UL 1030

STANDARD FOR SAFETY

Sheathed Heating Elements

UL Standard for Safety for Sheathed Heating Elements, UL 1030

Eighth Edition, Dated March 31, 2015

Summary of Topics

This revision of ANSI/UL 1030 dated October 31, 2019 includes Changes Regarding Electrical Insulation Requirements.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new requirements are substantially in accordance with Proposal(s) on this subject dated December 29, 2017.

No Text on This Page

MARCH 31, 2015
(Title Page Reprinted: October 31, 2019)

ANSI/UL 1030-2019

UL 1030

Standard for Sheathed Heating Elements

First Edition – July, 1973
Second Edition – July, 1975
Third Edition – February, 1979
Fourth Edition – September, 1986
Fifth Edition – November, 1991
Sixth Edition – November, 1994
Seventh Edition – November, 2004

Eighth Edition

March 31, 2015

This ANSI/UL Standard for Safety consists of the Eighth Edition including revisions through October 31, 2019.

The most recent designation of ANSI/UL 1030 as an American National Standard (ANSI) occurred on October 31, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 1030 on January 2, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

No Text on This Page

CONTENTS

INTRODUCTION

1 Scope 5
2 Glossary 5
3 Units of Measurement 6
4 Undated References 6

CONSTRUCTION

5 General 6
6 Insulation 7
7 Spacings 7

PERFORMANCE

8 General 8
9 Power Input Test 9
10 Dielectric Voltage-Withstand Test 10
10.1 General 10
10.2 Quadrature method 10
10.3 Single-phase method 10
11 Resistance to Moisture Test 11
12 Leakage Current Test 11
13 Thermal Endurance Test 14
14 Temperature Test 14

MANUFACTURING AND PRODUCTION TESTS

15 Dielectric Voltage-Withstand Test 15

RATING

16 Details 16

MARKING

17 Details 17

SUPPLEMENT SA – Medium Voltage Sheathed Heating Elements

INTRODUCTION

SA1 Scope 19
SA2 Glossary 19
SA3 Units of Measurement 19

CONSTRUCTION

SA4 General 19
SA5 Internal Insulation 19
SA6 Spacings 19

SA7 Electrical Insulation 20

PERFORMANCE

SA8 General 20
SA9 Power Input Test 21
SA10 Dielectric Voltage-Withstand Test 21
SA11 Resistance to Moisture Test 21

MANUFACTURING AND PRODUCTION LINE TESTS

SA12 Dielectric Voltage-Withstand Test 21

RATING

SA13 Details 22

MARKING

SA14 Details 22

INTRODUCTION

1 Scope

1.1 These requirements cover metal-sheathed heating elements intended for use in appliances and equipment that comply with the requirements for such appliances and equipment.

1.2 The main body of this standard covers requirements for sheathed heating elements rated 600 volts or less. Supplement SA covers cartridge-type sheathed heating elements that do not incorporate a bend in the sheath, rated between 601 and 15,000 V.

1.3 These requirements do not cover heating elements for use in equipment for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

1.4 Wherever the terms heating element and element are used in these requirements, they are intended to mean a sheathed heating element as defined in 2.4.

2 Glossary

2.1 For the purpose of this standard the following definitions apply.

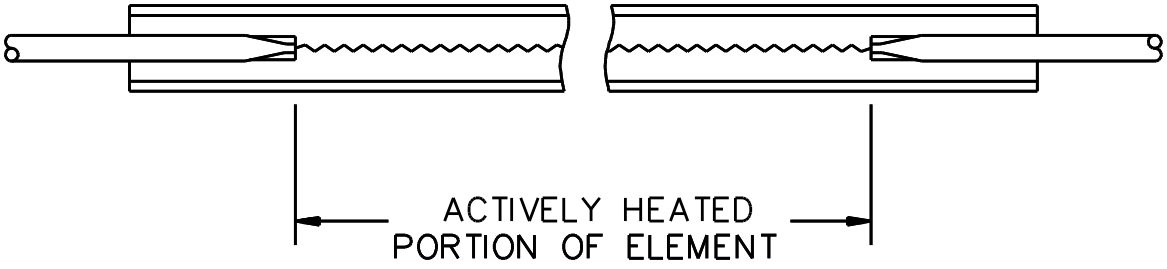
2.2 DIELECTRIC VOLTAGE WITHSTAND – The ability of a heating element to withstand specified voltages applied between current-carrying parts and dead metal parts for specified times without flashover or puncture.

