

UL 130

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Electric Heating Pads

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No Text on This Page

CONTENTS

FOREWORD	6
----------------	---

INTRODUCTION

1 Scope	7
2 Components	7
3 Units of Measurement	7
4 References	8

CONSTRUCTION

5 General	8
6 Envelope	8
7 Insulation	9
8 Spacings	10
9 Thermostats	10
10 Switches	11
10.1 Hospital pad	11
10.2 Household pad	11
11 Pilot Light	12
12 Supply, Control, and Interconnecting Cords	12
13 Connections	14

PERFORMANCE

GENERAL

14 General	15
15 Thermostats Tests	17
15.1 Original calibration	17
15.2 Overload	17
15.3 Endurance	18
15.4 Recalibration	18

ENCLOSURE MATERIALS (OUTER ENVELOPE)

16 Tests on Vinyl Sheeting	18
16.1 Low-temperature impact	18
16.2 Tear resistance	22
16.3 Leakage current	23
16.4 Leakage current (repeated)	23
16.5 Shrinkage	24
16.6 Physical properties	24
16.7 Tensile strength of seams	24
17 Tests on Treated-Fabric Envelopes	25
17.1 General	25
17.2 Leakage current	25
17.3 Bursting strength	26
17.4 Flexing	26
17.5 Leakage current (repeated)	26

17.6 Tensile strength of cemented seams	27
18 Flammability Tests	27
18.1 Liner	27
18.2 Supplementary cover	27
18.3 Test chamber	28
18.4 Control element	28
18.5 Specimen holder	28
18.6 Specimen holder base	28
19 Ease of Ignition Test	36

NORMAL TESTS ON COMPLETE PAD

20 General	39
21 Leakage Current Test	39
22 Input Test	41
23 Resistance to Moisture Test	41
24 Heating Test	41
25 Flexing Test	42
26 Twisting Test	43
27 Bunch Test	44
28 Connector Flexing Test	45
29 Laundering Test	48
30 Leakage Current Test	49
31 Dielectric Voltage-Withstand Test	49
32 Heating Test (Repeated)	49
33 Dielectric Voltage-Withstand Test	49
34 Strain-Relief Test	50
35 Internal Temperature Test	50

ABNORMAL TESTS ON COMPLETE PAD

36 Electric Shock Current Test	51
37 Dielectric Voltage-Withstand Test (Repeated)	52
38 Burnout Test	52
39 Blanketing Test	52
40 Pull Out Test	52
41 Switch Immersion Test	53
42 Effect of Cleaning Solvents Test	53
42.1 General	53
42.2 Conditioning	53
42.3 Examination	53
42.4 Operation	54
42.5 Physical properties	54
42.6 Flexing	54
42.7 Dielectric voltage-withstand	54

MANUFACTURING AND PRODUCTION-LINE TESTS

43 Input Test	54
44 Polarization Continuity Check Test	55

RATINGS

45 Details55
------------------	-----

MARKINGS

46 Details55
------------------	-----

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.

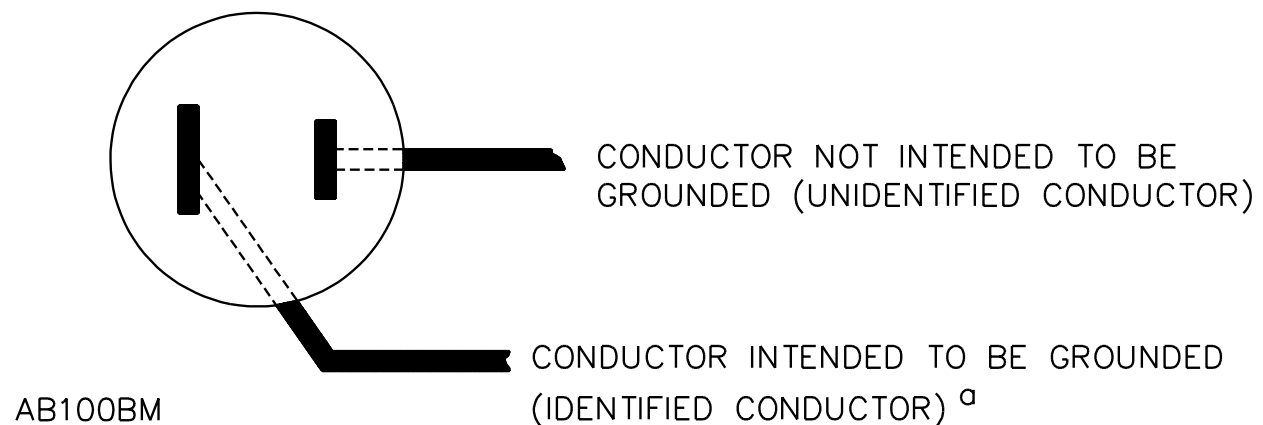
11.2 The pilot light shall be installed as a component of the switch assembly, being readily visible to the user of the pad when energized.

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

20) Effect of Cleaning Solvents (Section 42)

14.2 In the sequence specified in 14.1 (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."

14.3 In the test sequence specified in 14.1 (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 12.6.

14.4 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.

14.5 Unless otherwise specified in Sections 15 – 42, the above sequences of tests are to be performed on unaged and otherwise untested heating pad items and specimens.

14.6 The felt mentioned in 23.2, 23.3, 24.3, 24.7, 33.3, 35.2, 35.4 and 39.1 is to be 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/yd² (170 g/m²). The felt is to have a mass of 105 ±15 oz/yd² (3.560±0.508 kg/m²).

14.7 Wherever cloth is mentioned in the abnormal tests, the cloth is to be bleached cheesecloth running 14 ± 15 yd² /lb (approximately 26 ± 28 m² /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).

15 Thermostats Tests

15.1 Original calibration

15.1.1 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.

15.2 Overload

15.2.1 There shall not be electrical or mechanical malfunction or undue pitting or burning of the contacts in any of the six calibrated (see 15.1.1) thermostats as the result of their operating automatically on a 125-V supply circuit (see 15.2.2) 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.

15.2.2 An alternating-current supply circuit is to be used if the pad is rated (see 45.2) for use on only alternating current. A direct-current supply circuit is to be used if the pad is rated (see 45.2) for use on only direct current or for use on both direct current and alternating current.

15.3 Endurance

15.3.1 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 15.2.1 and 15.2.2 as the result of their additional automatic operation of a 125-V alternating-current supply circuit for at least (see 15.3.2) 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.

15.3.2 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.

15.4 Recalibration

15.4.1 After the six thermostats that performed acceptably in the endurance test described in 15.3.1 and 15.3.2 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 15.1.1.

ENCLOSURE MATERIALS (OUTER ENVELOPE)

16 Tests on Vinyl Sheeting

16.1 Low-temperature impact

16.1.1 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 16.1.2 – 16.1.9.

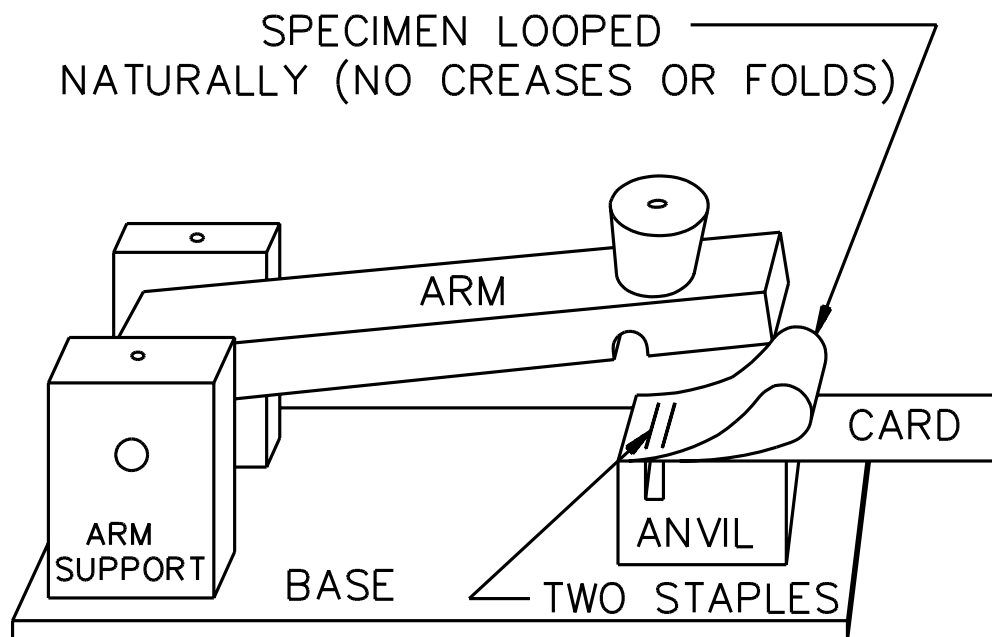
16.1.2 For the purposes of the requirements in 16.1.1 and 16.2.1, "vinyl" is to be understood to be material whose characteristic constituent is polyvinyl chloride resin or polyvinyl chloride-acetate copolymer resin, "flexible" is to be understood to mean fully plasticized, and "unsupported" is to be understood to be indicative of the complete absence from the sheet of reinforcing fibers, threads, and fabric.

16.1.3 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 $23.0 \pm 2.0^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$), 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.

