UL 130

STANDARD FOR SAFETY

Electric Heating Pads

UL Standard for Safety for Electric Heating Pads, UL 130

Thirteenth Edition, Dated July 15, 2011

Summary of Topics

This revision was issued to incorporate changes to the switch temperature limits.

The effective date for UL LLC will be announced through Industry File Review – Announcement Letter.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated October 31, 2014.

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.

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.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 130

Standard for Electric Heating Pads

Previous numbered and unnumbered editions of standards covering UL 130 have been published since 1933.

The fifth edition was titled Standard for Electrically Heated Pads and Bedding.

First Edition – May, 1933
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Thirteenth Edition

July 15, 2011

This UL Standard for Safety consists of the Thirteenth Edition including revisions through May 6, 2015.

The Department of Defense (DoD) has adopted UL 130 on February 15, 1983. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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 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 A component of a product covered by this standard shall:

a) Comply with the requirements for that component as indicated in this standard;

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 this standard is acceptable if:

a) The component also complies with the applicable component standard identified in this standard; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements NFPA 70, where appropriate;

2) Considers long-term thermal properties of polymeric insulating materials in accordance with 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.

2.2 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.

2.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards identified in this standard, and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable standard.

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

2.5 Materials used in a Class 105 (A) insulation system shall comply with the Heating Test, Section 27. Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials - General, UL 1446.

3 Units of Measurement

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

4 Undated 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 LOW-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 30 volts and supplied by a primary battery, by a standard Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting resistance in series with the supply circuit as a means of limiting the voltage and current is not considered to be a low-voltage circuit.

CONSTRUCTION

6 General

6.1 Each pad shall be provided with a means to limit temperatures, be cord-connected, and have a moisture-resistant construction. A 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.

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

7 Envelope

7.1 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.

7.2 An envelope of unsupported vinyl sheeting on a household pad shall not be thinner than 0.012 inch (0.3 mm). See 7.3 and 7.4 for the method of measurement.

7.3 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).

7.4 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).

7.5 A heating pad provided with a treated fabric envelope and no supplementary cover shall comply with the flammability tests specified in 21.2.1 – 21.6.17 and the Ease of Ignition Test, Section 22.

7.6 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.

8 Insulation

8.1 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.

8.2 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.

8.3 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.

8.4 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.

8.5 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.

8.6 Polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials - Use in Electrical Equipment Evaluations, UL 746C.

8.7 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 8.1 – 8.3 and 8.5 or a performance requirement of this standard. In such cases:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510;

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.

9 Spacings

9.1 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 No. 1: 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.

Exception No. 2: The spacings may be less than specified in 9.1 if in compliance with the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment UL 840. The following parameters shall be used unless the microenvironment is further evaluated and found to comply with other parameters:

a) Overvoltage shall be II;

b) Pollution Degree shall be 2; and

c) Material Group IIIb.

9.2 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.

10 Thermostats

10.1 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.

10.2 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.

10.3 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.

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

10.5 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.

10.6 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 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.

10.7 A pad shall be provided with at least one thermostat for each unit area of 90 inches^2 (0.058 m^2) 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.

10.8 If a pad consists of two or more adjoining sections, each section shall be provided with at least two thermostats. See also 15.6 and 38.6.

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

10.9 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.

11 Control Units

11.1 A temperature control shall comply with the requirements of the following:

a) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9; or

b) The Standard for Temperature-Indicating and –Regulating Equipment, UL 873.

Exception No. 1: A thermostat used in a heating pad assembly that complies with Thermostats, Section 10 of this end product standard is considered to meet the intent of this requirement.

Exception No. 2: For a control, the failure of which would not increase the risk of electric shock, fire, or personal injury, need only be subjected to the applicable requirements of this end product standard.

11.2 A timer used to comply with the maximum temperature requirements of this standard shall be evaluated per 11.1.

11.3 When a product employing a temperature control system employs an electronic circuit intended to provide a degree of protection against the risk of fire, electric shock, or injury if a fault should occur in the wire, the circuit shall comply with the requirements of the following:

a) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; including Annex H; or

b) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991.

11.4 Software relied on to provide a degree of protection against the risk of fire, electric shock, or injury if a fault should occur with the programming shall comply with the requirements of the following:

a) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; including Annex H, as software Class B; or

b) The Standard for Software in Programmable Components, UL 1998.

11.5 When the electronic circuit is provided with a fuse which is intended to open as a result of a fault in the wire, rendering the product inoperable, the fuse shall comply with the Standard for Low-Voltage Fuses - Part 1: General Requirements, UL 248-1, and the Standard for Low-Voltage Fuses - Part 14: Supplemental Fuses, UL 248-14.

11.6 A thermal cutoff shall comply with the Standard for Thermal-Links (Thermal Cutoffs) for Use in Electrical Appliances and Components, UL 60691.

12 Switches

12.1 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.

12.2 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.

12.3 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 15.1 specifies the polarity identification of the power-supply cord conductors.

12.4 If a detachable power-supply cord is provided, the switch specified in 12.1, or a control unit on a PTC semiconductor pad, shall be integral with the detachable power-supply cord.

12.5 Mechanical air-gap type switches shall comply with one of the following, as applicable:

a) The Standard for Switches for Appliances - Part 1: General Requirements, UL 61058-1;

b) The Standard for Special-Use Switches, UL 1054;

c) The Standard for General-Use Snap Switches, UL 20; or

d) The Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

Exception No. 1: Switching devices that comply with the appropriate Standard for specialty applications (e.g. transfer switch equipment), industrial use (e.g. contactors, relays, auxiliary devices), or are integral to another component need not comply.

Exception No. 2: A switching device in a low-energy circuit of 2.2 need not comply with this requirement.

13 Pilot Light

13.1 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.

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

14 Internal Wiring

14.1 Internal wiring, including heater wire, composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

Exception No. 1: Insulated conductors need not comply with the Standard for Appliance Wiring Material, UL 758 if they comply with one of the following:

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

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

c) The Standard for Fixture Wire, UL 66; or

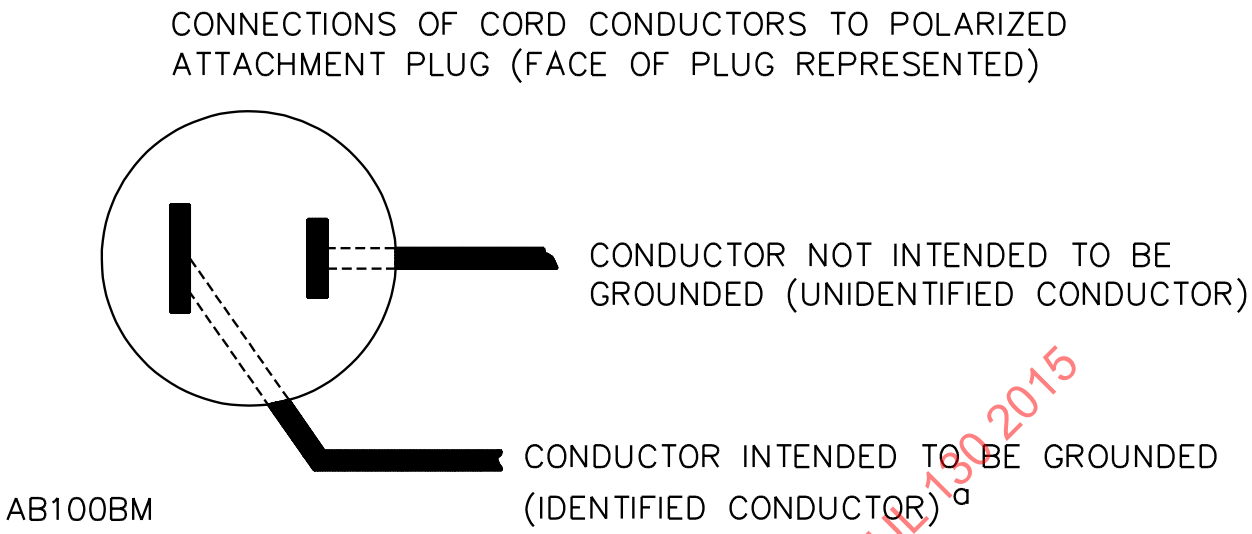
d) The appropriate UL standard(s) for other insulated conductor types specified in Chapter 3, Wiring Methods and Materials, of NFPA 70.

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with the Standard for Appliance Wiring Material, UL 758.

15 Supply, Control, and Interconnecting Cords

15.1 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 15.1, and the polarity identification of the flexible cord shall comply with Table 15.1

Figure 15.1
Connection to attachment plug



[a] Signifies a conductor identified in accordance with Table 15.1

Table 15.1
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.

15.2 A cord set, power supply cord, or interconnecting cord shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817.

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

15.4 The supply cord supplied with a household pad shall be a Type SPT-2, SP-2, 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.

15.5 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).

15.6 Wiring interconnecting two adjacent sections of a pad shall comply with 15.5.

15.7 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 15.11; the Connector Flexing Test, Section 31; the Laundering Test, Section 32; the Leakage Current Test, Section 33; the Dielectric Voltage-Withstand Test, Section 34; and the Effect of Cleaning Solvents Test, Section 45.

15.8 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 37.1 and 43.1.

Exception: A switch is not required to comply with this requirement if all connections are made as described in 15.9.

15.9 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.

15.10 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.

15.11 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.

16 Connections

16.1 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.

16.2 Connectors complying with any of the following fulfill 16.1:

a) Quick-connect terminals, both connectors and tabs, for use with one or two 22 - 10 AWG copper conductors, having nominal widths of 0.110, 0.125, 0.187, 0.205, and 0.250 inch (2.8, 3.2, 4.8, 5.2, and 6.3 mm), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, complying with the Standard for Electrical Quick-Connector Terminals, UL 310.

Exception No. 1: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with the Standard for Electrical Quick-Connector Terminals, UL 310.

Exception No. 2: A connector that complies with the Standard for Electrical Quick-Connector Terminals, UL 310 may be used with an appropriately sized tab that complies with the Table for Dimensions of Production and Test Tabs in Inches and the Figure for Dimensions of Production and Test Tabs of UL 310. The connector is the part of a quick-connect terminal that is pushed onto the male tab, and the tab is the part that receives the female connector.

b) Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, complying with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977.

c) Wire connectors complying with the Standard for Wire Connectors, UL 486A-486B.

d) Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

e) Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

f) Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with the Standard for Terminal Blocks, UL 1059 if the part complies with the requirements of Insulation, Section 8 and Spacings, Section 9 of this standard. This exception does not apply to protective conductor terminal blocks.

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

PERFORMANCE

GENERAL

17 General

17.1 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 (18.1.1)

2) Overload (18.2.1 and 18.2.2)

3) Endurance (18.3.1 and 18.3.2)

4) Recalibration (18.4.1)

b) Enclosure Material Test Sequence:

1) On Vinyl Sheeting:

i) Low-temperature impact (19.1.1 – 19.1.9)

ii) Tear resistance (19.2.1 – 19.2.3)

iii) Leakage current (19.3.1)

iv) Leakage current (repeated) (19.4.1)

v) Shrinkage (19.5.1 and 19.5.2)

vi) Physical properties (19.6.1)

vii) Tensile strength of seams (19.7.1 and 19.7.2)

2) On Treated-Fabric Envelopes:

i) Leakage current (20.2.1 and 20.2.2)

ii) Bursting strength (20.3.1 – 20.3.5)

iii) Flexing (20.4.1 and 20.4.2)

iv) Leakage current (repeated) (20.5.1 and 20.5.2)

v) Tensile strength of cemented seams (20.6.1 – 20.6.4)

3) Flammability Tests:

i) Liner (21.1.1)

ii) Supplementary cover (21.2.1 – 21.6.17)

4) On Treated Fabric Envelope (when no supplementary cover provided):

i) Ease of Ignition Test (22.1 – 22.13)

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 24)

2) Input Test (Section 25)

3) Resistance to Moisture Test (Section 26)

4) Heating Test (Section 27)

i) Flexing Test (Section 28) on three pads

ii) Twisting Test (Section 29) on three pads

iii) Bunch Test (Section 30) on three pads

iv) Dielectric Voltage-Withstand Test (Section 36)

6) Connector Flexing Test (Section 31)

7) Laundering Test (Section 32)

8) Leakage Current Test (Section 33)

9) Dielectric Voltage-Withstand Test (Section 34)

10) Heating Test (Repeated) (Section 35)

11) Dielectric Voltage-Withstand Test (Section 36)

12) Strain-Relief Test (Section 37)

13) Electric Shock Current Test (Section 39)

14) Dielectric Voltage-Withstand Test (Repeated) (Section 40)

15) Internal Temperature Test (Section 38)

16) Burnout Test (Section 41)

17) Blanketing Test (Section 42)

18) Pull Out Test (Section 43)

19) Switch Immersion Test (Section 44) for hospital pads

20) Effect of Cleaning Solvents (Section 45)

17.2 In the sequence specified in 17.1 (c), Tests 12, 13 and 14 shall not be performed on ″general-use pads″, and Test 3 shall not be performed on ″moisture-resistant pads.″

17.3 In the test sequence specified in 17.1 (c), Tests 5(iv), 6, 7, 8 and 9 are to be performed on pads employing a detachable power-supply cord in accordance with the Exception to 15.7.