2.3 LEAKAGE CURRENT – A current, including a capacitively coupled current, that may be conveyed between exposed conductive surfaces of a heating element and ground.

2.4 SHEATHED HEATING ELEMENT – A resistance element that is usually encased in magnesium oxide or encased in a similar insulating material that is, in turn, surrounded by a metal sheath.

2.5 SHEATH WATTAGE DENSITY – The watts per unit area of actively heated sheath surface area. The actively heated sheath surface area is considered to be the area of the exposed surface of that portion of the sheathed heating element between the terminal pins. See Figure 2.1.

Figure 2.1
Sheath wattage density



$$\text{SHEATH WATTAGE DENSITY}^{a} = \frac{\text{RATED WATTAGE}}{\text{ACTIVELY HEATED EXPOSED SHEATH SURFACE AREA}}$$

a – FORMULA BASED ON UNIFORM WATTAGE DENSITY ALONG THE LENGTH OF THE ELEMENT.

S3422

2.6 TEST VOLTAGE – The voltage required to obtain rated watt density, but no less than the rated voltage of the heating element.

3 Units of Measurement

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

4 Undated References

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

CONSTRUCTION

5 General

5.1 The acceptability of a heating element in any equipment or appliance depends upon its ability to withstand continued use under the conditions that prevail in actual service. In addition to the requirements contained herein, further considerations and investigations may be necessary, based upon the intended installation and use of the sheathed heating element.

5.2 A sheathed heating element shall employ materials and components throughout that meet the intent of the requirement, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

5.3 If a material or alloy not included in Table 14.1, a material provided with a coating, or a composite sheath utilizing dissimilar materials inside and outside is used, it shall be investigated to determine that the material is acceptable for the purpose and that it affords protection equivalent to that of the materials included in Table 14.1.

5.4 After being formed, the sheath of a heating element shall have a thickness not less than specified in Table 5.1.

Table 5.1
Sheath thickness

Application	Minimum thickness	
	Inch	(mm)
Surface-unit elements	0.016	(0.41)
Oven elements and space-heater elements:		
Stationary appliances	0.016	(0.41)
Portable appliances	0.013	(0.33)
Elements other than mentioned above, protected against mechanical damage	0.013	(0.33)

5.5 The values in Table 5.1 are intended to specify a minimum thickness for a sheath made of steel, titanium, copper, copper-clad steel, or steel and nickel alloys. Increased thickness may be required, based upon the particular end-use application of the heating element. A sheath made of aluminum or aluminum alloy and a sheath having a thickness less than specified in Table 5.1 is to be investigated under conditions of actual service to determine if it has the necessary mechanical properties and will withstand the most severe conditions likely to be met in service.

6 Insulation

6.1 An insulating washer, a bushing, or the like, that is an integral part of a heating element shall be of a material resistant to moisture, such as porcelain, and shall be acceptable for use at the maximum temperature to which it will be subjected under conditions of actual use. Such parts shall have adequate mechanical strength and rigidity to withstand the stress of actual service.

6.2 Insulating material employed in an integral part of a heating element, such as a terminal block, or the like, shall be strong, not easily ignited, and resistant to moisture. A material other than porcelain, phenolic, or one that is known to be acceptable for the support of current-carrying parts shall be investigated under conditions of actual service to determine if it has the necessary electrical and mechanical properties and will withstand the most severe conditions likely to be met in service.

