current-carrying metal parts shall not be less than 0.028 inch (0.71 mm) unless the parts are secured in position (to prevent their motion relative to one another, the envelope, or both). If the parts are secured, 0.013 inch (0.33 mm) is the minimum intended thickness.

7.6 If asbestos is employed as insulation in contact with the heating element, the quantity shall not be less than 3 pounds mass per 1000 feet (4.46 g/m) of heating element, based on a core diameter of 0.10 inch (2.5 mm). In USA customary units, the quantity for a core other than 0.10 inch in diameter shall be calculated from the equation

$$W = 0.70 + 23d$$

in which:

W is the mass in pounds per 1000 feet and

d is the outside diameter of the resistance element in inches.

In modernized metric units (SI), the quantity for a core other than 2.5 mm in diameter shall be calculated from the equation

$$W = 1.04 + 1.35d$$

in which:

W is the mass in grams per meter and

d is the outside diameter of the resistance element in millimeters.

8 Spacings

8.1 Over-surface and through-air spacings no smaller than 1/16 inch (1.6 mm) shall be maintained from uninsulated current carrying parts:

- a) To uninsulated current-carrying parts of opposite polarity, and
- b) To accessible metal parts.

Exception: Within a thermostat, other than at the contacts, the spacings between uninsulated current-carrying parts on opposite sides of the contacts that are less than 1/16 inch (1.6 mm) but not less than 1/32 inch (0.8 mm) over the surface of insulating material meet the intent of the requirement.

8.2 At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) meets the intent of the requirement.

9 Thermostats

9.1 A thermostat shall be durable, reliable, uniform in operation, and shall have the sensitivity necessary for its intended use as determined by the tests of this Standard.

9.2 If proper performance of a thermostat depends upon the integrity of a closed chamber, the construction shall prevent moisture leaks, which may affect the uniformity and proper operation of the thermostat.

9.3 A thermostat shall not be adjustable by the user of the pad and shall be covered or sealed to prevent the entrance of dirt and lint.

9.4 Materials employed in a thermostat shall not be affected adversely by any operating conditions presented by the tests described in these requirements.

9.5 Plated steel (except that the bimetal is not required to be plated) is capable of being used for a current-carrying part in a thermostat under condition that the part is protected by supplementary means (such as tape or sealed sleeving) against any conditions involving moisture to which the thermostat is capable of being exposed during actual use of the pad.

9.6 A pad shall be provided with as many thermostats as necessary and connected such that, under any operating conditions, no section of the heating element is in series with less than two thermostats in a household pad and four thermostats in a hospital pad. Each thermostat shall be held in position.

Exception: Thermostats are not required for heating pads that incorporate PTC (Positive Temperature Coefficient) semiconductor type heating element wire.

9.7 A pad shall be provided with at least one thermostat for each unit area of 90 inches² (0.058 m²) or portion thereof, the unit area being considered with respect to only one side (face) of the pad. The location of thermostats shall afford protection for the pad as a whole.

Exception: Thermostats are not required for heating pads that incorporate PTC (Positive Temperature Coefficient) semiconductor type heating element wire.

9.8 If a pad consists of two or more adjoining sections, each section shall be provided with at least two thermostats. See also 12.5 and 35.6.

Exception: Thermostats are not required for heating pads that incorporate PTC (Positive Temperature Coefficient) semiconductor type heating element wire.

9.9 No particular arrangement or relative location of thermostats is specified, but the acceptability of the arrangement and the number of thermostats employed are to be judged from the results of the specified tests on the complete pad.

10 Switches

10.1 Hospital pad

10.1.1 A hospital pad is not required to be supplied with a switch.

10.1.2 If a hospital pad is supplied with a switch, it shall comply with the requirements of 10.2.1 – 10.2.4 and the Switch Immersion Test, Section 41.

10.2 Household pad

10.2.1 A household pad shall be provided with a through-cord or end-of-cord switch having an "off" position. The switch shall be of a type intended for the particular application, shall have current and voltage ratings at least equal to the load controlled, and, in the case of a multiple-heat household pad, shall have positions that facilitate adjustment of the pad temperature.

10.2.2 The switch shall be located or protected to prevent it from being damaged physically during use. Each "off", "low", "medium", "high" and other position of the switch shall be appropriately indicated by a marking on the switch in letters and, if desired, also in braille.

10.2.3 A manually-operated, line-connected, single-pole switch for appliance on-off operation shall be connected to the ungrounded conductor of the power-supply cord. Table 12.1 specifies the polarity identification of the power-supply cord conductors.

10.2.4 If a detachable power-supply cord is provided, the switch specified in 10.2.1, or a control unit on a PTC semiconductor pad, shall be integral with the detachable power-supply cord.

11 Pilot Light

11.1 A household heating pad shall be provided with a neon or similarly durable pilot light that is extinguished only while the pad is unplugged or the switch is in the off position.