17.4 At the conclusion of each test in a sequence, each pad shall be in such condition that it complies with the requirements of the rest of the remaining tests in the sequence. If a sequence cannot be performed as a result of any prior test in the sequence, the results shall not be considered acceptable.

17.5 Unless otherwise specified in Sections 18 – 45, the above sequences of tests are to be performed on unaged and otherwise untested heating pad items and specimens.

17.6 The felt mentioned in 26.2, 26.3, 27.3, 27.7, 36.3, 38.2, 38.4 and 42.1 is to be minimum 1 inch thick (25 mm thick), 100-percent standard-weight, all-cattle-hair, punched felt with center reinforcement consisting of burlap having a mass of 5 oz/yd^2 (170 g/m^2). The felt is to have a mass of 105 ±15 oz/yd^2 (3.560 ±0.508 kg/m^2).

Exception: SAE J314, Grade F-11, minimum 1 inch (25 mm) thick wool felt is also acceptable.

17.7 Wherever cloth is mentioned in the abnormal tests, the cloth is to be bleached cheesecloth running 14 ±15 yd^2 /lb (approximately 26 ±28 m^2 /kg) and having what is known in the trade as a ″count of 32 by 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 in the other direction).

18 Thermostats Tests

18.1 Original calibration

18.1.1 The cut-off temperature of each of six thermostats that are identical to the thermostats used in the complete pad is to be measured by any method whereby the temperature can be closely regulated and accurately measured.

18.2 Overload

18.2.1 There shall not be electrical or mechanical malfunction or undue pitting or burning of the contacts in any of the six calibrated (see 21.1.1) thermostats as the result of their operating automatically on a 125 V supply circuit (see 21.2.2) for 100 cycles at a rate of not more than 6 cycles per minute making and breaking twice the maximum noninductive current that a thermostat normally carries in the pad.

18.2.2 An alternating-current supply circuit is to be used if the pad is rated (see 48.2) for use on only alternating current. A direct-current supply circuit is to be used if the pad is rated (see 48.2) for use on only direct current or for use on both direct current and alternating current.

18.3 Endurance

18.3.1 There shall not be electrical or mechanical malfunction or undue pitting or burning of the contacts in any of the six thermostats that performed acceptably in the overload test described in 18.2.1 and 18.2.2 as the result of their additional automatic operation of a 125 V alternating-current supply circuit for at least (see 18.3.2) 100,000 cycles at a rate of not more than 30 cycles per minute making and breaking the maximum noninductive current that a thermostat normally carries in the pad.

18.3.2 This test is intended to represent at least 1000 hours of service under conditions that produce the fastest operation of a thermostat in the pad. The test is to be extended as far beyond 100,000 cycles as may be necessary to represent 1000 hours of this rapid service.

18.4 Recalibration

18.4.1 After the six thermostats that performed acceptably in the endurance test described in 18.3.1 and 18.3.2 have been kept at a temperature of 0°C (32°F) for one hour and then at a temperature of 125°C (257°F) for an additional hour, the cut-off temperature of each of the six thermostats shall not be more than 5°C (9°F) higher than when originally determined in accordance with 18.1.1.

18A Permanence of Cord Flag

18A.1 To determine compliance with 49.3 when a cord flag is provided, representative samples that have been subjected to the tests described in 18A.3 – 18A.6 shall meet the following requirements:

a) The flag shall resist tearing for longer than 1/16 inch (1.6 mm) at any point;

b) The flag shall not separate from the power supply cord;

c) There shall be no permanent shrinkage, deformation, cracking, or any other condition that renders the marking on the flag illegible;

d) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible; and

e) The tag shall not slip or move along the length of the power-supply cord more than ½ inch (12.7 mm).

18A.2 For each type of conditioning mentioned in 18A.3 – 18A.5, three samples of the flag applied to the power supply cord in the intended manner are to be used. If flags are applied by an adhesive, tests are to be conducted no sooner than 25 hours after application of the flag.

18A.3 Three samples are to be tested as received.

18A.4 Following conditioning in an air-circulating oven at 60 ±1°C (140.0 ±1.8°F) for 240 hours, three samples are to be tested after 30 minutes of conditioning at a room temperature of 23 ±2°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity.

18A.5 Three samples are to be tested within 1 minute after exposure for 72 hours to a humidity of 85 ±5 percent at 32 ±2°C (89.6 ±3.6°F).

18A.6 Each sample is to consist of a length of power supply cord to which the flag has been applied. The power supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 lbf (22.2 N) is to be applied to the upper-most corner of the flag farthest from the power supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the flag. The force is to be applied vertically downward in a direction parallel to the major axis of the cord. In determining compliance with 18A.1(c), manipulation is permissible, such as straightening of the flag by hand. To determine compliance with 18A.1(d), each sample is to be scraped 10 times across printed areas and edges, with a force of approximately 2 lbf (8.9 N), using the edge of a 5/64 inch (2.0 mm) thick steel blade held at a right angle to the test surface.

ENCLOSURE MATERIALS (OUTER ENVELOPE)

19 Tests on Vinyl Sheeting

19.1 Low-temperature impact

19.1.1 Out of ten specimens of unsupported flexible vinyl sheeting, no more than two shall break into two or more pieces each when subjected to impact at low temperature. The specimens are to be prepared, conditioned, and tested as directed in 19.1.2 – 19.1.9.

19.1.2 For the purposes of the requirements in 19.1.1 and 19.2.1, ″vinyl″ is to be understood to be material whose characteristic constituent is polyvinyl chloride resin or polyvinyl chloride-acetate copolymer resin, ″flexible″ is to be understood to mean fully plasticized, and ″unsupported″ is to be understood to be indicative of the complete absence from the sheet of reinforcing fibers, threads, and fabric.

19.1.3 A piece of the unsupported, flexible, vinyl sheeting measuring approximately 36 by 24 inches (914 by 610 mm) is needed for this test and the tear resistance test. While the sheeting and the air surrounding it are in thermal equilibrium with one another at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F), the sheeting is to be cut by a die or other equivalent means into ten rectangular specimens, each of which is to be 2 inches wide and 5-3/4 inches long (51 mm wide and 146 mm long) with the longer dimension perpendicular to the striations (if any) left on the sheeting by the original forming process.

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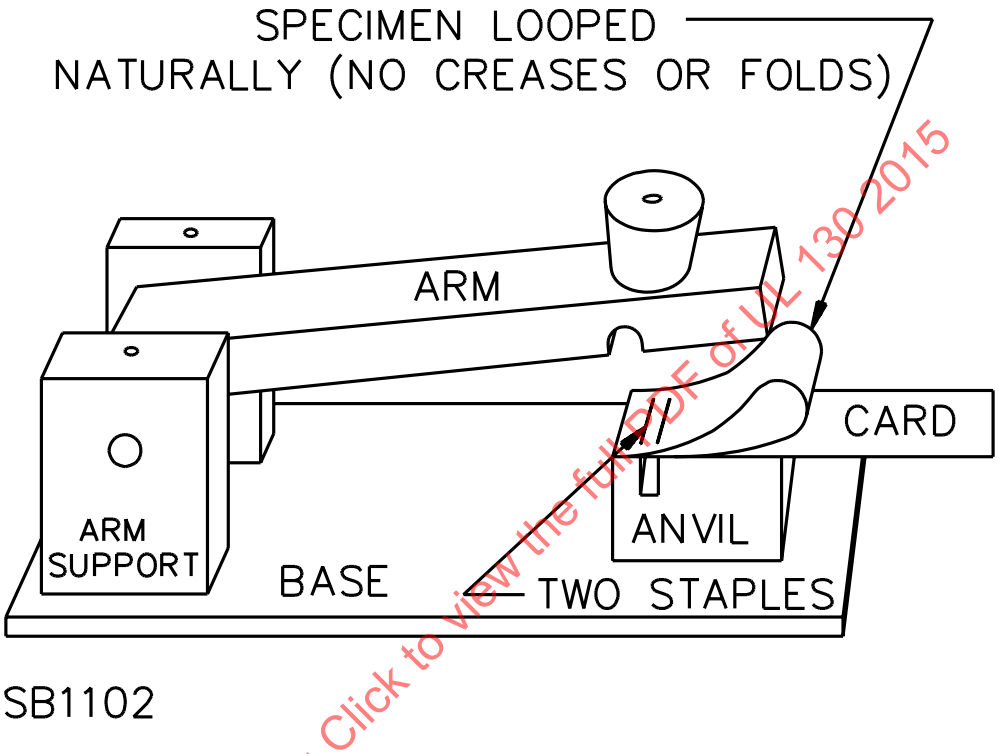
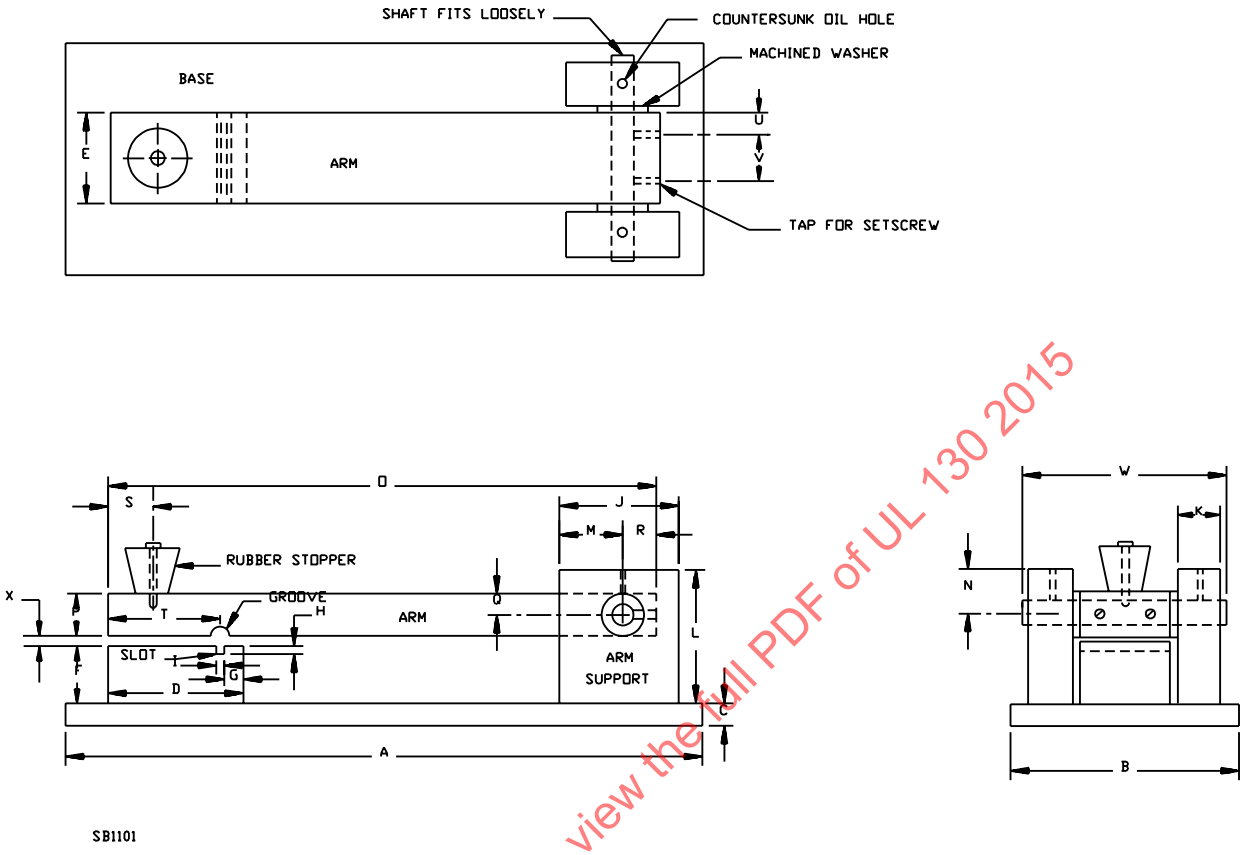
19.1.4 As shown in Figure 19.1, the short ends of each specimen are to be laid one atop the other and their edges aligned with one another and with the edges of an underlying 2 by 5-inch (51- by 127-mm) stiff, paper card (standard index-file card stock). The vinyl is to be allowed to loop naturally without creases or folds and is to be carefully stapled to the card twice with the staples close together and both parallel to and 1/2 inch (13 mm) from the 2-inch (51-mm) edges.