6.3 The thickness of magnesium oxide (MgO) or other similar insulating material between the resistance element and the inside of the sheath, and the material of an end seal between the terminal pin and the inside of the sheath shall not be:

a) Less than 0.016 inch (0.41 mm) for elements rated 300 volts or less, and

b) Less than 0.031 inch (0.79 mm) for elements rated more than 300 volts.

7 Spacings

7.1 A spacing, through air and over surface, of not less than 1/16 inch (1.6 mm) between live parts of opposite polarity and between live parts and dead metal parts shall be maintained at or near the end of the

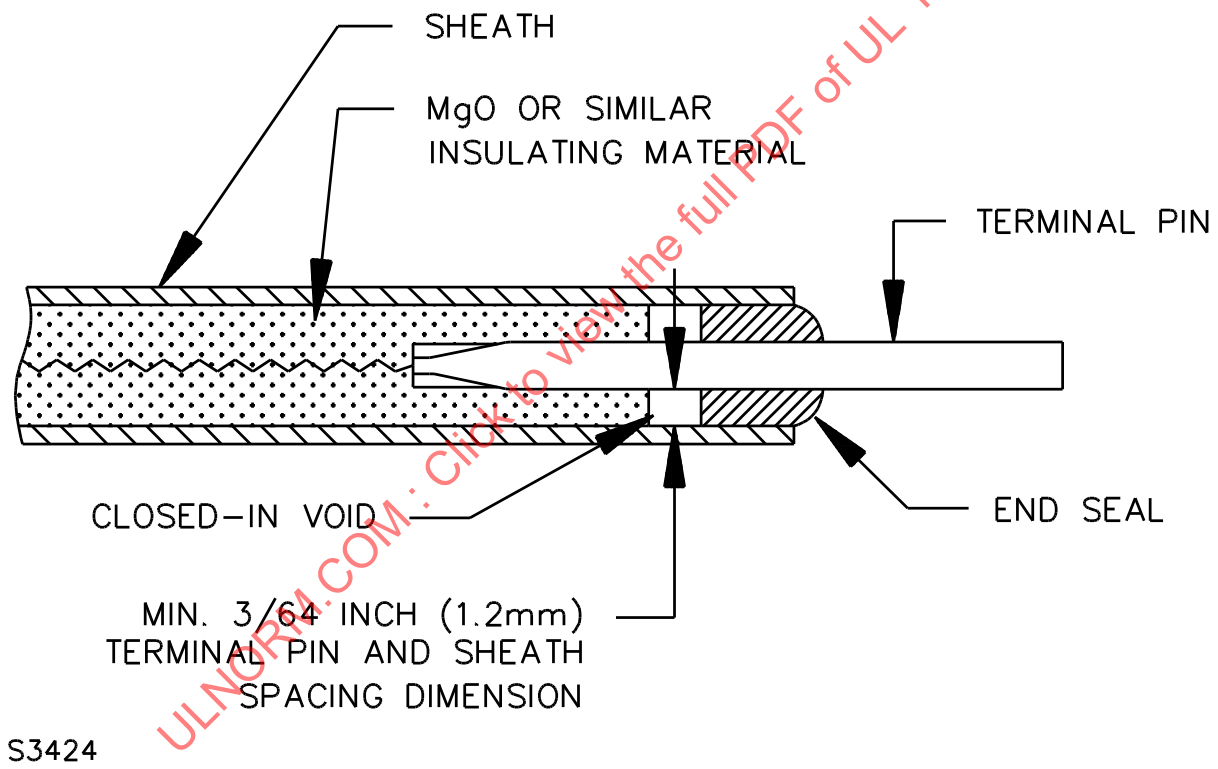
sheath of a heating element rated 300 volts or less. For an element rated more than 300 volts, the spacings at the end of the sheath shall not be less than 1/4 inch (6.4 mm).

Exception No. 1: When exact centering of a terminal pin is required to maintain the 1/16 inch spacing, a spacing of 3/64 inch (1.2 mm) in one location meets the intent of the requirement.

