



UL 923

STANDARD FOR SAFETY

Microwave Cooking Appliances

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UL Standard for Safety for Microwave Cooking Appliances, UL 923

Seventh Edition, Dated May 1, 2013

Summary of Topics

The revisions to ANSI/UL 923 dated August 27, 2020, include the withdrawal and replacement of 508C with UL 618005-1; [21.5](#)

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 revised requirements are substantially in accordance with Proposal(s) on this subject dated June 26, 2020.

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

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CONTENTS

INTRODUCTION

1	Scope	9
2	Glossary	9

CONSTRUCTION

3	General	13
4	Components	13
5	Frame and Enclosure	14
6	Accessibility of Live Parts	16
7	Protection Against Injury	20
7.1	General	20
7.2	Strength of mounting	21
7.3	Fans	21
8	Mechanical Assembly	21
9	Protection Against Corrosion	22
10	Interlocks	22
11	Interlock Monitors	22
12	Polymeric Materials	23
13	Supply Connections	29
13.1	Permanently-connected appliances	29
13.2	Cord-connected appliances	31
14	Live Parts	33
15	Polarization	34
16	Internal Wiring	34
16.1	General	34
16.2	Splices and connections	37
17	Heating Elements	38
18	Electrical Insulation	39
18.1	General	39
18.2	Printed wiring board	39
18.3	Film-coated wire (magnet wire)	40
18.4	Insulation systems	40
19	Thermal Insulation	40
20	Motors	41
21	Motor Overload Protection	41
22	Short-Circuit and Ground-Fault Protection	43
22.1	General	43
22.2	Motors and power transformers	43
22.3	Receptacles	44
23	Thermostats	45
24	Thermal Cutoffs	45
25	Attachment-Plug Receptacles	46
26	Lampholders	46
27	Switches and Controls	47
27.1	General	47
27.2	Power output control circuits	49
28	Protective controls (Limiting controls) – End Product Test Parameters	50
29	Filters	51
30	Spacings	52
31	Grounding	54
32	Secondary Circuits	56

32.1	General.....	56
32.2	Connections to frame	56
32.3	Separation of circuits	56
33	Transformers	56
34	Batteries and Battery Charging Circuits.....	57
35	Capacitors	57
36	Light Sources and Associated Components	58
36A	Child Resistant Oven Door.....	58
36A.1	General	58
36A.2	Door handle force test.....	59
36A.3	Override for single-action door opening	59

PERFORMANCE

37	General	60
38	Leakage Current Test	60
39	Microwave Radiation Emission Test.....	63
39.1	General.....	63
39.2	Instrumentation	63
39.3	Cavity load	63
39.4	Supply voltage.....	63
39.5	Microwave radiation emission measurement.....	63
40	Power Input Test	64
40.1	General.....	64
40.2	Supply voltage.....	64
40.3	Cavity load	64
40.4	Oven operation.....	64
41	Temperature Test	64
41.1	General.....	64
41.2	Temperature measurements.....	68
41.3	Installation	69
41.4	Supply voltage.....	77
41.5	Cavity load	77
41.6	Operating conditions.....	77
41.7	Motors used with solid-state controls	80
42	Surface Temperature Tests	82
42.1	General.....	82
42.2	Measurement of surfaces	83
42.3	Measurement of handles and knobs.....	85
42.4	Over-the-cooktop appliances.....	85
43	Insulation Resistance and Leakage Current Test as a Result of Moisture	87
44	Dielectric Voltage-Withstand Test	87
44.1	General.....	87
44.2	Primary circuits.....	88
44.3	Secondary circuits	89
45	Door Assembly Tests	92
45.1	Door operation	92
45.2	All doors.....	92
45.3	Side-hinged doors	92
45.4	Bottom-hinged doors.....	93
45.5	Impact tests.....	93
46	Glass Control Panel Test.....	94
47	Metal Enclosure Impact Test	94
48	Interlock System Endurance Test.....	96
48.1	General.....	96
48.2	Appliance connections	97

48.3	Test equipment	97
48.4	Operating sequence	97
49	Interlock Monitor Circuit Test	98
50	Mechanical Endurance Test	99
51	Moisture Conditioning Test	100
52	Spill Test	100
53	Spill Test for Horizontally-Mounted Openings	101
54	Abnormal Operation Tests	101
54.1	General	101
54.2	Appliance connections	101
54.3	Appliance configuration	102
54.4	Test duration	102
54.5	Shorted thermostat test	103
55	Abnormal Operation Tests on Motors Used With Solid-State Controls	104
56	Abnormal Operation – Fire Isolation Test	104
57	Magnetically Operated Interlock Test	107
58	X-Radiation Test	108
58.1	General	108
58.2	X-radiation under servicing conditions	108
59	Temperature Control Tests	108
60	Temperature Probe Test	109
61	Motor Switch Test	110
62	Interlock Malfunction Test	110
63	Salt Spray Corrosion Test	111
64	Cavity Fire Containment Test	111
64A	Forced Failure Fire Containment Tests	111
64A.1	General	111
64A.2	Potato fire containment test	112
64A.3	Waveguide and stirrer fire containment test	113
64A.4	Popcorn fire containment test	113
64A.5	Thermally protected AC fan motor ignition test	114
64A.6	Nichrome wire ignition tests	114
65	Strength of Mounting Test	115
66	Tests on Motors Exposed to Grease or Cooking Vapors	116
66.1	General	116
66.2	Grease conditioning	116
66.3	Oven and humidity conditioning	116

MANUFACTURING AND PRODUCTION-LINE TESTS

67	Dielectric Voltage-Withstand Test	117
68	Grounding-Continuity Test	118

RATING

69	Details	119
----	---------------	-----

MARKINGS

70	General	119
71	Visible After Installation	120
71.1	General	120
71.2	Combination microwave oven hood fans	121
72	Visible to the User During Use	122
73	Visible During Installation and Examination	123

74	Instruction Manuals	127
75	Important Safety Instructions	128
	75.1 General.....	128
	75.2 Over-the-cooktop microwave ovens	130
	75.3 Microwave oven-vent hood fans.....	131
	75.4 Self-cleaning appliances	131
76	Warning Markings and Instructions Concerning Microwave and X-Radiation Emission	131
77	Grounding Instructions.....	133

SELF-CLEANING OVENS

GENERAL

78	Scope.....	134
----	------------	-----

CONSTRUCTION

79	Materials.....	135
	79.1 Oven coating	135
	79.2 Smoke eliminators	135
	79.3 Oven vent tubes and smoke diverters.....	135
80	Oven Door Latch/Interlock Assembly	135
81	Seals and Gaskets	136

PERFORMANCE

82	General	136
83	Temperature Test	136
	83.1 General.....	136
	83.2 Normal temperature	136
84	Latch-Solenoid Temperature Test	137
85	Shorted Thermostat – Abnormal Test.....	137
86	Oven-Door Latch Endurance Test.....	137
87	Window Impact Tests.....	138

FIRE AND EXPLOSION

88	General	138
89	Test Electrodes	139
90	Test Samples	139
91	Installation of Test Sample	139
92	Fire and Explosion Test Within Oven.....	141
93	Emission of Carbon Monoxide.....	141
94	Vent Gases and Vapors Test	142
95	Vertical Cool-Air-Mixing Duct Test.....	142
96	Self-Cleaning of Removable Companion Oven Panels Test	143
97	Elevated Interlock Operating Temperature Tests	143

MARKING

98	Details.....	144
----	--------------	-----

SUPPLEMENT SA – MICROWAVE COOKING APPLIANCES FOR MARINE USE

GENERAL

SA1	Scope	145
-----	-------------	-----

CONSTRUCTION

SA2	Mounting	145
SA3	Corrosion	145
SA4	Supply Connections	145
SA4.1	Permanently-connected appliances	145
SA4.2	Cord-connected appliances	145
SA5	Internal Wiring	146
SA6	Electrical Connections	146

PERFORMANCE

SA7	General	146
SA8	Vibration Test	146
SA9	Shock Test	146
SA10	Salt Spray Corrosion Test	147

MARKINGS

SA11	Visible After Installation	147
SA12	Visible During Installation and Examination	147

SUPPLEMENT SB – MICROWAVE COOKING APPLIANCES EMPLOYING TUNGSTEN-HALOGEN LAMPS**GENERAL**

SB1	Scope	149
-----	-------------	-----

CONSTRUCTION

SB2	Interlocks	149
SB3	Switches and Controls	149

PROTECTION AGAINST INJURY TO PERSONS

SB4	Lamps	150
SB5	Impact	150
SB6	Thermal Shock	150
SB6.1	Spillage	150
SB6.2	Splashing	151

PERFORMANCE

SB7	Cavity load	151
SB8	Ultraviolet Radiation Emission Test	151
SB9	Markings	151

SUPPLEMENT SC – SAFETY OF SMART ENABLED MICROWAVE COOKING APPLIANCES

SC1	Scope	153
SC2	General	153
	SC2.1 Controls	153
	SC2.2 Separation of circuits	154
	SC2.3 Communication and display devices	154
	SC2.4 Communication conductors and cables	155
	SC2.5 Communication connectors	155
	SC2.6 Smart enabled or remote operation	155
SC3	Functional Safety	156
SC4	Resistance to Electro Magnetic Phenomena (Immunity)	157
SC5	Marking and Instructions	157

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INTRODUCTION

1 Scope

1.1 These requirements cover household and commercial microwave cooking appliances operated in the Industrial, Scientific and Medical (ISM) bands of 915 ± 25 and 2450 ± 50 MHz, for use in ordinary locations in accordance with the National Electrical Code, NFPA 70, and rated not more than 600 V.

1.2 These requirements also cover microwave cooking appliances intended for built-in installation, side-by-side mounting, stacking, wall mounting and installation over ranges.

1.3 For the purpose of these requirements, commercial microwave cooking equipment is that usually found in commercial kitchens, restaurants, or other business establishments where food may be dispensed. Household microwave cooking equipment is that intended for household use.

1.4 These requirements also cover the microwave cooking portion of a household electric range. The combination is to comply with the Standard for Household Electric Ranges, UL 858.

2 Glossary

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

2.2 AUTOMATICALLY CONTROLLED APPLIANCE – An appliance is considered to be automatically controlled under any one or more of the following conditions:

- a) If the repeated starting of the appliance, beyond one complete predetermined cycle of operation, is independent of any manual control;
- b) If, during any single predetermined cycle of operation, the appliance is caused to stop and restart, or change operating modes one or more times; or
- c) If, upon energizing the appliance, the initial starting of a motor may be intentionally delayed beyond normal, conventional starting.

2.3 CAVITY – That portion of the microwave cooking appliance in which food may be heated, cooked, or dried.

2.4 CLASS 2 CIRCUIT – An isolated secondary circuit involving a potential of not more than 42.4 V peak supplied by:

- a) An inherently-limited Class 2 transformer;
- b) A combination of an isolated transformer secondary winding and a fixed impedance or regulating network that together comply with the performance requirements for an inherently-limited Class 2 transformer;
- c) A dry-cell battery having output characteristics not greater than those of an inherently-limited Class 2 transformer;
- d) Any combination of (a), (b), and (c) that together comply with the performance requirements for an inherently-limited Class 2 transformer; or
- e) One or more combinations of a Class 2 transformer and an overcurrent protective device that together comply with the performance requirements for a noninherently-limited Class 2 transformer.

A circuit derived from a line-connected circuit by connecting impedance in series with the supply circuit as a means of limiting the voltage and current is not considered to be a Class 2 circuit. See Secondary Circuits, Section [32](#).

2.5 CONTROL, AUTOMATIC ACTION – A control in which at least one aspect is non-manual.

2.6 CONTROL, AUXILIARY – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

2.7 CONTROL, MANUAL – A device that requires direct human interaction to activate or rest the control.

2.8 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the potential hazard, is considered an operating control. Operating controls are also referred to as "regulating controls".

2.9 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as "limiting controls" and "safety controls."

2.10 CONTROL, TYPE 1 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested under this standard.

2.11 CONTROL, TYPE 2 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested under this standard.

2.12 CONTROLLED ENVIRONMENT – An environment relatively free of conductive contaminants, such as normal cooking vapors, carbon dust, and the like, that may be a result of the end-use equipment to which a control will be installed or may be due to the location of the end-use equipment, and protected against humidity and the formation of condensation. A controlled environment may be provided by means of a:

- a) Hermetically sealed enclosure,
- b) Encapsulation,
- c) A conformal coating, or
- d) A gasketed, tight-fitting enclosure or filter system preventing contamination in conjunction with a system preventing condensation (for example, the maintaining of the surrounding air at constant temperature and a suitably low relative humidity).

2.13 "CROWBAR" CIRCUIT – A circuit that causes an electrical overload to exist in the event certain other operations are not completed. The overload condition in turn causes an overcurrent or thermal device to function.

2.14 DOOR – The movable barrier that permits access to the cavity for placement or removal of food, and whose function is to prevent emission of microwave energy from the passage or opening which provides access to the cavity.

2.14.1 ELECTRICAL CONNECTION – The physical interface between two points in a circuit such as spade terminals, pin terminals, micro switch contacts, relay contacts, timer contacts, and crimped connections.

2.15 EQUIVALENT PLANE-WAVE POWER DENSITY – The square of the rms electric field strength divided by the impedance of free space (377 ohms).

2.15.1 FLAME CYLINDER – A projection of a vertical cylinder having a diameter of 20 mm and a height of 50 mm, placed above the center of the connection zone(s) and on top of any polymeric parts that are supporting current-carrying electrical connections as shown in [Figure 12.2](#).

2.16 INTERLOCK – A device or system, either electrical, mechanical, or electromechanical, that serves to prevent exposure to an electric shock, or physical injury, or excessive radiation emission when a door, cover, or access panel is opened or removed.

2.17 INTERLOCK MONITOR – An electrical, mechanical, or electromechanical system that serves to render a microwave cooking appliance incapable of generating microwave energy in the event the designated primary or secondary interlock, or both does not perform its intended function.

2.18 MAGNETRON – A type of microwave generator usually used in microwave cooking appliances.

2.19 MICROWAVE ENCLOSURE – Refers to the inner cavity walls, the door, waveguide, and radiation shielding around magnetron filament connections.

2.20 MICROWAVE RADIATION EMISSION – The microwave energy to which persons might be exposed during operation or user servicing of a microwave cooking appliance.

2.21 OVER-THE-COOKTOP MICROWAVE OVEN – Any appliance, including a combination microwave oven vent-hood fan, that may be located above a range, cooktop, or similar heating appliance. It also includes appliances that can be located on a vent-hood shelf above a range or cooktop.

2.21.1 POTENTIAL IGNITION SOURCES –

- a) The magnetron waveguide;
- b) High voltage or Line Voltage uninsulated and insulated terminals;
- c) High voltage or Line Voltage printed circuit board traces;
- d) High voltage or Line Voltage open coils/windings;
- e) High voltage or Line Voltage open contacts;
- f) High voltage or Line Voltage wiring not employing VW-1 insulation;
- g) Any other component containing high voltage or Line Voltage;
- h) Any exhaust opening in the oven cavity; or
- i) Any circuit or component that has normal operating wattage >60W.

2.22 POWER OUTPUT CONTROL CIRCUIT – A control circuit that supervises and/or manages the power output and must operate repetitively and consistently to assure compliance with the normal and abnormal operation tests specified in Sections [38](#) – [66](#).

2.23 PRIMARY INTERLOCK – A designation for one of the oven door interlocks. The primary interlock is intended to de-energize the microwave generator upon opening the oven door, before microwave radiation emission exceeds the levels specified in [39.1.1](#).

2.24 PRIMARY CIRCUITS – The wiring and components that are conductively connected to the branch circuit.

2.25 SAFETY CIRCUIT – Any primary or secondary circuit that is relied upon to reduce a risk of fire, electric shock, injury to persons, or excessive radiation (microwave or x-radiation) emission. An interlock circuit, for example, is considered to be a safety circuit.

2.26 SECONDARY CIRCUIT – A secondary circuit is one that is supplied from an isolated secondary winding of a transformer.

2.27 SECONDARY INTERLOCK – A designation for one of the oven door interlocks. The operation of the secondary interlock is intended to prevent microwave radiation emission from exceeding the level specified in [39.1.1](#) when the door is opened.

2.28 STIRRER – That feature of a microwave cooking appliance that serves to continuously change the standing wave pattern within the oven cavity.

2.29 UNDER-CABINET MOUNTED MICROWAVE OVENS – A microwave cooking appliance that is installed under a cabinet and over a non-heat producing surface.

2.30 USER SERVICING – Any form of servicing that might be performed by personnel other than those who are trained to maintain the appliance. Some examples of user servicing are:

- a) Cleaning any areas that are accessible without the use of tools;
- b) Replacing lamps, fuses, or other parts that are accessible without the use of tools;
- c) Adjustment of any controls that do not involve the use of tools; and
- d) Any operation described or implied in the operator's manual, whether or not tools are required.

2.31 VIEWING SCREEN – That feature of a microwave appliance, usually part of the door assembly, that is opaque to microwave energy but visually transparent to provide for viewing the cavity contents.

2.32 VIEWING SCREEN BARRIER – An optically transparent material adjacent to a viewing screen, which serves to prevent insertion of a wire or other object into the cavity.

2.33 VOLTAGE, EXTRA LOW – A circuit involving a potential of not more than 32 VAC RMS (42.4 volts peak) or 30 volts direct current (dc), and supplied by:

- a) A primary battery;
- b) A National Electrical Code, ANSI/NFPA 70, standard Class 2 transformer;
- c) A combination of a transformer and fixed impedance which, as a unit, complies with all performance requirements for a Class 2 transformer; or
- d) A Class 2 Power Supply.