16.1.4 As shown in Figure 16.1, 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.

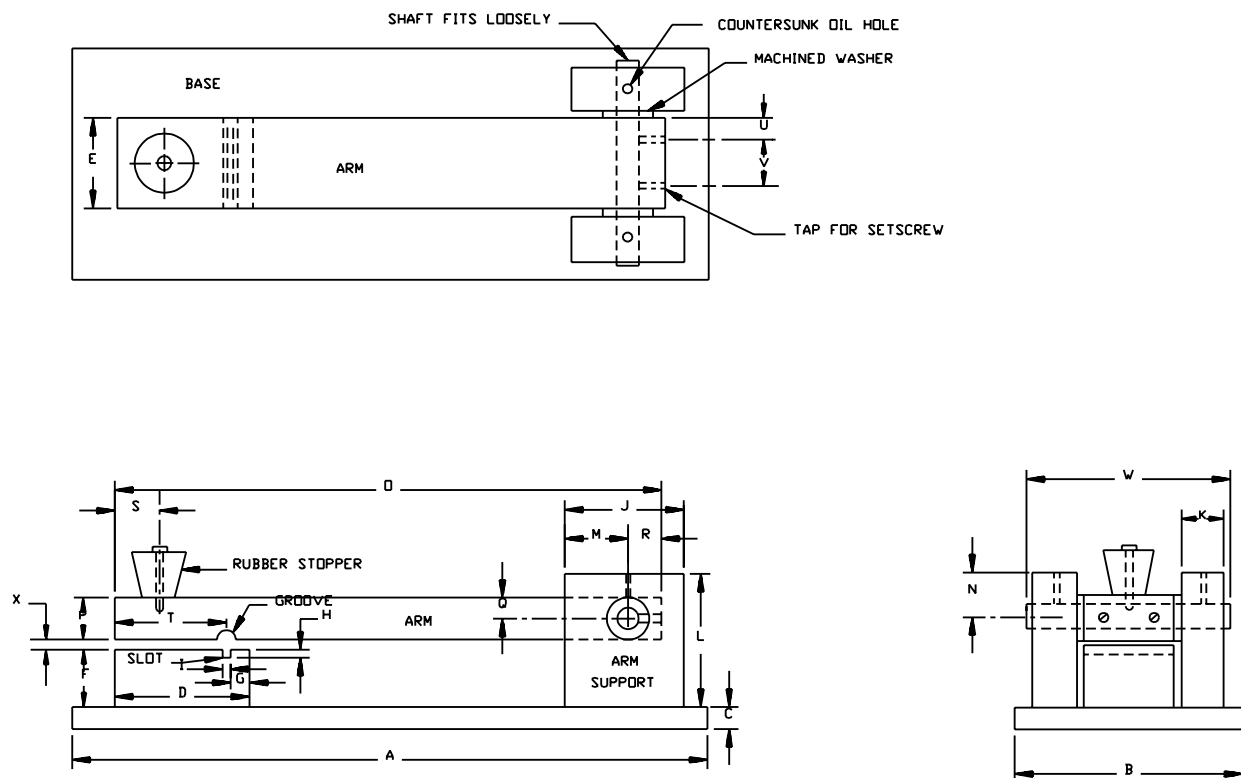
16.1.5 With its arm rotated 180 degrees from the anvil, the impacting device shown in Figure 16.2 (see Table 16.1 for the dimensions) is to be cooled to a temperature of $-20.0 \pm 1.0^\circ\text{C}$ ($\text{minus } 4.0 \pm 1.8^\circ\text{F}$) in a shallow refrigerator compartment or dry-ice cabinet (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 16.1
Specimen and arm in place before impact



SB1102

Figure 16.2
Impacting device



SB1101

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 16.1
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)

16.1.6 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 16.1. 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.

16.1.7 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.

16.1.8 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.

16.1.9 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.

16.2 Tear resistance

16.2.1 The average resistance to tensile tearing of five specimens of unsupported flexible vinyl sheeting (see 16.1.2 for definitions) shall be 2.8 or more pounds force (12.5 N) per overall thickness at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$). The specimens are to be prepared and tested as indicated in 16.2.2 and 16.2.3.

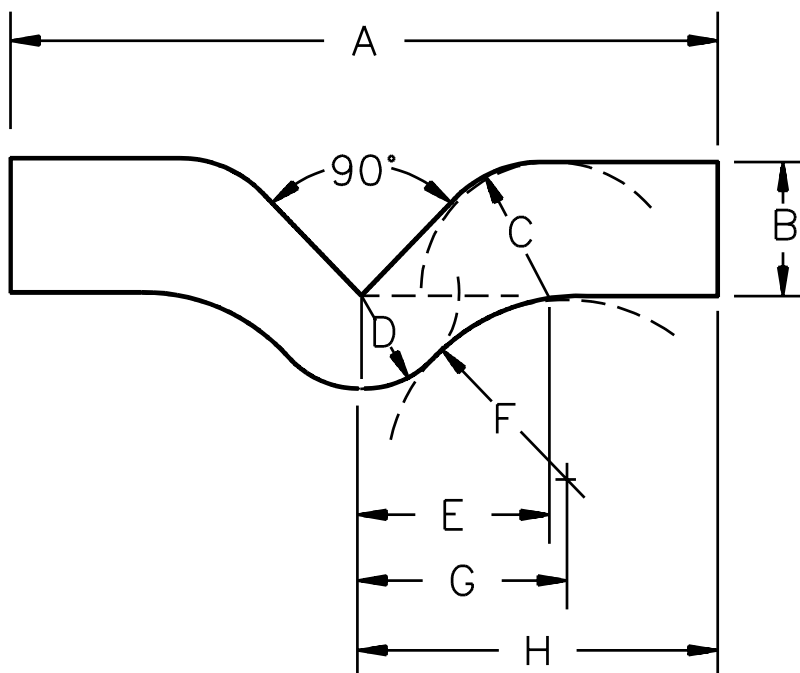
16.2.2 A piece of the unsupported, flexible, vinyl sheeting measuring approximately 36 by 24 inches (914 by 610 mm) is needed for this test and the impact test. While the sheeting and the air surrounding it are in thermal equilibrium with one another at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$), the sheeting is to be cut by means of the die illustrated in Figure 16.3 (see Table 16.2 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.

Table 16.2
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)

16.2.3 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 16.2.1.

Figure 16.3
Die for tear-resistance test



SB1103

16.3 Leakage current

16.3.1 Unsupported vinyl sheeting shall not show a leakage current of more than 0.5 mA at 120 V when tested in accordance with 17.2.2.

16.4 Leakage current (repeated)

16.4.1 Representative unsupported vinyl sheeting conditioned as specified in 16.5.2 shall not show a leakage current of more than 1.0 mA at 120 V when tested in accordance with 17.2.2.

16.5 Shrinkage

16.5.1 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 16.5.2 shall not be greater than 15 percent of the total dimensions (length and width) of the pad measured in the as-received condition.

16.5.2 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 $136.0 \pm 1.0^{\circ}\text{C}$ ($276.8 \pm 1.8^{\circ}\text{F}$) or for 60 days in the oven at $113.0 \pm 1.0^{\circ}\text{C}$ ($235.4 \pm 1.8^{\circ}\text{F}$). 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.

16.6 Physical properties

16.6.1 Either specimens of unsupported vinyl sheeting that have been aged in air as indicated in 16.5.2 for:

- a) 7 days at $136.0 \pm 1.0^{\circ}\text{C}$ ($276.8 \pm 1.8^{\circ}\text{F}$) shall exhibit no less than 70 percent of the tensile strength and elongation exhibited by similar unaged specimens, or
- b) 60 days at $113.0 \pm 1.0^{\circ}\text{C}$ ($235.4 \pm 1.8^{\circ}\text{F}$) 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.

16.7 Tensile strength of seams

16.7.1 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 16.5.2.

16.7.2 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.

17 Tests on Treated-Fabric Envelopes

17.1 General

17.1.1 An envelope of rubberized or otherwise treated fabric shall comply with the requirements in 17.2.1 – 17.6.4.

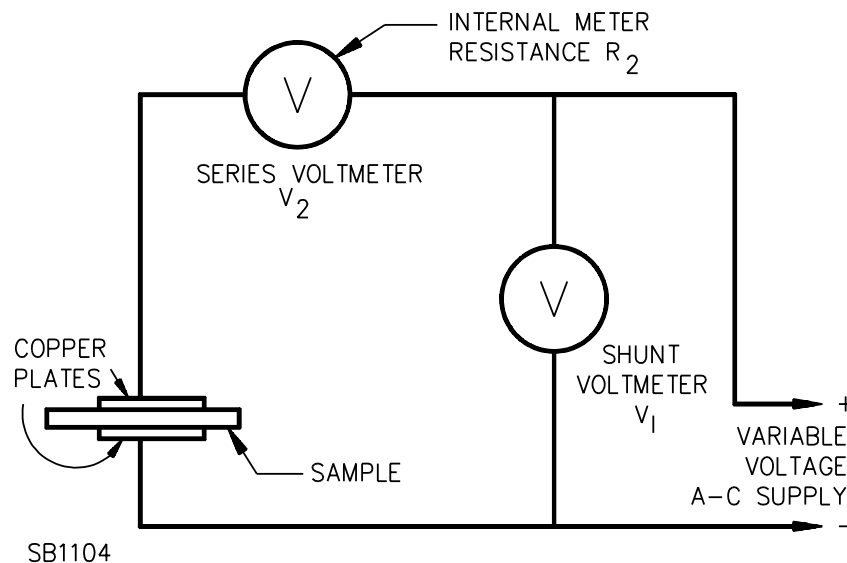
17.1.2 For the tests described in 17.2.1 – 17.6.4, five complete pads and a sheet of the treated fabric approximately 36 inches by 12 inches (914 by 305 mm) in size, or six pieces of the treated fabric approximately 6 inches by 2 inches (152 by 51 mm) in size, are to be provided.

17.2 Leakage current

17.2.1 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 17.2.2.

17.2.2 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 17.1. A 60 Hz essentially sinusoidal potential of 120 V is to be applied across the test section.

Figure 17.1
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.

17.3 Bursting strength

17.3.1 The average bursting strength of three specimens of rubberized or otherwise treated fabric shall not be less than 70 lb/in² (0.48 N/mm²), and the bursting strength of each specimen shall not be less than 60 lb/in² (0.41 N/mm²), when the material is tested in accordance with 17.3.2.

17.3.2 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.

17.3.3 The average bursting strength of each set of three specimens of rubberized or otherwise treated fabric, after conditioning in accordance with 17.3.4 and 17.3.5, shall not be less than 70 percent of the average bursting strength of the specimens of the fabric determined in accordance with 17.3.1 and 17.3.2.

17.3.4 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 $100.0 \pm 1.0^{\circ}\text{C}$ ($212.0 \pm 1.8^{\circ}\text{F}$) for 1000 hours, following which they are to be immersed again for 1 hour in boiling water.

17.3.5 Another set of three specimens is to be aged in an air oven for 7 days at $100.0 \pm 2.0^{\circ}\text{C}$ ($212.0 \pm 3.6^{\circ}\text{F}$).

17.4 Flexing

17.4.1 Rubberized or otherwise treated fabric which has been conditioned in accordance with 17.3.4 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.

17.4.2 The test described in 17.4.1 is to be performed on three otherwise untested representative sections.

17.5 Leakage current (repeated)

17.5.1 Rubberized or otherwise treated fabric which has been conditioned in accordance with 17.3.4 shall not show a leakage current of more than 1.0 mA at 120 V when tested in accordance with 17.5.2.

17.5.2 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 17.2.2.

17.6 Tensile strength of cemented seams

17.6.1 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 17.6.2 – 17.6.4.

17.6.2 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.

17.6.3 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 17.3.4, and another set of five pieces is to be tested after being subjected to the air oven conditioning described in 17.3.5.

17.6.4 After being conditioned as described in 17.6.3, 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.

18 Flammability Tests

18.1 Liner

18.1.1 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.

18.2 Supplementary cover

18.2.1 The fabric used in the manufacture of the supplementary cover shall be tested as described in 18.6.10 – 18.6.17. 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.

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

18.2.3 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).

18.2.4 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 18.2.5.

18.2.5 If two or more sections from either Groups A or B or any combination thereof char or burn, as described in 18.2.1, 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 18.2.1.

18.3 Test chamber

18.3.1 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 18.1.