Exception No. 2: For an element rated 300 volts or less, a spacing not less than 3/64 inch measured between a terminal pin and the sheath is acceptable at a closed-in void, such as between an end seal and the element insulating material. See Figure 7.1.

Exception No. 3: For an element rated more than 300 volts, a spacing not less than 3/64 inch measured between terminal pin and sheath is acceptable when a closed-in void is not present between an end seal and element insulation of dissimilar materials.

Figure 7.1
Spacings at closed-in voids



7.2 Spacings at wiring terminals shall be in accordance with the requirements for the end-use product.

PERFORMANCE

8 General

8.1 The performance of a heating element shall be investigated by subjecting representative samples to the tests described in Sections 9 – 14. Three samples in a set are to be subjected to the tests specified in Table 8.1. Insofar as practicable, the tests shall be conducted in the sequence specified in Table 8.1.

Table 8.1
Test sequence

Sample set	Number of samples	Test	Paragraph
A	3	Dielectric	10.1.1
		Resistance to Moisture (Humidity Conditioning)	11.1
		Insulation Resistance	11.1(a)
		Dielectric	11.1(b)
B	3	Power Input	9.1
		Dielectric	10.1.1
		Leakage Current	12.1
		Endurance	13.1
		Temperature	14.1
		Leakage Current or Insulation Resistance	14.4(a) or 14.4(b)
		Dielectric	14.4(c)

8.2 For all tests, the heating element is to be mounted or installed in a manner that simulates its intended end-use application.

8.3 A representative test sample as mentioned in 8.1 is one that represents the combination of factors in (a) – (d) that results in the most severe test conditions for each material of sheath used.

a) Diameter of sheath;

b) Sheath wattage density (W/in.^{2});

c) Number and sharpness of bends; and

d) Rated voltage.

8.4 All test are to be performed at test voltage, see 2.6, except for the Thermal Endurance Test, Section 13, which is to be performed at 108 percent of test voltage.

9 Power Input Test

9.1 At rated voltage, the power input to a heating element shall not be more than 105 percent of its marked wattage or volt-ampere rating.

9.2 To determine whether a heating element complies with the requirement in 9.1, the maximum power input is to be measured with the element connected to a supply circuit adjusted to:

a) Other than as noted in (b), the highest marked voltage rating; or

b) If the highest marked voltage falls within a range of 100 – 120, 220 – 240, 257 – 277, or 440 – 480 volts, the highest voltage of the range.

9.3 Power input is to be recorded when element temperatures have stabilized. A temperature is considered stabilized when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than five-minute intervals, indicate no change.

10 Dielectric Voltage-Withstand Test

10.1 General

10.1.1 A heating element shall withstand without breakdown for one minute the application of a 60-hertz essentially sinusoidal potential of the value specified in Table 10.1 between live parts and exposed dead metal parts. The test is to be conducted using the quadrature method described in 10.1.3 and 10.2.1.

Table 10.1
Potentials for dielectric voltage-withstand test

Method	Rating of element, volts	Test potential, volts
Quadrature[a]	0 – 250	1000
	251 – 600	1000 + 2V[b]
Single-phase[c]	0 – 250	1000 + V[b]
	251 – 600	1000 + 3V[b]

[a] The quadrature method is described in 10.2.1.

[b] V is the voltage determined in accordance with 9.2.

[c] The single-phase method is described in 10.3.1.

10.1.2 When a 3-phase source of supply is not available, and when it is agreeable to those concerned, the single-phase test described in 10.3.1 may be conducted instead of the test described in 10.2.1. The dielectric and power supply voltages are to be monitored to ensure that they are 180 degrees out-of-phase. Otherwise, the summation of the in-phase cycles will result in a net test potential in excess of what is required in Table 10.1.

10.1.3 To determine whether a heating element complies with the requirement in 10.1.1, the heating element is to be tested by means of a 500-volt-ampere or larger capacity transformer, the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test level is reached, and is to be held at that level for one minute. The increase in the applied potential is to be at a substantially uniform rate as rapid as is consistent with correct indication of its value by a voltmeter.