Figure 19.1
Specimen and arm in place before impact



19.1.5 With its arm rotated 180 degrees from the anvil, the impacting device shown in Figure 19.2 (see Table 19.1 for the dimensions) is to be cooled to a temperature of minus 20.0 ±1.0°C (minus 4.0 ±1.8°F) in a shallow refrigerator compartment or dry-ice cabinet (the latter is to be cooled by circulating air and solid carbon dioxide) having a square level floor 18 or more inches (457 or more millimeters) on a side and opening from the top.

Figure 19.2
Impacting device



NOTE: Except for the bolts, screws, and rubber stopper, all parts are to be cold-rolled steel. The base, anvil, arm, arm supports, and the shaft are able to be chromium-plated. The arm, stopper, and stopper bolt taken together are to have a mass of 6.81 pounds ±0.06 pounds (3.089 ±0.03 kilograms mass). Usually, the shaft is not required to be lubricated but, if lubrication is used, it is to be of a low-temperature type.

Table 19.1
Dimensions of impact device

Part	Dimensions			
	Name	Identification letter on drawing	Inches	(mm)
Base	length	A	14	(356)
	width	B	5	(127)
	thickness	C	1/2	(13)
Anvil–bolted to base with machine screws (not shown)	length	D	3	(76)
	width	E	2	(51)
	height	F	1-7/16	(37)
	slot location	G	7/16	(11)
	slot depth	H	1/4	(6)
	slot width	I	1/8	(3)
Two arm supports–bolted to base with machine screws (not shown)	length	J	3	(76)
	thickness	K	1	(25)
	height	L	3	(76)
	diameter of oil holes	none	1/8	(3)
	oil-hole and shaft-hole centerline	M	1-1/2	(38)
	shaft-hole centerline	N	1/2	(13)
	diameter of shaft hole	none	slightly greater than 1/2	(slightly greater than 13)
Arm	length	O	12	(305)
	width	E	2	(51)
	thickness	P	1	(25)
	diameter of shaft-hole	none	slightly greater than 1/2	(slightly greater than 13)
	shaft-hole centerline	Q	1/2	(13)
	shaft-hole centerline	R	1	(25)
	stopper-hole centerline	S	1	(25)
	groove centerline	T	2-1/2	(64)
	groove diameter	none	1/4	(6)
	setscrew centerline	U	1/2	(13)
	centerline separation of setscrews	V	1	(25)
Two machined washers	outside diameter	none	1	(25)
	inside diameter	none	slightly greater than 1/2	(slightly greater than 13)
Shaft	diameter	none	1/2	(13)
	length	W	4-1/2	(114)
Separation between anvil and arm		X	1/16	(1.6)

19.1.6 With their loops up and without being touched by the hands (use the card for a handle), one another, or anything else, all ten specimens are to be placed on the floor of the cold chamber and allowed to cool for 1 hour. Then, while the specimens and the impacting device remain in the cold chamber, one of the specimens is to be placed loop up on the anvil of the impacting device with the staples in the slot

as shown in Figure 19.1. Care is to be taken to avoid having the vinyl touch anything during this process. The arm of the impacting device is to be raised from the 180-degree position to one in which the impacting face of the arm is at an angle of 85 degrees with the horizontal face of the anvil.

19.1.7 By means of a mechanical release, the arm is to be freed and allowed to fall and strike the specimen. The arm is then to be raised and secured again at the 85-degree position, and the specimen is to be removed and examined. An unacceptable result is to be recorded for that specimen if the vinyl has broken into two or more pieces.

19.1.8 In as rapid succession as possible (to avoid warming the specimens) each of the nine remaining specimens is to be placed on the anvil, impacted by the arm (with care being taken that the staples are in the slot), and examined for breakage of the vinyl.

19.1.9 The vinyl sheeting is not acceptable for use in a heating pad if three or more of the ten specimens of it break into two or more pieces each.

19.2 Tear resistance

19.2.1 The average resistance to tensile tearing of five specimens of unsupported flexible vinyl sheeting (see 19.1.2 for definitions) shall be 2.8 or more pounds force (12.5 N) per overall thickness at 23.0 ±2.0°C (73.4 ±3.6°F). The specimens are to be prepared and tested as indicated in 19.2.2 and 19.2.3.

19.2.2 A piece of the unsupported, flexible, vinyl sheeting measuring approximately 36 by 24 inches (914 by 610 mm) is needed for this test and the impact test. While the sheeting and the air surrounding it are in thermal equilibrium with one another at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F), the sheeting is to be cut by means of the die illustrated in Figure 19.3 (see Table 19.2 for the dimensions) into five specimens, each of which is to have its 4-inch (102-mm) dimension perpendicular to the striations (if any) left on the sheeting by the original forming process.

Figure 19.3
Die for tear-resistance test

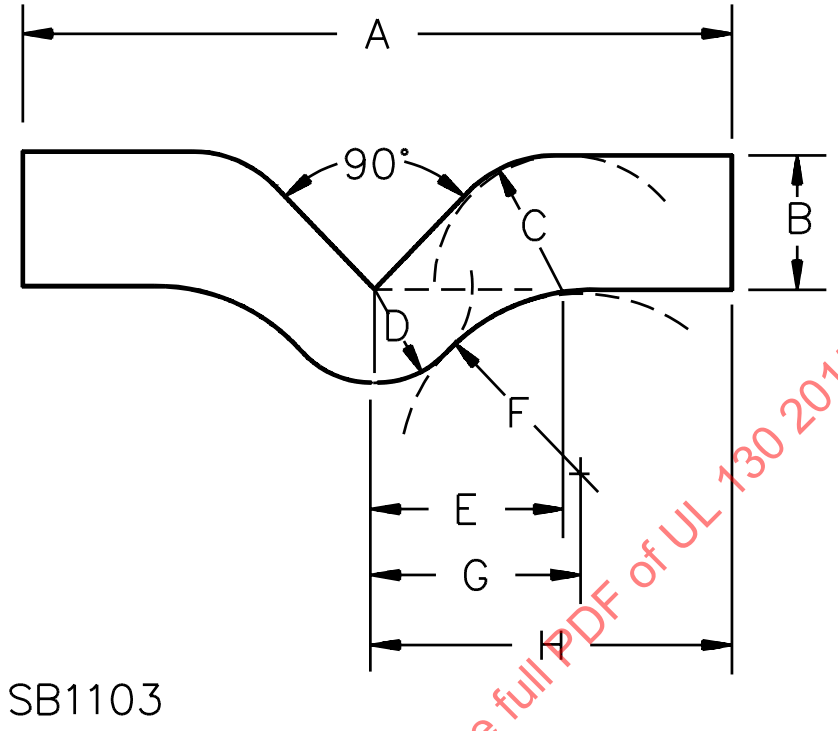


Table 19.2
Dimensions of die

Identification letter on drawing	Inches (mm)	
	Maximum	Minimum
A	4.002 (101.65)	3.998 (101.55)
B and C	0.752 (19.10)	0.748 (19.00)
D	0.502 (12.75)	0.498 (12.65)
E	1.063 (27.00)	1.059 (26.90)
F	1.002 (25.45)	0.998 (25.35)
G	1.120 (28.45)	1.118 (28.40)
H	2.002 (50.85)	1.998 (50.75)

19.2.3 One specimen is to be secured in the grips of a power-driven testing machine with the longitudinal axis of the specimen coincident with the vertical axis of the grips. The machine is to be started and the grips separated at the rate of 2 inches per minute (essentially 51 millimeters per minute) until the specimen parts. The maximum load observed for the specimen is to be recorded in pounds or newtons as the tear resistance for that specimen. The tear resistance is to be determined in this manner for each of the four remaining specimens. The average of all five tear resistances is to be determined for comparison with the requirement in 19.2.1.

19.3 Leakage current

19.3.1 Unsupported vinyl sheeting shall not show a leakage current of more than 0.5 mA at 120 V when tested in accordance with 20.2.2.

19.4 Leakage current (repeated)

19.4.1 Representative unsupported vinyl sheeting conditioned as specified in 19.5.2 shall not show a leakage current of more than 1.0 mA at 120 V when tested in accordance with 20.2.2.

19.5 Shrinkage

19.5.1 The shrinkage of each of two complete vinyl pads, each of six die-cut specimens, and each of three square specimens which have been conditioned in accordance with 19.5.2 shall not be greater than 15 percent of the total dimensions (length and width) of the pad measured in the as-received condition.

19.5.2 Each of two complete representative pads employing an envelope of unsupported vinyl sheeting, six die-cut specimens (three cut from the longitudinal direction and three from the transverse direction using Die A described in ASTM D 412), and each of three square sections of the material 8 inches (203 mm) on a side are to be immersed in boiling water for 1 hour, and then aged in a full-draft circulating-air oven for 7 days at a temperature of 136.0 ±1.0°C (276.8 ±1.8°F) or for 60 days in the oven at 113.0 ±1.0°C (235.4 ±1.8°F). The pads are then to be immersed again in boiling water for 1 hour. The envelope of each pad is to be punctured at one corner to relieve internal pressure, and this corner is to be kept out of the water during immersion of the pad.

19.6 Physical properties

19.6.1 Either specimens of unsupported vinyl sheeting that have been aged in air as indicated in 19.5.2 for:

a) Seven (7) days at 136.0 ±1.0°C (276.8 ±1.8°F) shall exhibit no less than 70 percent of the tensile strength and elongation exhibited by similar unaged specimens; or

b) Sixty (60) days at 113.0 ±1.0°C (235.4 ±1.8°F) shall exhibit no less than 75 percent of the tensile strength and elongation exhibited by similar unaged specimens.

The measurements are to be made in the manner specified in the requirements for thermoplastic-insulated wires.

19.7 Tensile strength of seams

19.7.1 The tensile strength of each of five representative sections of dielectrically or otherwise sealed vinyl seam shall not be less than 5 pounds per linear inch (876 N/m). The average tensile strength of five additional sections of the seam shall not be less than 5 pounds per linear inch (876 N/m) after the sections have been subjected to the conditioning described in 19.5.2.

19.7.2 Each section of seam is to have a width along the seam of 1 inch (25 mm) and a length perpendicular to the seam of not less than 3 inches (76 mm) on each side of the seam. Each section is to be stressed in a tensile-strength testing machine having provision for measuring the applied force, and the grips are to be separated at a rate of 20 inches per minute (508 mm/min) until the seam starts to separate.

20 Tests on Treated-Fabric Envelopes

20.1 General

20.1.1 An envelope of rubberized or otherwise treated fabric shall comply with the requirements in 20.2.1 – 20.6.4.

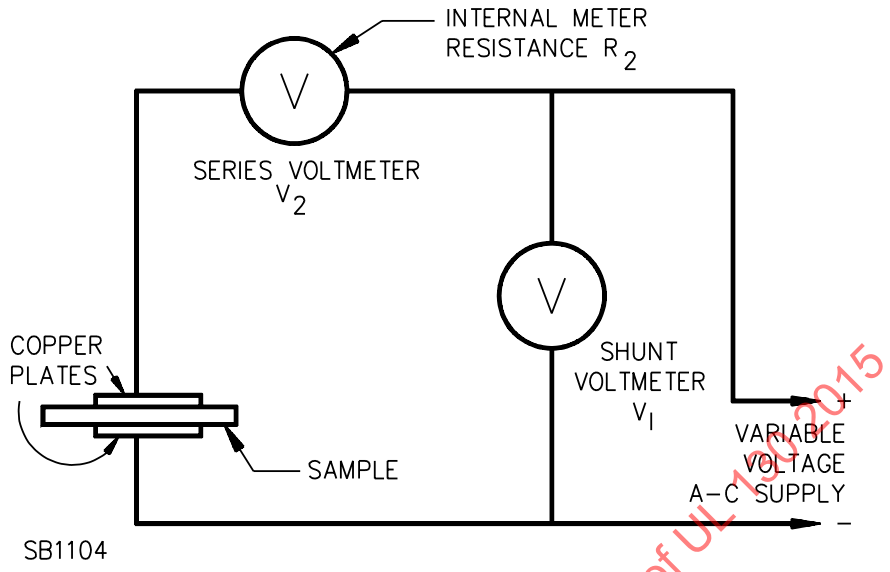
20.1.2 For the tests described in 20.2.1 – 20.6.4, five complete pads and a sheet of the treated fabric approximately 36 inches by 12 inches (914 by 305 mm) in size or six pieces of the treated fabric approximately 6 inches by 2 inches (152 by 51 mm) in size, are to be provided.