18.4 Control element

18.4.1 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.

18.5 Specimen holder

18.5.1 The specimen holder shall consist of two rectangular aluminum plates held together. See Figures 18.2 and 18.3.

18.6 Specimen holder base

18.6.1 The specimen holder base shall be made of metal as detailed in Figures 18.2 and 18.3 and shall maintain the specimen holder in a horizontal position in the approximate center of the test chamber floor. See Figure 18.4. 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).

18.6.2 BURNER – The burner shall be as detailed in Figure 18.5. The gas input line to the burner shall be equipped with a needle valve which is used to control the flame length.

18.6.3 GAS SUPPLY SYSTEM – There shall be a pressure regulator to furnish gas to the burner under a gauge pressure of $2\text{-}1/2 \pm 1/2$ psi or 129 ± 26 millimeters of mercury (17.2 ± 3.4 kN/m²) at the needle valve inlet.

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

18.6.5 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.

18.6.6 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 18.6.

18.6.7 BRUSHING DEVICE – A brushing device similar to the one shown in Figure 18.7 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.

Figure 18.1
Test chamber

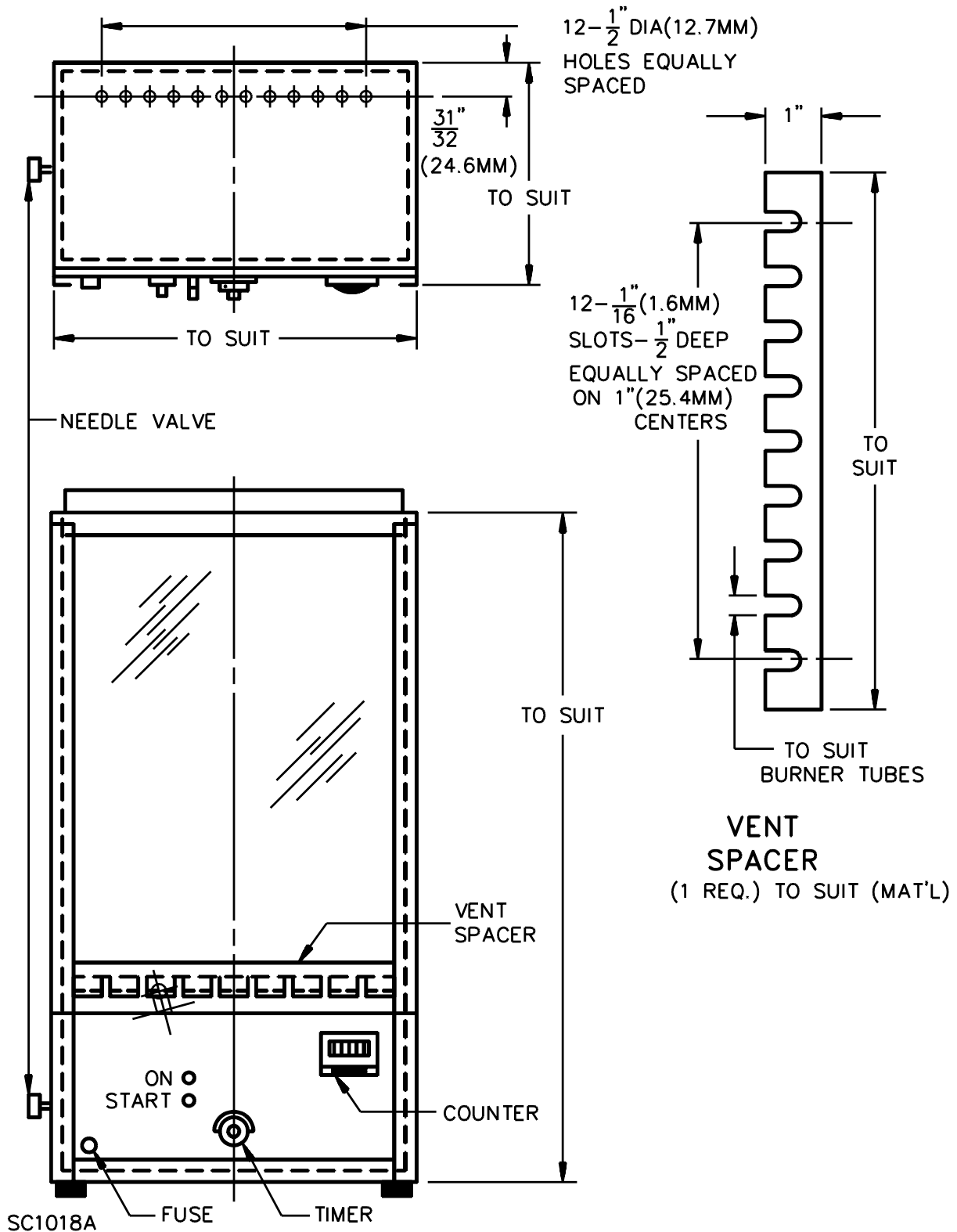
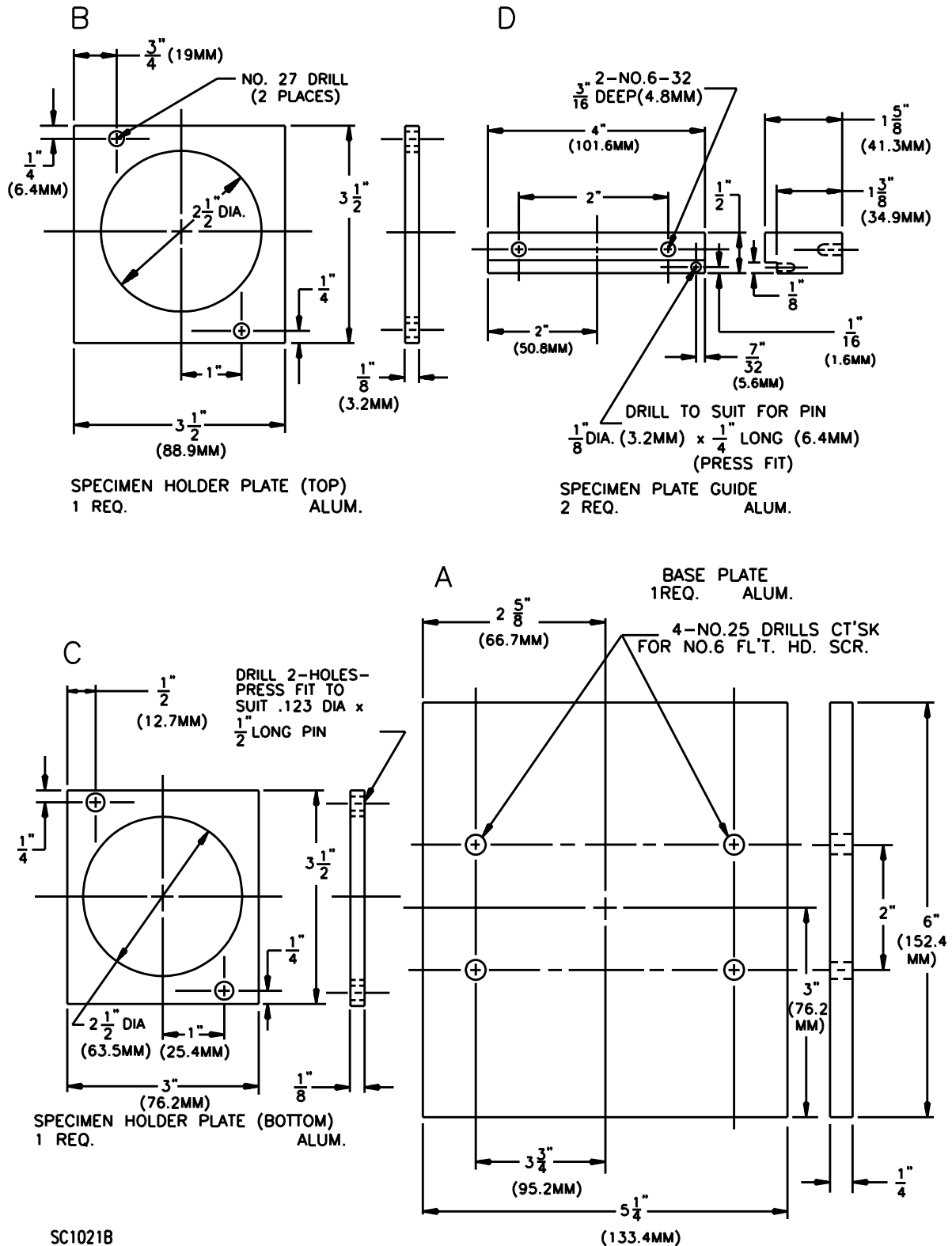
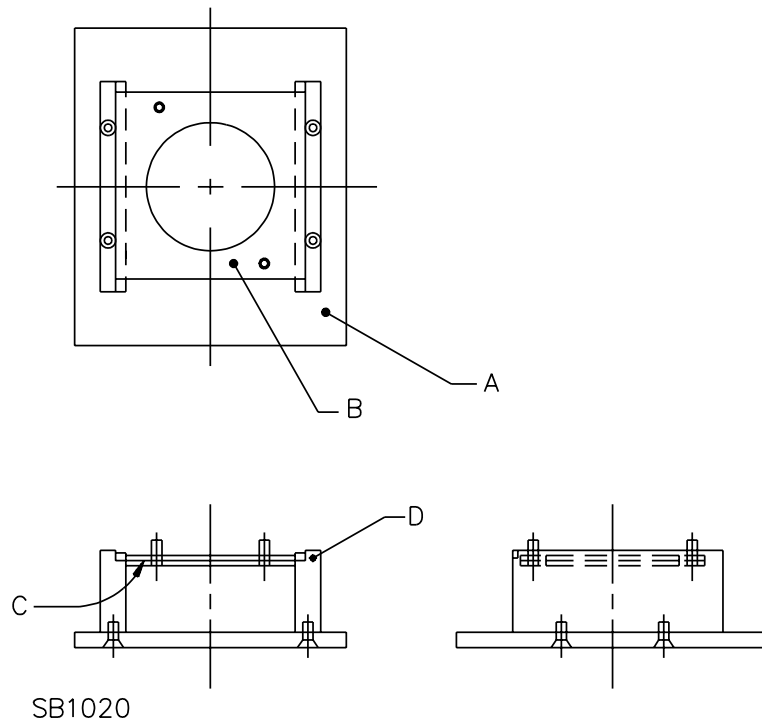


Figure 18.2
Specimen holder assembly



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Figure 18.3
Specimen holder assembly