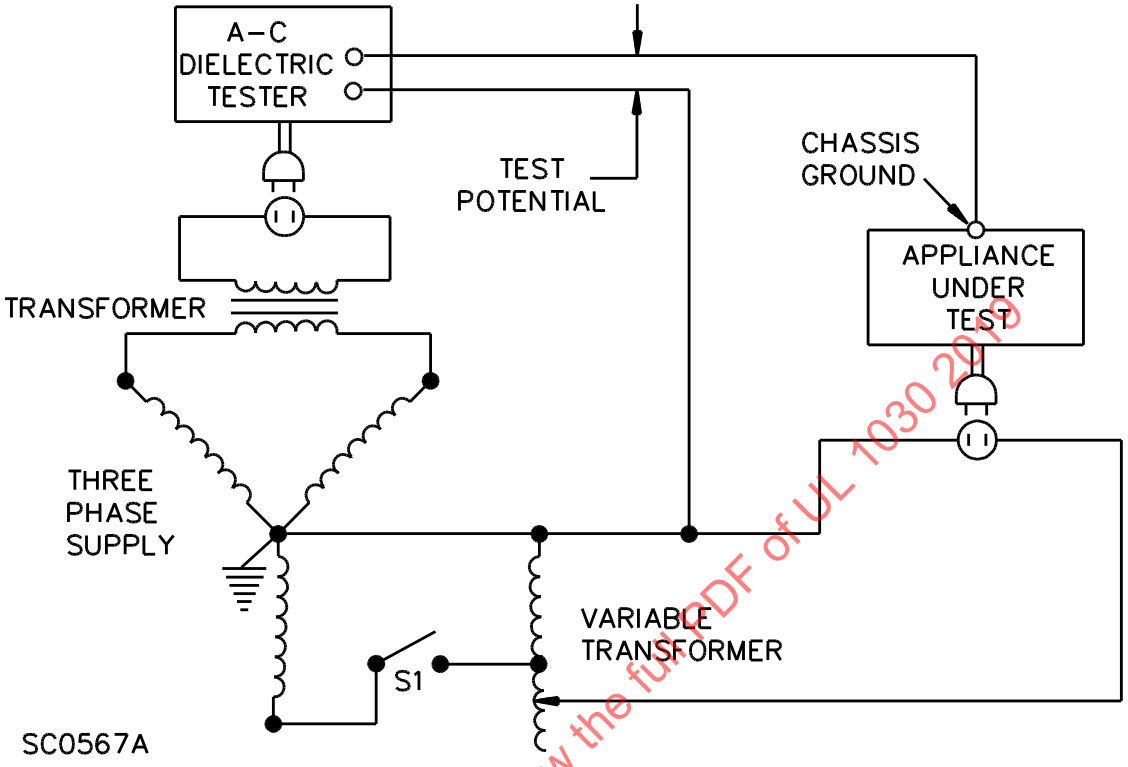
10.2 Quadrature method

10.2.1 The element is to be connected to a test circuit as illustrated in Figure 10.1 and energized at rated voltage as described in 9.2. At stabilized temperature, the test potential is to be applied in quadrature. After 45 seconds, the element is to be de-energized – switch S1 in Figure 10.1 is to be opened – and the test potential is to be applied for an additional 15 seconds.

10.3 Single-phase method

10.3.1 The element is to be energized at rated voltage as described in 9.2. At stabilized temperature, the test potential specified in Table 10.1 from a single-phase source of supply is to be applied. After 45 seconds, the element is to be de-energized and application of the test potential is to be continued for an additional 15 seconds.

Figure 10.1
Circuit diagram for quadrature dielectric test



11 Resistance to Moisture Test

11.1 After a heating element is conditioned for 60 days in moist air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (90 ±4°F):

a) The insulation resistance shall not be less than 50,000 ohms after being operated to thermal stabilization, and

b) The heating element shall comply with the dielectric voltage-withstand test in 10.1.1.