20.2 Leakage current

20.2.1 The treated fabric shall not show a leakage current of more than 0.5 mA at 120 V when the material is tested in accordance with 20.2.2.

20.2.2 The leakage current determination is to be made by placing a representative section of the treated fabric between a horizontal pair of square copper plates, each 6 inches (152 mm) on a side, and applying a force of 10 lbf (45 N) vertically downward on the upper plate. The leakage current between the plates is then to be determined by the two-voltmeter method as described in Figure 20.1. A 60 Hz essentially sinusoidal potential of 120 V is to be applied across the test section.

Figure 20.1
Two-voltmeter leakage determination



NOTE: Adjust the variable voltage so that V_1 minus V_2 = 120 volts, where V_1 and V_2 are the readings of the two voltmeters. The leakage current is then V_2 / R_2, where R_2 is the internal resistance of the series voltmeter.

20.3 Bursting strength

20.3.1 The average bursting strength of three specimens of rubberized or otherwise treated fabric shall not be less than 70 lb/in^2 (0.48 N/mm^2), and the bursting strength of each specimen shall not be less than 60 lb/in^2 (0.41 N/mm^2), when the material is tested in accordance with 20.3.2.

20.3.2 For the determination of bursting strength, a circular specimen of the treated fabric approximately 3 inches (76 mm) in diameter is to be held between two circular clamps. Each clamp is to have a diameter of not less than 3 inches (76 mm) and a concentric circular aperture having a diameter of 1.020 ±0.001 inch (25.91 ±0.025 mm). The assembly of clamps and treated fabric is to be mounted such that water pressure can be applied to the fabric side of the material. The pressure, measured by means of a Bourdon-tube gauge, is to be gradually increased until leakage occurs through the treated fabric.

20.3.3 The average bursting strength of each set of three specimens of rubberized or otherwise treated fabric, after conditioning in accordance with 20.3.4 and 20.3.5, shall not be less than 70 percent of the average bursting strength of the specimens of the fabric determined in accordance with 20.3.1 and 20.3.2.

20.3.4 One set of three specimens is to be immersed in boiling water for 1 hour. The specimens are then to be aged in an oven at a temperature of 100.0 ±1.0°C (212.0 ±1.8°F) for 1000 hours, following which they are to be immersed again for 1 hour in boiling water.

20.3.5 Another set of three specimens is to be aged in an air oven for 7 days at 100.0 ±2.0°C (212.0 ±3.6°F).

20.4 Flexing

20.4.1 Rubberized or otherwise treated fabric which has been conditioned in accordance with 20.3.4 and which subsequently has been folded and unfolded back and forth three times shall not crack, shall have no hard spots, and shall show no other evidence of deterioration.

20.4.2 The test described in 20.4.1 is to be performed on three otherwise untested representative sections.

20.5 Leakage current (repeated)

20.5.1 Rubberized or otherwise treated fabric which has been conditioned in accordance with 20.3.4 shall not show a leakage current of more than 1.0 mA at 120 V when tested in accordance with 20.5.2.

20.5.2 Each of three specimens, other than those subjected to the bursting strength test and to the flexing test, are to be tested for leakage current. The test is to be performed in accordance with 20.2.2.

20.6 Tensile strength of cemented seams

20.6.1 The average tensile strength of each set of five pieces of a representative cemented seam in a treated-fabric envelope shall not be less than 5 pounds per linear inch (876 N/m) when tested as described in 20.6.2 – 20.6.4.

20.6.2 The representative cemented seam is to be cut into 15 pieces. Each piece of cemented seam is to have a width along the seam of 1 inch (25 mm) and a length perpendicular to the seam of not less than 3 inches (76 mm) on each side of the seam.

20.6.3 One set of five pieces is to be tested in the as-received condition, an additional set of five pieces is to be tested after being subjected to the boiling-water and oven conditioning described in 20.3.4, and another set of five pieces is to be tested after being subjected to the air oven conditioning described in 20.3.5.

20.6.4 After being conditioned as described in 20.6.3, each piece is to be stressed in a tensile-strength testing machine having provision for measuring the applied force, and the force is to be increased gradually until the seam starts to separate.

21 Flammability Tests

21.1 Liner

21.1.1 A liner (material between the heating element and the outer envelope) of foam used in a heating-pad construction shall not have a burning rate greater than 2.5 inches (63.5 mm) per minute when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

21.2 Supplementary cover

21.2.1 The fabric used in the manufacture of the supplementary cover shall be tested as described in 21.6.10 – 21.6.17. There shall not be charring or burning of the paper monitor as the result of ignition, surface flash, or burning of the representative section under test.

21.2.2 Each different blend or combination thereof shall be tested with intended results.

21.2.3 From each fabric to be tested, and prior to being cut to size for the supplementary cover, a strip of fabric is to be taken, measuring approximately 45 inches by 3 inches (1140 mm by 76 mm). Each of fifteen individual sections are then to be cut from this strip, each with the following dimensions, 2.75 ±0.13 inches by 2.75 ±0.13 inches (69.9 ±3.3 mm by 69.9 ±3.3 mm).

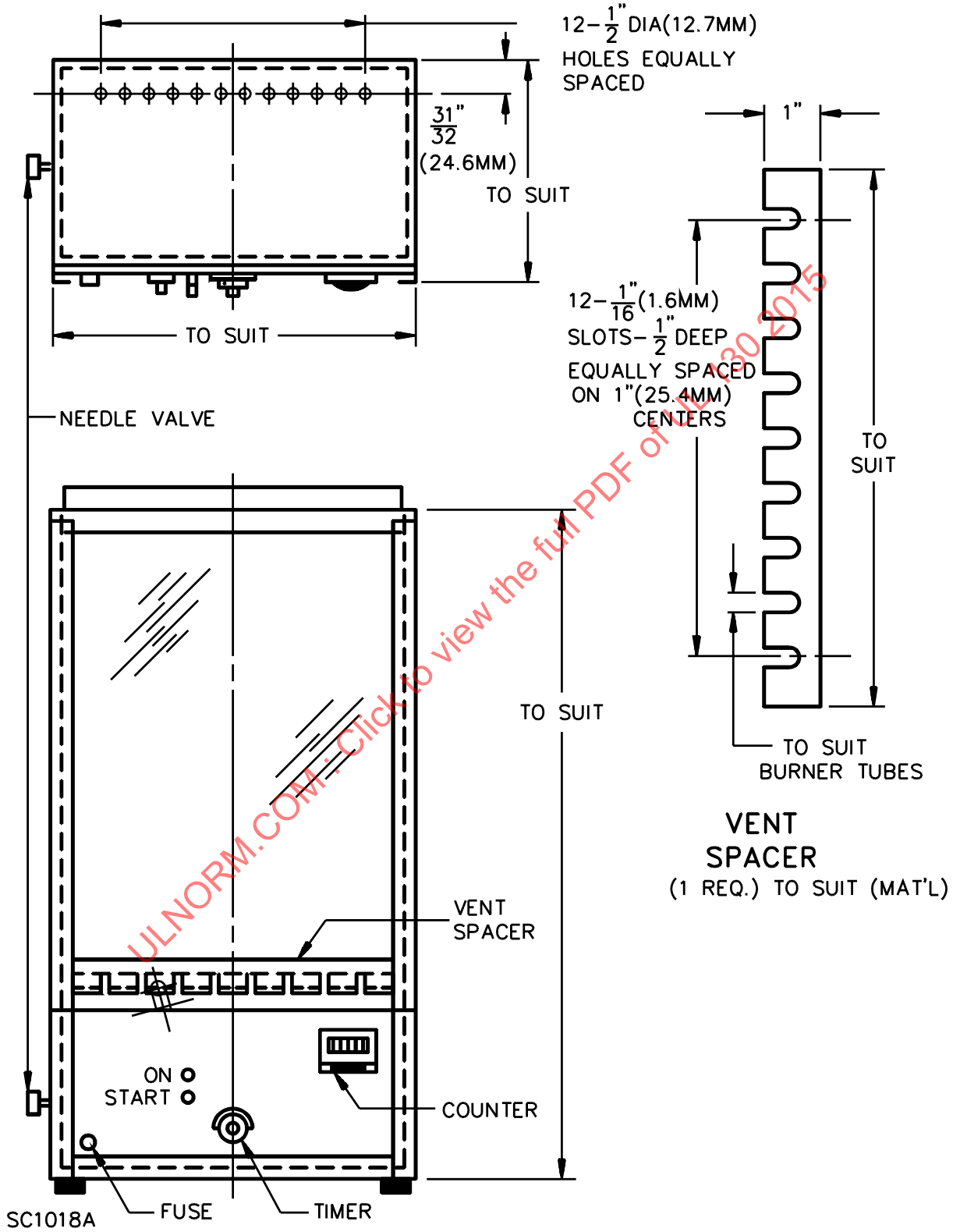
21.2.4 One group of five sections is to be tested face up and designated Group A. A second group of five sections is to be tested face down and designated Group B. The remaining group of five sections is to be tested either face up or face down as described in 21.2.5.

21.2.5 If two or more sections from either Groups A or B or any combination thereof char or burn, as described in 21.2.1, this constitutes unintended results for that fabric. If the results are unintended for only one section, then the five additional sections are to be tested, in whichever mode the unintended results occurred originally, either face up or face down. All five of the new test sections shall have intended results per 21.2.1.

21.3 Test chamber

21.3.1 The test chamber shall be a metal cabinet with inside dimensions of 14-1/2 inches (368 mm) wide, 8-1/8 inches (206 mm) deep, and 13-3/4 inches (349 mm) high. Outside dimensions are not specified. The front of the cabinet shall be of a close fitting door (sliding or hinged) with a transparent insert to permit observation of the entire test. Vent holes shall be distributed across the bottom portion of the front panel of the chamber and the rear portion of the cover of the test chamber as shown in Figure 21.1.

Figure 21.1
Test chamber



21.4 Control element

21.4.1 The test cabinet shall be equipped with control elements which will control the time of flame impingement on the specimen to ±0.05 seconds. The control system shall consist of two parts:

a) An adjustable timer that actuates the burner mechanism; and

b) A counter that is actuated by the burner mechanism when the burner is in position to impinge the flame on the specimen.

21.5 Specimen holder

21.5.1 The specimen holder shall consist of two rectangular aluminum plates held together. See Figures 21.2 and 21.3.

21.6 Specimen holder base

21.6.1 The specimen holder base shall be made of metal as detailed in Figures 21.2 and 21.3 and shall maintain the specimen holder in a horizontal position in the approximate center of the test chamber floor. See Figure 21.4. The specimen holder base shall be rigidly held in place (for example, screwed to the floor of the test cabinet or held by means of side guides).

21.6.2 BURNER – The burner shall be as detailed in Figure 21.5. The gas input line to the burner shall be equipped with a needle valve which is used to control the flame length.

21.6.3 GAS SUPPLY SYSTEM – There shall be a pressure regulator to furnish gas to the burner under a gauge pressure of 2-1/2 ±1/2 psi or 129 ±26 millimeters of mercury (17.2 ±3.4 kN/m^2) at the needle valve inlet.

21.6.4 GAS – The gas shall be at least 97 percent pure technical grade methane.

21.6.5 HOOD – A hood or other similar enclosure shall be used to provide a draft protected environment surrounding the test chamber. This enclosure shall have a fan or other means for exhausting smoke, toxic gases, or both produced by testing.

21.6.6 PAPER – White paper which conforms to the Federal Specification for Lens Paper, A-A-50177, shall be used as a monitor to determine if ignition has occurred. This paper shall be cut into a 3-1/2 by 3 inch (89 by 76 mm) rectangle with holes punched as shown in Figure 21.6.

21.6.7 BRUSHING DEVICE – A brushing device similar to the one shown in Figure 21.7 shall be used to brush up the nap or fiber on specimens which have raised fiber surfaces. The brush shall consist of two staggered rows of stiff nylon bristles, 0.016 inch (0.4 mm) diameter with 20 bristles per tuft and four tufts per inch. The tufts shall be cut to a uniform length of 0.75 inch (19 mm). The downward force of the brush shall be 75.0 ±10.0 g.

21.6.8 CIRCULATING AIR OVEN – A forced circulation drying oven capable of maintaining the specimens at 105 ±2.8°C (221 ±5°F) shall be used to dry the specimens while mounted in the specimen holders.

21.6.9 DESICCATOR – An airtight and moisture-tight desiccating chamber shall be used for cooling mounted specimens after drying. Anhydrous silica gel with an indicator shall be used as the desiccant in the desiccating chamber. The desiccant shall be replaced or reactivated when it becomes inactive.