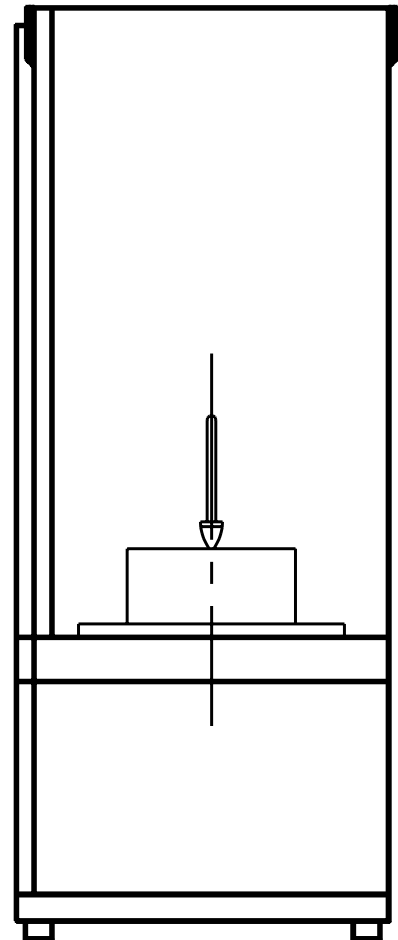
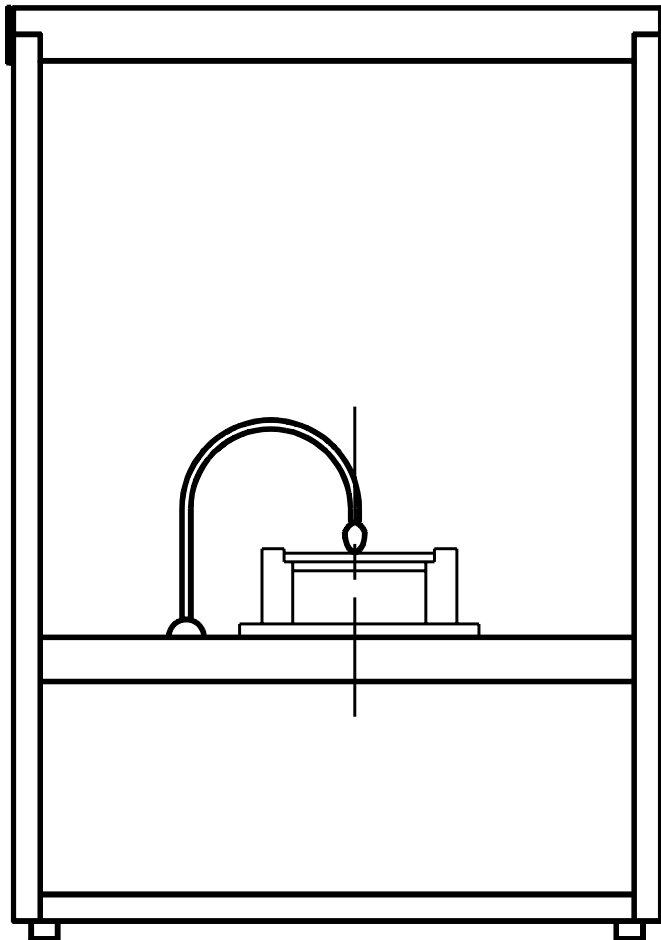
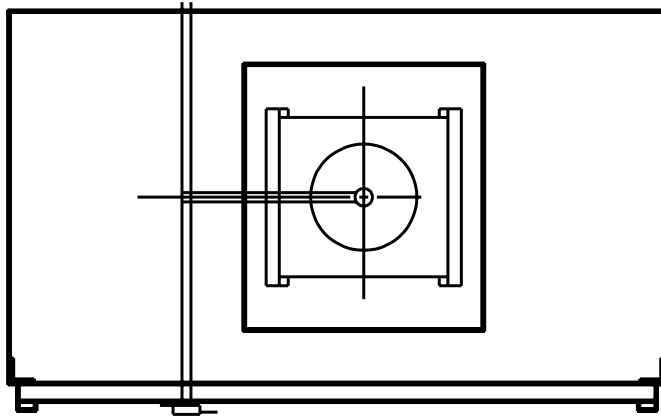
18.6.8 CIRCULATING AIR OVEN – A forced circulation drying oven capable of maintaining the specimens at $105 \pm 2.8^{\circ}\text{C}$ ($221 \pm 5^{\circ}\text{F}$) shall be used to dry the specimens while mounted in the specimen holders.

18.6.9 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.

18.6.10 SPECIMEN PREPARATION – The specimens are to be washed in a neutral soap solution as indicated in 18.6.11. Neutral chip soap may be used.

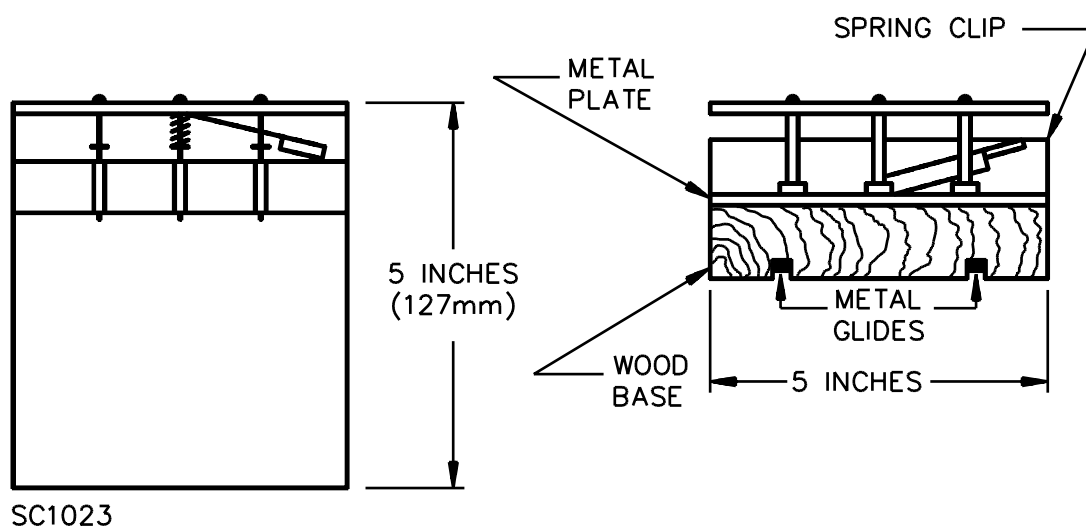
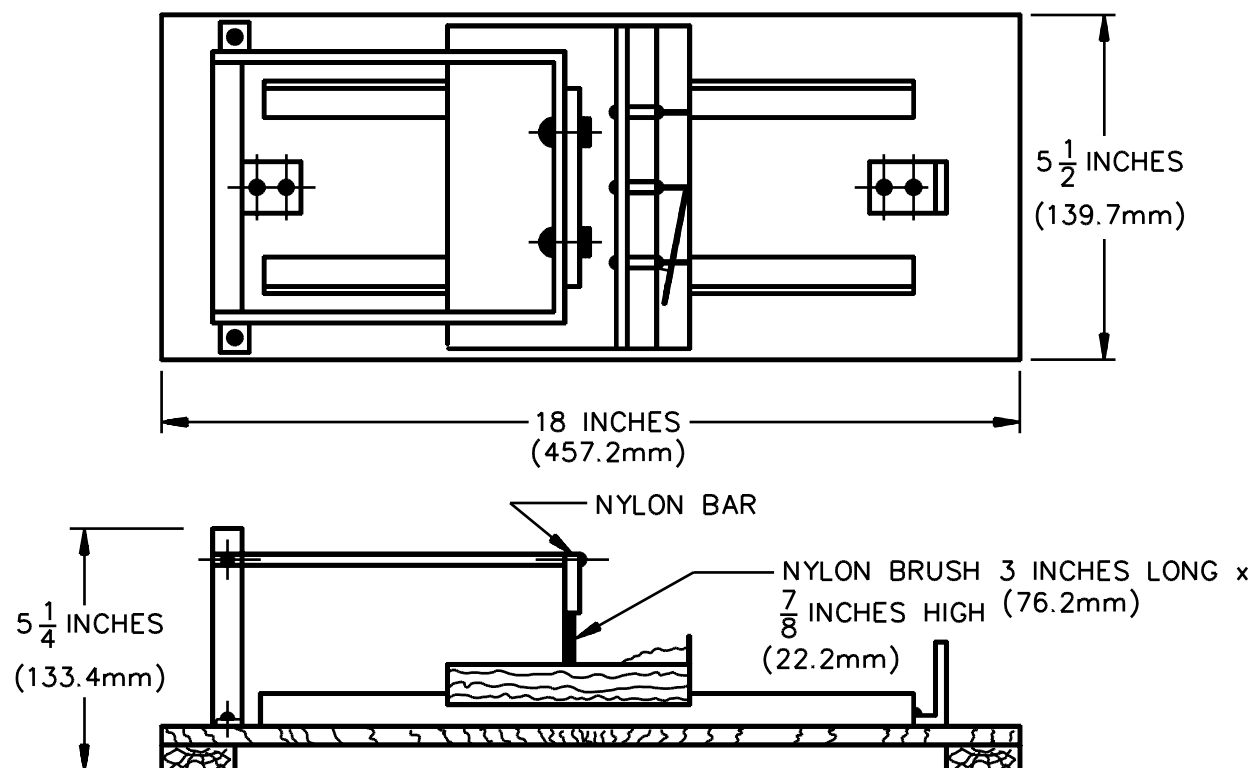
18.6.11 The specimens are to be put into a 3-US-gallon-capacity (11 L) right-circular cylindrical container [approximate dimensions: 13 inches (330 mm) long by 8-3/4 inches (222 mm) in diameter] that is fitted with a water-tight cover at one end, preferably is of metal, and is mounted on a shaft whose 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 $35.0 - 37.8^{\circ}\text{C}$ ($95.0 - 100.0^{\circ}\text{F}$) and into which 0.5 percent by weight of the neutral soap mentioned in 18.6.10 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.

Figure 18.4
Specimen holder assembly



SB1019

Figure 18.7
Brushing device



18.6.15 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.

18.6.16 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 18.5.

18.6.17 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 18.2.1.

19 Ease of Ignition Test

19.1 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 19.1, 19.2, and 19.3.