2.34 VOLTAGE CIRCUIT, HIGH – Any circuit involving potential greater than 600 volts.

2.35 VOLTAGE CIRCUIT, LOW OR LINE – Any circuit with characteristics in excess of those of an extra low-voltage circuit but less than that of a high voltage circuit.

CONSTRUCTION

3 General

3.1 A microwave cooking appliance shall be made and finished with the degree of uniformity and grade of workmanship that is practicable in a well-equipped factory.

4 Components

4.1 A component of a product covered by this standard shall:

- a) Comply with the requirements for that component as indicated in the individual section(s) covering that component;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability; and
- d) Additionally comply with the applicable requirements of this end product standard.

Exception No. 1: A component of a product covered by this standard is not required to comply with a specific component requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product;*
- b) Is superseded by a requirement in this standard; or*
- c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.*

Exception No. 2: A component complying with a component standard other than those cited in this standard is acceptable if:

- a) The component also complies with the applicable component standard indicated in this standard; or*
- b) The component standard:*
 - 1) Is compatible with the ampacity and overcurrent protection requirements of the National Electrical Code, ANSI/NFPA 70, where appropriate;*
 - 2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B; and*
 - 3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.*

4.2 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.

4.3 A component that is also intended to perform other functions, such as:

- a) Overcurrent protection;
- b) Ground-fault circuit-interruption;
- c) Surge suppression;
- d) Any other similar functions; or
- e) Any combination thereof

shall comply additionally with the requirements of the applicable UL standard(s) that cover devices that provide those functions.

Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

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

5 Frame and Enclosure

5.1 A microwave cooking appliance shall be so formed and assembled that it will have the strength and rigidity necessary to resist the abuses that it is likely to be subjected, without increasing the risk of fire, electric shock, injury to persons, or exposure to radiation emission in excess of the limits specified in these requirements due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

5.2 The enclosure of a microwave cooking appliance shall house all electrical parts, except a supply cord, that may cause a fire, electric shock, injury to persons, or exposure to radiation emission in excess of the limits specified in these requirements under any condition of use. No dependence shall be placed on adjacent walls or adjacent equipment to complete an enclosure. If a microwave cooking appliance is intended for permanent installation (intended for permanent connection to the power supply), the appliance shall be provided with means for mounting in the intended manner and shall be furnished with any necessary fittings, such as brackets, hangers, or sleeve.

5.3 Among the factors that shall be taken into consideration when an enclosure is being evaluated are its:

- a) Mechanical strength,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Combustibility,
- e) Resistance to corrosion, and
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of use. For a nonmetallic enclosure, all of these factors shall be considered with respect to thermal aging.

5.4 An enclosure constructed of polymeric material shall comply with the requirement in [12.3](#). A metal enclosure or enclosure part shall be tested in accordance with Metal Enclosure Impact Test, Section [47](#), for resistance to impact.

5.5 Cast- and sheet-metal portions of the enclosure shall be no thinner than indicated in [Table 5.1](#) unless the enclosure is found to be acceptable when evaluated under considerations such as are mentioned in [5.3](#) and [5.6](#).

5.6 In addition to being considered with reference to the factors mentioned in [5.3](#), an enclosure of sheet metal shall be evaluated with respect to its size and shape, the thickness of metal and its acceptability for the particular application, considering the intended use of the appliance.

Table 5.1
Minimum acceptable thickness of metal enclosure

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, or the like, (or are otherwise of a shape and/or size to provide acceptable physical strength)		At surfaces to which a wiring system is to be connected in the field		At relatively large unreinforced flat surfaces	
	in	(mm)	in	(mm)	in	(mm)
Die-cast metal	3/64	(1.2)	—		5/64	(2.0)
Cast malleable iron	1/16	(1.6)	—		3/32	(2.4)
Other cast metal	3/32	(2.4)	—		1/8	(3.2)
Uncoated sheet steel	0.026	(0.66)	0.032	(0.81) ^a	0.026	(0.66)
Galvanized sheet steel	0.029	(0.74)	0.034	(0.86) ^a	0.029	(0.74)
Nonferrous sheet metal	0.036	(0.91)	0.045	(1.14)	0.036	(0.91)

^a Sheet steel of a thickness less than that mentioned, but not less than 0.026 in (0.66 mm) if uncoated steel or not less than 0.029 in (0.74 mm) if galvanized steel, is acceptable if the area surrounding the knockout has a thickness not less than 0.053 in (1.35 mm).

5.7 If openings for exhaust ventilation are provided in the enclosure of a microwave cooking appliance they shall be so located that they will not vent into concealed spaces of a building structure, such as into false-ceiling space or into hollow spaces in the wall, when the appliance is installed as intended.

5.8 The microwave enclosure of a microwave cooking appliance shall be so constructed as to prevent microwave radiation emission in excess of the values specified in [39.1.1](#).

5.9 With reference to [5.8](#), there shall be no openings in external surfaces of an appliance that will enable insertion of an insulated wire of any diameter into the cavity, wave guide, or other microwave-energy-containing spaces while the door is closed, provided the wire, when inserted, could consist of two straight segments forming an obtuse angle of not less than 170 degrees. The appliance is to be fully assembled during the examination except for parts that are removable without the use of tools. Typically, a solid wire approximately 0.04 in (1.0 mm) in diameter is used to determine possible insertion paths. The rotating fan blade of a blower motor in the direct line of sight to a small hole or crack leading to a microwave containing space is considered an acceptable barrier to the insertion of a wire.

Exception: Entry of a wire of any diameter may be considered acceptable if it can be demonstrated that the insertion of any such wire will not result in an equivalent plane-wave power density of microwave radiation in excess of 1 mW/cm² at any point 5 cm or more from the external surface of the enclosure when subjected to the Microwave Radiation Emission Test, Section [39](#), with all interlocks in the circuit.

5.10 A countertop microwave cooking appliance that employs electrical components or internal wiring located below an opening that is more than 45 degrees from the vertical plane on the top of a countertop microwave oven shall comply with Spillage on Horizontally-Mounted Openings, Section [53](#).

6 Accessibility of Live Parts

6.1 The electrical parts of an appliance shall be so located or enclosed that persons are protected against unintentional contact with uninsulated live parts. The method of evaluating openings in the enclosure is given in [6.2](#) – [6.6](#).

6.2 An opening in the enclosure of an appliance that will not permit entrance of a rod 1 in (25.4 mm) in diameter is acceptable if a probe as illustrated in [Figure 6.1](#), when inserted into the opening, cannot be made to touch any part where leakage current to earth ground, or to other accessible parts, would exceed the levels specified in [38.1](#).

6.3 With respect to the requirement in [6.2](#), the probe may be articulated into any configuration and may be rotated or angled to any position before, during, or after insertion into the opening; and the penetration may be to any depth allowed by the opening size, including minimal depth combined with maximum articulation.

6.4 An opening that has a minor dimension of 1 in (25.4 mm) or more, in an enclosure, as illustrated in [Figure 6.2](#), is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire less than, R distance from the inside edge of the perimeter of the opening and X distance from the plane of the opening. T equals the enclosure thickness, R equals X minus T, and X equals five times the diameter of the largest round rod that can be inserted through the opening but not less than 6-1/16 in (154 mm). In evaluating an opening, any barrier located within the volume is to be ignored unless it intersects the boundaries of the volume in a continuous, closed line.

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Figure 6.1
Accessibility probe

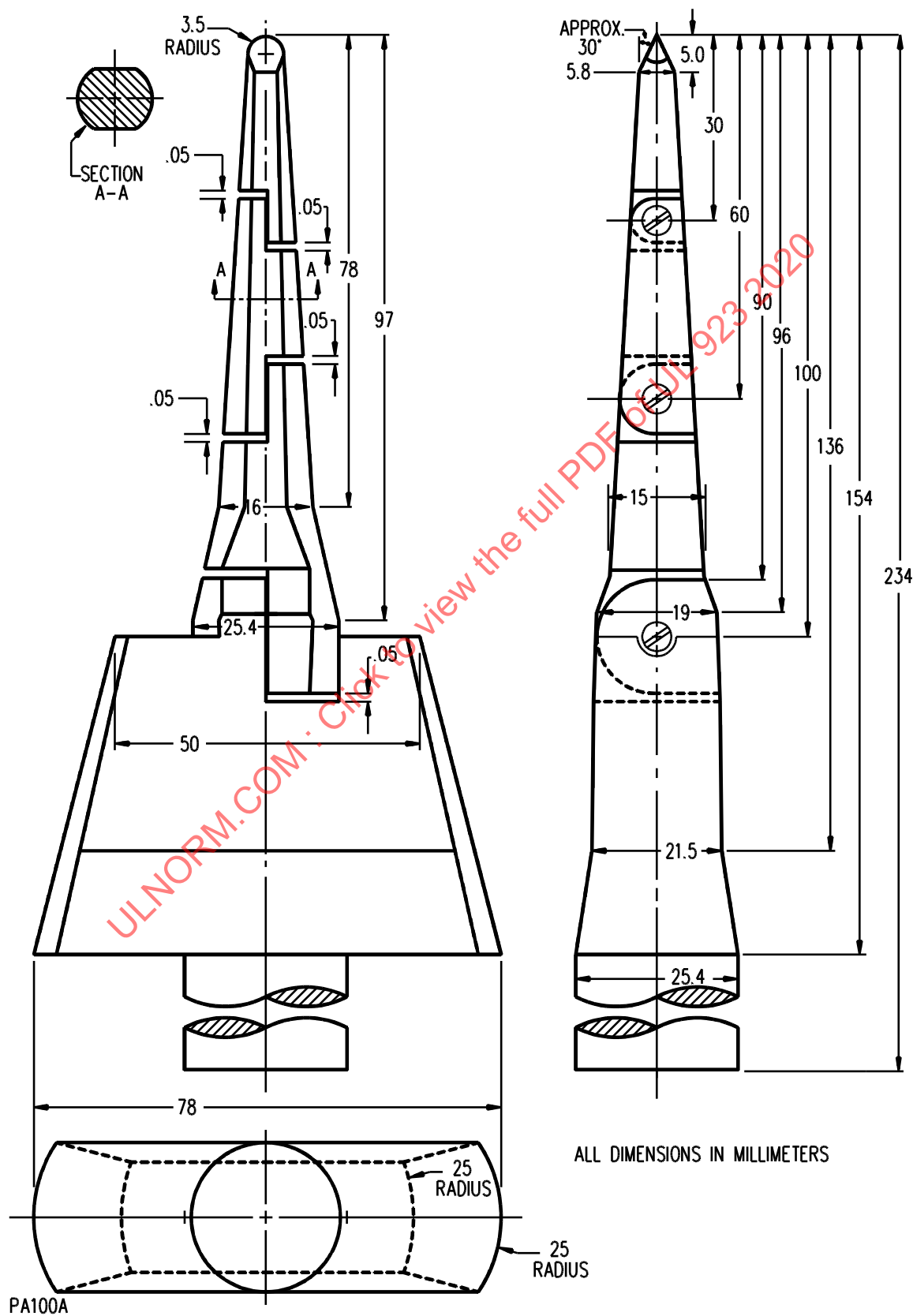
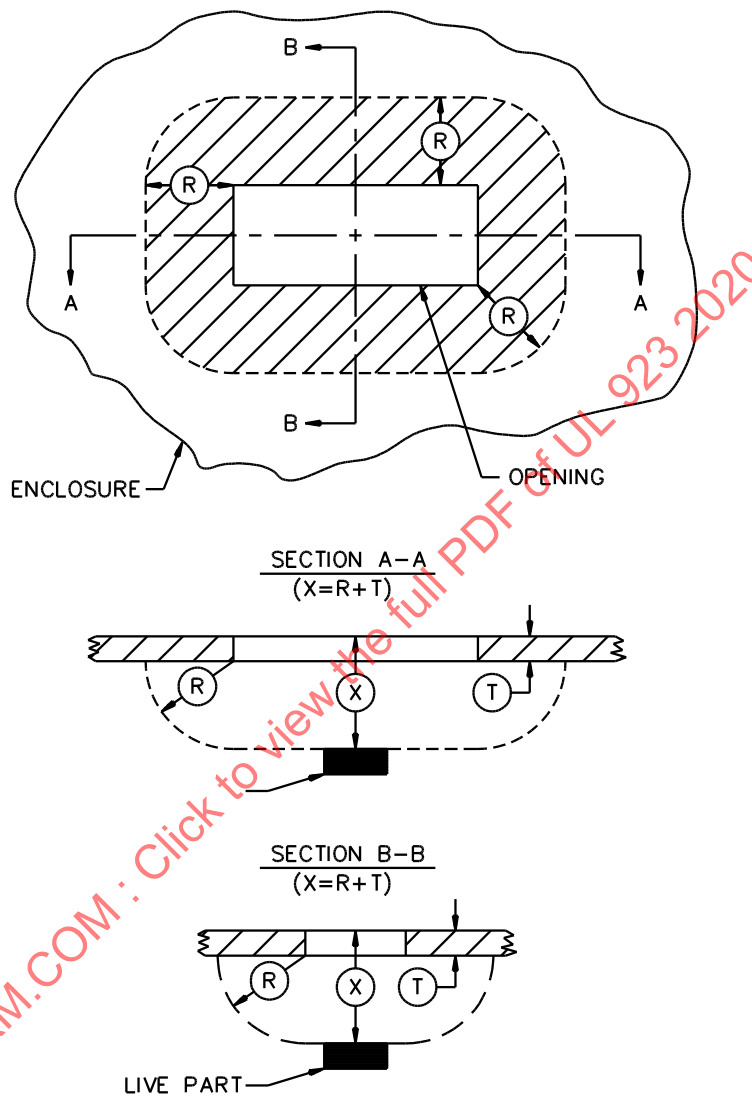


Figure 6.2
Opening in enclosure
Proportions exaggerated for clarity



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6.5 In connection with the requirements in [6.1](#) – [6.4](#), a part of the outer enclosure that may be removed without the use of tools by the user of the appliance (for the attachment of accessories, to allow access to means for making operating adjustments, or for other reasons) is to be disregarded – that is, it is not to be assumed that the part in question affords protection against electric shock. A warning marking, such as that specified in [71.1.8](#) is not considered to eliminate this condition.

6.6 With reference to [6.7](#) and [6.8](#), the outer enclosure of a household counter-top appliance that requires removal for servicing is to be removed when determining compliance with the requirements.

6.7 A component (such as a lampholder, fuseholder, circuit breaker, or the like) intended to be user serviceable shall be so located that persons replacing or resetting the component in a line-voltage circuit cannot unintentionally touch an uninsulated live part.

Exception: The requirement does not apply to the screwshell or center contact of a screwshell lampholder or to the clips of a fuseholder that is associated with the component being replaced.

6.8 Uninsulated live parts of the line or high voltage circuits shall be individually insulated, guarded, or located such that the probe illustrated in [Figure 6.3](#) cannot contact live parts with the outer enclosure removed.

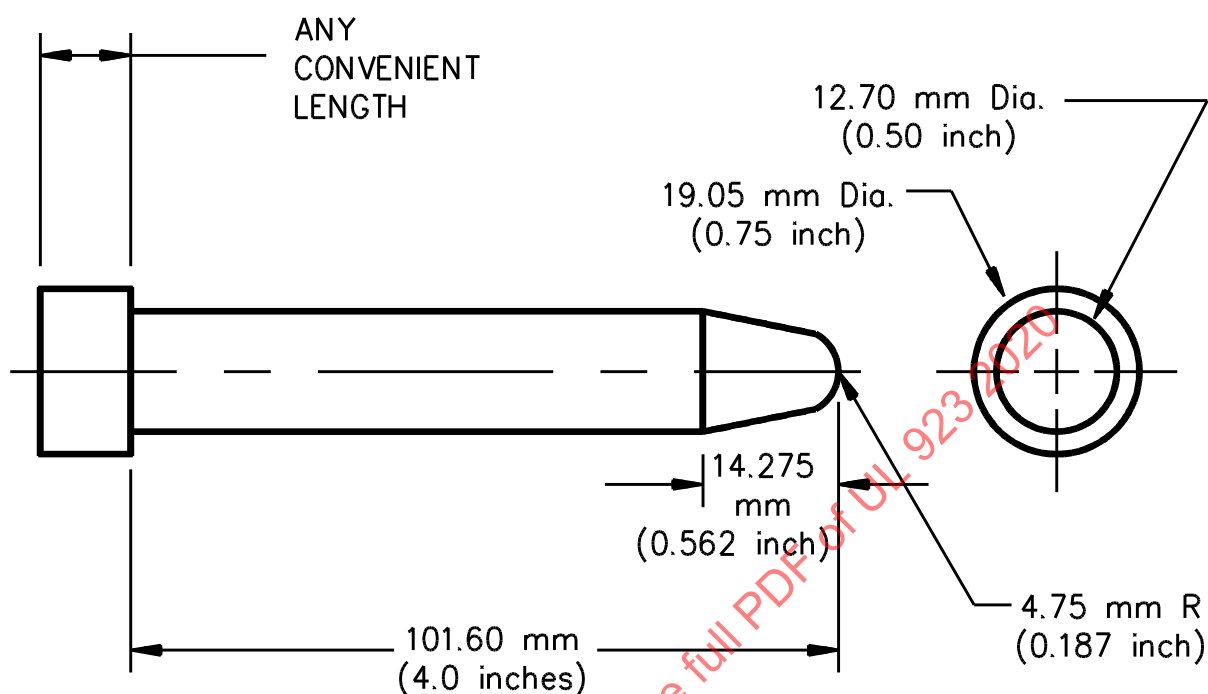
Exception No. 1: This requirement does not apply to enamel-coated line or low voltage connected coil windings. The secondary voltage coil of the magnetron transformer shall not be exempt from the requirement.

Exception No. 2: An interlock system may be provided in lieu of insulating, guarding, or locating the live parts if the system disconnects all poles of the power supply, and the live parts that can be contacted by the probe are reliably deenergized. The actuator for such an interlock shall be concealed and not obvious to the person servicing the microwave oven.