Figure 21.2
Specimen holder assembly

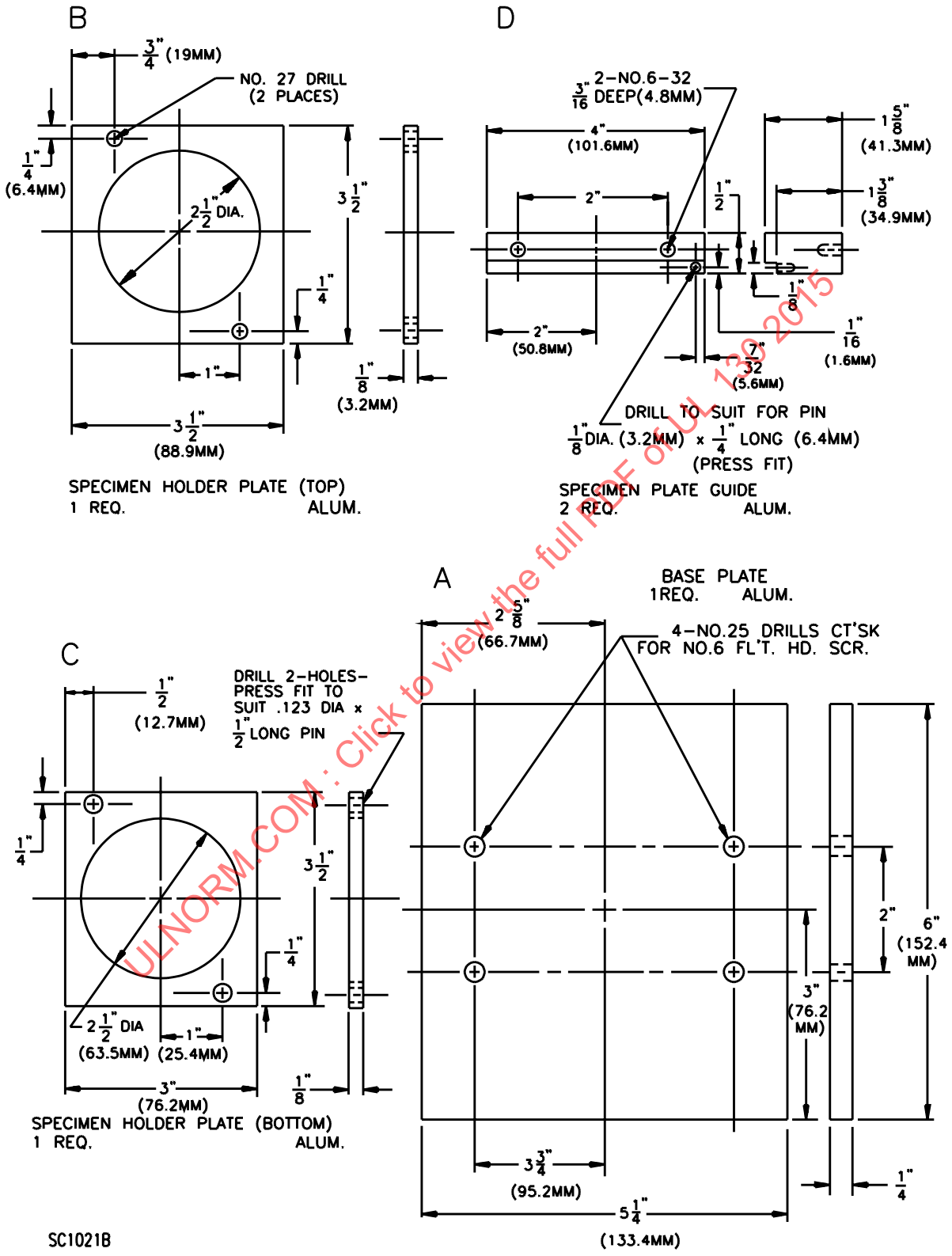
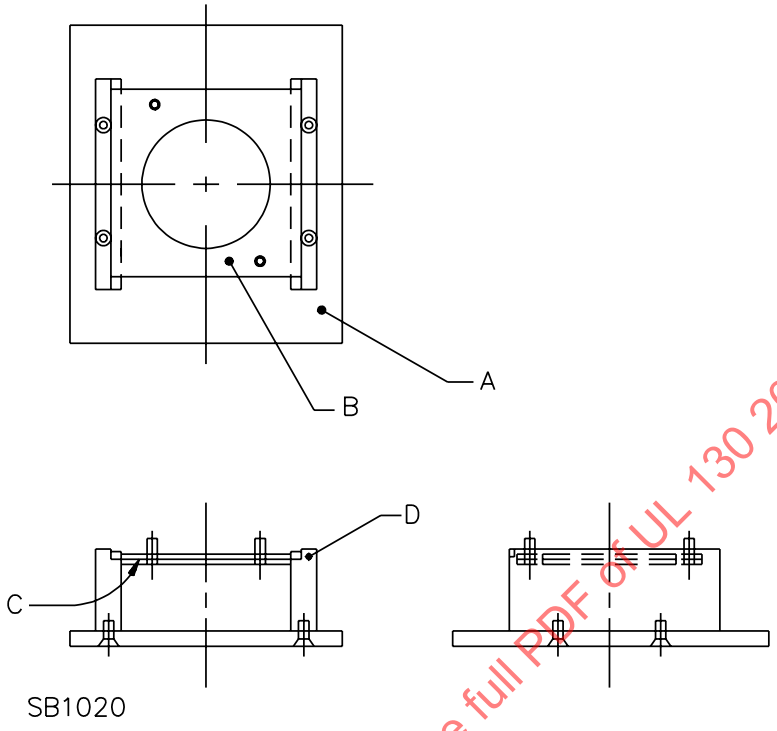


Figure 21.3
Specimen holder assembly



21.6.10 SPECIMEN PREPARATION – The specimens are to be washed in a neutral soap solution as indicated in 21.6.11. Neutral chip soap may be used.

21.6.11 The specimens are to be put into a 3-US-gallon-capacity (11 L) right-circular cylindrical container [approximate dimensions: 13 inches (330 mm) long by 8-3/4 inches (222 mm) in diameter] that is fitted with a water-tight cover at one end, preferably is of metal, and is mounted on a shaft whose longitudinal axis is in the same plane as the longitudinal axis of the container, intersects the longitudinal axis of the container at an angle of 50 degrees, and intersects the outside surface of the container at a point equidistant from the ends of the container. The shaft is to be oriented so that the longitudinal axis of the container is vertical while the container is in one of the two positions of rotation in which the plane of the axes is vertical. Soft water at a temperature of 35.0– 37.8°C (95.0 – 100.0°F) and into which 0.5 percent by weight of the neutral soap mentioned in 21.6.10 has been thoroughly mixed is to be poured into the container in an amount equal to 30 times the mass of the specimens dry. The specimens are to be worked gently in the solution for 5 minutes by rotating the shaft on which the container is mounted at a rate of 45 – 50 revolutions per minute, after which they are to be rinsed twice in 26.7°C (80.0°F) water, spun to remove most of the water, and then laid flat on a horizontal surface and allowed to dry completely at room temperature.

21.6.12 After the washed specimens have dried thoroughly, they are to be individually brushed as follows: clamp the specimen on the carriage of the brushing device. Pull the carriage with the specimen underneath the brush, brushing the specimen surface once in the direction which raises the nap or fibers as much as possible. Before brushing the next specimen, the tufts of the brush should be cleared of residual fibers. After brushing, with the bottom plate of the holder on a mounting plate, mount the specimen in the specimen holder. Do not handle the specimens except on the edges. Mount the specimens and paper monitors in the following order: bottom plate, specimen, paper monitor, top plate.