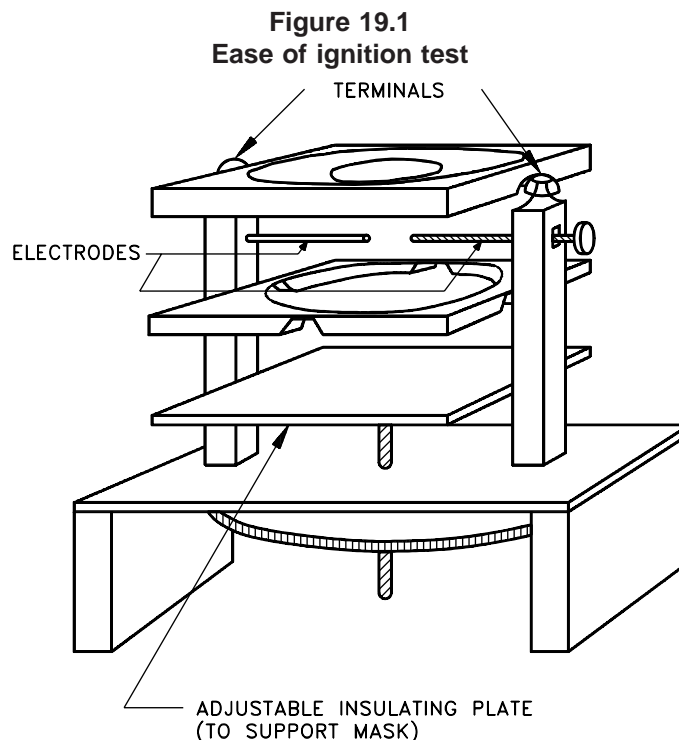
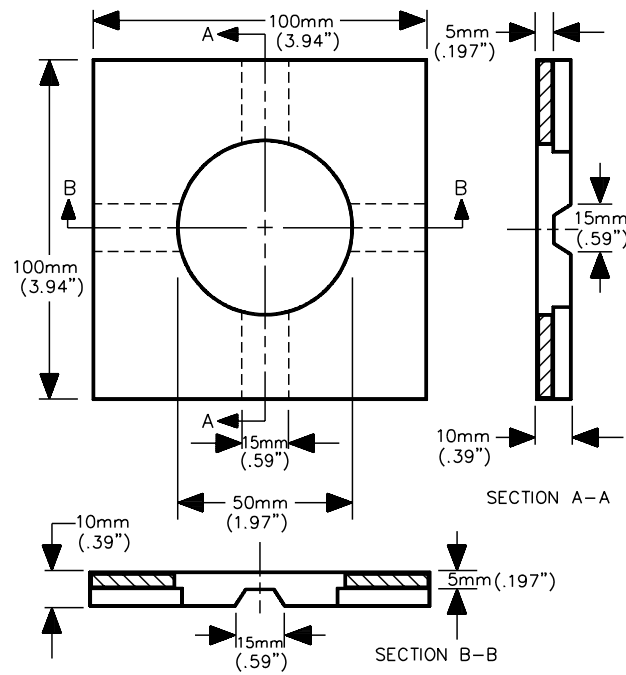
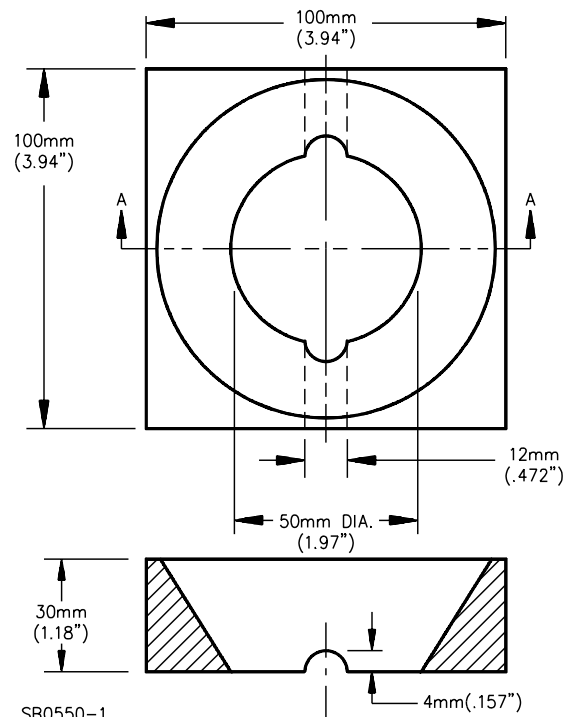


Figure 19.2
Lower mask



SB0549

Figure 19.3
Upper mask



SB0550-1

19.2 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.

19.3 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.

19.4 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.

19.5 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).

19.6 The lower member of a two-part hardwood mask, as shown in Figures 19.1 and 19.2 is fixed to the adjustable table in the position indicated, and the whole assembly, together with the upper member of the mask, Figure 19.3, is placed in an oven with a glass inspection door, the oven being heated by natural convection.

19.7 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 $65 \pm 2^{\circ}\text{C}$ ($149 \pm 3.6^{\circ}\text{F}$).

19.8 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.

19.9 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.

19.10 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.

19.11 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.

19.12 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.

19.13 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

20 General

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

21 Leakage Current Test

21.1 The leakage current of the nine heating pads, when tested in accordance with 21.3 – 21.5, shall not be more than 0.5 mA on each pad.

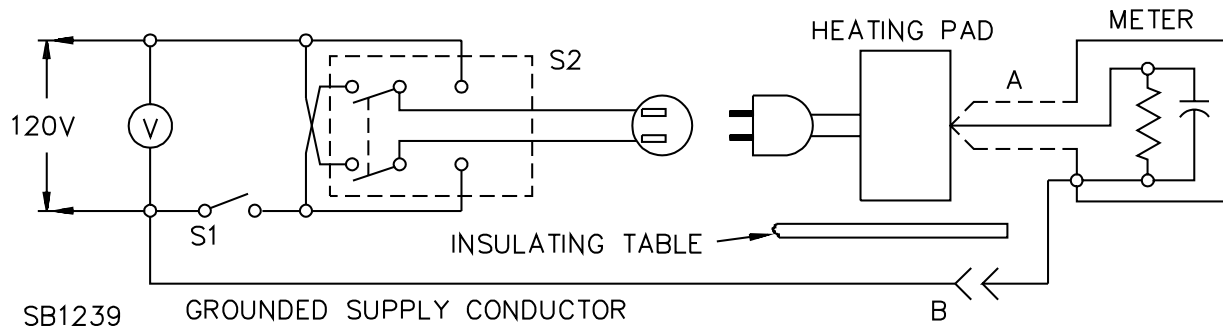
21.2 Leakage current refers to all currents, including capacitively coupled currents, which may be conveyed between exposed conductive surfaces, or other exposed surfaces, of a heating pad and ground.

21.3 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.

21.4 The measurement circuit for leakage current is to be as shown in Figure 21.1. 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 21.1
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.

21.5 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 21.1) 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 24.

22 Input Test

22.1 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 45.3.

23 Resistance to Moisture Test

23.1 As noted in 14.2, 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.

23.2 To determine whether each pad complies with the requirement in 23.1, 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 23.3; and a pad with a leakage current of more than 8 mA at 120 V is not demonstrating intended performance.

23.3 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 cm³ 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 36.3) 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.

24 Heating Test

24.1 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 24.3 and 24.4; 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).

24.2 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 24.3 and 24.4.

24.3 To determine whether each pad complies with the requirement in 24.1 or 24.2, 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 No. 30 AWG (0.05 mm²) 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.

24.4 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 Initial Calibration Tolerances for Thermocouples table in Temperature-Measurement Thermocouples ANSI/ ISA MC96.1(1982).

24.5 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 35.1. Temperatures measured on the outer surface of the switch shall not exceed 45°C (113°F). Care is to be taken that the temperatures measured are maximum temperatures.

24.6 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).

24.7 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.

24.8 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 24.7, except that only one thermostat is to be exposed in a pad having three thermostats.

25 Flexing Test

25.1 Each of three representative complete pads shall be capable of performing successfully (see 25.2 and 25.3) 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 25.4 – 25.9.

25.2 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 24.1 and 24.2,
- 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.

25.3 In addition to performing successfully, as described in 25.2, a pad shall be in such condition that it will comply with the requirements of Sections 32 – 40, in the sequence indicated by 14.1.

25.4 To reduce friction, each pad may be subjected to the flexing test in a covering of cheesecloth of double thickness. See 14.7.

25.5 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.

25.6 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.

25.7 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.

25.8 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.

25.9 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.

26 Twisting Test

26.1 Each of three representative complete pads shall be capable of performing successfully (see 25.2 and 25.3) when subjected to the twisting test – 6000 cycles for a household pad and 7200 cycles for a hospital pad – described in 26.2 – 26.5 while connected to a supply circuit of rated voltage, with the heating pad switch in the high position.

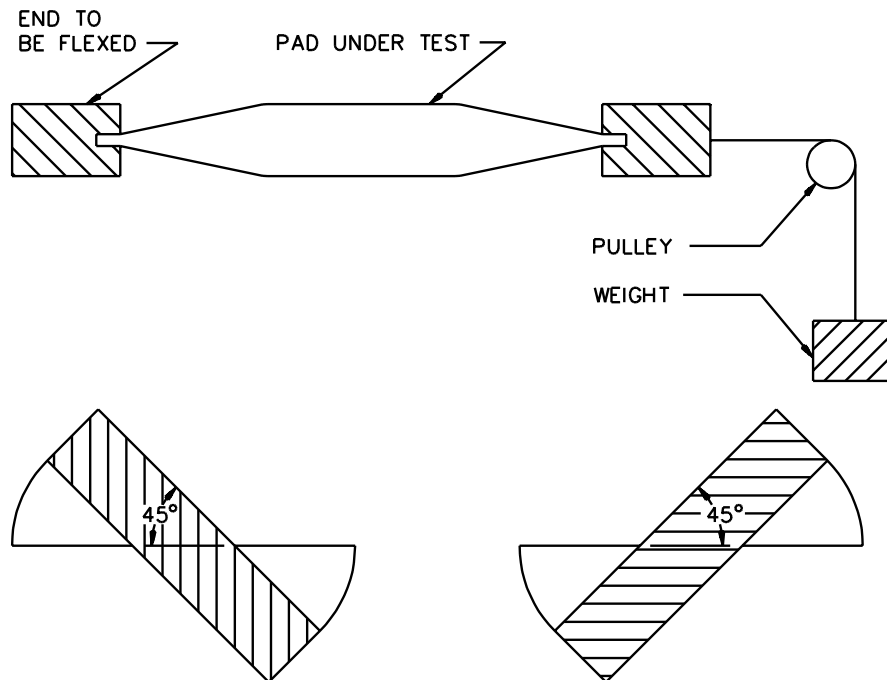
26.2 The apparatus for conducting the twisting test is to consist of a power-driven twisting machine, and a pair of wide clamps for gripping the edges of each heating pad.

26.3 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.

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

26.5 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 26.1.