Exception No. 3: Non-removable type fasteners or other means of securing the outer enclosure to the oven may be provided in lieu of insulating guarding, locating or interlocking the live parts if:

- a) The securing means if determined through trial removal to be unlikely to be removed,*
- b) The securing means is provided with a tool interface that will not accommodate a slotted, a Phillips, a square, or torx driver, or wrench of any type for removal,*
- c) The securing means has a curved head that cannot be gripped by pliers. A securing means provided with a maximum 0.020-in (0.50-mm) radius curve above the exposed outer surface of the appliance to which the securing means is affixed is considered as not be capable of being gripped,*
- d) A minimum of two such securing means are provided,*
- e) The securing means are located such that removal of the non tamper-resistant screws will not allow access to the high voltage circuits (such as at the bottom of the enclosure), and*
- f) The appliance is marked in accordance with [73.23](#).*

Figure 6.3
Probe for uninsulated live parts



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7 Protection Against Injury

7.1 General

7.1.1 A moving part, such as the rotor of a motor, a chain, a pulley, a belt, or a gear, shall be enclosed or guarded to reduce the risk of injury to persons.

7.1.2 With reference to the requirement in [7.1.1](#), the degree of protection required of the enclosure depends upon the general construction and intended use of the appliance. The factors to be taken into consideration in determining the acceptability of an exposed moving part are:

- a) The degree of exposure;
- b) The sharpness of the moving part;
- c) The likelihood of unintentional contact with the moving part;
- d) The speed of movement of the part; and
- e) The likelihood of a finger, an arm, or clothing being drawn into the moving part (such as at points where gears mesh, where a belt travels onto a pulley, or where moving parts close in a pinching or shearing action).

7.1.3 A microwave cooking appliance, and any item furnished with the appliance, shall have no sharp edge, burr, point, or spike inside or outside the appliance that may cause injury during use, including a cleaning operation.

7.1.4 Materials employed in the construction of the appliance depended upon for protection against injury shall be acceptable for the particular use. See [5.1](#) and [5.3](#).

7.2 Strength of mounting

7.2.1 A support bracket, hanger, or the like, of a wall-mounted appliance, shall not weaken, crack, or break; and shall support the oven and mounting bracket assembly when subjected to the conditions described in Strength of Mounting Test, Section [65](#).

7.3 Fans

7.3.1 A removable filter that complies with the requirements in Filters, Section [29](#), is acceptable as a guard of a fan.

7.3.2 A side of a fan need not be guarded provided that:

- a) The appliance is marked as specified in [73.27](#); and
- b) The installation instructions are such that, when installed per the instructions, an opening allowing the user access to an unguarded side of a fan is at least 7 ft (2.13 m) above the floor.

8 Mechanical Assembly

8.1 A switch, a fuseholder, a lampholder, an attachment plug receptacle, a power inlet (motor attachment cap), or other component that is handled by the user shall be mounted securely and shall be prevented from turning. See [14.3](#).

Exception: The requirement that a switch be prevented from turning may be waived if all four of the following conditions are met:

- a) The switch is of a plunger, slide, or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during operation of the switch;*
- b) The means of mounting the switch makes it unlikely that operation of the switch will loosen the switch;*
- c) Spacings are not reduced below the minimum acceptable values and there is no stress on internal wiring or terminals of internal wiring if the switch moves; and*
- d) Intended operation of the switch is by mechanical means rather than by direct contact by persons.*

8.2 The means by which the turning mentioned in [8.1](#) is prevented is to consist of more than friction between surfaces – for example, a lock washer, properly applied, is acceptable as the means to prevent turning of a device having a single-hole mounting means.

8.3 If a factory installed part of an appliance is normally removed from the appliance by the installer to convert the appliance from one type of installation to another, (for example, counter top installation to built-in), and the part is not replaced during such conversion, the appliance shall, with the part removed, comply with all requirements in this standard that apply to all types of installation for which the appliance is intended.

9 Protection Against Corrosion

9.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if corrosion of such parts would be likely to result in a risk of fire, electric shock, injury to persons, or excessive radiation emission.

Exception: This requirement does not apply to bearings, laminations, or minor parts of iron or steel, such as washers or screws. The sheath of a heating element need not be protected against corrosion.

9.2 If the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast iron parts within an enclosure may not be required to be protected against corrosion.

10 Interlocks

10.1 Opening the door of a microwave cooking appliance shall operate a minimum of two door interlocks. At least one door interlock on a fully assembled microwave oven shall not be operable by any part of the human body, or any object with a straight insertable length of 3.9 in (99.6 mm). Such an interlock shall also be concealed (not within line-of-sight), unless its actuation is prevented when access to the interlock is possible. Any visible actuator or device to prevent actuation of this interlock shall not be removable without disassembly of the oven or its door. For magnetically operated interlocks see [57.1](#) and [57.2](#) also.

10.2 The interlocks designated as primary and secondary shall prevent microwave radiation emission in excess of the requirements in [39.1.1](#) for the primary and secondary interlocks under the normal operating conditions described in this standard.

11 Interlock Monitors

11.1 An interlock monitor circuit shall be provided as part of the microwave cooking appliance and shall comply with the applicable constructional requirements of [11.2](#) – [11.4](#), and test requirements in Interlock Monitor Circuit Test, Section [49](#).

11.2 An interlock monitor circuit component or system shall not serve as one of the door interlocks. Door interlock malfunctions shall not disrupt the monitoring function of the interlock monitor circuit.

Exception: With reference to the first sentence of [11.2](#), a multiple circuit switch employing separate contact sets serving as door interlock and monitor switches may be acceptable provided:

- a) The presence of the interlock contact set does not increase the probability of malfunction of the monitoring function of the monitor contact set; and*
- b) There are no common-mode malfunctions that could lead to or result in malfunction of the monitoring function of the monitor contact set and an unacceptable operation of the interlock, unless there are at least two other operable door interlocks in the appliance.*

11.3 Any overcurrent device or fusible element necessary for proper operation of a monitor circuit, such as a crowbar circuit, shall be provided in the appliance and located where it is not accessible to the user without the use of tools.

11.4 The means of monitoring one or both of the required interlocks shall cause the microwave generator of a microwave cooking appliance to become inoperable until the appliance is serviced by qualified service personnel if any interlock being monitored fails to perform its required function with all other control devices in the monitor circuit set to the closed position. Instructions for servicing associated with the

operation of the interlock monitor shall be provided for the serviceman, but shall not be provided for the user as part of the user operating instructions packaged with the product. See [76.2](#).

12 Polymeric Materials

12.1 Polymeric materials employed in the construction of gaskets, spacers, dielectric media of wave traps, or other structural parts of a microwave cooking appliance shall be investigated for the application if the partial or total deterioration of such parts could result in microwave radiation emission exceeding the limits specified in [39.1.1](#).

12.2 Compliance with [12.1](#) is determined by subjecting the specific construction to the test described in [45.1.1](#) – [45.5.7](#) and [48.1.1](#) – [48.4.1](#).

12.3 A polymeric material enclosure of electrical parts shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, as applicable to polymeric enclosures.

Exception No. 1: A minimum impact of 5 ft-lbf (6.8 J) shall apply to all microwave cooking appliances when determining the impact resistance of a polymeric material enclosure of live parts.

Exception No. 2: An enclosure of Class 2 circuits – see Secondary Circuits, Section [32](#) – shall be treated as a decorative part, see [12.6](#).

Exception No. 3: For the abnormal operation and severe conditioning test of UL 746C, the appliance enclosure is to be evaluated under the abnormal operation tests specified in Abnormal Operation Tests, Section [54](#), and Potato Fire Containment Test, Section [64A.2](#), of this standard.

12.4 A polymeric material that only limits access to microwave energy-containing spaces to comply with [5.8](#) and [5.9](#), and does not serve to retard propagation of flame initiated within appliance, or to prevent accessibility to parts which may present risk of electric shocks and injury, shall comply with the following:

- a) Impact Test – In accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. An impact of 2 ft-lbf (2.7 J) is to be applied. As a result of this test, the appliance shall comply with [5.8](#) and [5.9](#);
- b) Mold Stress-Relief Distortion – In accordance with UL 746C. As a result of this test, the appliance shall comply with [5.8](#) and [5.9](#);
- c) Abnormal Conditions – See Abnormal Operation Tests, Section [54](#); and
- d) Flammability – The material shall be classed as minimum HB, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

12.5 When determining compliance with the enclosure requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C:

- a) A microwave cooking appliance is to be considered an unattended, stationary appliance;
- b) A microwave oven intended for indoor use shall be considered subject to normal room temperature environmental conditions.

12.6 Decorative parts of or on the electrical enclosure constructed of polymeric materials shall comply with the flammability requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, as applicable to decorative parts of enclosures.

Exception No. 1: Polymeric materials that are located entirely external to a metallic enclosure of the appliance need not be classed HB minimum, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, provided:

- a) The metallic enclosure complies with the requirements in [5.5](#); and*
- b) The polymeric material does not cover any openings in the metallic enclosure.*

Exception No. 2: Polymeric parts not more than 0.010-in (0.25-mm) thick need not be classed HB, minimum.

12.7 Except where superseded by other requirements in this standard, polymeric materials shall have a flammability classification of HB minimum, when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 1: Materials covered by one or more of the exceptions to [12.6](#) need not be classed HB, minimum.

Exception No. 2: Parts of a fixed or stationary appliance are not required to be made of a material classed HB, minimum, provided the part does not occupy a volume greater than 0.24 in³ (4 cm³), does not have any dimension greater than 2.4 in (60.1 mm), and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

12.8 Polymeric materials that serve as direct or indirect support of live parts, or an electrical or mechanical barrier shall comply with the requirements for electric insulation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. An impact of 5 ft-lbf (6.8 J) is to be used for the applicable tests.

12.8.1 Polymeric material within 50 mm of any ignition source specified in [2.21.1](#) shall meet the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94 V0 minimum.

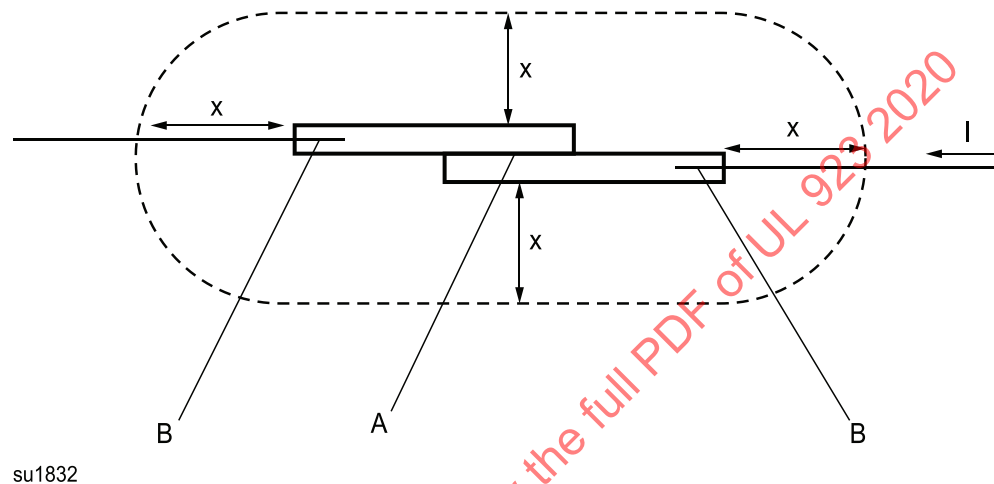
Exception No. 1: Polymeric material may be HB minimum, provided the part does not occupy a volume greater than 0.122 in³ (2 cm³), does not have any dimension greater than 2.4 in (60.1 mm), and is located so it cannot propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

Exception No. 2: Polymeric materials may be HB minimum, provided that the unit fails safe and the material is ignited during the applicable Forced Failure Fire Containment Tests of the ignition source in Section [64A](#).

Exception No. 3: Polymeric materials may be HB minimum, provided that a metal sub-enclosure houses the ignition source fully and has a thickness as specified in [5.5](#) provided:

- a) The polymeric material does not cover any openings in the metallic enclosure other than those of minimum size for the passage of the display, control shaft or rods; and*
- b) All other openings shall be judged on the basis of the necessity for their existence. On any one surface, the minor dimension of an opening shall not exceed 3/8 in (9.5 mm) and the maximum area shall not exceed 0.25 in² (161 mm²). The area may be increased to a maximum of 1.0 in² (645 mm²) if a barrier of metal or 5V material is secured in place and interposed between ignition sources and flammable material. In any case, the maximum aggregate area of all openings in any one surface shall not exceed 1.0 in².*

Figure 12.1
Definition of “within 3 mm of an electrical connection”



su1832

“Within 3 mm of an electrical connection” means falling within the dotted boundary formed by the cylinder with hemispherical ends, as shown in the above drawing.

A – Terminal connection zone

B – Wire crimp connection zone

I – Current through the connection

X – Distance from the connection

12.8.2 With reference to [12.8.1](#), polymeric materials located within 3 mm of an electrical connection where the total circuit load is greater than 60 watts during normal operation shall have a flammability classification as follows:

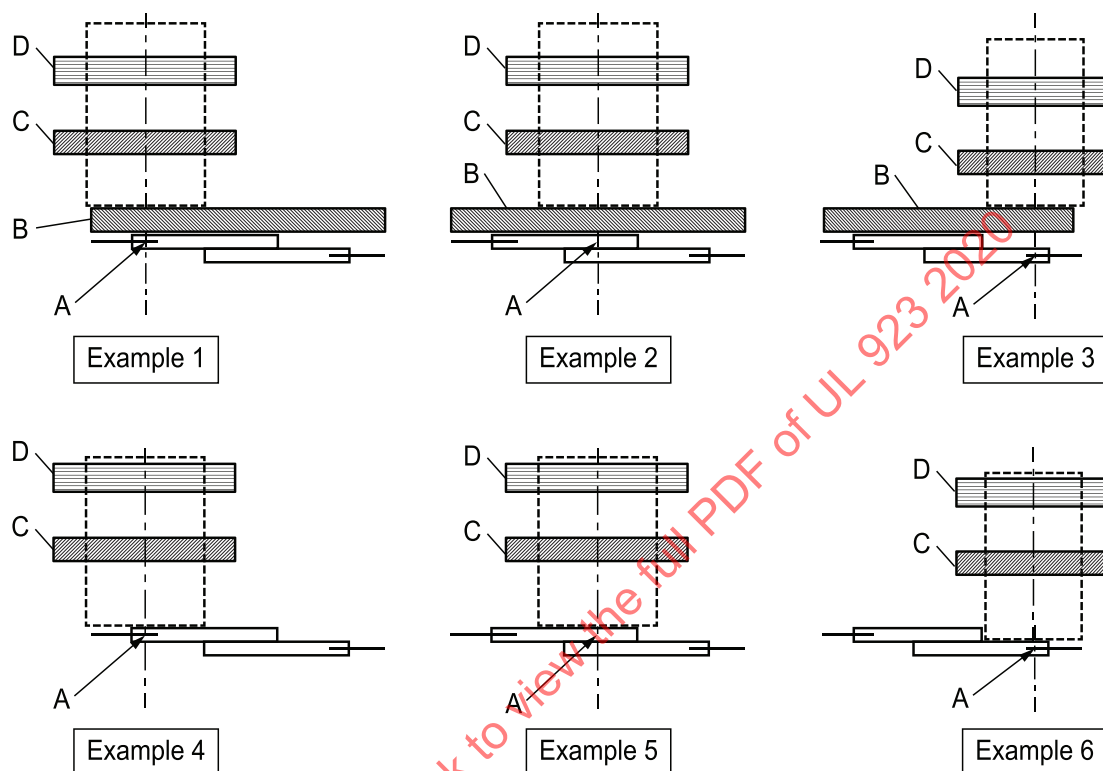
- a) A minimum V-0 or VTM-0, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, or
- b) A minimum SC-0 or SCTC-0, in accordance with the Standard for Tests for Flammability of Small Polymeric Component Materials, UL 1694, or
- c) A minimum glow wire ignition temperature (GWIT) of 775°C according to Fire Hazard Testing – Part 2-13: Glowing/Hot-wire Based Test Methods – Glow-wire Ignition Temperature (GWIT) Test Method for Materials, IEC 60695-2-13, or
- d) The material withstands the glow-wire test (GWT) according to Fire Hazard Testing – Part 2-11: Glowing/Hot-wire Based Test Methods – Glow-wire Flammability Test Method for End-products (GWEPT), IEC 60695-2-11 with a minimum test severity of 750°C, and during the test, flames persists for no longer than 2 seconds.

12.8.3 With reference to [12.8.1](#), all polymeric materials located within the envelope of a vertical cylinder having a diameter of 20 mm and a height of 50 mm, placed above the center of the connection zone and on top of the polymeric parts that are supporting current-carrying electrical connections where the total circuit load is greater than 60 watts during normal operation shall have a flammability classification as follows:

- a) A minimum of V-0, VTM-0, or HF-1, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and Fire Hazard Testing – Part 11-10: Test Flames – 50 W Horizontal and Vertical Flame Test methods, IEC 60695-11-10, or
- b) A minimum of SC-0 or SCTC-0, in accordance with the Standard for Tests for Flammability of Small Polymeric Component Materials, UL 1694, or
- c) A minimum VW-1 for wire, tubing, sleeving and tape in accordance with [16.1.2.1](#).

12.8.4 With reference to [12.8.3](#) and [Figure 12.2](#), the flame cylinder shall be placed above the center of each connection zone and on top of any polymeric parts that are supporting current-carrying connections as shown in Examples 1-3 of [Figure 12.2](#). In the case of uninsulated connections, the flame cylinder shall be placed above the center of each connection zone and directly on top of current-carrying conductors as shown in Examples 4-6 of [Figure 12.2](#). The flame cylinder shall project through all metallic and non-metallic material. If “C” is intended to act as a barrier to “D”, then the adequacy of the barrier shall be demonstrated by testing as described in Nichrome Wire Ignition Tests, Section [64A.6](#).