Figure 21.4
Specimen holder assembly

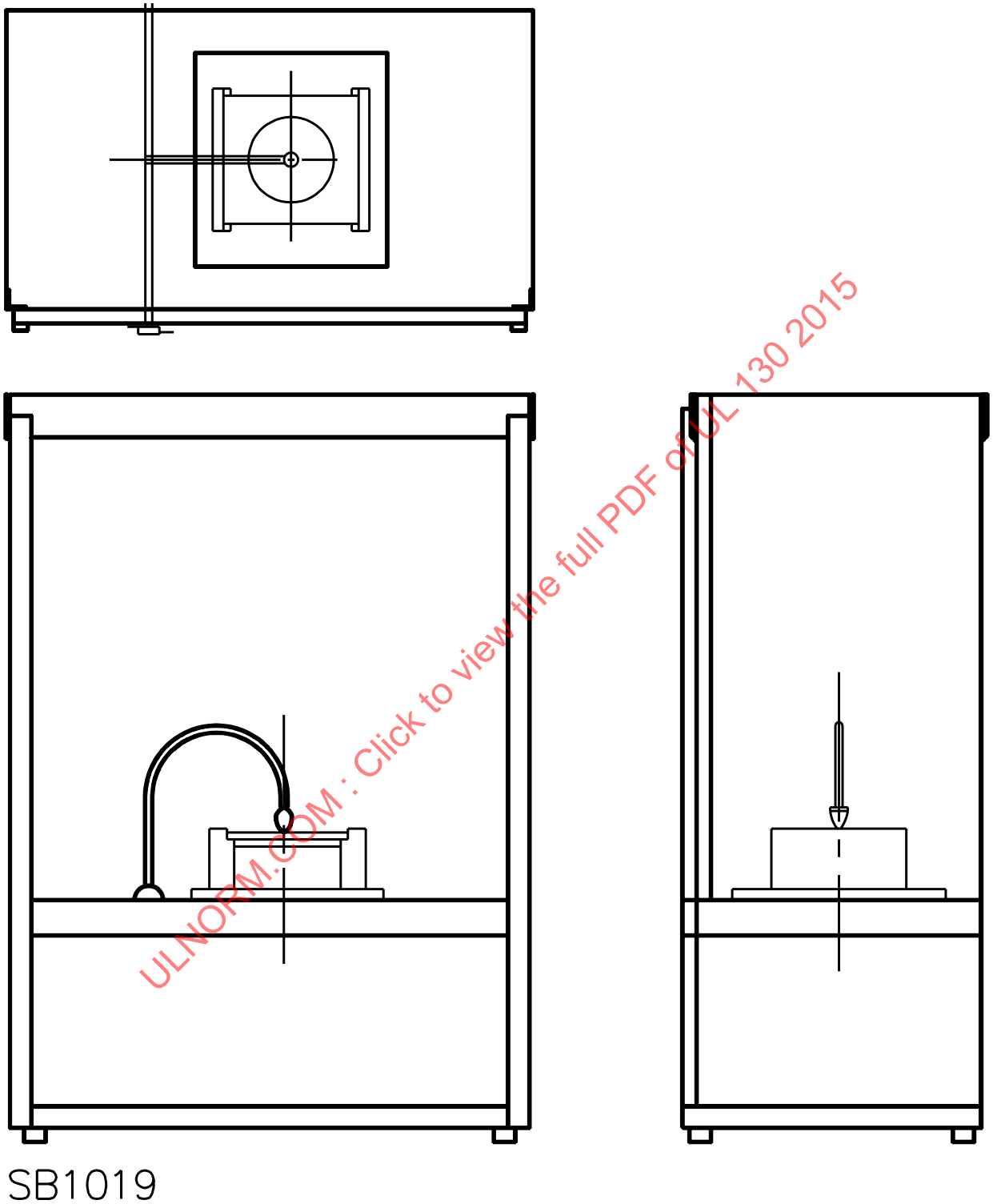


Figure 21.5
Burner

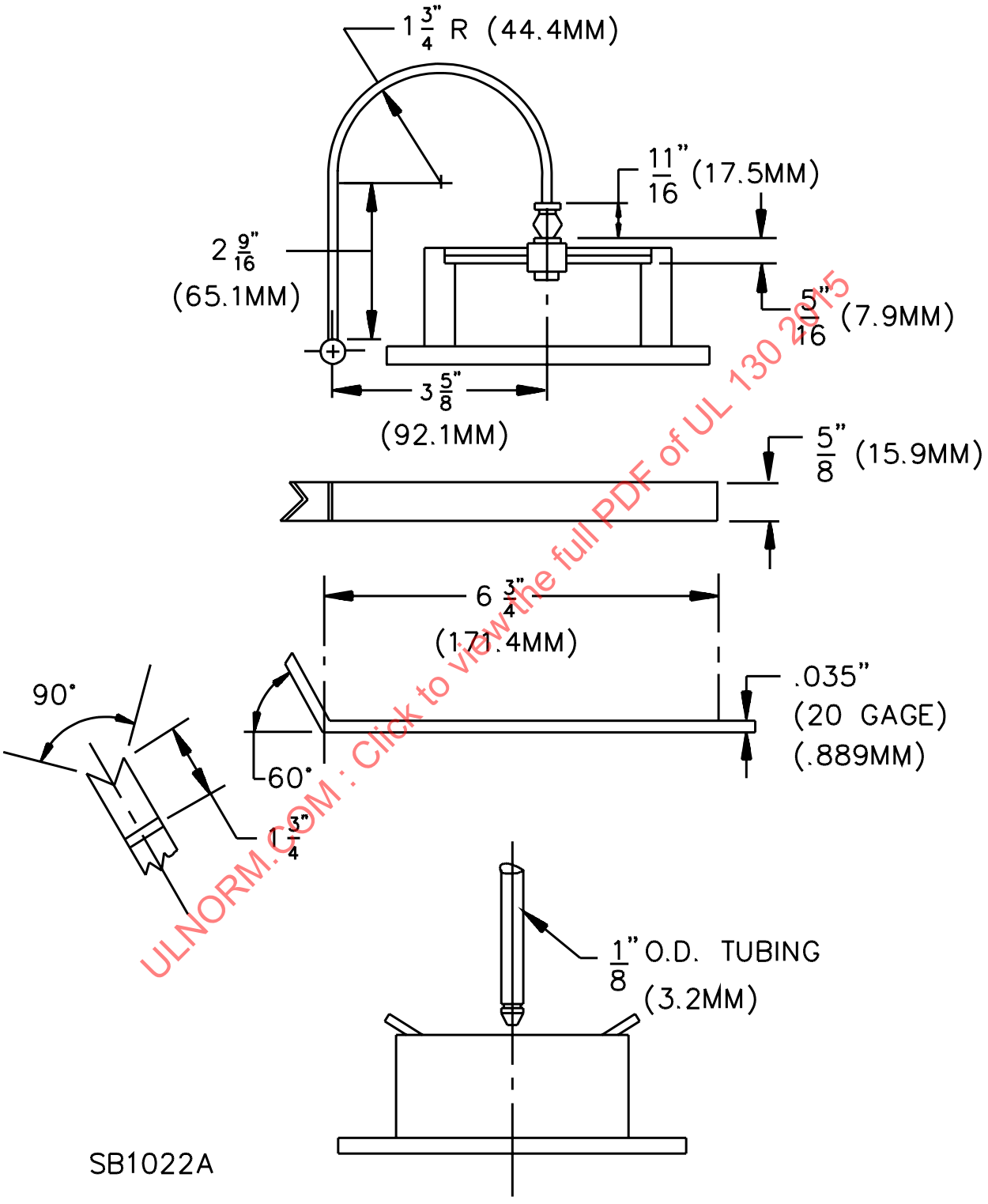
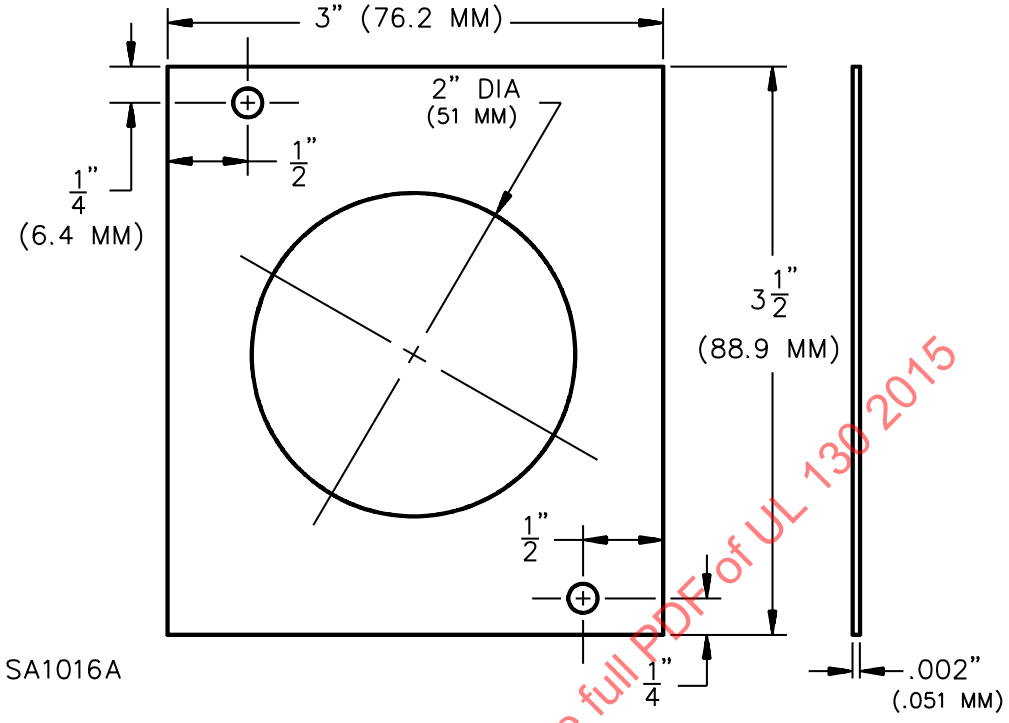


Figure 21.6
Paper indicator



Place the paper monitor such that the two small holes fit over the guide pins on the bottom plate of the specimen holder. This shall set the large circular hole in the paper monitor concentric with the hole in the top plate of the specimen holder.

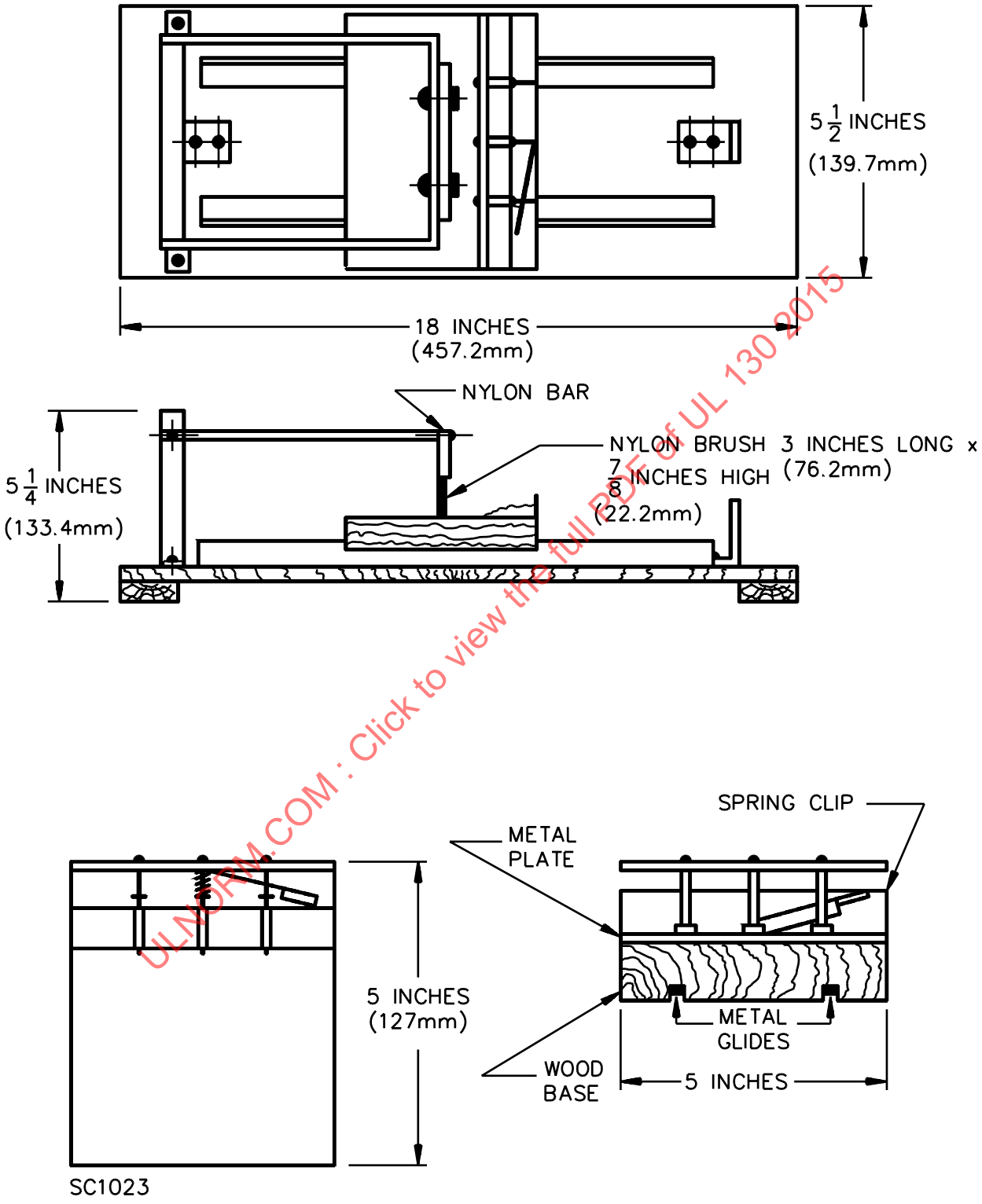
21.6.13 CONDITIONING – Place the mounted specimens in a drying oven in a manner that will permit free circulation of air at 105 ±2.8°C (221 ±5°F) around them for at least 30 minutes. Remove the mounted specimens from the oven and place them in a desiccator to cool, taking care that the brushed surface of each specimen is not touched. No more than five specimens are to be placed in each desiccator at one time. Specimens are to remain in the desiccator at least 30 minutes and not more than 60 minutes.

21.6.14 BURNER ADJUSTMENT – Adjust the burner actuating linkage so that the burner tip, in the actuated position, is 0.31 inch (7.9 mm) from the specimen surface. With the burner in the actuated position, move the base and holder assembly away from the burner tube so that the burner tip is 0.13 inch (3.3 mm) off center. Secure holder assembly to floor.

21.6.15 CONTROL ADJUSTMENT – The timer is to be adjusted so that the burner, when actuated, remains in position to impinge the flame on the specimen for 1 ±0.05 second. This is accomplished by actuating the control elements thereby sweeping the burner forward, reading the time on the counter, and adjusting as necessary.

21.6.16 FLAME LENGTH ADJUSTMENT – With the hood fan turned off and the burner in the relaxed position, use the needle valve to adjust the flame length to 0.63 inch (16 mm) from the tip of the burner parallel to the floor of the cabinet measuring only the clearly visible, yellow portion of the flame. A gauge that may be used for this adjustment is shown in Figure 21.5.

Figure 21.7
Brushing device

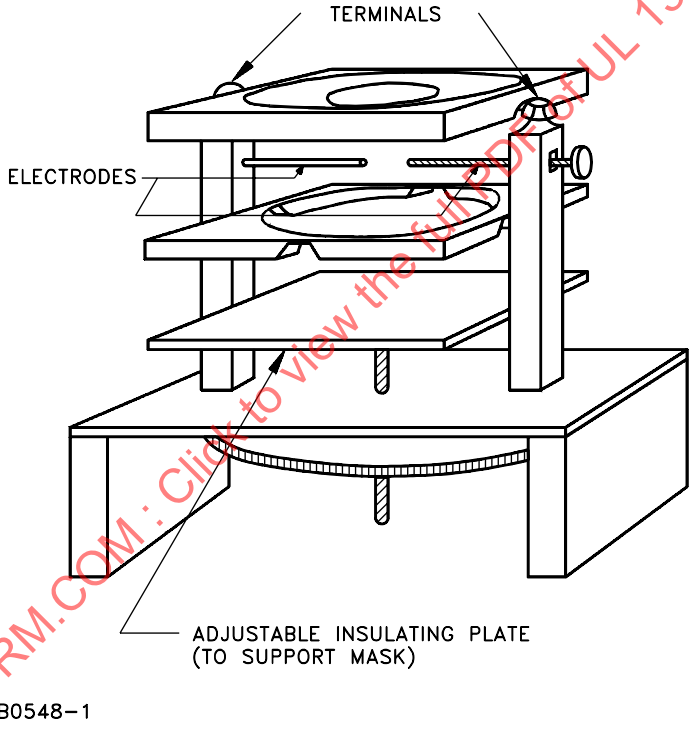


21.6.17 SPECIMEN EVALUATION – Remove the mounted specimens from the desiccator one at a time and insert them in the cabinet for testing. Close the cabinet door and actuate the burner mechanism. The control equipment will automatically cause the flame to impinge on the surface of the specimen for 1 ±0.05 second. If more than 30 seconds elapse between removal of a specimen from the desiccator and the initial flame impingement, that specimen shall be reconditioned prior to testing. When combustion has stopped, as evidenced by absence of flame and afterglow, remove the mounted specimen from the cabinet and place it on a flat surface. The surface shall be a white paperboard sheet. Determine for each specimen whether the paper monitor is charred or burned at any point. See 21.2.1.