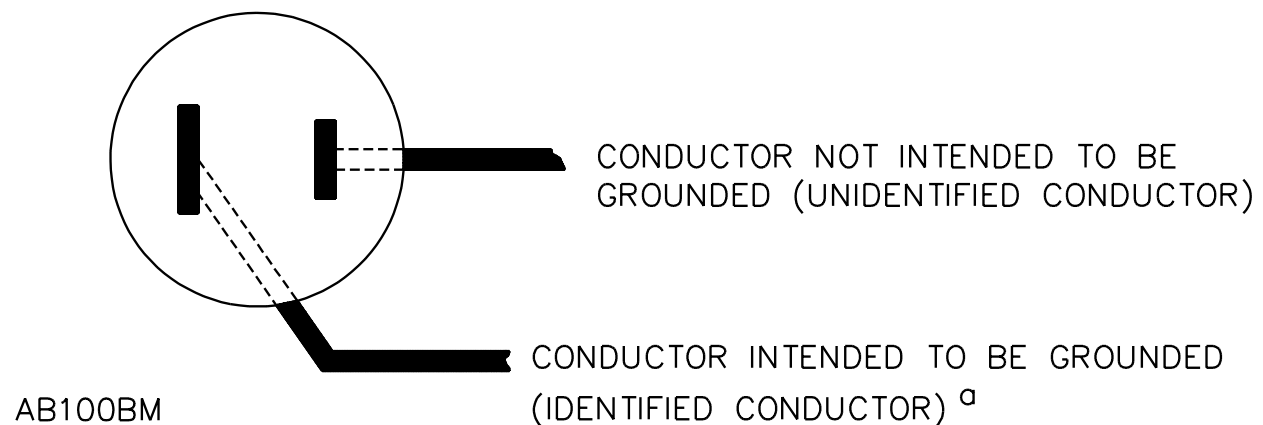
11.2 The pilot light shall be installed as a component of the switch assembly, being readily visible to the user of the pad when energized.

12 Supply, Control, and Interconnecting Cords

12.1 For connection to the supply circuit, a pad shall be provided with a 125-V attachment plug attached to a length of two-conductor flexible cord. In the absence of a through-cord switch, the cord shall not be less than 6 ft long (1.8 m), measured from the face of the plug to the point at which the cord enters the pad. If a through-cord switch is used, the length of cord between the plug and the switch (supply cord) may be less than 6 ft (1.8 m) but the overall length of the supply cord, the switch, and the cord from the switch to the pad (control cord), measured from the face of the plug to the point at which the control cord enters the pad, shall not be less than 6 ft (1.8 m). The attachment plug connections shall comply with Figure 12.1, and the polarity identification of the flexible cord shall comply with Table 12.1

Figure 12.1
Connection to attachment plug

CONNECTIONS OF CORD CONDUCTORS TO POLARIZED
ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



^a Signifies a conductor identified in accordance with Table 12.1

Table 12.1
Polarity identification of flexible cords

Method of identification	Acceptable combinations	
	Wire intended to be grounded ^d	Other wire ^d
Color of braids on individual conductors	A Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	B Color other than white or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	C ^a Solid white or gray	Solid color other than white or gray
	C1 ^d Light blue	Solid color other than light blue, white, or gray
Color of separators	D ^b White or gray	Color other than white or gray
Other means	E ^c Tin or other white metal on all strands of the conductor	No tin or other white metal on the strands of the conductor
	F ^b A stripe, ridge or groove on the exterior surface of the cord	

^a Only the cords – other than Type SP-1, and SPT-1 – having no braid on any individual conductor.

^b Only for Type SP-1, SP-2, SPT-1, and SPT-2 cords.

^c Only for Type SPT-1 and SPT-2 cords.

^d For jacketed cord.

12.2 The ampacity of the supply cord shall not be less than the current stated or implied in the ratings marked on the pad.

12.3 The supply cord supplied with a household pad shall be a Type SPT-2, SP-2, or heavier flexible cord. The supply cord supplied with a hospital pad shall be a Type SJT or heavier flexible cord. The bond between the cord and the envelope of a moisture-resistant pad shall be mechanically complete, secure, watertight, and otherwise appropriate for the purpose.

12.4 The wiring (control cord) between a switch or a control unit and a household pad or the female half of the pad connector and the wiring (pigtail cord), if any, between the male half of the pad connector and the pad itself shall be Type SPT-2, SP-2, or heavier flexible cord containing two or more circuit conductors (no grounding conductor) or shall be appliance-wiring material of the SPT-2, SP-2, or other appropriate construction containing two or more circuit conductors (no grounding conductor). The wiring (control cord) between a switch or a control unit and a hospital pad or the female half of the pad connector and the wiring (pigtail cord), if any, between the male half of the pad connector and the pad itself shall be Type SJT or heavier flexible cord containing two or more circuit conductors (no grounding conductor) or shall be appliance-wiring material of the SJT or other appropriate construction containing two or more circuit conductors (no grounding conductor).

12.5 Wiring interconnecting two adjacent sections of a pad shall comply with 12.4.

12.6 Both ends of each supply, control, and interconnecting cord shall be permanently attached.

Exception: A detachable power-supply cord is capable of being used if a heating pad complies with the requirements of 12.10; the Connector Flexing Test, Section 28; the Laundering Test, Section 29; the Leakage Current Test, Section 30; the Dielectric Voltage-Withstand Test, Section 31; and the Effect of Cleaning Solvents Test, Section 42.