11.2 Ordinarily, insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms and using a 250 volt direct-current, or equivalent circuitry.

12 Leakage Current Test

12.1 The leakage current of a heating element intended for use in a household or similar cord-connected appliance, when tested in accordance with 12.2 and 12.4 (a) and (b), shall not exceed the values specified in Table 12.1. The values recorded during testing in accordance with 12.4 (c) shall comply with the requirements for the appliance in which the heating element is to be used.

Exception: A heating element intended exclusively for use in a household electric range, oven, or surface assembly having exposed metal parts connected to the neutral terminal or lead at the factory, or provided with a four-conductor cord at the factory need not be tested for leakage current. See 17.3.

Table 12.1
Maximum acceptable leakage current

Intended use	Maximum leakage current, mA
120 volt two wire appliance	0.50
120/240 volt portable appliance	0.50
120/240 volt stationary or fixed appliance	0.75
NOTE – Additional leakage current requirements may be found in individual product standards.	

12.2 The measurement circuit for leakage current is to be as illustrated in Figure 12.1. The measurement instrument is defined in (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad;

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; and

c) Over a frequency range of 0 – 100 kilohertz, 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 microfarad capacitor to 1500 ohms. At an indication of 0.5 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

12.3 The meter is to be connected between the sheath and the grounded supply conductor.

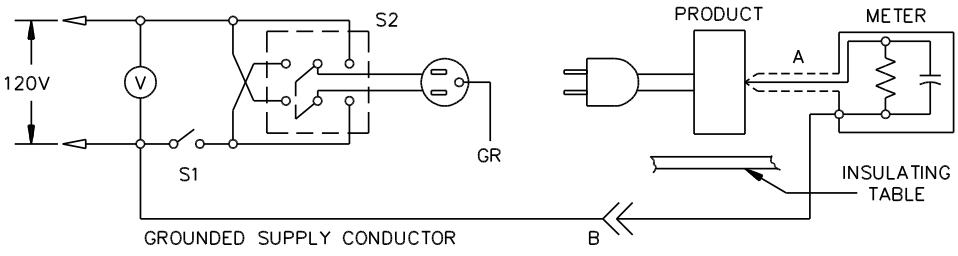
12.4 A sample of the heating element is to be tested for leakage current when connected to a supply voltage of 120 or 240 volts, as applicable. The test sequence, with reference to the measuring circuit – Figure 12.1 – is to be as follows:

a) With switch S1 open, the element is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2;

b) Switch S1 is then to be closed energizing the element, and within five seconds, the leakage current is to be measured using both positions of switch S2; and

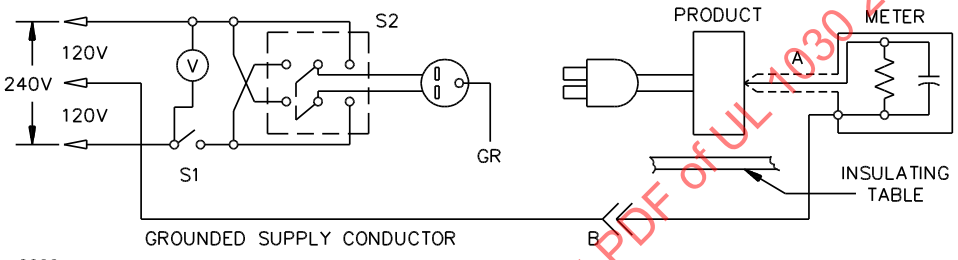
c) The leakage current is to be monitored using both positions of switch S2 until thermal stabilization as described in 9.3 is reached. At thermal stabilization, switch S1 is to be opened, de-energizing the heating element, and the leakage current is to be monitored using both positions of switch S2. The monitoring is to be continued while the element is cooling, using both positions of switch S2.

Figure 12.1
Leakage current measurement circuits



LC100

Heating element intended for use in an appliance intended for connection to a nominal 120-volt power supply.



LC200

Heating element intended for use in an appliance intended for connection to a nominal 120/240-volt, 3-wire, grounded-neutral power supply.