22 Ease of Ignition Test

22.1 Each of six sections of a shell, each measuring 3.9 inches by 7.9 inches (100 mm by 200 mm), is to be tested in the apparatus shown in Figures 22.1, 22.2, and 22.3.

Figure 22.1
Ease of ignition test



22.2 The sections are to be cut from the test heating pad so that the short side is parallel to the run of the heating elements, and the sections are taken from positions in the heating pad such that as far as possible, no two sections contain the same warp or the same weft threads. If this is not possible then the same warp or weft thread must not appear in more than two sections.

Figure 22.2
Lower mask

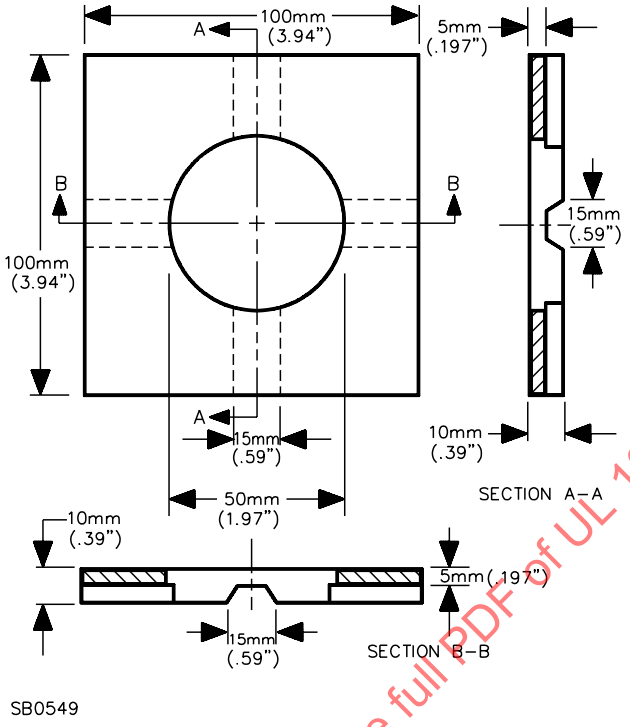
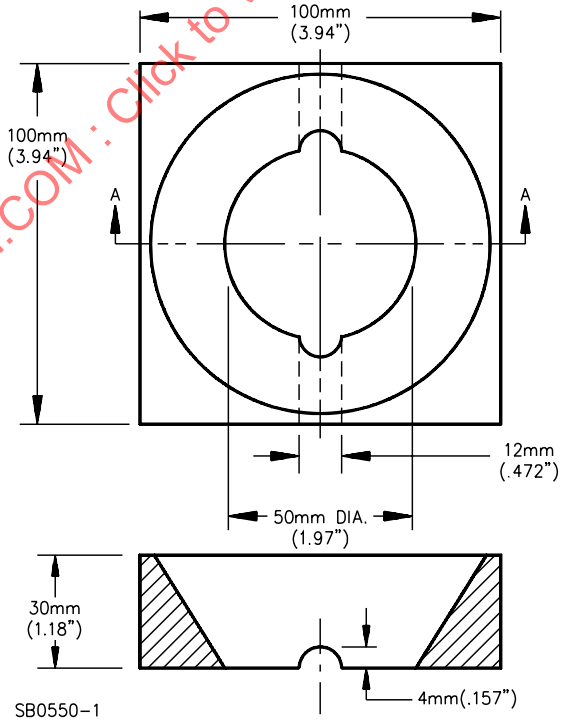


Figure 22.3
Upper mask



22.3 After removal of the heating elements, wires, and similar components, the section is to be conditioned in the oven with the test apparatus for a period of not less than 3 hours.

22.4 At the end of the conditioning period each section is to be subjected to the following test, which is made once at one end of the section with one side uppermost and once at the other end with the other side uppermost.

22.5 The test apparatus has two 0.118-inch (3-mm) diameter brass electrodes, supported on a common axis by brass pillars mounted on an insulating base plate. The base plate also carries a platform of insulating material measuring 3.94 inches square (100 mm by 100 mm) that is mounted centrally between the brass pillars, with the mounting means such that the height of the platform can be adjusted. One electrode is fixed in position while the other is movable with an effective stop so that it can be withdrawn to enable the section to be mounted in a test apparatus and then returned in position so that there is a required gap between the two electrodes. The fixed electrode is cut such that the plane of the section is at an angle of 45 degrees to the axis of the electrodes and is mounted with the plane of the section such that the point furthest from the electrode support is at the top and at a distance of approximately 0.118 inch (3 mm) from the center of the platform. The movable electrode is flat-ended, the face being cut at 90 degrees to the axis of the electrode. The stop is so adjusted that when the electrode is at the operating position, the horizontal distance between the ends of the electrodes is 0.236 inch (6.0 mm).

22.6 The lower member of a two-part hardwood mask, as shown in Figures 22.1 and 22.2 is fixed to the adjustable table in the position indicated, and the whole assembly, together with the upper member of the mask, Figure 22.3, is placed in an oven with a glass inspection door, the oven being heated by natural convection.

22.7 While in the oven, electrodes are connected in series with an acceptable noninductive resistance bank to the output terminals of an oil ignition or similar transformer having a sinusoidal output voltage rated 10 kV (rms) and an output rating such that the output voltage does not fall by more than 100 V when a current of 1 mA is flowing. The oven is maintained at a temperature of 65 ±2°C (149 ±3.6°F).

22.8 When steady temperatures are achieved, the transformer primary voltage is adjusted if necessary, to give a terminal output voltage of 10 kV. The electrodes are then short-circuited and the resistance bank adjusted so that a current of 1 mA flows. The supply is then switched off without alteration to the circuit conditions.

22.9 Without removing the apparatus from the oven, the movable electrode is withdrawn and the section threaded over the fixed electrode, so that it lies centrally in one of the element pockets, with the end of the section approximately level with the edge of the adjustable platform. The movable electrode is then threaded into the same pocket and fixed in the position necessary to give the specified gap between the electrodes. The section is then smoothed out, care being taken that the material is not looped or caught between electrodes. After this, the platform height is adjusted so that the centerline of the electrodes lies approximately in the plane of the element pockets and the mask is placed in position. The oven door is then closed and 5 minutes is allowed for the conditions to stabilize.

22.10 The supply is then switched on and sparks allowed to pass between electrodes for a period of 2 minutes. If the section ignites, the time in seconds is recorded, from the instant of switch on until the flame reaches the edge of the mask. If the section does not ignite, the result is recorded as 120 seconds. The ignition of surface hairs lasting not more than 3 seconds is ignored.

22.11 If any result is below 30 seconds, the test is repeated on a second batch of sections. If the result for any section in the second batch falls below 30 seconds the material is not acceptable.

22.12 If no results are below 30 seconds, the mean of all 12 readings is calculated. All results different by more than ±30 seconds from the mean are then ignored and, if necessary, the average value for the remainder calculated.

22.13 If the average figure for the sections differing by not more than 30 seconds from the original mean falls below 80 seconds, the material is not acceptable.

NORMAL TESTS ON COMPLETE PAD

23 General

23.1 A pad that is provided with a separate outer covering is to be tested with such covering removed.

24 Leakage Current Test

24.1 The leakage current of the nine heating pads, when tested in accordance with 24.3 – 24.5, shall not be more than 0.5 mA on each pad.

24.2 Leakage current refers to all currents, including capacitively coupled currents, which may be conveyed between exposed conductive surfaces, or other exposed surfaces, of a heating pad and ground.

24.3 Leakage current is to be measured using metal foil which is placed in direct contact with all surfaces of the heating pad. The metal foil is not to remain in place long enough to affect the temperature of the pad.

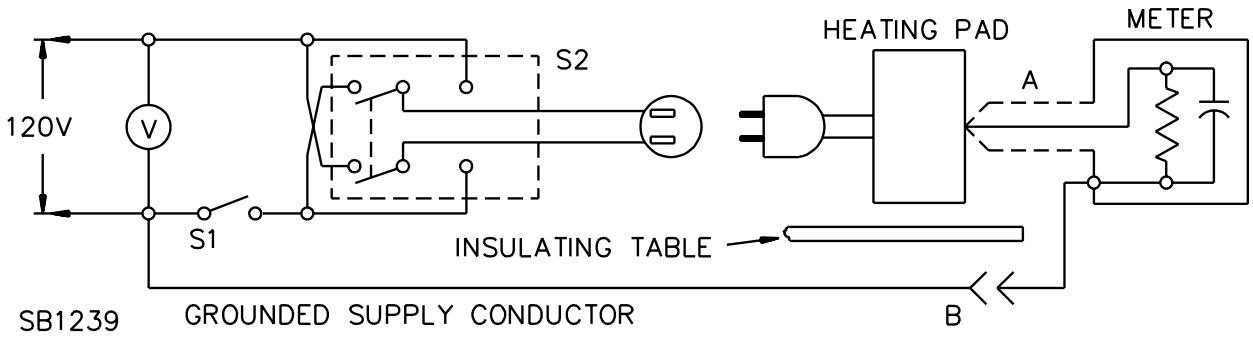
24.4 The measurement circuit for leakage current is to be as shown in Figure 24.1. The ideal instrument is defined in (a) – (c). The meter which is actually used for a measurement is required only to indicate the same numerical value for a particular measurement as would the ideal instrument. The meter used is not required to have all the attributes of the ideal instrument.

a) The meter is to have an input impedance of 1500 ohms resistance shunted by a capacitance of 0.15 µF.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kHz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500 ohm resistor shunted by a 0.15 µF capacitor to 1500 ohms. At an indication of 0.5 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.

Figure 24.1
Leakage current test circuit



NOTES:

A – Probe with shielded lead.

B – Separated and used as clip when measuring currents from one part of the device to another.

24.5 Each representative pad is to be tested for leakage current starting with the ″as-received″ condition (without prior energization, except as may occur as part of the production line testing). The supply voltage is to be adjusted to 120 V. The test sequence, with reference to the measuring circuit (Figure 24.1) is as follows:

a) With switch S1 open, the pad is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2 and with the pad switching devices in all their normal operating positions.

b) The switch S1 is then to be closed energizing the pad, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2, with the pad switching devices in all of their normal operating positions.

c) The leakage current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation as in the Heating Test, Section 27.

25 Input Test

25.1 The power input to each of the nine representative complete pads shall not be more than 105 percent nor less than 85 percent of the marked rating (watts or amperes) of the pad when the pad is operated at rated voltage. See 48.3.

26 Resistance to Moisture Test

26.1 As noted in 17.2, the envelope of each of nine complete general-use pads shall be capable of withstanding 300 hours of intended service with the pad at its maximum operating temperature without loss of its moisture-resistant properties and without developing hard spots.

26.2 To determine whether each pad complies with the requirement in 26.1, it is to be laid out flat on a 1 inch (25 mm) thick felt mat and operated continuously while connected in the intended manner to a supply circuit of rated voltage. After operation for 300 hours, the surface of the envelope is to be examined carefully to determine whether there are any hard spots in the material. It is then to be folded and manipulated back and forth several times to flex the material throughout the entire surface. Following the manipulation, the envelope is to be tested for current leakage in accordance with 26.3; and a pad with a leakage current of more than 8 mA at 120 V is not demonstrating intended performance.

26.3 Each pad is to be laid out flat on a horizontal supporting surface, with the edges of the pad turned up at right angles for approximately 1 inch (25 mm) to form a shallow tray. The side (face) which was in contact with the felt mat during the 300-hour test is to become the upper or inside surface of the tray. A solution of approximately 8 g (0.28 oz) of NaCl per 1000 cm^3 of water is to be introduced into the tray to a minimum depth of about 1/4 inch (6 mm) and the current leakage between the electrolyte and the heating element of the pad is then to be measured. The solution is to be allowed to remain on the pad for a period of 3 hours, and if no current leakage (see 39.3) is then shown, the test may be discontinued; but, if any current leakage is indicated, the test is to be continued until ultimate results are obtained.

27 Heating Test

27.1 Each of the nine complete household pads, initially at room temperature, shall not attain a temperature higher than 90°C (194°F) at any exterior point when the pad is tested in accordance with 27.3 and 27.4; and 20 minutes after the first opening of a thermostat and subsequently, the temperature on the exterior of the pad shall not be higher than 80°C (176°F).