Figure 26.1
Twist test apparatus



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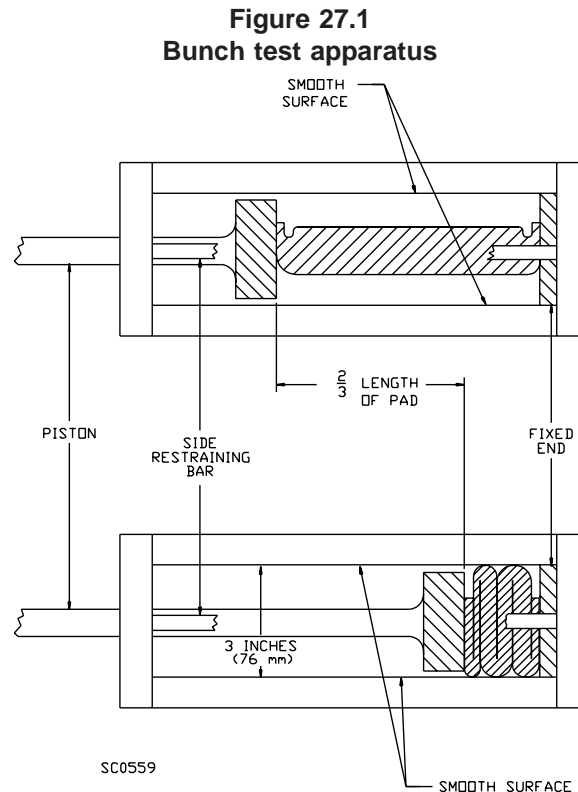
27 Bunch Test

27.1 Each of three representative complete pads shall be capable of performing successfully (see 25.2 and 25.3) when subjected to the bunch test – 8,000 cycles for a household pad and 10,000 cycles for a hospital pad – described in 27.2 – 27.5 while connected to a supply circuit of rated voltage, with the heating pad switch in the high position.

27.2 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.

27.3 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 27.1.

27.4 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.



27.5 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.

28 Connector Flexing Test

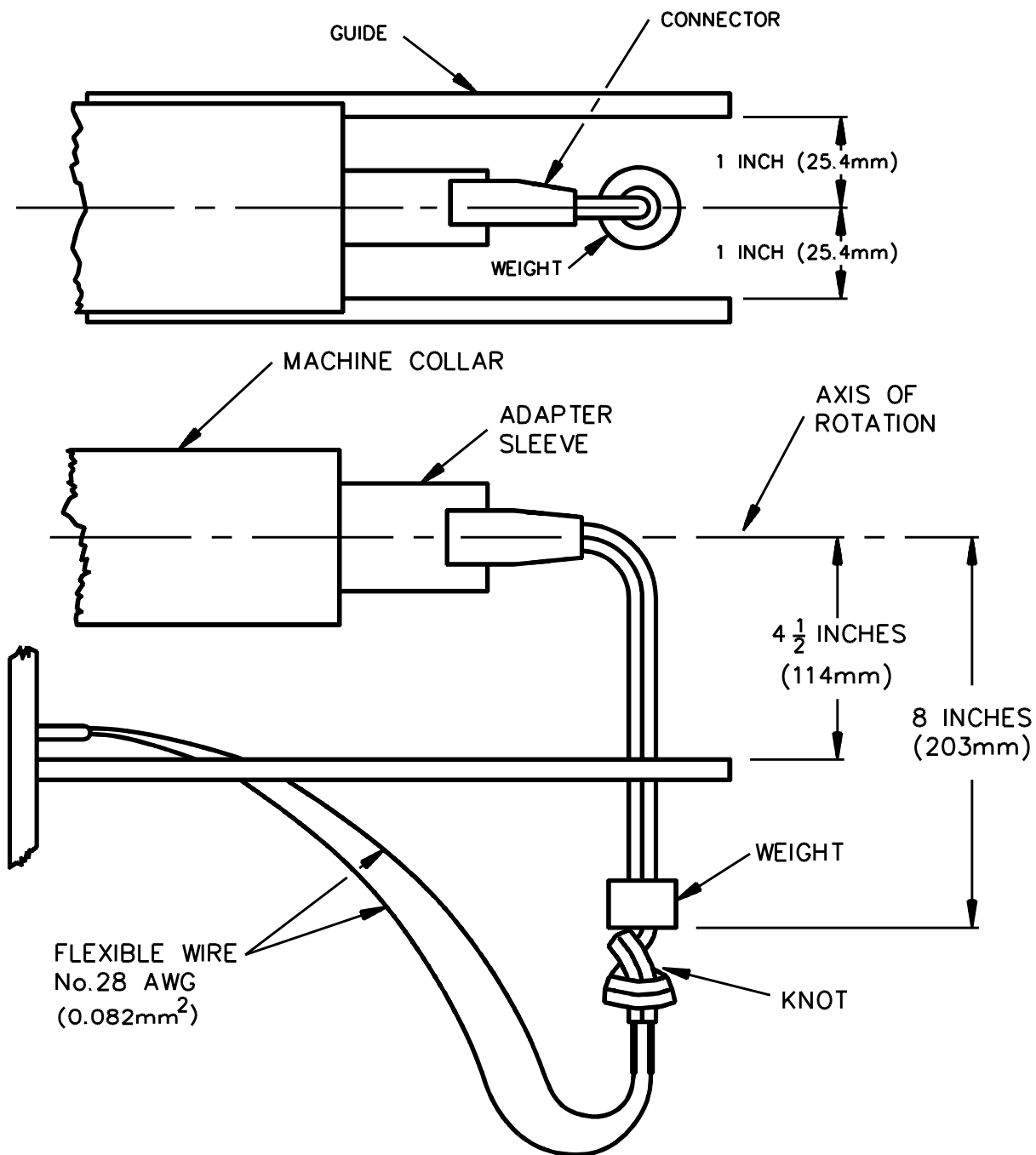
28.1 Each of 6 female cord connectors with cord attached is to be subjected to 900 cycles of the cord flexing test described in 28.3.

28.2 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.

28.3 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 No. 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 28.1. 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.

Figure 28.1
Flexing test apparatus^a



S2281A

^a A cycling machine manufactured by R. J. Wilson Associates, Hingham, MA is acceptable. Other cycling machines with like properties will also be acceptable.

29 Laundering Test

29.1 Each of the nine heating pads with a detachable power-supply cord is to be subjected to five consecutive washings and dryings in the most severe manner described in the manufacturer's instructions for the pad material employed. In decreasing order of severity are considered to be home machine washing and hand washing. The pads are to be laundered as indicated in 29.3, or according to the manufacturer's instructions.

29.2 After each pad is laundered as described in 29.1 and 29.3, there shall not be:

- a) Loosening of the cord from the pad,
- b) Unraveling, breakage or loosening of the stitching at the ends of the dividers for a distance greater than 3/4 inch (19 mm),
- c) Breakage or loosening of any wiring connections,
- d) Appreciable shifting of position of the heating element within the shell, or
- e) Breakage of the heating-element conductor or other interruption of the electrical circuit through the pad; or water inside the seal around a thermostat or in any other electrical component.

29.3 Unless otherwise specified by the manufacturer's instructions, each pad is to be laundered as outlined in (a) or (b).

- a) Each pad to be laundered in an automatic washer is to be laundered as follows:

The washer is to be filled with warm water and a minimum amount of all-purpose powdered detergent or mild soap chips is to be added and dissolved by agitation. Each pad is then to be placed in the washer and allowed to soak for 5 minutes followed by 2 minutes of slow agitation and spin drying at normal speed. The washer is then to be filled for a cool rinse, agitated for 1 minute, and spun at normal speed. A second, identical rinse is to be made. Each pad is then to be hung on a clothesline and allowed to dry until damp, or it may be damp-dried in an automatic dryer on high heat for 5 minutes. Each pad is then to be formed to its original shape and size on a flat surface until completely dry. This laundering process is to be repeated four times (a total of five launderings) before the pad is immersed in the salt solution as required in 30.1.

- b) A pad permanently marked to be washed by hand only is to be laundered as follows:

A large tub is to be filled with warm water and a minimum amount of all-purpose powdered detergent or mild soap chips added and dissolved by agitation. Each pad is then to be placed in the tub and allowed to soak for 5 minutes followed by 15 minutes of vigorous scrubbing with a washboard, scrubbing brush, or similar scrubbing aid. The tub is then to be filled with cool water and rinsed until all cleaning agents are removed. A second identical rinse is then to be made. Each pad is then to be hung on a clothesline and allowed to dry until damp. Each pad is then to be formed to its original shape and size on a flat surface until completely dry. This laundering process is to be repeated four times (a total of five launderings) before the bedding is immersed in the salt solution as required in 30.1.

30 Leakage Current Test

30.1 Each of the nine heating pads subjected to the Laundering Test, Section 29, is to be immersed – no controls, cord, and similar current-carrying parts – for 1 hour in a salt solution as described in 30.2. The leakage current shall not be higher than 5.0 mA when an a-c potential of 120 V, or 0.5 mA when a d-c potential of 120 V, is applied between the solution and current-carrying parts of the pad. The connections are to be made to the pad plug, which is to remain dry and out of the solution throughout the test.

30.2 The salt solution is to consist of 8 g (0.28 oz) of sodium chloride (NaCl) per liter. A metal tub is to be employed as a container.

31 Dielectric Voltage-Withstand Test

31.1 While still immersed in the salt solution mentioned in 30.1 and 30.2, each pad shall be capable of withstanding for 1 minute without breakdown a 60 Hz essentially sinusoidal potential of 1000 V plus twice its rated voltage applied between the solution and current-carrying parts of the pad. The connections are to be made to the pad plug, which is to remain dry and out of the solution throughout the test.

31.2 To determine whether a pad complies with the requirement in 31.1, each pad is to be tested by means of a 500-VA or larger-capacity transformer whose output voltage is essentially sinusoidal and can be varied. The applied potential is to be increased at a uniform rate from zero until the required test level is reached, and is to be held at that level for 1 minute.

32 Heating Test (Repeated)

32.1 The Heating Test, Section 24, shall be repeated on all nine representative pads following the appropriate test from either the Flexing Test, Section 25; the Twisting Test, Section 26; or the Bunch Test, Section 27.

33 Dielectric Voltage-Withstand Test

33.1 Following the Heating Test (Repeated), Section 32, each of the nine representative complete pads shall be capable of withstanding without breakdown the application of a 60 Hz essentially sinusoidal potential of 1000 V plus twice rated voltage for a period of 1 minute.

33.2 To determine whether each pad complies with the requirement in 33.1, it is to be tested by means of a 500-VA or larger-capacity transformer, the output voltage of which can be varied and is essentially sinusoidal. The applied potential is to be increased at a uniform rate from zero until the required test value is reached, and is to be held at that value for 1 minute.

33.3 The test potential is to be applied between interconnected current-carrying parts of each pad and sheets of metal foil on both sides (faces) of the pad. The pad, with the foil on either side (face), is to be laid between 1-inch-thick (25-mm) felt mats as described in 24.3. A uniform pressure of 25 lbf/ft² (1200 N/m²) is to be applied to the felt mats to secure close proximity of the metal foil to the pad.

34 Strain-Relief Test

34.1 As noted in 14.1 and 14.2, and following the Dielectric Voltage-Withstand Test, Section 33, the attachment of each supply, control, and interconnecting cord to each of the nine complete, moisture-resistant heating pads, and to the strain relief provided, shall be such that the complete assembly successfully withstands a 35-lbf (156 N) pull between the pad and the cord without impairing the moisture-resistance qualities of the pad, as determined by the Electric Shock Current Test, Section 36.