12.7 Strain relief shall be provided on all cords to reduce the risk of mechanical stress on the cord being transmitted to any wire connections. See 34.1 and 40.1.

Exception: A switch is not required to comply with this requirement if all connections are made as described in 12.8.

12.8 A switch shall be provided with an effective means for strain relief unless all connections in the switch (except for a soldered joint in the slack portion of the through conductor in a through-cord switch) are riveted or welded, or unless such connections are made by means of eyelets, pressure wire connectors with closed-loop tangs, soldered loops in the conductor, or soldered joints where mechanical security is provided without depending upon the solder. Terminal binding screws shall be prevented from unthreading completely when the switch is assembled.

12.9 Supply and control cords shall be secured to the switch such that the conductor insulation and the braid, if any, are prevented from slipping to the extent that the conductor is exposed or a short circuit may occur.

12.10 When a detachable power-supply cord is provided, the female connector on the control cord shall not accommodate any attachment plug with an American National Standard configuration of the contacts. The male connector attached (pigtail or other) to the pad shall not fit into any receptacle, current tap, or cord connector body with an American National Standard configuration of contacts. While both halves of the pad connector are completely mated, current-carrying parts shall not be exposed to unintentional contact. The pad connector shall be rated 125 V, and shall have a current rating at least equal to the current rating marked on the pad.

13 Connections

13.1 All connections shall be mechanically secure, shall provide good electrical continuity and conductivity, and shall be insulated. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection shall result in risk of fire, electric shock, or injury to persons. Consideration shall be given to flexure and other conditions of use when judging the acceptability of electrical connections. Mechanical splicing devices shall be of a type intended for the application. Each connection to a thermostat shall be provided with strain relief.

13.2 A pad shall be constructed to avoid the imposition of undue flexing and stress on any electrical connection during use and handling.

PERFORMANCE

GENERAL

14 General

14.1 The specified number of heating pads shall be subjected to all of the following tests, in this order (This sequence shall be followed even though some of the numbers of the test Sections may not be numbered consecutively):

a) Thermostat Test Sequence (Using 6 representative thermostats, each tested separately):

- 1) Original calibration (15.1.1)
- 2) Overload (15.2.1 and 15.2.2)
- 3) Endurance (15.3.1 and 15.3.2)
- 4) Recalibration (15.4.1)

b) Enclosure Material Test Sequence:

1) On Vinyl Sheeting:

- i) Low-temperature impact (16.1.1 – 16.1.9)
- ii) Tear resistance (16.2.1 – 16.2.3)
- iii) Leakage current (16.3.1)
- iv) Leakage current (repeated) (16.4.1)
- v) Shrinkage (16.5.1 and 16.5.2)
- vi) Physical properties (16.6.1)
- vii) Tensile strength of seams (16.7.1 and 16.7.2)

2) On Treated-Fabric Envelopes:

- i) Leakage current (17.2.1 and 17.2.2)
- ii) Bursting strength (17.3.1 – 17.3.5)
- iii) Flexing (17.4.1 and 17.4.2)
- iv) Leakage current (repeated) (17.5.1 and 17.5.2)
- v) Tensile strength of cemented seams (17.6.1 – 17.6.4)

3) Flammability Tests:

- i) Liner (18.1.1)

- ii) Supplementary cover (18.2.1 – 18.6.17)
- 4) On Treated Fabric Envelope (when no supplementary cover provided):
 - i) Ease of Ignition Test (19.1 – 19.13)
- c) Complete-Pad Test Sequence (Using 9 representative complete pads, except where noted otherwise, each tested separately, with supplementary cover removed):
 - 1) Leakage Current Test (Section 21)
 - 2) Input Test (Section 22)
 - 3) Resistance to Moisture Test (Section 23)
 - 4) Heating Test (Section 24)
 - i) Flexing Test (Section 25) on three pads
 - ii) Twisting Test (Section 26) on three pads
 - iii) Bunch Test (Section 27) on three pads
 - iv) Dielectric Voltage-Withstand Test (Section 33)
 - 6) Connector Flexing Test (Section 28)
 - 7) Laundering Test (Section 29)
 - 8) Leakage Current Test (Section 30)
 - 9) Dielectric Voltage-Withstand Test (Section 31)
 - 10) Heating Test (Repeated) (Section 32)
 - 11) Dielectric Voltage-Withstand Test (Section 33)
 - 12) Strain-Relief Test (Section 34)
 - 13) Electric Shock Current Test (Section 36)
 - 14) Dielectric Voltage-Withstand Test (Repeated) (Section 37)
 - 15) Internal Temperature Test (Section 35)
 - 16) Burnout Test (Section 38)
 - 17) Blanketing Test (Section 39)
 - 18) Pull Out Test (Section 40)
 - 19) Switch Immersion Test (Section 41) for hospital pads