Figure 12.2
Placement of flame cylinder



su1833

- A – Center of connection zone
- B – Non-metallic material supporting current carrying connection
- C – Metallic or non-metallic material
- D – Metallic or non-metallic material

12.9 An adhesive material that is used to secure a portion of an enclosure, electrical or thermal insulation, an electrical component, an internal barrier (such as film, door screen, or the like), a mechanical component of a door interlock system, or a part that affects the routing of a cooling air stream shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: An adhesive need not comply with the requirements in UL 746C if the appliance complies with all of the requirements in this standard under all conditions of complete or partial failure of the adhesive.

12.10 With respect to [12.9](#), the as-received bond strength of the adhesive shall be not less than four times the strength necessary to perform its intended function, but in no case shall the as-received bond strength be less than 2 lbf/in². For an adhesive used with a flexible substrate, the as-received bond strength shall be not less than 2 lbf/in width.

12.11 With respect to [12.9](#), adhesive test samples shall be subjected to temperature, humidity, and cyclic conditioning. In addition, adhesive materials that may be exposed to food or cooking vapors during normal operation shall be subjected to corn oil exposure conditioning consisting of ten specimen samples immersed in corn oil for 7 days at the maximum adhesive temperature measured during the test specified in Temperature Test, Section [41](#).

12.12 A polymeric duct or grill that prevents exhaust air from venting into a concealed space of a building structure (see [5.7](#)) shall comply with the following tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. As a result of these tests there shall not be cracking, warpage, or other distortion to the extent that a solid 18 AWG (0.82 mm²) uninsulated wire can be inserted into any opening in the duct or grill.

a) ENCLOSURE IMPACT – When conducting the Resistance to Impact test, an impact of 2 ft-lbf (2.7 J) is to be applied to any surface that is exposed to a blow during normal use (not including during installation). A grill, and a duct provided as part of a counter top appliance and intended to become part of the built-in ductwork, are examples of surfaces exposed to a blow during normal use.

b) MOLD STRESS-RELIEF DISTORTION – Mold stress-relief distortion tests are required for all applications. However, a repeated input test after the Mold Stress-Relief Distortion Test is not required.

c) ABNORMAL OPERATION – For the abnormal operation and severe conditions tests, the material is to be investigated for compliance with the Abnormal Operation Tests, Section [54](#).

d) FLAMMABILITY – The duct assembly shall be subjected to the 500 w (125 mm) Vertical Burning Test, or shall have a flammability classification of 5VA (as classed by the vertical burning rate test described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94). A duct or grill that only exhausts air other than oven cavity exhaust shall have a flammability classification of 5VA.

Exception: A polymeric duct or grill that exhausts air directly from the oven cavity is not prohibited from having a flammability classification of V-0 (as classed by the vertical burning rate test described in UL 94) when the appliance is provided with a manual reset temperature limiting control or a thermal cutoff that is located adjacent to the duct or grill, complies with the applicable requirements for appliance limit controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, or in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9; or with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691, and functions to de-energize the entire appliance when subjected to the Potato Fire Containment Test, Section [64A.2](#), with the

potato or potatoes located as close to the duct or grill as possible. See [59.1](#) for the applicable manual reset control endurance test.

12.13 A duct or grill as described in [12.12](#) may be part of the appliance or provided as a separately supplied accessory intended for field installation in or on the appliance to convert it from a counter top installation to a wall-mounted or built-in installation. The duct or grill, including a separately supplied accessory, is to be mounted as intended during the tests specified in [12.12](#).

13 Supply Connections

13.1 Permanently-connected appliances

13.1.1 General

13.1.1.1 A microwave appliance intended for permanent connection to the power supply shall be so constructed that it can be readily and permanently connected to one of the wiring systems that, in accordance with the National Electrical Code, ANSI/NFPA 70, would be acceptable for the appliance.

13.1.1.2 An appliance intended to be built-in or recessed may be provided with 3 – 8 ft (0.91 – 2.44 m) of flexible metal conduit with leads and a grounding conductor installed to facilitate servicing and installation. The flexible conduit need not terminate in an outlet box at the free end but an antishort bushing is to be installed and retained reliably.

13.1.1.3 Sheet metal to which a wiring system is to be connected in the field, shall have a thickness of not less than that specified in [Table 5.1](#).

13.1.1.4 A wiring compartment for field-wiring connections shall be of size to accommodate such connections.

13.1.1.5 If inspection indicates a compartment volume may not be large enough to accommodate the intended wiring, a trial installation is to be made using wires of the size indicated in [13.1.2.1](#) and conduit and fittings sized for the wire in accordance with the National Electrical Code, ANSI/NFPA 70.

13.1.1.6 The location of a terminal box or compartment in which branch-circuit connections to a permanently wired appliance are to be made shall be such that these connections can be readily inspected without disturbing the wiring or the appliance after the appliance has been installed as intended. See also [13.1.1.7](#).

13.1.1.7 An outlet or terminal box mounted integrally with a permanently connected, built-in or wall-mounted, microwave cooking appliance shall be so located that the power-supply connections can be inspected without the necessity of moving the appliance to the extent that it will not be supported by the building structure only.

13.1.1.8 No electrical component shall be mounted on a part that must be removed for the examination of field-wiring connections.

13.1.1.9 A terminal compartment intended for connection of a supply raceway shall be so attached to the appliance as to be prevented from turning with respect thereto.

13.1.2 Field wiring terminals and leads

13.1.2.1 A microwave cooking appliance intended for permanent connection to the power supply shall be provided with wiring terminals or leads for the connection of conductors. Each terminal or lead shall be

sized for connection of a branch-circuit conductor having an ampacity equal to or greater than the noncontinuous load plus 125 percent of the continuous load.

13.1.2.2 Pigtail leads provided for connection to the branch-circuit supply shall have an ampacity not less than that of the conductor of the next smaller size than that appropriate for the rating of the appliance. See [13.1.2.3](#).

13.1.2.3 For the purpose of these requirements it is assumed that 60°C (140°F) wire will be installed, unless the appliance is marked in accordance with [73.2](#), [73.3](#), and [73.4](#).

13.1.2.4 If terminals of unequal sizes are provided because of unbalanced loads, each terminal shall be sized to accept a conductor as in [13.1.2.1](#), but based on the total current that will be carried by the conductor connected to that terminal. See [71.1.6](#) and [73.3](#).

13.1.2.5 A field-wiring terminal or lead for connection of an equipment-grounding conductor shall be provided.

13.1.2.6 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size acceptable for the particular application, in accordance with the National Electrical Code, ANSI/NFPA 70. See [13.1.2.8](#).

13.1.2.7 The surface of an insulated lead intended for the connection of an equipment-grounding conductor shall be green, with or without one or more yellow stripes, and no other lead shall be so identified.

13.1.2.8 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of the equipment grounding conductor shall be marked in accordance with [71.1.4](#). The wire-binding screw or pressure wire connector shall be so located that it does not require removal during the servicing of the appliance not involving the disconnecting of the supply conductors. Sheet-metal screws shall not be used for connection of equipment grounding conductors to enclosures at field wiring connections.

13.1.2.9 The free length of a lead inside an outlet box or field-wiring compartment shall be 6 in (152 mm) or more.

Exception: A lead may be less than 6 in (152 mm) in length if it is evident that the use of a longer lead might result in a risk of fire or electric shock.

13.1.2.10 A field-wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces. This may be accomplished by two screws or rivets, by square shoulders or mortises, by a dowel pin, lug or offset, by a connecting strap or clip fitted into an adjacent part, or by some other equivalent method.

13.1.2.11 A field-wiring terminal shall be provided with a soldering lug or pressure wire connector firmly bolted or held by a screw.

Exception: A wire-binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm²) or smaller conductor if upturned lugs, cupped washers or the equivalent are provided to hold the wire in position.

13.1.2.12 Upturned lugs or a cupped washer shall retain a power-supply conductor corresponding in size to that mentioned in [13.1.2.1](#), but not smaller than 14 AWG (2.1 mm²), under the head of the screw or the washer.

13.1.2.13 A wire-binding screw at a wiring terminal shall not be smaller than No. 10 (4.8 mm diameter). The threads shall not be finer than that of the National Fine Thread Series for the screw size.

Exception: A No. 8 (4.2 mm diameter) screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm²) or smaller conductor, and a No. 6 (3.5 mm diameter) screw may be used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm²) control-circuit conductor.

13.1.2.14 14 AWG (2.1 mm²) is the smallest conductor that can be used for branch-circuit wiring and thus is the smallest conductor that is to be anticipated at a terminal for connection of a branch-circuit conductor.

13.1.2.15 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050-in (1.27-mm) thick except that a plate not less than 0.030-in (0.76-mm) thick is acceptable if the tapped threads have equivalent mechanical strength. There shall not be less than two full threads in the metal of the plate.

13.1.2.16 A terminal plate formed from stock having the minimum acceptable thickness mentioned in [13.1.2.15](#) may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

13.1.2.17 A field-wire connected appliance rated 125 or 125/250 V (3-wire) or less shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit.

13.1.2.18 A field-wiring terminal intended for the connection of a grounded-supply conductor shall be substantially white in color and shall be easily distinguishable from the other terminals, or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram. If wire leads are provided instead of terminals, the surface of the lead intended to be connected to the grounded supply circuit conductor shall be finished to show white or grey color and shall be easily distinguishable from the other leads.

13.2 Cord-connected appliances

13.2.1 General

13.2.1.1 A cord-connected microwave cooking appliance (an appliance intended to be connected to the power-supply circuit by means of a flexible cord) shall be provided with a length of attached flexible cord and an attachment plug for connection to the supply circuit. The type of flexible cord shall be as indicated in [Table 13.1](#), or shall have such properties that it will be at least equally serviceable for the application. The length of attached cord shall be within the limits indicated in [Table 13.2](#).

Table 13.1
Acceptable types of cord and applicable limitations on their use

Appliance on which the cord is to be used	Cords acceptable where temperatures are more than 121°C (250°F) on any surface that the cord is likely to touch when the appliance is used as intended	Cords acceptable where temperatures are 121°C (250°F) or less on any surface that the cord is likely to touch when the appliance is used as intended
Household except built-in and wall mounted	HPN, HSJ, HSJO, or HSJOO	HPN, HSJ, HSJO, HSJOO, SP-2, SPE-2, SPE-3 ^a , SPT-2 ^a , SPT-3 ^a , SV, SVE, SVO, SVOO, SVT, SVTO, SVTOO, SJ, SJO, SJOO, SJT, SJTO, or SJTOO
All commercial and built-in and wall mounted household	HSJ, HSJO, or HSJOO	HSJ, HSJO, HSJOO, S, SE, SO, SOO, ST, STO, STOO, SJ, SJO, SJOO, SJT, SJTO, SJTOO
^a SPT-2, SPT-3, and SPE-3 cords are acceptable only for appliances not likely to be moved frequently. An SPT-2, SPT-3, or SPE-3 cord is not acceptable on microwave cooking appliances provided with rolling carts, or similar accessories that provide mobility, which are provided by the manufacturer, or described in the manufacturer's literature.		

Table 13.2
Lengths of cord connection

Type of microwave cooking appliance	Minimum acceptable length ^a		Maximum acceptable length ^a	
	ft	(m)	ft	(m)
Household, except appliances intended for only wall mounting	4.5 ^b	(1.37) ^b	7.0	(2.13)
Household, wall mounted	3.0 ^b	(0.91) ^b	7.0	(2.13)
Commercial except floor mounted	2.0	(0.61)	6.0	(1.83)
Commercial, floor mounted	3.0	(0.91)	6.0	(1.83)
^a Measured external to the appliance and including the fittings but excluding the blades on the attachment plug.				
^b The supply cord may be a minimum of 2 ft (610 mm) if a marking or instructions are provided in accordance with 73.13 .				

13.2.1.2 The current rating of the cord and fittings of an appliance shall not be less than the current rating of the appliance. For an appliance rated more than 15 A and which will operate continuously (3 h or more), the current rating of the attachment plug shall not be less than 125 percent of the current rating of the appliance.

Exception: An attachment plug rated 20 A is acceptable for an appliance rated at not more than 4000 W at 240 V.

13.2.1.3 The voltage rating of the cord shall not be less than the voltage rating of the appliance. The voltage rating and blade configuration of the fittings shall be such that the appliance can be connected to the proper supply source (voltage, phase, and the like).

13.2.1.4 Supplementary insulation employed on a flexible cord shall not extend more than 1/2 in (12.7 mm) outside the appliance (unless provided with additional mechanical protection), and shall be prevented from fraying or unraveling, and shall not affect adversely the means of providing strain relief.

13.2.1.5 A power supply cord shall comply with the requirements in the Standard for Cord Sets and Power-Supply Cords, UL 817.

13.2.2 Strain relief

13.2.2.1 Strain relief shall be provided so that a mechanical stress on a flexible cord will not be transmitted to terminals, splices, or interior wiring. Means shall be provided for preventing the cord from being pushed into the appliance, if such displacement is likely to subject the cord to mechanical damage or to a temperature higher than that for which it is rated or can reduce spacings (such as to a metal strain-relief attachment) below the minimum acceptable values.

13.2.2.2 A knot shall not be employed to provide strain relief.

13.2.2.3 When tested in accordance with [13.2.2.4](#) the strain relief shall withstand for 1 min, without displacement, a direct pull of 35 lbf (156 N) applied to the cord with the connections within the appliance disconnected.

13.2.2.4 The specified force is to be applied to the cord so that the strain-relief means will be stressed from any angle that the construction of the appliance permits. The means of affording strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress would have resulted on the connections. The cord shall not have internal displacement lengthwise by more than 0.078 in (2 mm).

13.2.3 Bushings

13.2.3.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall be secured in place, and shall have a smooth, well-rounded surface against which the cord may bear. If Type SP-2, SPE-2, SPT-2, or other cord lighter than Type HSJ is employed, if the wall or barrier is of metal, and if the construction is such that the cord may be subjected to strain or motion, an insulating bushing shall be provided. The heat- and moisture-resistant properties of the bushing material shall be such that the bushing is acceptable for the particular application.

13.2.3.2 If the cord hole is in wood, porcelain, phenolic composition, or other nonconducting material, a smooth, well-rounded surface is considered to be equivalent to a bushing.

13.2.3.3 Ceramic materials and some molded compositions are acceptable generally for insulating bushings, but a separate bushing of wood, hot-molded shellac and tar composition, or rubber material is not acceptable.

13.2.3.4 Vulcanized fiber may be employed if the bushing is not less than 3/64-in (1.2-mm) thick and is so formed and secured in place that it will not be affected adversely by conditions of ordinary moisture and temperature.

13.2.3.5 An insulated metal grommet may be accepted in place of an insulating bushing if the insulating material used is not less than 1/32-in (0.8-mm) thick, and completely fills the space between the grommet and the metal in which it is mounted.

14 Live Parts

14.1 Each current-carrying part shall be made of metal that is acceptable for the particular application.

14.2 A current-carrying part made of a corrosion-resistant ferrous alloy (for example, stainless steel) is acceptable regardless of temperature. A current-carrying part made of ordinary iron or steel is not acceptable unless it is rendered corrosion-resistant by an appropriate coating and, even then, it is acceptable only in the construction of the following parts:

- a) A part within a motor and its governor (if any),
- b) A part that operates at a temperature higher than 100°C (212°F) during the test in accordance with Temperature Test, Section [41](#),
- c) A coated iron or coated steel part of a component that the requirements referred to in [4.1](#) indicate as being acceptable,
- d) A part in a nonsafety isolated secondary circuit provided the coating consists of a copper underplate and tin or nickel overplate, or
- e) A part in a safety or line connected circuit that complies with the requirements in Salt Spray Corrosion Test, Section [63](#).

14.3 Uninsulated live parts shall be so secured to the base or surface that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacing below the minimum values specified in Spacings, Section [30](#), or stress internal wiring, or terminals of internal wiring.

14.4 Friction between surfaces is not acceptable as a means to prevent shifting or turning of live parts; but a lock washer properly applied is acceptable.

15 Polarization

15.1 If an appliance is connected to a circuit that incorporates a grounded conductor, the screw shells of lampholders shall be connected:

- a) To the grounded circuit conductor or terminal of a permanently connected appliance, or
- b) To the grounded circuit conductor of the supply cord of a cord-connected appliance.

15.2 If there is no grounded conductor, as mentioned in [15.1](#) and if two lampholders are connected in series, the lampholder screw shells shall be common and the center contacts of the lampholders shall be connected toward the supply.

15.3 The following primary circuit components shall be connected to or cause the opening of an ungrounded conductor of the supply circuit:

- a) Fuseholder,
- b) Single-pole overcurrent protective device,
- c) Single-pole switch with a marked off position, and
- d) Automatic control with a marked off position.

15.4 The screw shell of a plug-type fuseholder and the accessible contact of an extractor-type fuseholder shall be connected toward the load.

16 Internal Wiring

16.1 General

16.1.1 Internal wiring composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758. Wire employed for the internal wiring of an appliance shall be acceptable for the particular application.

Exception No. 1: Insulated conductors need not comply with UL 758 if they comply with one of the following:

- a) The Standard for Thermoset-Insulated Wires and Cables, UL 44;*
- b) The Standard for Thermoplastic-Insulated Wires and Cables, UL 83; or*
- c) The applicable UL standard(s) for other insulated conductor types specified in Chapter 3, Wiring Methods and Materials, of the National Electrical Code, ANSI/NFPA 70.*

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

Exception No. 3: The high voltage transformer filament winding lead need not comply with UL 758 if the filament winding lead was evaluated with the transformer insulation system according to the Standard for Systems of Insulating Materials – General, UL 1446.