34.2 To determine whether each pad complies with the requirements in 34.1, the cord is to be subjected to a pull of 35 lbf (156 N) – a weight applied gradually – with each edge held, in turn, in a clamp, except that, if the cord enters the pad within 2 inches (51 mm) of a corner, neither edge of the pad adjacent to that corner is to be held in the clamp.

34.3 In each case, the edge of the pad in the clamp is to be held in a horizontal position. The test period for each pull is to be 1 minute divided by the number of pulls to be made (two or three).

34.4 A pad of other than rectangular shape is to be given special consideration as required and tested in accordance with the intent of 34.1 – 34.3.

35 Internal Temperature Test

35.1 Following the Dielectric Voltage-Withstand Test (Repeated), Section 37, or the Dielectric Voltage-Withstand Test, Section 33, (see 14.1 and 14.2), each of the nine representative complete pads, initially at room temperature, shall not attain a temperature higher than that specified in Table 35.1 on any material within the pad assembly, as measured 20 minutes after the first opening of a thermostat and subsequently until constant temperatures have been attained.

Table 35.1
Maximum acceptable temperatures

Materials	Degrees
Rubber- or thermoplastic-insulated conductors	60°C (140°F) ^a
Cotton or other combustible material	105°C (221°F) ^b
Fiber employed as electrical insulation	90°C (194°F)
Phenolic composition used as electrical insulation or as a part whose malfunction would result in a risk of fire, electric shock or personal injury	150°C (302°F) ^a
^a The limitation on phenolic composition, rubber, and thermoplastic insulation does not apply to a compound that has been investigated and found to have special heat-resistant properties. ^b Charring of combustible material during the initial 20-minute period of operation or at the conclusion of the test is not acceptable.	

35.2 To determine whether or not each pad complies with the requirement in 35.1, it is to be laid flat between two felt mats, each 1 inch (25 mm) thick and of area sufficient to 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 until constant temperatures are attained as determined by means of thermocouples located as described in 35.3. Care should be taken to determine that temperatures measured are maximum temperatures, such as are able to be observed using a recording potentiometer.

35.3 Temperature measurements are to be observed by means of thermocouples attached to the exterior of the heating-element insulation at least three points of highest temperature as determined by the first heating test. Thermocouples are to be tied with thread or string to the heating element insulation; however, the fastening of the thermocouples should not be so tight that the cross-sectional area of the insulation is reduced adversely.

35.4 Following the operation with each pad completely covered, and except as noted in 35.6, the test is to be repeated for a second period with approximately half of the pad between the two felt mats and the other half exposed. The position of the pad is able to 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.

35.5 Following the operation with half of each pad exposed, and except as noted in 35.6, the test is to be repeated for a third period with the pad reversed so that the part previously covered is exposed. The exposure of thermostats is to be as indicated in 35.4, except that only one thermostat is to be exposed in a pad.

35.6 If the pads are composed of two sections (see 9.8), each section is to be subjected to the half-blanketing tests in 35.4 and 35.5.

35.7 At the conclusion of the test, the interior of each pad is to be examined to determine the condition of materials employed, but the pad is not to be disarranged to the extent that it is not usable in subsequent tests. The charring of combustible material does not indicate intended performance.

ABNORMAL TESTS ON COMPLETE PAD

36 Electric Shock Current Test

36.1 As noted in 14.1 and 14.2, and following the Strain-Relief Test, Section 34, each of the nine complete, moisture-resistant heating pads shall not present a risk of electric shock when subjected to the immersion test described in 36.2 and 36.3. Risk of electric shock is determined to exist if the current from any point of the pad is greater than 5 mA when an alternating current potential of 120 V is applied between the salt solution and current-carrying parts of the heating pad. The connections shall remain dry and out of the solution throughout the test. The control also is not required to be immersed.

36.2 Each of the nine pads shall be immersed for a period of 24 hours in a salt solution consisting of 8 g (0.28 oz) of NaCl per liter of distilled water. A metal tub shall be used as a container.

36.3 Following the 24-hour immersion, and while each pad is still in the salt-water solution, the two blades of the attachment plug on each pad are to be connected together and to the ungrounded side of a 60-Hz, 120-V essentially sinusoidal power supply. A 500-ohm noninductive resistor is to be connected between the grounded side of the power supply and the steel tub. The current through the resistor is to be measured by means of a high-impedance voltmeter connected across the resistor or by some other equivalent means.

37 Dielectric Voltage-Withstand Test (Repeated)

37.1 As noted in 14.1 and 14.2, each of the nine complete, moisture-resistant heating pads, while still immersed following the electric shock-current test, shall be capable of withstanding without breakdown for a period of 1 minute the application of a 60 Hz essentially sinusoidal potential of 1000 V plus twice the rated voltage between the heating element and the electrolyte.

37.2 To determine whether each pad complies with the requirement in 37.1, it is to be tested by means of a 500-VA or larger capacity transformer, the output voltage of which can be varied and is essentially sinusoidal. The applied potential is to be increased at a uniform rate from zero until the required test value is reached, and is to be held at that value for 1 minute.

38 Burnout Test

38.1 Following the Internal Temperature Test, Section 35, each of the nine representative, complete pads shall not attain a temperature higher than 160°C (320°F) at any point when it is subjected to continuous operation until thermal equilibrium is reached, while connected to a circuit of rated voltage, and with the pad folded tightly so that the thermostats are on the outside. During this test, all parts of the pad except thermostats shall be covered closely with a quadruple thickness of a wool blanket material having approximately 1-1/2 oz/ft² (458 g/m²).

38.2 Each of two or more thermocouples are to be inserted into each folded pad and are to be located such that they indicate the maximum interior temperature. Thermocouples used in the internal-temperature test described in 35.1 are to be used to measure temperatures in this test (this is a continuation of the heating test in 35.1 but with the pad folded).

39 Blanketing Test

39.1 Following the Burnout Test, Section 38, there shall not be flaming or charring of any part of any of the nine representative, complete pads or of a cheesecloth covering on the felt mats when any unprotected area of a pad is blanketed in any way utilizing the mats described in 35.2.

40 Pull Out Test

40.1 Except that the attachment plug is to be excluded, the attachment and strain relief provided at each end of each supply, control, and interconnecting cord on each of the nine representative, complete pads shall withstand 50 lbf (222 N) applied between the cord and the pad or the switch, to be tested after the Blanketing Test, Section 39.

40.2 To determine whether each pad complies with the requirement in 40.1, the cord is to be subjected to a pull of 50 lbf (222 N) – a weight gently applied perpendicular to the plane of the cord-entry hole – for a period of 1 minute while the switch or envelope of the pad is securely held in a clamp located such that, when the pull is applied to the cord, the direction of the force will pass through the approximate center of the switch or the pad. The pull is to be applied to the cord itself rather than to the connection at the far end of the cord. Connections in the switch, other than those made by the means mentioned in 12.8, are to be severed at the switch terminals prior to the test. The construction is not in a usable condition if the cord becomes loose or detached from the pad or if there is any loosening or breaking of any electrical connection within the envelope or at any unsevered connection within the switch. In the case of severed connections within the switch, the strain relief is not usable if the conductors of the cord are pulled away from the switch terminals by the applied force.

41 Switch Immersion Test

41.1 If a switch or control is used on a hospital pad, it shall comply with the test criteria enumerated in 41.2 – 41.4. This test is to be performed after the Pull Out Test, Section 40.

41.2 After being subjected to the immersion test described in 41.3, a hospital pad pendant control or similar device likely to be taken into a patient's bed, shall comply with the requirements for electric shock in 36.1 and the Dielectric Voltage-Withstand Test (Repeated), Section 37.

41.3 Each of three representative controls or other devices is to be immersed for a period of 24 hours in a solution containing 1/2 g of NaCl per liter of distilled water. Immediately thereafter, these controls or devices are to be subjected to the test outlined in 41.2 and disassembled for examination for compliance with 41.4.

41.4 The test described in 41.3 shall not result in the entrance of water into the interior of the control or device in such a manner that it might come into contact with uninsulated current carrying parts.

42 Effect of Cleaning Solvents Test

42.1 General

42.1.1 The test program described in 42.2.1 – 42.7.1 is to be employed to determine whether or not the marking requirement in 46.12 regarding dry cleaning, is applicable to an electric heating pad with a detachable power-supply cord.

42.2 Conditioning

42.2.1 A total of five heating pads shall be processed as follows: Each of two heating pads are to be dry-cleaned ten times in petroleum solvent (Stoddard solvent or high-flash naphtha), and each of two heating pads dry-cleaned ten times in perchlorethylene. Regular commercial equipment is to be employed for cleaning, extracting, tumbling, and brushing the pads; and each heating pad is to be cleaned and processed by itself and not mixed in with other articles or blankets. The fifth heating pad is to be subjected to five successive dry-cleanings in five different local establishments picked at random.

42.3 Examination

42.3.1 Following the dry cleaning conditioning, the five heating pads are to be examined visually and shall not show:

- a) Any of the adverse features mentioned in 25.2,
- b) Deterioration such as, cracking, or brittleness of the connector body or seals around the thermostats, or
- c) Mechanical damage to the male pins.

42.4 Operation

42.4.1 The five sections shall be capable of performing in the intended manner when connected to a supply circuit of rated voltage.

42.5 Physical properties

42.5.1 The insulated electrical parts are to be removed from each of the five processed heating pads and the insulation compared with that of an untested heating pad. Tensile-strength and elongation values determined on processed heating pads shall not be less than 80 percent of values determined on otherwise untested heating pads. The physical test procedure is to be as specified in the requirements for thermoplastic-insulated wires.

42.6 Flexing

42.6.1 Specimens of the insulating heating element from the processed pads shall be capable of withstanding the standard 100,000-cycle flexing test for pad wire without breakage of the conductors or damage to the insulation. For this test, six U-shaped specimens, each having a total length of approximately 24 inches (610 mm), are to be mounted vertically (bottom of the U uppermost) between two 1/2-inch-diameter (13-mm) horizontal metal rods, with a slight clearance to either side of the wire, and with a weight that exerts a force of 3/4 ounce (0.2 N) attached to the lower end of each wire. There are thus to be 12 wire ends weighted and 12 points of flexure where the wires pass between the horizontal rods. While so mounted and carrying rated current, the specimens are to be bent back and forth from one horizontal position through 180 degrees to the opposite horizontal position.

42.7 Dielectric voltage-withstand

42.7.1 Following the flexing test, the six wire specimens are to be immersed, except for approximately 4 inches (102 mm) at each end, in a salt solution as described in 30.2. Each specimen shall then comply with Dielectric Voltage-Withstand Test, Section 31.