27.2 Each of nine complete hospital pads, initially at room temperature, shall not attain a temperature higher than 55°C (131°F) at any exterior point when the pad is tested in accordance with 27.3 and 27.4.

27.3 To determine whether each pad complies with the requirement in 27.1 or 27.2, it is to be laid out flat between two felt mats, each 1 inch (25 mm) thick and with an area that will cover the pad completely with a margin of not less than 2 inches (51 mm) all the way around. It is then to be connected to a supply circuit of rated voltage and operated for a period of 4 hours, or for a longer time if necessary to reach thermal equilibrium. A temperature is to be considered constant when three successive readings taken at 15-minute intervals indicate no change. During this test, temperatures are to be observed on each pad by means of a temperature indicating instrument and no fewer than six thermocouple probes are to be located at points in close contact with the exterior of the pad. The thermocouple probes are to consist of 30 AWG (0.05 mm^2) iron and constantan wire thermocouples with the bead soldered to a copper strip approximately 1/4 by 1/2 inch, by 0.022 inch thick, (6.4 by 12.7 by 0.56 mm) with rounded corners.

27.4 The thermocouples and related measuring instruments are to be accurate and calibrated according to good laboratory practice. The thermocouple wire is to conform to the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard for Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples ANSI/ASTM E230/E230M.

27.5 During the test of a pad, the switch is to be positioned separately from the pad itself but is to be blanketed in the same manner as the pad. Particular attention is to be paid to localized temperatures that can occur on or within the switch body. Temperatures on the internal parts of the switch are to be measured by means of thermocouples and shall not exceed the values in Table 38.1. Temperatures measured on the outer surface of the switch shall not exceed 55°C (131°F). Care is to be taken that the temperatures measured are maximum temperatures.

27.6 The temperatures given in these requirements are based on a room temperature of 25°C (77°F). Tests are not prohibited from being done at any room temperature between 20°C (68°F) and 30°C (86°F) and the observed temperatures corrected for a room temperature of 25°C (77°F).

27.7 Following the operation with each pad completely covered, the test is to be repeated for a second 4-hour or longer period with approximately half of the pad between the two felt mats and the other half exposed. The position of the pad may be such that any half of the pad area is exposed. For a pad having two thermostats, the exposed part is to include one thermostat; and for a pad having three or four thermostats, the exposed part is to include two thermostats.

27.8 Following the operation with half of each pad exposed, the test is to be repeated for a third 4-hour or longer period with the pad reversed so that the part previously covered is exposed. The exposure of thermostats is to be as indicated in 27.7, except that only one thermostat is to be exposed in a pad having three thermostats.

28 Flexing Test

28.1 Each of three representative complete pads shall be capable of performing successfully (see 28.2 and 28.3) when subjected to a flexing test – 8000 cycles for a household pad and 10,000 for a hospital pad – while connected to a supply circuit of rated voltage, with the switch of the heating pad in the high position, under the conditions described in 28.4 – 28.9.

28.2 Performing successfully means that there shall not be:

a) Loosening of the cord from the pad;

b) Breakage of the envelope material or the seams of the envelope;

c) Breakage or loosening of any wiring connections;

d) Temperatures higher than those indicated in 27.1 and 27.2;

e) Appreciable shifting of the position of the heating element within the envelope; and

f) Breakage of the conductor of the heating element or other interruption of the electrical circuit through the pad.

28.3 In addition to performing successfully, as described in 28.2, a pad shall be in such condition that it will comply with the requirements of Sections 35 – 43, in the sequence indicated by 17.1.

28.4 To reduce friction, each pad may be subjected to the flexing test in a covering of cheesecloth of double thickness. See 17.7.

28.5 The apparatus for conducting the flexing test is to consist of power-driven testing machine, a pair of wide clamps for gripping the edges of each heating pad, and a number of weights, each being large enough to exert 1 lbf (4.45 N) when suspended from a clamp.

28.6 The machine is to draw each pad back and forth by means of a clamp over the 1/2-inch-radius (13-mm-radius) edge of a smooth, horizontal, metal bed; at a rate of approximately 15 cycles per minute. The stroke of the machine is to be adjustable to accommodate pads of various dimensions, so that the greatest possible area of a pad is subjected to the flexing.

28.7 The clamps are to be in pairs, of 12 inch (300 mm) and 18 inch (460 mm) lengths to accommodate edges of different dimensions, and may be of any construction that securely grips the edges of the pad. One clamp of each length is to be provided with hooks for the suspension of the weights.

28.8 The clamps are to be applied to opposite edges of each pad, which is then to be adjusted in the machine with the weighted clamp hanging over the rounded edge of the bed. A weight exerting a 1 lbf (4.45 N) is to be used for each 6 inches (152 mm) or fraction thereof of the edge of the pad in the clamp.

28.9 Each pad is to be connected by means of its flexible cord and plug to a supply circuit of rated voltage. After 2000 cycles of continuous operation of a household pad, 2500 cycles for a hospital pad, the machine is to be stopped, the pad turned 90 degrees so that the bending is at right angles to that previously made, and operation resumed. After the second 2000- or 2500-cycle period of operation, the machine is to be stopped, the pad turned over, and operation resumed. After the third 2000- or 2500-cycle period of operation, the machine is to be stopped, the pad turned again through 90 degrees, and the operation continued for a fourth 2000- or 2500-cycle period.

29 Twisting Test

29.1 Each of three representative complete pads shall be capable of performing successfully (see 28.2 and 28.3) when subjected to the twisting test – 6000 cycles for a household pad and 7200 cycles for a hospital pad – described in 29.2 – 29.5 while connected to a supply circuit of rated voltage, with the heating pad switch in the high position.

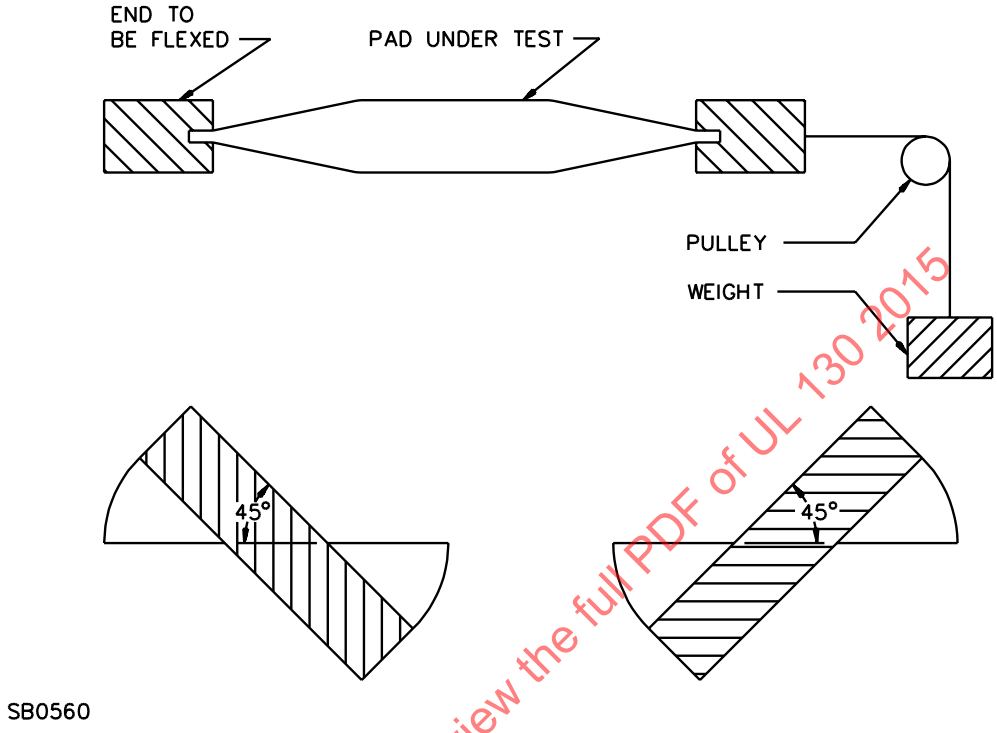
29.2 The apparatus for conducting the twisting test is to consist of a power-driven twisting machine, and a pair of wide clamps for gripping the edges of each heating pad.

29.3 One end of the heating pad is to be rigidly clamped in a horizontal plane along the width of the pad. This end of the pad is to be prevented from twisting. The pad is kept in tension by a pull of 5 lbf (22 N) which is placed on this end.

29.4 The other end of the pad is to be clamped in the twisting machine along the width of the pad.

29.5 The machine is to twist the pad back and forth through a 90 degree arc. Each pad is to be twisted both 45 degrees clockwise and 45 degrees counterclockwise through a horizontal position with the opposite end remaining fixed. See Figure 29.1.

Figure 29.1
Twist test apparatus



30 Bunch Test

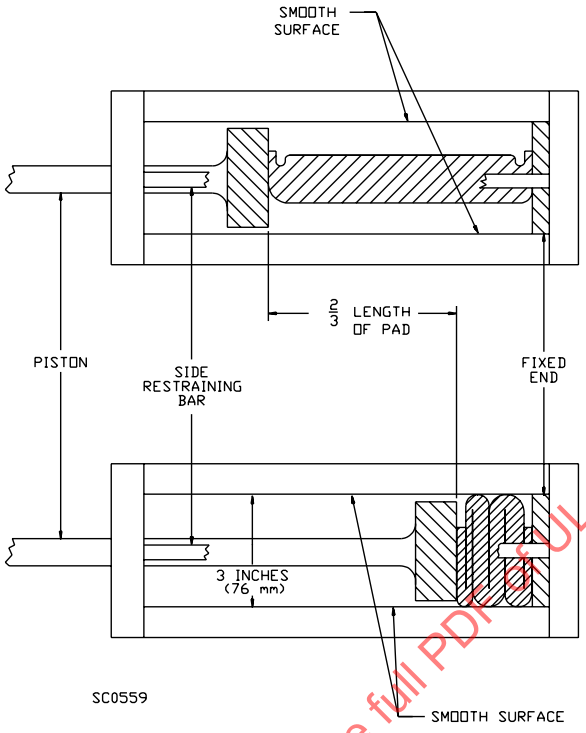
30.1 Each of three representative complete pads shall be capable of performing successfully (see 28.2 and 28.3) when subjected to the bunch test – 8,000 cycles for a household pad and 10,000 cycles for a hospital pad – described in 30.2 – 30.5 while connected to a supply circuit of rated voltage, with the heating pad switch in the high position.

30.2 The apparatus for conducting the bunch test is to consist of a power driven testing machine, a pair of wide clamps for gripping the edges of each heating pad, and the bunch test apparatus.

30.3 The heating pad is rigidly clamped on one end and clamped on a movable slide on the other end of the apparatus. An air piston moves the free end of the heating pad in and out of the test apparatus. In the extended position, the apparatus holds the pad flat, in a horizontal plane. See Figure 30.1.

30.4 The stroke of the air piston is to be adjusted to be equal to two-thirds of the overall length of the heating pad, excluding the supply cord.

Figure 30.1
Bunch test apparatus



30.5 Each pad is to be connected by means of its flexible cord and plug to a supply circuit of rated voltage. After 2,000 cycles of continuous operation of the household pad and 2,500 cycles for a hospital pad, the machine is to be stopped, and, leaving the ends clamped, the pad is turned over so that the side previously on the bottom is now on top. Operation of the apparatus is now resumed. After the second 2,000, or 2,500, cycles of operation, the machine is to be stopped, the clamped ends of the pad exchanged, and operation resumed. After the third 2,000 or 2,500 cycle period of operation, the machine is to be stopped, the pad turned over again, as before, and operation continued for a 2,000 or 2,500 cycle.

31 Connector Flexing Test

31.1 Each of 6 female cord connectors with cord attached is to be subjected to 900 cycles of the cord flexing test described in 31.3.

31.2 After being subjected to the flexing test there shall not be:

a) Breakage of the cord or exposure of an uninsulated conductor strand; and

b) Breakdown when each device is subjected to a 1000-V dielectric voltage-withstand test between the individual conductors of the flexible cord.

31.3 Each device is to be mounted in a guide with a 1/4-lb (113-g) doughnut-shaped weight attached to approximately 10 inches (254 mm) of cord, 8 inches (203 mm) from the point at which the cord enters the connector. The 10 inch length of cord is then to be spliced to a length of 28 AWG (0.08 mm^2) flexible wire, which is then to be connected to the flexing machine. The setup is to be such that the cord-connector can be rotated 540 degrees about the axial center of the cord. A typical setup is illustrated in Figure 31.1. The rate of flexing is to be at least 10 cycles per minute. Each cycle is to consist of 540 degrees of rotation in one direction and then 540 degrees in the reverse direction back to the starting point. During the test the supply cord is to carry the same current as it does in the electric heating pad.