16.1.2 Among the factors considered when determining the acceptability of internal wiring, tubing, sleeving or tape are the flame rating, temperature and voltage to which it may be subjected during normal operation.

16.1.2.1 All internal wiring, tubing, sleeving or tape shall possess a VW-1 flame rating or comply with the Standard for Vertical Flame Test described in the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

Exception No. 1: If solid conductor internal wirings are used as filament winding or secondary output wirings of high voltage transformer they are not required to be VW-1 provided that they are routed away from dead metal parts, wiring or uninsulated live parts of other circuits in [32.3](#), the voltage suitability of this internal wiring, may be judged under Dielectric Voltage Withstand Test, Section [44](#).

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in an extra low-voltage circuit not involving the risk of fire, electric shock or injury to persons need not comply with VW-1 provided it complies with the Standard for Appliance Wiring Material, UL 758 or the Standard for Metal-Clad Cables, UL 1569.

Exception No. 3: Glass fiber beads of inorganic material, or the equivalent, employed as conductor insulation need not comply with this requirement.

16.1.3 There is no temperature limit applicable to glass fiber, beads of inorganic material, or the equivalent, employed as conductor insulation.

16.1.4 The wiring and electrical connections between parts of an appliance shall be protected or enclosed. Wiring and connections in circuits other than those covered in Secondary Circuits, Section [32](#), shall not be subject to handling during routine user servicing.

Exception: A length of flexible cord of a type specified in [Table 13.1](#) shall be employed for external connections between parts if flexibility is essential.

16.1.5 With reference to exposure of internal wiring, the protection of wiring required in [16.1.4](#) is considered to exist, if, when considered as if it were enameled wire, the wiring would be acceptable according to [6.2](#) – [6.6](#).

16.1.6 Internal wiring not so protected may be accepted if it is so secured within the enclosure that neither it nor related electrical connections can be subjected to stress or mechanical damage. All wiring that is accessible to the operator is to be clamped or otherwise secured to prevent it from being unintentionally hooked, and the like.

16.1.7 No open wiring – that is wiring that is not separately and immediately enclosed in conduit, armored cable, metal raceway, or the like – shall be located where it is likely to be contacted during operator servicing or cleaning. For example, no wiring shall be located where it must be moved to replace fuses, operate a circuit-breaker handle, or adjust a manually reset control.

16.1.8 Wires within an enclosure, compartment, raceway, or the like shall be so disposed or protected that no damage to conductor insulation can result from contact with any rough, sharp, or movable part.

16.1.9 An appliance shall be so constructed that wires can be pulled through, or the appliance otherwise wired, without injuring the coverings or insulation on the conductors. A wireway shall be free from burrs and fins.

16.1.10 With reference to the requirement in [16.1.9](#), male screw threads shall not be exposed anywhere inside a raceway or wireway where wire is pulled.

16.1.11 Internal wiring, insulating tubing or sleeving, and electrical components shall be so located that they will not be exposed to the vapors from a vented oven cavity of the appliance.

Exception No. 1: This requirement does not apply to polyvinylchloride and similar moisture- and oil-resistant insulated wires and insulating tubing.

Exception No. 2: This requirement does not apply to the heater portion of an open-wire type heating element when the electrical spacings at the parts exposed to the vapors are at least twice the minimum specified in [Table 30.2](#).

Exception No. 3: This requirement does not apply to electrical components, wiring, and the like employed in nonsafety Class 2 circuits as described in Secondary Circuits, Section [32](#).

Exception No. 4: Unenclosed live parts of components, such as terminals, connectors, and the like, need not comply with this requirement if electrical spacings of the unenclosed parts are at least twice the minimum specified in [Table 30.2](#).

Exception No. 5: This requirement does not apply to unenclosed contacts of components not relied upon to comply with the performance requirements of this standard.

Exception No. 6: This requirement does not apply to electrical components when live parts, including film-coated wire, are enclosed and not adversely affected by moisture when the appliance is tested in accordance with Moisture Conditioning Test, Section [51](#).

Exception No. 7: Internal spacings within the enclosure of a component (such as within the case of a relay or switch) are to be evaluated in accordance with the requirements that cover that component.

16.1.12 A hole, through which insulated wires pass in a sheet-metal wall within the overall enclosure of the appliance, shall be provided with a smooth, rounded bushing or shall have smooth surfaces upon which the wires may bear to prevent abrasion of the insulation. A flexible cord used for external interconnection as mentioned in [16.1.4](#) shall be provided with bushings and strain relief in accordance with [13.2.2.1](#) – [13.2.3.5](#) unless the construction is such that the cord will be protected from stress or motion.

16.1.13 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of the appliance.

16.2 Splices and connections

16.2.1 All splices and connections shall be mechanically secured and shall provide good electrical contact.

16.2.2 A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in risk of fire, electric shock, or excessive radiation emission.

16.2.3 A wire inserted into a hole in a terminal is considered to be mechanically secure whether or not it is bent before soldering.

16.2.4 Any flexing or movement of internal wiring in an appliance that occurs during the normal cooking or a routine user-servicing function shall not result in stress on electrical connections.

16.2.5 A splice shall be provided with insulation unless permanence of spacing between the splice and other metal parts of the appliance is provided.

16.2.6 Stranded internal wiring shall be so connected to a wire-binding screw or stud-terminal that no loose strands result.

16.2.7 At a wire-binding screw, use of upturned ends or lugs, a cupped washer, barriers, or other equivalent means to hold the wires under the head of the screw is suitable for compliance as long as no loose strands are exposed. Other acceptable means of retaining the stranded internal wiring in position are use of a pressure terminal connector, soldering lug, or crimped eyelet.

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

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

Exception No. 2: A connector that complies with UL 310 may be used with an appropriately sized tab that complies with the material, configuration, and dimensional requirements for production tabs as specified in UL 310. The connector is the part of a quick-connect terminal that is pushed onto the male tab, and the tab is the part that receives the female connector.

16.2.9 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B.

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

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

Exception: A Class 2 connector, located in a low-voltage circuit not involving the risk of fire, electric shock or injury to persons, need only be subjected to applicable requirements of this end product standard.

16.2.12 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459.

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

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

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of Mechanical Assembly, Section 8; Live Parts, Section 14; Electrical Insulation, Section 18; and Spacings, Section 30 of this end product standard. This exception does not apply to protective conductor terminal blocks.

17 Heating Elements

17.1 A heating element shall be supported in a reliable manner. It shall be protected against mechanical damage and contact with outside objects.

17.2 A movable heating element shall be protected against damage caused by contact with other parts of the appliance when the element is moved. See Mechanical Endurance Test, Section 50.

17.3 An exposed open-wire element in an appliance shall not be accessible to contact by the user. See 6.1.

17.4 An appliance in which the heating element is intended for use only in an air blast shall be so wired or controlled that the element can be operated only when under the cooling effect of the blast. An appliance in which the cooling effect of the motion of a part is necessary to prevent excessive temperature shall be so wired or controlled that the heating element cannot be operated in the absence of such motion.

17.5 A microwave cooking appliance employing thermal heating elements or similar auxiliary heating element such as a resistive element, halogen or quartz lamp for browning or convection cooking shall be subjected to the tests specified in 54.5.1 and 54.5.2.

17.6 An appliance provided with a self-cleaning feature shall comply with the requirements in 27.1.7 – 27.1.10 and Sections 78 – 98.

17.7 An appliance employing thermal heating elements (sheathed, open-wire, and/or halogen lamps) shall be provided with a power-on indicator. The power-on indicator shall be readily visible in each intended installation configuration. The power-on indicator shall be readily distinguishable from any off position indicator and from all other control feature indicators by color, location, or the like.

17.8 The power-on indicator may be of an illuminated or nonilluminated type. The power-on indicator shall remain readily visible during any operating condition (including cycling of a thermostat) whenever the appliance is operated in a mode of operation where a thermal element may be energized.

17.9 Thermistor-type heaters (e.g. PTC heaters) shall comply with the Standard for Thermistor-Type Devices, UL 1434.

18 Electrical Insulation

18.1 General

18.1.1 An insulating washer, a bushing, a lining, a barrier, and the like that is an integral part of an appliance and a base or a support for the mounting of live parts shall be of a moisture-resistant material that will not be adversely affected by the temperatures to which it will be subjected under conditions of actual use.

18.1.2 Insulating material is to be judged with respect to the particular application. Materials such as mica, some molded compounds, and certain refractory materials are usually acceptable for use as the sole support of live parts. Some other materials that are unacceptable for general use, such as magnesium oxide, may be acceptable if used in conjunction with other insulating materials or if so located and protected that mechanical damage is prevented and the absorption of moisture is minimized.

18.1.3 When it is necessary to investigate a material to determine whether it is acceptable, consideration is to be given to its mechanical strength, dielectric properties, insulation resistance, heat-resistant qualities, the degree that it is enclosed or protected, and any other features having a bearing on the risk of fire, electric shock, and injury to persons involved, in conjunction with conditions of actual service. All of these factors are to be considered with respect to thermal aging.

18.1.4 Thermoplastic material is not usually determined to be capable of being used for the sole support of uninsulated live parts. However, such material is not prohibited from being employed when determined to have the required mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric-voltage withstand, and other appropriate properties as indicated in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

18.1.5 Screws or other fastenings used to mount or support small, fragile, insulating parts shall not be so tight as to crack or break such parts with expansion and contraction. Generally, such parts should be slightly loose.

18.1.6 Electrical insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510.

18.1.7 Electrical insulating sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441.

18.1.8 Electrical insulating tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

18.2 Printed wiring board

18.2.1 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796. A printed-wiring board shall be rated V-1 or better and shall with the direct-support requirements for insulating materials in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C.

Exception: A printed-wiring board containing Class 2 non-safety circuit only is required to comply with the Standard for Printed-Wiring Boards, UL 796 with flammability rating of HB or better.

18.2.2 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

18.3 Film-coated wire (magnet wire)

18.3.1 The component requirements for film coated wire and Class 105 (A) insulation systems are not specified.

18.3.2 Film coated wire in intimate combination with one or more insulators, or the magnet wire of induction heating coil, incorporated with an insulation system rated above Class 105 (A), shall comply with the magnet wire requirements in the Standard for Systems of Insulating Materials – General, UL 1446 and shall have a suitable temperature class.

18.4 Insulation systems

18.4.1 Class A insulation systems shall consist of a combination of magnet wire and major component insulation materials evaluated and found to operate as intended in its end use. Thermoset materials and materials in [Table 18.1](#) at the thicknesses specified are permitted to be used without further evaluation.

Table 18.1
Primary Class A insulating materials and minimum thicknesses

Material	Minimum thickness	
	in	(mm)
Vulcanized fiber	0.028	(0.71)
Polyethylene terephthalate film	0.007	(0.018)
Cambric	0.028	(0.71)
Treated Cloth	0.028	(0.71)
Electrical grade paper	0.028	(0.71)
Mica	0.006	(0.15)
Aramid paper	0.010	(0.25)

18.4.2 For Class A insulation systems employing other materials or thinner materials than those indicated in [Table 18.1](#) or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in [18.4.3](#).

18.4.3 A polymeric material employed in a Class 105 (A) insulation system that isolates the windings from dead metal parts shall be unfilled or glass-reinforced nylon, polycarbonate, polybutylene terephthalate, polyethylene terephthalate, phenolic or acetal, and shall have a relative or generic thermal index for electrical properties of 105°C (221°F) minimum. Leads shall be rated 90°C (194°F) minimum.

18.4.4 Materials used in an insulation system that operates above Class 105 (A) temperatures, shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

18.4.5 All insulation systems employing integral ground insulation, including filament winding, shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

19 Thermal Insulation

19.1 Combustible or electrically conductive thermal insulation shall not contact uninsulated live parts of the appliance.

19.2 With reference to [19.1](#), some types of mineral-wool thermal insulation contain conductive impurities in the form of slag that make their use unacceptable if they are in contact with uninsulated live parts.

19.3 A material of asbestos composition shall not be used.

19.4 Fiberglass thermal insulation shall not be used in areas where forced air movement could cause particles to be blown into food contact areas of the appliance or into food preparation areas outside the appliance.

20 Motors

20.1 A motor shall be capable of handling its maximum intended load without introducing a risk of fire or electrical shock.

20.2 A motor winding shall be such as to resist the absorption of moisture.

20.3 With reference to [20.2](#), film-coated wire need not be additionally treated to preclude absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorbent materials are to be impregnated or otherwise treated to preclude moisture absorption.

20.4 An appliance that is provided with a motor where the motor current is controlled by a triac or other solid-state device shall comply with the temperature test for motors used with solid-state controls, [41.7.1](#), and the Abnormal Operation Test on Motors Used With Solid-State Controls, Section [55](#).

20.5 A motor employed in a combination microwave oven vent hood fan shall either:

- a) Be located such that it will not be exposed to grease or cooking vapors;
- b) Be constructed so that accumulation of grease on the motor windings will be prevented – such as by use of a totally enclosed motor; or
- c) Comply with the requirements in Tests on Motors Exposed to Grease or Cooking Vapors, Section [66](#).

21 Motor Overload Protection

21.1 A continuous-duty motor in a permanently connected appliance, an automatically controlled fractional-horsepower motor in an appliance, the motor of an appliance intended to be operated unattended, a motor the operation of which or inability to operate will not be evident to the operator, and a continuous-duty integral-horsepower motor shall be provided with overload protection. The protection is to be as specified in [21.2](#). See [2.2](#).

Exception No. 1: A motor that is used for a direct drive blower or fan is considered to have overload protection if it is protected against locked-rotor conditions only.

Exception No. 2: A shaded-pole motor having a difference of 1 A or less between no-load and locked-rotor currents and having a 2:1 or smaller ratio between locked-rotor and no-load currents is to be considered to have overload protection if it is protected against locked-rotor conditions only.

21.2 Motor-overload protection required in [21.1](#) shall consist of one of the following:

- a) Thermal protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111; or with the Standard for Thermally Protected Motor, UL 1004-3.

Electronically protected motor shall comply with the Standard for Electronically Protected Motors, UL 1004-7.

Exception No. 1: When a product includes a control, such as a timer, that positively and reliably limits the length of time the product is able to operate, a shorter test duration for the Locked-Rotor Temperature and the Locked-Rotor Endurance tests meets the intent of the requirement. For this construction, the duration of these tests shall not be less than the time to which the control limits product operation.

Exception No. 2: When the time required to operate a manually reset protective device through 10 c of operation is longer than the time the product is intended to be operated during each use, less than 10 c of operation of the device for the Locked-Rotor Temperature Test meets the intent of the requirement. For this construction, the number of cycles shall be 4 c or the number of cycles required for maximum intended operating time of the product, whichever is longer.

Exception No. 3: A motor intended only for moving air and that has an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor shaft is not required to have running overload protection.

b) Impedance protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111; or with the Standard for Impedance Protected Motors, UL 1004-2, when the motor is tested as used in the product under stalled motor conditions.

c) Other protection that is shown by tests to be equivalent to the protection specified in item (a).

21.3 Motor-overload protection provided for a product not required to have such protection shall:

a) Comply with the requirements in [21.2](#), or

b) Be shown by test not to result in a risk of fire, electric shock, or injury to persons.

21.4 Fuses may be used to provide the necessary overcurrent protection if compliance with the requirements will be provided by the largest ampere-rated fuse that can be mounted in the fuseholder or if a noninterchangeable fuse is used. The fuse used to provide this protection need not be of a type acceptable for branch-circuit protection.

21.5 Electronically protected motor circuits shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. When the protective electronic circuit is relying upon software as a protective component, it shall comply with the requirements in the Standard for Software in Programmable Components, UL 1998. If software is relied upon to perform a safety function, it shall be considered software Class 1;

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1. If software is relied upon to perform a safety function, it shall be considered software Class B; or

c) The Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1.

Exception No. 1: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or injury to persons during abnormal testing with the motor electronic circuit rendered ineffective; compliance with the applicable requirements of this end product standard is then required.

Exception No. 2: For DC motors used in Class 2 low-voltage circuits, the above evaluation does not apply. Only the applicable requirements for risk of fire and injury in this end product standard shall apply.

22 Short-Circuit and Ground-Fault Protection

22.1 General

22.1.1 The overcurrent protection mentioned in [22.2.1](#) shall be of a type acceptable for branch-circuit protection.

22.1.2 A fuse, used as the overcurrent protection means referred to in [22.1.1](#), shall be Class CC, G, H, J, K, R, or T cartridge fuses or Type S or an Edison-base plug fuse.

22.1.3 It will be assumed that the rating of the branch-circuit overcurrent protective device will be 150 percent of the rating of the appliance unless the appliance is marked to specify the use of a protective device having a lower rating. Standard ampere ratings for overcurrent-protective devices are 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, and 200. If 150 percent of the rating of the appliance does not equal one of the standard overcurrent-protective device ratings mentioned above, it will be assumed that the next lower rating or setting of overcurrent protective device will be employed.

22.1.4 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1; and the applicable UL 248 Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate UL standard for the fuse are considered to comply with this requirement.

22.1.5 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9).

Exception: Fuseholder mounted on printed wiring board, can be evaluated to the applicable requirements of this end product standard.

22.1.6 When provided, circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, need not comply with UL 489.

22.1.7 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

22.1.8 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

22.2 Motors and power transformers

22.2.1 A transformer and motor shall be protected by overcurrent protection:

- a) Rated 20 A or less,
- b) If the primary only is protected, the transformer protective device is rated or set at not more than 125 percent of the primary current, or
- c) If both primary and secondary circuits are protected, the transformer protective devices are rated or set at no more than 250 percent of the primary current and 125 percent of the secondary current.