MANUFACTURING AND PRODUCTION-LINE TESTS

43 Input Test

43.1 Each finished product shall be subjected, as a routine production-line test, to an operational input power, or current, check while operated at rated voltage. If multiple heat settings are provided, each setting shall be checked. Input power, or current, outside the range indicated in 22.1 for the intended rating at the particular setting, or any evidence of erratic readings, shall be cause for rejection of the pad.

44 Polarization Continuity Check Test

44.1 As a routine production-line verification, each heating pad provided with a line switch shall be examined or tested for electrical continuity between the line switch and the ungrounded circuit-supply conductor of the attachment plug, (narrower blade of the 2-wire plug). If the continuity cannot be readily determined by visual inspection and component checking, an electrical continuity test is to be conducted. Continuity is determined using any indicating device, such as an ohmmeter, a battery and buzzer combination, or similar tools.

RATINGS

45 Details

45.1 An electric heating pad shall be rated in watts or amperes, and in volts.

45.2 A pad shall be rated for use on alternating current only unless it has been investigated and found to be acceptable for use on either alternating or direct current. In addition, the rating shall include the frequency if necessary because of any component.

45.3 The voltage rating shall not be higher than 125 V.

MARKINGS

46 Details

46.1 All markings that appear on the pad, supplementary cover, durable card, or the individual pad package shall be plainly visible, shall be legible, and shall contrast with either a light or dark background.

46.2 A product shall be legibly and permanently marked with:

- a) The manufacturer's name, trade name, or trademark or other descriptive marking by which the organization responsible for the product may be identified;
- b) A distinctive ("catalog" or "model") number or the equivalent;
- c) The electrical rating; and
- d) The date or other dating period of manufacture not exceeding any three consecutive months.

Exception No. 1: When the product is identified by the brand or trademark owned by a private labeler, the manufacturer's identification is able to be in a traceable code.

Exception No. 2: The date of manufacture is able to be abbreviated; or in a nationally accepted conventional code affirmed by the manufacturer, provided that the code:

- a) Does not repeat in less than 10 years for a household product and less than 20 years for a commercial product, and*
- b) Does not require reference to the production records of the manufacturer to determine when the product was manufactured.*

46.3 A pad surface shall be marked with a permanent warning against any of the principal abuses to which the pad is capable of being subjected. The warning shall be separate from any other markings, and shall include the following wording, or its equivalent, in lettering as described in Table 46.1. Additional items shall be specified as required for the particular pad.

Exception No. 1: A specialty pad, as described in 46.4, is required to only include the markings specified in 46.4.

Exception No. 2: Those treated fabric-envelope heating pads which are not provided with a supplementary cover are not required to include the markings specified in Items 6 and 12.

DANGER^c

TO REDUCE THE RISK OF BURNS, ELECTRIC SHOCK, AND FIRE, THIS PRODUCT MUST BE USED IN ACCORDANCE WITH THE FOLLOWING INSTRUCTIONS^a

1. DO NOT USE WHILE SLEEPING. ^{a or b}
2. DO NOT USE ON AN INFANT. ^{a or b}
3. THIS PAD IS NOT TO BE USED BY OR ON AN INVALID, SLEEPING OR UNCONSCIOUS PERSON, OR A PERSON WITH POOR BLOOD CIRCULATION UNLESS CAREFULLY ATTENDED. ^{a or b}
4. DO NOT USE ON AREAS OF INSENSITIVE SKIN. ^{a or b}
5. BURNS CAN OCCUR REGARDLESS OF CONTROL SETTING, CHECK SKIN UNDER PAD FREQUENTLY. ^{a or b}
6. NEVER USE PAD WITHOUT COVER IN PLACE ^{a or b} (hospital pads if provided with cover and all household pads).
7. DO NOT USE IN OXYGEN ATMOSPHERE ^a (applies to hospital pads).
8. DO NOT USE PINS OR OTHER METALLIC MEANS TO FASTEN THIS PAD IN PLACE. ^a
9. DO NOT SIT ON OR CRUSH PAD – AVOID SHARP FOLDS. ^a
10. NEVER PULL THIS PAD BY THE SUPPLY CORD. ^a
11. DO NOT USE THE CORD AS A HANDLE. ^a
12. CAREFULLY EXAMINE INNER COVER BEFORE EACH USE. DISCARD THE PAD IF INNER COVERING SHOWS ANY SIGN OF DETERIORATION. ^{a or b}
13. READ AND FOLLOW ALL INSTRUCTIONS ON BOX OR PACKED WITH PAD BEFORE USING. ^{a or b}

Table 46.1
Lettering

Item	Types of letters required	Minimum height of lettering	
		Inch	(mm)
a	Bold face, upper case	1/8	(3)
b	Light face, upper case	1/8	(3)
c	Bold face, upper case	3/16	(5)

46.4 The marking on the surface of a specialty pad (heated caps, sinus pads, or similar items) having a surface area (on the side where marking is applied) less than 130 inches² (0.084 m²) shall include the following in letters described in Table 46.1.

DANGER^c

1. BURNS WILL RESULT FROM IMPROPER USE. ^a
2. READ ALL INSTRUCTIONS ON BOX OR PACKAGED WITH PAD BEFORE USING. ^a
3. NEVER USE PAD WITHOUT THE REMOVABLE COVER. ^{a or b}
4. TEMPERATURE SUFFICIENTLY HIGH TO CAUSE BURNS MAY OCCUR REGARDLESS OF CONTROL SETTING. ^{a or b}
5. DO NOT USE ON AN INFANT, AN INVALID, A SLEEPING OR UNCONSCIOUS PERSON, OR A PERSON WITH POOR BLOOD CIRCULATION. ^{a or b}
6. DO NOT USE PINS OR OTHER METALLIC MEANS TO FASTEN THE PAD IN PLACE. ^a

46.5 The marking described in 46.3 shall be repeated in its entirety on the supplementary cover of a household pad and if provided on a hospital pad. All markings shall be permanent and shall be in letters that meet the lettering requirement in 46.3. Labels used for this purpose shall be securely fastened in place. If sewn, stitching shall be made on all sides.

46.6 Full instructions for the use and care of the pad shall be contained on the box or in a booklet (or equivalent) provided with the heating pad. The instructions shall include the important safety instructions indicated below. Unless otherwise indicated, the text of the instructions shall be verbatim, or in equally definitive terminology. The items may be numbered, and the phrases "READ ALL INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall be first and last respectively, in the list of items. Other important safety instructions considered appropriate by the manufacturer may be inserted, provided such instructions do not conflict with or contradict the required markings and instructions. The letter height shall be as indicated in Table 46.2.

IMPORTANT SAFETY INSTRUCTIONS

DO NOT DESTROY^d

DANGER^e – To reduce the risk of burns, electric shock and fire, this product must be used in accordance with the following instructions. ^{f, g, or h}

1. READ ALL INSTRUCTIONS. ^{g or h}

2. DO NOT USE WHILE SLEEPING. ^{g or h}
3. DO NOT USE ON AN INFANT. ^{g or h}
4. THIS PAD IS NOT TO BE USED ON OR BY AN INVALID, SLEEPING OR UNCONSCIOUS PERSON, OR A PERSON WITH POOR BLOOD CIRCULATION UNLESS CAREFULLY ATTENDED. ^{g or h}
5. DO NOT USE ON AREAS OF INSENSITIVE SKIN. ^{g or h}
6. BURNS CAN OCCUR REGARDLESS OF CONTROL SETTING, CHECK SKIN UNDER PAD FREQUENTLY. ^{g or h}
7. NEVER USE PAD WITHOUT COVER IN PLACE ^{g or h} (hospital pads if provided with cover and all household pads).
8. DO NOT USE IN AN OXYGEN ATMOSPHERE ^h (applies to hospital pads).
9. DO NOT USE PINS OR OTHER METALLIC MEANS TO FASTEN THIS PAD IN PLACE. ^h
10. DO NOT SIT ON OR CRUSH PAD – AVOID SHARP FOLDS. ^h
11. NEVER PULL THIS PAD BY THE SUPPLY CORD. ^h
12. DO NOT USE THE CORD AS A HANDLE. ^h
13. CAREFULLY EXAMINE INNER COVER BEFORE EACH USE. DISCARD THE PAD IF INNER COVERING SHOWS ANY SIGN OF DETERIORATION. ^{g or h}
14. SAVE THESE INSTRUCTIONS. ^{g or h}

Exception: The instructions for those treated fabric envelope heating pads which are not provided with a supplementary cover are not required to include the instructions specified in Items 7 and 13.

Table 46.2
Lettering

Item	Type of letters required	Height of lettering			
		Lettering on package		Lettering on card	
		Inch	(mm)	Inch	(mm)
d	Bold face, upper case	1/4	(6)	3/8	(10)
e	Bold face, upper case	3/16	(5)	3/16	(5)
f	Light face, lower case	1/8	(3)	3/16	(5)
g	Light face, upper case	1/8	(3)	3/16	(5)
h	Bold face, upper case	1/8	(3)	3/16	(5)

46.7 The instructions provided with each heating pad shall include the following: "This heating pad has a polarized plug (one blade is wider than the other) as a safety feature. This plug will fit into a polarized outlet only one way. If the plug does not fit fully into the outlet, reverse the plug. If it still does not fit, contact a qualified electrician. Do not attempt to defeat this safety feature."

46.8 If a manufacturer produces or assembles electric heating pads at more than one factory, each finished pad shall have a distinctive marking – which may be in code – by which it may be identified as the product of a particular factory.

46.9 The following or equivalent permanent marking, shall appear on electric heating pads provided with detachable power-supply cords. A flag-type label is not acceptable.

"WASHING INSTRUCTIONS"

"Wash by hand or as follows in automatic washer using slow agitation and normal spin speed: Fill washer with warm water. Add minimum amount of all-purpose detergent, agitate to dissolve, measure heating pad before washing. Add heating pad and soak five minutes. Agitate two minutes. Spin. Fill for cool rinse, agitate one minute then spin. Dry in automatic dryer on high heat, five minutes only, or line dry. Remove damp heating pad from dryer, block to original size, and drape to finish drying. Do not iron your heating pad."

46.10 The markings specified in 46.9 and 46.12 shall be in letters not less than:

- a) 1/8 inch (3.2 mm) in height for letters shown in uppercase.
- b) 1/16 inch (1.6 mm) in height for letters shown in lowercase.

46.11 A complete set of instructions explaining the care and use of the heating pad and directions for laundering shall be furnished with the heating pad.

46.12 If a heating pad provided with a detachable power-supply cord is adversely affected by dry cleaning, as determined by the conditioning and examination described in 42.2.1 and 42.3.1, the following warning shall be included in the instructions: "Do not dry-clean this heating pad. Cleaning solvents may have a deteriorating effect on the insulation of the heating element. " The lettering shall be in accordance with 46.10.

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