NOTE:

A: Probe with shielded lead.

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

12.5 Normally, the complete leakage-current-test program as described in 12.4 is to be conducted, without interruption for other tests. With the concurrence of those concerned, the leakage-current tests may be interrupted for the purpose of conducting other nondestructive tests.

13 Thermal Endurance Test

13.1 When tested as described in 13.2:

a) A heating element shall not rupture nor otherwise exhibit mechanical damage;

b) There shall be no emission of flame or molten metal; and

c) The fuse connected to the element sheath shall not open.

13.2 The elements are to be subjected to 1000 cycles of heating and cooling, each cycle consisting of 60 minutes on and 20 minutes off. During the thermal endurance test, the sheath of the heating element is to be grounded through a 3-ampere fuse and the heating element samples are to be connected to a supply voltage equal to 108 percent of the test voltage. With the concurrence of those concerned, test time may be reduced by forced cooling of the element.

Exception: A metal-sheathed oven broil heating element is to be subjected to 250 cycles of heating and cooling.

14 Temperature Test

14.1 At the completion of the thermal endurance test described in Section 13, Thermal Endurance Test, the supply voltage is to be adjusted to the input test voltage. After temperatures have stabilized, see 9.3, the temperature of the sheath shall not exceed the applicable limit specified in Table 14.1. See 6.1 and 6.2.

Exception: Table 14.1 specifies the maximum acceptable sheath temperatures for heating elements used in air. Higher temperatures are capable of being used, based upon the particular end-use application of the heating element.

Table 14.1
Temperature limits for sheathed heating element materials

Material	Maximum temperature	
	°F	°C
A. METALLIC MATERIALS		
1. Copper	350	177
2. Aluminum	500	260
3. Brass	750	399
4. Cold rolled steel	750	399
5. Nickel silver	1000	538
6. Stainless steel[a]		
a. Types 302, 303, 304, 316, 321, 347	1400	760
b. Type 309S	1500	816
c. Type 310	1600	871
d. Types 403,405,410,416,501	1200	649

Table 14.1 Continued on Next Page

Table 14.1 Continued

Material	Maximum temperature	
	°F	°C
e. Type 430	1300	704
f. Type 442	1400	760
g. Type 446	1500	816
7. Nickel alloys[b]		
a. Alloy 400	900	482
b. Alloy 600	1800	982
c. Alloy 800	1700	927
d. Alloy 825	1100	593
e. Alloy 840	1700	927
8. Cast iron	1200	649
9. Titanium	750	399
B. NONMETALLIC MATERIALS[c]	Recognized temperature rating	

[a] American Iron and Steel Institute (AISI) type designations.

[b] American Society of Mechanical Engineers (ASME) type designations.

[c] Includes but is not limited to insulated wire, polymeric materials, bushings, washers, end seals, and other components.

14.2 The temperatures specified in Table 14.1 are based on an assumed ambient temperature of 25°C (77°F). A test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). If a test is conducted at an ambient temperature other than 25°C, the difference between the test ambient and 25°C is to be added to or subtracted from the values indicated in Table 14.1.

Exception: At the request of the manufacturer a sheathed heating element that is designed for operation only in a forced-air condition shall be subjected to the test in a forced-air ambient condition that simulates its intended end-use application.

14.3 Sheath temperatures are to be measured by thermocouples attached to the hottest points on the sheath by welding, brazing, or other equivalent means.

14.4 Immediately after the temperature test and with the element at room temperature:

a) A heating element requiring testing in accordance with Section 12, Leakage Current Test, shall be subjected to a repeat leakage current test. The leakage current shall not be more than the applicable value specified in Table 12.1;

b) A heating element not requiring testing in accordance with Section 12 shall have an insulation resistance not less than 50,000 ohms; and

c) A heating element shall comply with the dielectric voltage-withstand test in 10.1.1.