Exception No. 1: The overcurrent protection need not be provided as part of the appliance if the overcurrent protection of the branch circuit with which the appliance will be connected will provide equal or better protection.

Exception No. 2: The overcurrent protection may be omitted from the primary of a transformer if there is no emission of flame or molten metal from the appliance enclosure when the transformer is operated under the conditions described in [22.2.3](#) and [22.2.4](#).

22.2.2 Ordinarily, a motor having an inherent thermal protector that complies with the requirements for such devices as acceptable with respect to the requirements in [22.2.1](#) if, in the appliance, it will be connected in series with a branch-circuit overcurrent-protective device of the same type and having a current rating equal to or less than that with which the motor-protector combination was tested during the investigation of the protector.

22.2.3 The transformer is to be operated continuously at the test voltage indicated in [40.2.1](#) and at rated frequency with the enclosure grounded. The load connected to the output terminals is to be a resistance of such value that three times the rated full-load current will be drawn from the secondary winding. Operation is to be continued until constant temperatures are indicated by a thermocouple on the transformer coil or until burnout, whichever occurs first. The circuit on which the transformer is tested is to be protected by fuses rated at not less than that required for the appliance. If accessible fuses are provided with the transformer, they are to be replaced by dummy fuses, but inaccessible fuses are to remain in the circuit.

Exception: The load may be connected to the output terminals as indicated in [22.2.4](#).

22.2.4 The burnout test is to be conducted with the output terminals of the transformer short circuited if such condition results in less than three times maximum normal current being drawn from the secondary. Otherwise, the test is to be conducted as follows:

- a) If the transformer controls a motor and the motor locked-rotor load plus the additional load on the transformer is equal to or greater than three times the full-load normal current, the test is to be conducted with output terminals connected to the motor with the rotor locked, and the other loads in parallel;
- b) If the transformer does not control a motor, the load imposed on the transformer by the coils of any solenoids, relays, or the like, with the armature of the largest such device blocked open, is determined, and the test is to be conducted with an equal resistance load substituted for the coils if this load is equal to or greater than three times the full-load normal current; or
- c) If under the conditions specified in (a) and (b) the current is less than three times the full-load normal current, the transformer is to be loaded in a manner such that the current is equal to three times the full-load normal current.

22.3 Receptacles

22.3.1 Attachment plug receptacles intended for general use shall have branch-circuit overcurrent protection rated not more than ampacity rating of the power supply cord attachment plug configuration in the appliance.

Exception: A microwave oven provided with a 20 A power supply cord attachment plug configuration need not be provided with such protection inside the appliance.

22.3.2 Appliances employing attachment plug receptacles for general-use are to be loaded to the maximum resistive load for the branch circuit configuration of the receptacle.

22.3.3 A receptacle with a standard branch circuit configuration such as 15 A parallel blade or 20 A "T" configuration is considered to be suitable for general use regardless if it is intended for use with a specific appliance or marked to indicate that only a specific appliance or load is to be connected.

23 Thermostats

23.1 A manually reset thermostat intended to be operated by the user shall be capable of being reset:

- a) From outside the appliance, or
- b) After opening a hinged door or the equivalent that does not give access to uninsulated live parts.

23.2 The reset button of a manually reset thermostat shall be protected from mechanical abuse and the construction shall provide for trip-free operation.

23.3 If a thermostat in a microwave cooking appliance has a marked off position, when the thermostat is set to the off position lowering of temperature or loss of capillary tube pressure shall not cause the contacts to close and the heating element or microwave generating circuits shall not produce heat. "No heat," "Cold," or the like are considered to be off markings.

23.4 A malfunction such as short-circuiting or changing of impedance of a pilot light or indicating lamp shall not affect the proper functioning of a temperature control system.

23.5 For the test required in [23.4](#), the series resistor of a gaseous discharge lamp is to be left in the circuit.

23.6 Thermostats shall comply with the Standard for Electrical Temperature-Indicating and -Regulating Equipment, UL 873; or with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

24 Thermal Cutoffs

24.1 A thermal cutoff shall be secured in place and shall be so located that it will be accessible for replacement without damaging other connections or internal wiring.

Exception: Thermal cutoffs that are an integral part of a component that necessitates replacement of the entire component, for example, thermal cutoffs embedded in the windings of motors, transformers, and the like are not required to be located so that it will be accessible for replacement without damaging or displacing other connections or internal wiring.

24.2 Wiring connected to a thermal cutoff shall be so secured that replacement of the cutoff will not result in displacement of internal wiring other than leads to the cutoff itself.

Exception: As noted in the Exception to [24.1](#).

24.3 A thermal cutoff shall comply with the requirements in the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

24.4 A thermal cutoff shall open the circuit in the intended manner without causing the short-circuiting of live parts and without causing live parts to become grounded to the enclosure when the appliance is connected to a circuit of voltage in accordance with [40.2.1](#) and operated to cause abnormal heating. See [24.5](#).

24.5 To determine whether a thermal cutoff complies with the requirement in [24.4](#) the appliance is to be operated with separate thermal cutoffs five times as described in [24.3](#) and [24.4](#) and with any other thermally operated control devices in the appliance short-circuited. Each thermal cutoff is required to

perform acceptably. During the test, the enclosure is to be connected through a fuse rated 3 A, other than the time-delay type, to ground.

Exception No. 1: A thermal cutoff incorporated in an interlock monitor circuit shall be tested as specified in [49.1](#) and [49.2](#).

Exception No. 2: A completely encapsulated-type thermal cutoff that is not incorporated in an interlock circuit need not be subjected to this test.

25 Attachment-Plug Receptacles

25.1 An attachment-plug receptacle rated 15 or 20 A intended for general use shall be of the grounding type. The grounding contact of the receptacle shall be electrically conductively connected to the point of connection of the equipment-grounding conductor to the appliance.

25.2 An attachment plug receptacle shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

26 Lampholders

26.1 A lampholder intended to be connected to a power-supply circuit without a grounded conductor shall be located so that a tool is required to change the lamp.

26.2 A screw-shell lampholder for an infrared lamp shall be of the unswitched medium-base type, and for use with a lamp rated 300 W or less.

Exception: A lamp-and-lampholder combination need not comply if an unacceptable temperature is not produced on any of the components in the temperature test, and if the switching mechanism of a switched lampholder is capable of performing acceptably without undue burning, pitting, and the like.

26.3 A lampholder screw shell of a cord-connected appliance shall not operate at a potential of more than 150 V to ground.

Exception: This requirement does not apply to a lampholder for a pilot light or indicating lamp.

26.4 A female screw shell used as a holder for a heating element shall be of copper or a copper base alloy and shall be plated with nickel or equivalent oxidation-resistant metal.

26.5 A lampholder shall not employ a paper liner if the lampholder is likely to be exposed to moist vapors during the operation of the appliance.

26.6 A lampholder constructed with a cavity depth less than that specified by the Standard for Lampholders, UL 496, may be used provided:

- a) The lamp is not user serviceable; or
- b) The lamp is user serviceable, and the appliance is marked in accordance with [71.1.9](#).

26.7 Lampholders and indicating lamps integral with lampholder shall comply with the Standard for Lampholders, UL 496.

27 Switches and Controls

27.1 General

27.1.1 A switch shall be of a type intended for the particular application and shall have a current and voltage rating not less than that of the circuit (load) that it controls when the appliance is operated as described in Power Input Test, Section [40](#).

27.1.2 The current rating of a switch or other control device that controls a solenoid, a magnet, a transformer, an electric-discharge-lamp ballast, or another inductive load shall be at least twice the rated full-load current of the component that it controls unless the switch is rated for the particular application.

27.1.3 Any switch is acceptable for controlling a tungsten-filament load if its rating is more than six (for alternating current) or ten (for direct current) times the rating of the load, or if it is provided with a tungsten-filament load rating equal to or greater than the load it controls.

27.1.4 A switch shall be evaluated with respect to the temperature limitations of the materials employed.

27.1.5 A switch or other means of control intended to limit the number of heating elements used at one time shall be so located or of such type that the user cannot readily change the connections to use more elements than intended.

27.1.6 An appliance control containing solid-state components shall comply with the applicable requirements in the Standard for Solid-State Controls for Appliances, UL 244A. Compliance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

27.1.7 An oven employing a temperature-regulating control, the malfunction or breakdown of which would result in a risk of fire, as determined by the Abnormal Operation Test, Section [54](#), and [85.1](#) and [85.2](#), during any operation including self-clean operation, shall be provided with a temperature-limiting control. The control shall open a sufficient number of ungrounded conductors to the heating elements to limit the oven temperature and shall be:

- a) A thermal cutoff;
- b) A manually reset control not capable of being reset from outside the appliance without using a tool to gain access to the reset mechanism; or
- c) An automatically reset control if a means, such as an indicator light or audible signal, is provided to alert the user that the oven is not operating normally when in the self-cleaning mode. See [27.1.9](#) and [27.1.10](#).

Exception: The means to alert the user of oven malfunction may be omitted if it can be shown that, for all alternate temperature-regulating devices employed, any malfunction of the device during the self-clean mode will always result in a malfunction that will not permit normal operation in any other normal operating mode.

27.1.8 A limiting control provided to comply with the requirements in [27.1.7](#) shall not function during the test in Temperature Test, Section [41](#).

27.1.9 With regard to [27.1.7](#)(c), if an indicator light is provided to alert the user that the oven in the self-cleaning mode is not operating normally, the following conditions apply:

- a) The light shall withstand, without burnout or failing to light, an endurance test consisting of 6000 c of 1 min on and 30 s off.

b) The light shall have a minimum rated life of 20,000 continuous hours at the operating voltage and shall be connected in a circuit in which the increased voltage incident to switching or any other operational characteristic of the appliance does not exceed 120 percent of the voltage recommended to provide the required life.

c) The light shall be readily visible under all conditions of normal use.

d) If the light turns on as a result of a malfunction when the oven is operating in the self-cleaning mode, the light shall remain on even though the limiting control functions to reduce oven temperatures.

e) The marking and instructions described in [72.1](#) and [75.4.1](#) shall be provided.

27.1.10 With regard to [27.1.7](#) (c), if an audible signal is provided to alert the user that the oven is not operating normally, the following conditions apply:

a) The signal shall withstand, without malfunction or breakdown, an endurance test consisting of 6000 c of 1 min on and 30 s off.

b) The signal shall withstand, without malfunction or breakdown, a durability test consisting of 72 h of continuous energization while in an ambient 10°C (18°F) higher than the maximum operating temperature of the device under normal operating conditions, but not less than 70°C (158°F).

c) The marking and instructions described in [72.2](#) and [75.4.1](#) shall be provided.

27.1.11 Switches shall comply with the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

Exception: Switching devices that comply with the appropriate UL standard for specialty applications (e.g. transfer switch equipment), industrial use (e.g. contactors, relays, auxiliary devices), or are integral to another component (e.g. switched lampholder) need not comply with this requirement.

27.1.12 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with one of the following:

a) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7; or

b) The Standard for Clock-Operated Switches, UL 917.

27.1.13 An electromechanical and electronic temperature control shall comply with one of the following:

a) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

27.1.14 A temperature sensing positive temperature coefficient (PTC) or a negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control shall comply with:

a) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with Annex J; or

b) The Standard for Thermistor-Type Devices, UL 1434.

27.1.15 An electronic, auxiliary or operating control (e.g. non-limiting control, non-protective control, or operating-type 1 action control), the failure of which would not increase the risk of fire, electric shock, or injury to persons, need only be subjected to the applicable requirements of this end product standard.

Exception: Operating Type 2 action control, where failure of which would increase the risk of fire, electric shock, or injury to persons, shall comply with the applicable requirements in [27.1.13](#) – [27.1.18](#).

27.1.16 An automatic vent-hood fan control that energizes the vent fan under conditions of elevated temperatures to cool components, is considered as an Operating Type 2 action control in [41.6.3.2](#), [42.4.5.3](#), [56.8](#), and [71.2.2](#).

Exception: An automatic vent-hood fan control that energizes the vent fan under conditions of elevated temperatures at microwave mode to cool components, can be considered as an Operating Type 1 action control in [41.6.3.2](#), [42.4.5.3](#), [56.8](#), and [71.2.2](#), when all of the following conditions are met:

- a) Loss of fan operation will cause operation of magnetron thermostat to cycle magnetron on and off; and*
- b) The cord connected appliance is provided with readily visible cautionary marking in [71.2](#) to alert user to unplug before removing fan guard.*

27.1.17 Solid-state protective controls that do not rely upon software as a protective component shall comply with one of the following:

- a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; or
- b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, except the Controls Using Software requirements, Clause H 11.12.

27.1.18 Solid-state protective controls that rely upon software as a protective component shall comply with one of the following:

- a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998; or
- b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

27.2 Power output control circuits

27.2.1 These requirements cover electronic operating controls (See [2.8](#)) that serve to manage the operation of the microwave oven in order to provide preprogrammed operating cycles that rely on timing, by scoring a series of events or by modifying the appliances' operation in a predetermined, repetitive fashion in order to comply with the normal and/or abnormal operation tests specified in Sections [38](#) – [66](#).

27.2.2 An electronic control provided to comply with the normal and/or abnormal operation tests specified in Sections [38](#) – [66](#) shall be subjected to a Failure-Mode and Effect Analysis (FMEA) as follows:

- a) All active terminals of a multi-pin device shall be considered input, output, power supply, or ground.
- b) Each electronic component in the control is to be included in this analysis.
- c) Each component is to be identified as R1, C1, or an equivalent component identification.

- d) The function of each component is to be described.
- e) The effects of open and short faults are to be evaluated for each component. The following are alternatives to shorting all combinations of terminals on multiple pin components, such as integrated circuits:
 - 1) Short each pair of adjacent pins.
 - 2) Short each input pin to (referenced) ground.
 - 3) Short each output pin to (referenced) ground.
 - 4) Short each input pin to the power supply.
 - 5) Short each output pin to the power supply.

27.2.3 A circuit analysis made to assess the performance of individual components under a fault condition rather than actually creating the fault to determine its effect also meets the intent of the requirements. The effect resulting from the failure on the control and also on the end use product is to be stated. Results of the FMEA indicating operation outside the intended parameters of the control's normal operation (for example, input power exceeding the appliance branch-circuit rating, component temperatures exceeding specified limits, or the inability to recognize required events) are to be subjected to the Abnormal Operation Test requirements in Section 54 with each fault applied independently (single-fault conditions).

27.2.4 The FMEA is to be conducted as described in the Procedure for Preparing/Performing a Failure Mode, Effects and Criticality Analysis, Military Specification Number 1629.

28 Protective controls (Limiting controls) – End Product Test Parameters

28.1 An electronic control that performs a protective function shall comply with the applicable requirements in 27.1.17 – 27.1.18 while tested using the parameters in this section. Examples of protective controls are: a control used to sense abnormal temperatures of components within the appliance; door interlock function; temperature protection of the motor due to locked rotor, running overload, loss of phase; or other function intended to reduce the risk of electric shock, fire, or injury to persons.

28.2 The following test parameters shall be among the items considered when determining the acceptability of an electronic protective control investigated using the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1:

- a) Failure-Mode and Effect Analysis (FMEA) or equivalent Risk Analysis method;
- b) Power Supply Voltage Dips, Variation and Interruptions within a temperature range of 10°C (18°F) and the maximum ambient temperature determined by conducting the Temperature Test; see Section 42;
- c) Surge Immunity Test – installation class 3 shall be used;
- d) Electrical Fast Transient/Burst Test, a test level 3 shall be used;
- e) Electrostatic Discharge Test;
- f) Radio-Frequency Electromagnetic Field Immunity:
 - 1) Immunity to conducted disturbances – When applicable, test level 3 shall be used; and

2) Immunity to radiated electromagnetic fields; field strength of 3 V/m shall be used;

g) Thermal Cycling Test shall be conducted at ambient temperatures of $10.0 \pm 2^{\circ}\text{C}$ ($50.0 \pm 3^{\circ}\text{F}$) and the maximum ambient temperature determined by conducting the Temperature Test; see Section 42. The test shall be conducted for 14 days;

h) Overload shall be conducted based on the maximum declared ambient temperature (T_{max}) or as determined by conducting the Temperature Test; see Section 42; and

i) If software is relied upon as part of the protective electronic control, it shall be evaluated as software class B.

28.3 The test parameters and conditions used in the investigation of the circuit covered by 28.1 shall be as specified in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, using the following test parameters:

a) With regard to electrical supervision of critical components, for attended appliances, a motor operated system becoming permanently inoperative with respect to movement of an exposed portion of the appliance meets the criteria for trouble indication. For unattended appliances, electrical supervision of critical components may not rely on trouble indication;

b) A field strength of 3 V/m is to be used for the Radiated EMI Test;

c) The Composite Operational and Cycling Test is to be conducted for 14 days at temperature extremes of 0°C (32°F) and 70°C (158°F);

d) The Humidity Class is to be based on the appliance's intended end use and is to be used for the Humidity Test;

e) A vibration level of 5 g is to be used for the Vibration Test;

f) The Computational Investigation is not applicable to appliances covered by this end product standard;

g) For the Demonstrated Method Test, the multiplier for the test acceleration factor is to be 576.30 for intermittent use appliances, or 5,763.00 for continuous use appliances. The test acceleration factor equation is to be based on a 25°C (77°F) use ambient;

h) The Endurance Test is to be conducted concurrently with the Operational Test. The control shall perform its intended function while being conditioned for 14 days in an ambient air temperature of 60°C (140°F), or 10°C (18°F) greater than the operating temperature of the control, whichever is higher. During the test, the control is to be operated in a manner representing normal use;

i) For the Electrical Fast Transient Burst Test, test level 1 is to be used;

j) Conduct a failure-mode and effect analysis (FMEA).

k) If software is relied upon as part of the protective electronic control, it shall be evaluated as software class 1 in accordance with the Standard for Software in Programmable Components, UL 1998.