MANUFACTURING AND PRODUCTION TESTS

15 Dielectric Voltage-Withstand Test

15.1 Each heating element shall withstand without electrical breakdown, as a routine production-line test, the application of a potential as specified in Table 15.1 applied between live and exposed dead metal parts.

15.2 The production-line test shall be in accordance with either the 60-second test or the one-second test in Table 15.1.

Table 15.1
Production-line test conditions

Method[a]	Application time, seconds	Applied potential		
		Volts		Frequency
		Element rating, volts		
		0 – 250	251 – 600	
1	60	1000	1000 + 2V[b]	60 Hz
2	60	1000	1200	60 Hz
3	1	1200	1200 + 2.4V[b]	60 Hz
4	1	1.7(1000 + V)[b]	1.7(1000 + 3V)[b]	DC
5	1	1200	1200 + 2.4V[b]	60 Hz

[a] Method 1 is described in 15.4; method 2 is described in 15.3; methods 3 and 4 are described in 15.5; and method 5 is described in 15.6.
[b] V is the voltage determined in accordance with 9.2.

15.3 For the 60-second single-phase test, the heating element may be in a heated or unheated condition.

15.4 For the 60-second quadrature test, the test potential is to be applied by the method illustrated in Figure 10.1. The heating element is to be energized at rated voltage and subjected to the test when temperatures have stabilized.

15.5 For the one-second single-phase and direct-current tests, the element need not be preheated. The potential is to be applied while the heating element is cold and de-energized.

15.6 For the one-second quadrature test, the test potential is to be applied by the method illustrated in Figure 10.1. The element need not be preheated. The test potential is to be applied while the element is energized.

15.7 The test equipment is to include a visible indication of application of the test potential and an indication of breakdown that is audible or visible or both. In the event of breakdown, manual resetting of an external switch is to be required, or an automatic reject of the unit under test is to result. Other arrangements may be considered and accepted when found to achieve the results contemplated. A 500-volt-ampere or larger capacity transformer need not be used in tests by the manufacturer when the transformer is provided with a voltmeter to measure directly the applied output potential.

RATING

16 Details

16.1 A heating element shall be rated in volts and volt-amperes or watts. The voltage rating shall be any appropriate single voltage or range of voltage such as 100 – 120, 208, 220 – 240, 257 – 277, 416, 440 – 480, 550, 575, and 600.

MARKING

17 Details

17.1 A heating element 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 heating element 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: The manufacturer's identification may be in a traceable code when the heating element is identified by the brand or trademark owned by a private labeler.

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

a) Does not repeat in less than 20 years, and

b) Does not require reference to the production records of the manufacturer to determine when the heating element was manufactured.

Exception No. 3: The electrical rating may be omitted when a separate identifying designation is assigned for each rating.

17.2 A heating element intended for use in a household or similar cord-connected appliance, see 12.1, or the container in which the element is shipped shall be marked to indicate such use.

17.3 A heating element intended exclusively for use in a household electric range, oven, or surface assembly – see the Exception to 12.1 – or the container in which such an element is shipped – shall be marked with the word "CAUTION" and the following or the equivalent: "For use only in a household electric range, oven, or surface assembly where the exposed metal parts are connected to the neutral at the factory or provided with a four-conductor cord at the factory. Use in any other cord-connected household appliance may result in a risk of electric shock."

17.4 When a manufacturer produces or assembles heating elements at more than one factory, each finished heating element shall have a distinctive marking, which may be in code, by which it may be identified as the product of a particular factory.

17.5 When the sheathed portion of the heating element is marked, the marking shall not be located on the outside diameter of a bend, and the element shall comply with the performance requirements in the standard after the marking is applied.

17.6 A heating element not intended for use in free air, or the container in which the element is shipped, shall be marked with the word "CAUTION" and the specific use for which it is intended, such as "For use only submersed in water" or "For use only in a metal heat sink."

17.7 The marking specified in 17.2, 17.3, and 17.6 shall appear on the heating element or shipping container. The marking may also be included in the installation instructions but shall be separated in format from the installation instructions.