28.4 Unless otherwise specified in this standard, protective controls shall be evaluated for 100,000 cycles for Type 2 devices and 6,000 cycles for Type 1 devices with rated current.

29 Filters

29.1 An air filter exposed to cooking vapors shall comply with the requirements in the Standard for Air Filter Units, UL 900.

30 Spacings

30.1 The spacings between field-wiring terminals of opposite polarity and the spacings between a field-wiring terminal and any other uninsulated metal part (dead or live) not always of the same polarity shall not be less than indicated in [Table 30.1](#).

Table 30.1
Minimum acceptable spacings at field-wiring terminals

Parts involved	Potential involved, V	Through air in (mm)	Over surface in (mm)
Between live parts of opposite polarity; and between a live part and a dead metal part, other than the enclosure, which may be grounded.	0 – 250	1/4 (6.4)	3/8 (9.5)
	251 – 600	3/8 (9.5)	1/2 ^a (12.7) ^a
Between a live part and the enclosure	0 – 600	1/2 (12.7)	1/2 (12.7)
NOTES – 1 These spacings do not apply to connecting straps or busses extending away from wiring terminals. Such spacings are to be evaluated under Table 30.2 . 2 Applies to the sum of the spacings involved where an isolated dead part is interposed. ^a A spacing of not less than 3/8 in (9.5 mm), through air and over the surface, is acceptable at wiring terminals in a wiring compartment or terminal box if the compartment or box is integral with a motor.			

30.2 In primary circuits, other than at field-wiring terminals, and in secondary circuits that are safety circuits:

- a) Spacings between uninsulated live parts of opposite polarity,
- b) Spacings between primary circuits and secondary circuits, and
- c) Spacings between an uninsulated live part and a dead metal part shall not be less than specified in [Table 30.2](#).

Exception No. 1: The spacings specified as the minimum acceptable in [Table 30.2](#) do not apply to the inherent spacings of a component of the appliance, such as a switch. The acceptability of spacings of a component is based on the requirements that cover the component.

Exception No. 2: At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, in an appliance rated 250 V or less, a spacing of 3/64 in (1.2 mm) is acceptable. Within a thermostat, the spacing (except at contacts) between uninsulated live parts on opposite sides of the contacts shall not be less than 1/32 in (0.8 mm) through air and 3/64 in over the surface of insulating material. The construction is to be such that the spacings will be maintained permanently.

Exception No. 3: The spacings within a motor shall comply with the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

Exception No. 4: A microwave oven control containing solid-state components may have reduced spacings in accordance with the Standard for Solid-State Controls for Appliances, UL 244A. See [30.5](#). Compliance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

Table 30.2
Minimum acceptable spacings through air or over surface at points other than field-wiring terminals or inside motors

Parts involved	Potential involved, V	in	(mm)
Between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part and a dead metal part that either is exposed for persons to contact or may be grounded	0 – 250	1/16 ^a	(1.6) ^a
	251 – 600	1/4 ^{b,c}	(6.4) ^{b,c}
^a If an uninsulated live part is not rigidly supported, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum acceptable spacing of 1/16 in (1.6 mm) is maintained under all operating conditions and under all intended conditions of handling. ^b Enamel-insulated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 in (2.4 mm) (over surface and through air) is acceptable between a dead metal part and film-coated wire rigidly supported and held in place on a coil. ^c A spacing of 1/16 in (1.6 mm) is permissible at the heating element only, in a heater rated for 300 V or less, if exact centering of the cold pin is required to maintain the 1/16 in (1.6 mm) spacing. A spacing of 3/64 in (1.2 mm) in one location is acceptable.			

30.3 Spacings in all secondary circuits other than safety circuits are evaluated by the performance of the appliance while undergoing applicable dielectric voltage-withstand tests. The construction is to be such that spacings necessitated by the tests are permanently provided.

30.4 An insulating lining or barrier of vulcanized fiber or similar material employed where spacings would otherwise be unacceptable shall not be less than 1/32-in (0.8-mm) thick, and shall be so located or of such material that it will not be affected adversely by arcing.

Exception No. 1: Vulcanized fiber not less than 1/64-in (0.4-mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception No. 2: An insulating liner or barrier may be less than 1/64-in (0.4-mm) thick if the material is judged acceptable for the application in accordance with [18.1.2](#) and [18.1.3](#).

30.5 With respect to Exception No. 4 to [30.2](#), a controlled environment is considered to exist only when the environment is protected against contaminants, including cooking vapors and condensation, as noted in [2.12](#).

30.6 When conducting evaluations in accordance with the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, the following guidelines shall be used:

- a) A microwave cooking appliance is to be categorized as Overvoltage Category II;
- b) The applicable Material Group per [Table 30.3](#);
- c) The Pollution Degree shall be Pollution Degree 3 for over-the-cooktop microwave ovens and Pollution Degree 2 for all others;
- d) Any printed-wiring board which complies with the requirements in the Standard for Printed-Wiring Boards, UL 796, shall be determined to provide a Comparative Tracking Index (CTI) of 100, and when it further complies with the requirements for Direct Support in UL 796 then it shall be determined to provide a CTI of 175; and
- e) The minimum acceptable spacings shall be maintained per [Table 30.2](#).

Table 30.3
Material Group

CTI PLC value of insulating materials	Material group
CTI \geq 600 (PLC = 0)	I
400 \leq CTI < 600 (PLC = 1)	II
175 \leq CTI < 400 (PLC = 2 or 3)	III ^a
100 \leq CTI < 175 (PLC = 4)	III ^b
NOTE – PLC stands for Performance Level Category, and CTI stands for Comparative Tracking Index as specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.	

31 Grounding

31.1 All microwave cooking appliances shall have provisions for grounding.

31.2 On a cord connected microwave cooking appliance, the power-supply cord shall include a grounding conductor that shall be:

- a) Green with or without one or more yellow stripes,
- b) Connected to the grounding blade of an attachment plug of a grounding type, and
- c) Connected to the enclosure of the appliance so that it is not likely to be removed during any servicing not involving the supply cord. Solder alone is not acceptable for making this connection.

31.3 A microwave cooking appliance intended for permanent connection to the power supply shall be provided with an equipment-grounding terminal or lead. See [13.1.2.5](#) – [13.1.2.16](#).

31.4 All exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation, including maintenance and repair, and that can become energized shall be electrically connected to the equipment grounding terminal; and to the metal enclosure surrounding a knockout, hole, or bushing provided for field connection of the power supply system; or to the grounding conductor of a supply cord.

Exception: A dead metal part within the enclosure need not be grounded provided the appliance is marked in accordance with [73.22](#).

31.5 With reference to the requirements in [31.4](#), the following dead metal parts are not considered as being likely to become energized:

- a) A small metal part – such as an adhesive-attached foil marking, screw, or handle – that is:
 - 1) On the exterior of the enclosure and separated from all electrical components by grounded metal, or
 - 2) Electrically isolated from all electrical components;
- b) A panel, cover, or other metal part that is isolated from all electrical components, including wiring, by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 1/32-in (0.8-mm) thick and secured in place;
- c) A panel, cover, or other metal part that does not enclose uninsulated live parts and that is electrically isolated from other electrical components; and
- d) A door or the like that may only become energized through a grounded part.

31.6 Unless the dead metal parts described in [31.4](#) are bonded together, an individual bonding conductor or strap shall be used for this purpose.

31.7 Bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connections, brazing, or welding. The bonding connection shall penetrate nonconductive coatings such as paint.

31.8 A bonding conductor shall be of material acceptable for use as an electrical connector, of acceptable size, and protected from corrosion unless inherently resistant thereto. An individual bonding conductor or strap shall be so installed that it is protected from mechanical damage.

31.9 Bonding conductors or straps used to provide grounding continuity between stacked ovens may be applied in the field if marking is provided in accordance with [73.6](#).

31.10 The size of an individual conductor or strap employed to bond an electrical enclosure or motor frame shall be determined by the rating of the overcurrent-protective device of the branch circuit to which the equipment will be connected in accordance with Table 250-95 of the National Electrical Code, ANSI/NFPA 70.

Exception: A conductor smaller than that indicated may be used if the bonding connection does not open when carrying, for the interval indicated in [Table 31.1](#), twice the current equal to the rating of the branch-circuit overcurrent device. A bonding conductor to a motor is not required to be larger than the motor-circuit conductors.

Table 31.1
Duration of current flow, bonding-conductor test

Rating of overcurrent device, A	Minimum duration of current flow, min
30 or less	2
31 – 60	4
61 – 100	6

31.11 If more than one size branch-circuit overcurrent device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent-protective device intended to provide ground fault protection for the component bonded by the conductor. For example, if a motor is individually protected by a branch-circuit overcurrent device smaller than the overcurrent devices protecting the overall equipment, the size of a bonding conductor for that motor may be selected on the basis of the overcurrent device intended for ground fault protection of the motor.

31.12 The resistance shall not be more than 0.1 ohm between any point required to be grounded, as mentioned in [31.4](#), and:

- a) The equipment-grounding conductor terminal in the case of an appliance intended for permanent electrical connection, or
- b) The point to which the grounding conductor of the power-supply cord is connected.

31.13 With reference to [31.12](#), the resistance is to be determined by any convenient method. However, if a resistance of greater than 0.1 ohm is indicated, then either a direct or alternating current is to be passed between the points in question, the resultant voltage drop (in ohms) computed by dividing the voltage drop (in V) by the current (in A). The value of the current is to equal the current rating of the largest overcurrent protective device anticipated in a branch circuit to which the appliance can be properly connected.

31.14 Upon insertion of a removable heating element or other removable part required to be grounded, the grounding connection shall be made before the electrical connection, and, upon removal, the grounding connection shall be broken after the electrical connection.

32 Secondary Circuits

32.1 General

32.1.1 All secondary circuits shall be judged under the requirements for primary circuits unless they comply with [32.1.2](#) and [32.3.1](#) – [32.3.3](#).

32.1.2 Components, wiring, printed-wiring assemblies, insulating material, and so forth, and associated circuitry that are employed in Class 2 circuits that comply with the applicable requirements in the Standard for Solid-State Controls for Appliances, UL 244A, or in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series; need not be investigated provided that the Class 2 circuit does not perform a safety related function, that is, it is not a safety circuit.

Exception No. 1: A circuit supplied by a Class 2 transformer complying with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3 is considered to fulfill these requirements.

Exception No. 2: A circuit, such as switching mode Class 2 power supply circuit etc, complying with the Standard for Class 2 Power Units, UL 1310, is considered to fulfill these requirements.

32.2 Connections to frame

32.2.1 Secondary circuits may be connected to the frame of the unit.

32.2.2 If the frame is used as a current-carrying part of a secondary circuit, hinges or other movable parts shall not be depended upon as a current-carrying means.

32.3 Separation of circuits

32.3.1 The wiring in secondary circuits described in [32.1.2](#) shall be routed away from the wiring of other circuits or shall be provided with insulation that is rated for use at the highest of the voltages in the other circuits.

32.3.2 The wiring in secondary circuits described in [32.1.2](#) shall be routed away from the uninsulated live components of other circuits or all of the requirements that apply to other circuits shall be applied to the secondary circuits as well.

32.3.3 External wires and cables that are part of the secondary circuits covered in [32.1.2](#) shall be provided with strain relief in accordance with [13.2.2.1](#) – [13.2.2.4](#) if stresses on wire or cable could cause the internal wiring of the circuits to contact uninsulated live parts of other circuits.

33 Transformers

33.1 General-purpose transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2.

Exception No. 1: A transformer that complies with the Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411, and that is used in a circuit involving an audio or video component, meets the intent of this requirement.

Exception No. 2: A high voltage transformer for magnetron circuit, need not comply with UL 5085-1 and UL 5085-2 if it complies with the requirements of Mechanical Assembly, Section 8; Live Parts, Section 14; Internal Wiring, Section 16; Electrical Insulation, Section 18; and Spacings, Section 30 in this end product standard.

33.2 Class 2 and Class 3 transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

34 Batteries and Battery Charging Circuits

34.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642.

34.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the applicable construction and performance requirements of this end product standard.

34.3 Rechargeable nickel metal-hydride (Ni-MH) battery cells and packs shall comply with the applicable construction and performance requirements of this end product standard, or the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

34.4 Primary batteries (non-rechargeable) that comply with the relevant UL standard and 4.1 are considered to fulfill the requirements of this standard.

34.5 A Class 2 battery charging circuits shall comply with one of the following:

- a) The Standard for Class 2 Power Units, UL 1310; or
- b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 with an output marked "Class 2".

35 Capacitors

35.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container that shall protect the plates against mechanical damage and prevent the emission of flame or molten material resulting from malfunction of the capacitor. The container shall be of metal providing strength and protection not less than that of uncoated steel having a thickness of 0.020 inch (0.51 mm). Sheet metal having a thickness less than 0.026 inch (0.66 mm) shall not be used.

Exception No. 1: The individual container of a capacitor may be of sheet metal less than 0.020-inch thick or may be of material other than metal if the capacitor is mounted in an enclosure that houses other parts of the appliance and provided that such housing is acceptable for the enclosure of live parts.

Exception No. 2: A capacitor complying with the Standard for Capacitors, UL 810, is considered to fulfill this requirement.

Exception No. 3: Capacitors, connected across the line, complying with the applicable requirements in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed

Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, is considered to fulfill this requirement.

35.2 A capacitor connected from one side of the line to the frame or enclosure of an appliance, shall have a capacitance rating of not more than 0.10 μF and shall comply with the applicable requirements in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

35.3 The voltage rating of a capacitor other than a motor-starting or motor-running capacitor shall equal or exceed the maximum steady-state potential to which the capacitor is subjected during operation of the unit at the rated voltage.

35.4 Under both normal and abnormal conditions of use, a capacitor employing a liquid dielectric medium more combustible than askarel shall not cause a risk of electric shock or fire and shall be protected against expulsion of the dielectric medium.

35.5 High voltage capacitor located in the secondary circuit of high voltage transformer for magnetron circuit, shall comply with the requirements of Mechanical Assembly, Section 8; Live Parts, Section 14; Electrical Insulation, Section 18; Spacings, Section 30; and Abnormal Operation test, Section 54 of this end product standard.

36 Light Sources and Associated Components

36.1 Lighting ballasts shall comply with the Standard for Fluorescent-Lamp Ballasts, UL 935, or the Standard for High-Intensity Discharge Lamp Ballasts, UL 1029. Ballasts forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

Exception: Ballasts for other light sources shall comply with the appropriate standard(s) and need not comply with UL 935 or UL 1029.

36.2 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use In Lighting Products, UL 8750. LED light sources forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

Exception: Individual LED light sources intended for indicating purposes only, need not comply with UL 8750.

36A Child Resistant Oven Door

36A.1 General

36A.1.1 The user shall be required to perform two distinct actions to open a door that provides access to the oven cavity. Actions such as slide and pull or twist and push are examples of actions which generally comply with the intent of the requirement. For touch-type controls, touching two different touch pads but not the same touch pad twice meets the intent of the requirement.

Exception: This section does not apply on the following product types:

a) Over-the-cooktop or under-cabinet mounted ovens provided the manufacturer's installation instructions is marked in accordance with 74.6.

b) Built-in or wall-mounted ovens provided either:

- 1) *The manufacturer's installation instructions are marked in accordance with [74.7](#);*
- 2) *The product has a bottom-hinged door; or*
- 3) *The product is a drawer microwave.*

c) Microwave ovens intended for commercial use only, and marked in accordance with [71.1.3\(f\)](#).

36A.1.2 Microwave ovens where there is more than one method (sequence of actions) to open the door shall have each method evaluated separately for compliance with [36A.1.1](#).

36A.1.3 For touch-type controls, a nonvalid or a single input shall be cancelled within 10 s. A single motion of a finger or hand across the control shall not activate the door to open. The following comply with the requirement:

- a) A construction in which it would be necessary for the user to remove their finger or hand from contact with the control between each operation. If a cancel pad is used to comply with the single motion requirement, the pressure and time necessary to activate the cancel pad shall not be greater than the Step 1 and Step 2 pads.
- b) A construction in which the distance between Step 1 and Step 2 pads and the timing software are such that a lock will not be disengaged when a finger or hand touches each pad, traveling along any path not affected by (a), at a rate of 15 in (381 mm) per second between the pads. In addition, a control employing this means shall be such that activation of the Step 1 and Step 2 pads require contact by the user for a minimum time of 100 ms.

36A.2 Door handle force test

36A.2.1 An oven that requires a pulling motion to open the door and that may be installed on a countertop shall be subjected to a force on the door handle (or grip point) per test procedure in [36A.2.2](#) – [36A.2.4](#). During this test the door shall not open and the appliance shall not move on the test surface.

36A.2.2 The appliance shall be placed on a horizontal surface having a coefficient of static friction of 0.20 ± 0.02 as determined by [36A.2.3](#) and consisting of non-textured laminated thermosetting countertop type material having a smooth matte finish and adhered to a wood base surface rigidly fixed for the intended use.

36A.2.3 The coefficient of static friction of the test surface in [36A.2.2](#) shall be established by use of a test block weighing 7.55 lb (33.7 N) and having a surface area of 32 in² (206 cm²). The surface is to consist of 304 stainless steel with a No. 3 finish. The coefficient of static friction is to be determined by the equation: $\mu = F_s/W$ where F_s is the force required to overcome the static friction between the test block and the test surface, and where W is the weight of the test block.

36A.2.4 A force gauge or weight shall be used to apply a 10 pound force to the center of the door handle (without actuating the two distinct steps). The force shall be applied normal to the front surface of the door.

36A.3 Override for single-action door opening

36A.3.1 An appliance complying with two-action door opening per [36A.1](#) may be provided with a means to allow the user to convert the product to single-action door opening (that is, disable one of the actions specified in [36A.1](#)). Conversion from two-action operation shall be accomplished by one of the following methods:

- a) An operation that requires a tool, or

- b) An operation that requires inputting a code consisting of at least 3 distinct key-presses on a touch control.

36A.3.2 The product shall be shipped from the manufacturer complying with [36A.1](#). The test in [36A.2](#) shall be performed while the product complies with [36A.1](#).

PERFORMANCE

37 General

37.1 Prior to performing any of the tests involving the complete appliance, all factory made adjustments are to be checked to determine that they are set in accordance with the manufacturer's specifications. All user adjustments are to be varied during the operating procedure and set to produce the most unfavorable results with respect to any or all performance features associated with the appliance (fire, electric shock, injury to persons, or excessive radiation emission, microwave or x-radiation).

37.2 A microwave cooking appliance that is rated for use at more than one supply frequency, voltage, or for a range of voltages, and contains a tapped transformer or other means of being adapted manually in the field to different supply frequencies or voltages is to be tested with the most unfavorable combination of supply frequency, voltage, and internal adjustments.

Exception: A microwave cooking appliance that is marked in accordance with [73.11](#) and [73.12](#) may be tested while connected in accordance with the manufacturer's instructions. In such cases, the appliance shall also comply with [54.4.4\(d\)](#).

37.3 The performance of an appliance shall be investigated by subjecting the requisite number of samples to all the applicable tests as described in Sections [38](#) – [66](#). Samples shall be subjected to leakage-current tests and preliminary microwave radiation tests in the as-received condition (that is, before being subjected to any other tests).

38 Leakage Current Test

38.1 The leakage current of a cord-connected appliance rated 120, 208, or 240 V nominal when tested in accordance with [38.2](#) – [38.6](#) shall not be more than:

- a) 0.5 mA for a portable appliance, and
- b) 0.75 mA for a stationary or fixed appliance employing a standard attachment-plug rated 20 A or less.

Exception: For appliances employing sheathed heating elements, the leakage current may exceed the limits specified above during heatup and cooldown during a period not more than 5 min. However, at no time shall the leakage current exceed 2.5 mA.

38.2 Leakage current refers to all currents, including capacitively coupled currents, that may be conveyed between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of an appliance.

38.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered acceptable for protection against electric shock as defined in [6.1](#) – [6.5](#). Surfaces are considered to be simultaneously accessible if they can be readily contacted by one or both hands of a person at the same time. These

measurements do not apply to terminals operating at voltages that are considered not to involve an electric shock.

38.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 3.9 by 7.9 in (100 by 200 mm) in contact with the surface. If the surface is less than 3.9 by 7.9 in (100 by 200 mm), the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the appliance.

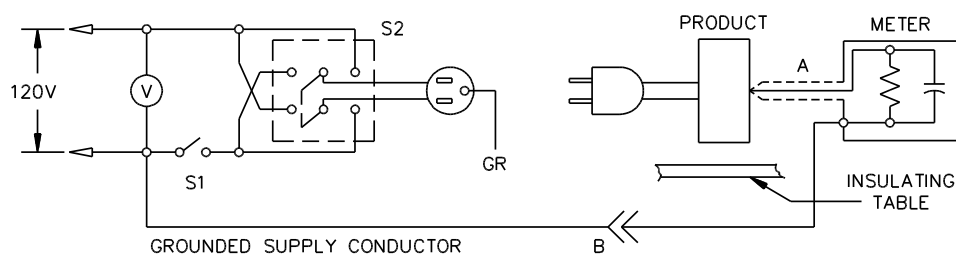
38.5 The measurement circuit for leakage current is to be as shown in [Figure 38.1](#). The measurement instrument is defined in (a) – (d). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter 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 microfarads (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 circuit is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of impedance of a 1500-ohm resistor shunted by a 0.15 μf capacitor to 1500 ohms. At an indication of 0.5 or 0.75 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.
- d) Unless the meter is being used to measure leakage from one part of an appliance to another, the meter is to be connected between an accessible part and the grounded supply conductor.

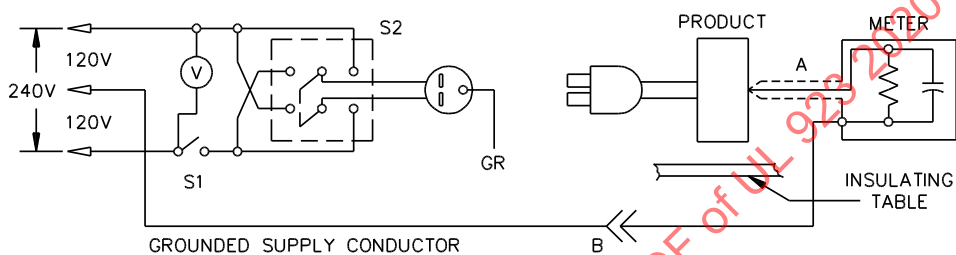
38.6 A sample of the appliance is to be tested for leakage current starting with the as-received condition with all its switches and thermostats closed, but with its grounding conductor, open at the attachment plug (open at receptacle – see [Figure 38.1](#)). The as-received condition is without prior energization except as may occur as part of the production-line testing. The supply voltage is to be adjusted to 120, 208, or 240 V as appropriate. The test sequence, with reference to the measuring circuit ([Figure 38.1](#)) is to be as follows:

- a) With switch S1 open, the appliance is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, thermostats set for maximum heating, and with switching devices in all their operating positions.
- b) Switch S1 is then to be closed, energizing the appliance, and within a period of 5 s the leakage current is to be measured using both positions of switch S2, and with the appliance operated at the maximum heat setting of thermostats and with switching devices in all their operating positions. The load in the oven cavity shall be as described in [41.5](#). The water load and container shall be of such quantity to enable completion of a continuous cooking cycle without necessitating replenishment to prevent boil dry of the water load.
- c) Leakage current is to be monitored until thermal stabilization under the maximum-heat conditions and the maximum value is to be recorded. Both positions of switch S2 are to be used. The equivalent of thermal stabilization is considered to be obtained as in the temperature test. If an adjustable temperature-regulating thermostat does not cycle at the maximum heat setting, it is to be adjusted until it does cycle before the final measurements at thermal stabilization are taken. Measurements are to be made with the heating-element thermostat, if any, open and closed and with switching devices in all their operating positions. Upon evidence of stabilizing readings, monitoring periods may be increased.
- d) Switch S1 is then to be opened and monitoring of a leakage current is to continue, using both positions of switch S2, until the leakage current stabilizes or decreases during cool down.

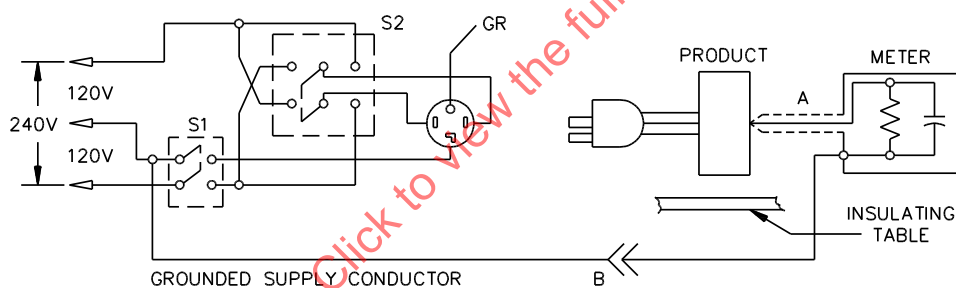
Figure 38.1
Leakage-current measurement circuits



Product intended for connection to a 120-volt power supply, as illustrated above.



Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.



Product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

LC300J

NOTE – 120/240 V circuit also applies to 208Y/120 V supply.

A – Probe with shielded lead

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

39 Microwave Radiation Emission Test

39.1 General

39.1.1 Prior to conducting any of the tests in Sections [40](#) – [66](#), the equivalent plane-wave power density of microwave radiation existing in the proximity of the external appliance surface shall not exceed 1 mW/cm² at any point 5 cm or more away from the external surface of the appliance with only the designated primary interlock in the circuit (all other door interlocks bypassed). The emission shall not exceed 5 mW/cm² at any point 5 cm or more away from the external surface of the appliance with only the designated secondary interlock in the circuit (all other door interlocks bypassed).

39.2 Instrumentation

39.2.1 Compliance with the equivalent plane-wave power density limits in [39.1.1](#) is to be determined by measurement with an instrument system that reaches 90 percent of its steady-state reading within 3 s when the system is subject to a stepped input signal and a test that accounts for all measurement errors and uncertainties.

39.2.2 During each reading, the meter sensing element is to be moved gradually at a maximum rate of 1 in per antenna (stirrer) revolution but no faster than 1 in/s or than the response time of the instrument will allow for an accurate reading. The sensing element is to be moved over all external surfaces of the appliance at a distance of 5 cm or more from the surface.

39.3 Cavity load

39.3.1 The load for all microwave radiation emission measurements shall consist of 275 ±15 mL of tap water initially at 20 ±5° C (68 ±9° F), contained in a low form, 600 mL beaker with an inside diameter of approximately 8.5 cm, constructed of electrically nonconductive material. The container is to be placed in the center of the load-carrying surface of the cavity.

39.4 Supply voltage

39.4.1 The appliance shall be tested at a voltage in accordance with [40.2.1](#).

39.5 Microwave radiation emission measurement

39.5.1 Microwave radiation emission measurements are to be made with the door fully closed and also with the door opened to any other position that enables generation of microwave energy into the cavity. During the test the door shall be held in that position, achievable during the normal door opening sequence, which results in maximum radiation emission.

39.5.2 User adjustments and adjustments that may be made without the use of a tool are to be set to create the most unfavorable results.

39.5.3 A barrier, shield, cover, and the like, that may be removed or opened without the use of a tool, is to be positioned in any manner possible for the measurements of microwave radiation emission in order to obtain the most unfavorable results.

39.5.4 Each microwave radiation emission measurement is to be made with only the designated primary interlock in the circuit (all other door interlocks bypassed) and with only the designated secondary interlock in the circuit (all other door interlocks bypassed). The interlock monitor circuit shall be disabled, if necessary, to make the emission measurements.

40 Power Input Test

40.1 General

40.1.1 The input power (or current if so rated) to a microwave cooking appliance shall not be more than 110 percent of the rated value when the appliance is tested under the conditions described in [40.2.1](#) – [40.4.1](#). See also [69.1](#).

40.2 Supply voltage

40.2.1 For the input test, the voltage of the supply circuit is to be 120 V if the appliance is rated between 110 and 120 V, or 240 V if the appliance is rated between 220 and 240 V. At any other voltage rating, the appliance is to be tested at its marked voltage rating if a single voltage is indicated, or at the maximum value if a voltage range is indicated. The frequency of the supply circuit is to be the rated frequency. See also [69.1](#).

40.3 Cavity load

40.3.1 For the input test, the load shall be the same as the load specified in [41.5](#). The water load and the container, shall be of such quantity, to enable completion of a continuous cooking cycle without necessitating replenishment to prevent boil dry of the water load.

40.4 Oven operation

40.4.1 While connected to a voltage supply and loaded as indicated in [40.2.1](#) and [40.3.1](#), the appliance is to be operated in its various intended operating modes and input amperes and watts measured with the appliance in a well heated condition. Operation for a minimum 20 min is considered to be a well heated condition.

41 Temperature Test

41.1 General

41.1.1 An appliance, when tested under the conditions described in [41.1.4](#) – [41.7.3](#) shall not attain at any point a temperature high enough to adversely affect any materials employed in the appliance, or show at any time during the test temperature rises at specific points greater than those indicated in [Table 41.1](#).

Table 41.1
Maximum acceptable temperature rises

Materials and components		Degrees	
		C	F
1.	Any point within a terminal box or wiring compartment of a permanently connected appliance in which field-installed conductors are to be connected, including such conductors themselves, unless the appliance is marked in accordance with 73.2 .	35	63
2.	Any point on a surface adjacent to an appliance, including the surface on which the appliance is mounted.	65	117
3.	At any point on an appliance surface other than in contact with the supporting surface, located directly above a storage drawer or directly	125	225

Table 41.1 Continued on Next Page

Table 41.1 Continued

Materials and components		Degrees	
		C	F
	above the plane of the top surface of the base of the test enclosure, see Figure 41.1 .		
4.	Fuses other than Classes CC, G, J, T.	65	117
5.	Class CC, G, J, or T fuses.	85	153
6.	Vulcanized fiber used as electrical insulation or as cord bushings.	65	117
7.	Wood and other combustible material.	65	117
8.	Class 105(A) insulation systems:		
	A. Relay or solenoid windings:		
	Thermocouple method	65 ^a	117 ^a
	Resistance method	85	153
	B. Coils of an electric-discharge-lamp ballast:		
	Thermocouple method	65 ^a	117
	Resistance method	80	144
	C. Coils of a Class 2 transformer:		
	Thermocouple method	65	117
	Resistance method	85	153
	D. Coils of a power transformer ⁹ :		
	Thermocouple method	65	117
	Resistance method	75	135
	E. Buzzer coil:		
	Thermocouple method	65	117
	Resistance method	75	135
9.	Class 105(A) insulation systems on coil windings of an ac motor having a frame diameter ^b of more than 7 in (178 mm) and of a dc and a universal motor:		
	A. In an open motor:		
	Thermocouple method	65 ^a	117 ^a
	Resistance method	75	135
	B. In a totally enclosed motor:		
	Thermocouple method	70	126
	Resistance method	80	144
10.	Class 105(A) insulation systems on coil windings of an ac motor (not including a universal motor) having a frame diameter ^b of 7 in (178 mm) or less – thermocouple or resistance method:		
	A. In an open motor	75 ^a	135 ^a
	B. In a totally enclosed motor	80	144
11.	Class 130(B) insulation systems:		
	A. Relay or solenoid windings:		
	Thermocouple method	85	153
	Resistance method	105	189
	B. Power-transformer or motor transformer coils ⁹ :		
	Thermocouple method	85	153
	Resistance method	95	171

Table 41.1 Continued on Next Page

Table 41.1 Continued

Materials and components		Degrees	
		C	F
12.	Class 130(B) insulation systems on coil windings of an ac motor having a frame diameter ^b of more than 7 in (178 mm) and of a dc and a universal motor:		
A.	In an open motor:		
	Thermocouple method	85 ^a	153 ^a
	Resistance method	95	171
B.	In a totally enclosed motor:		
	Thermocouple method	90	162
	Resistance method	100	180
13.	Class 130(B) insulation systems on coil windings of an ac motor (not including a universal motor) having a frame diameter ^b of 7 in (178 mm) or less – thermocouple or resistance method:		
A.	In an open motor	95 ^a	171 ^a
B.	In a totally enclosed motor	100	180
14.	Class 155(F) insulation system on coil windings of an ac motor having a frame diameter ^b of 7 in (178 mm) or less (not including a universal motor) – thermocouple or resistance method:		
A.	In an open motor	120 ^a	216 ^a
B.	In a totally enclosed motor	125	225
15.	Class 155(F) insulation systems on coils of power transformers or motor transformers ⁹ :		
	Thermocouple method	110	198
	Resistance method	120	216
16.	Class 180(H) insulation system on coil windings of an ac motor having a frame diameter ^b of 7 in (178 mm) or less (not including a universal motor) – thermocouple or resistance method:		
A.	In an open motor	135 ^a	243 ^a
B.	In a totally enclosed motor	140	252
17.	Class 180(H) insulation systems on coils of power transformers or motor transformers ⁹ :		
	Thermocouple method	125	225
	Resistance method	135	243
18.	Class 200(N) insulation systems on coils of power transformers and motor transformers ⁹ :		
	Thermocouple method	140	252
	Resistance method	150	270
19.	Class 220(R) insulation systems on coils of power transformers and motor transformers ⁹ :		
	Thermocouple method	155	279
	Resistance method	165	297
19- A.	Class 240(S) insulation systems on coils of power transformers and motor transformers ⁹ :		
	Thermocouple method	170	306
	Resistance method	180	324

Table 41.1 Continued on Next Page

Table 41.1 Continued

Materials and components		Degrees	
		C	F
20.	Phenolic composition employed as electrical insulation or where deterioration would result in a risk of fire, electric shock, injury to persons, or excessive radiation emission. ^c	125	225
21.	A copper conductor (bare or insulated) without a nickel coating or other equivalent protection.	125	225
22.	Termination of a copper conductor and a pressure terminal connector without a nickel coating or other equivalent protection.	125	225
23.	Insulated wire or cord.	25°C (77°F) less than its temperature rating	
24.	Sealing compound.	40 ^e	72 ^e
25.	On the surface of a capacitor casing:		
	Electrolytic	65 ^f	117 ^f
	Other types		

^a At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may be higher by the following amount than the maximum indicated, provided that it does not exceed the value indicated in the table.

Item	Additional
8 (A) and 8 (B)	15°C (27°F)
9(A)	15°C (27°F)
10(A)	5°C (9°F)
12(A)	20°C (36°F)
13(A)	10°C (18°F)
14(A)	5°C (9°F)
16(A)	10°C (18°F)

^b The frame diameter is the diameter measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, boxes, and the like used solely for motor mounting, assembly or connection.

^c The limitation on phenolic does not apply to a compound that has been investigated and found to have heat-resistant properties.

^d Unless a thermosetting material, the maximum sealing-compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound.

^e For an electrolytic capacitor that is integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure is not to be higher than 65°C (117°F).

^f A capacitor that operates at a temperature rise of more than 65°C (117°F) can be evaluated on the basis of its marked temperature limit.

^g Some types of coil construction may have a smaller difference of temperature between the thermocouple method and the resistance method than conventional types of coil windings. In such cases the limiting values shown may be ignored if an investigation shows that the hottest-spot (limiting) temperature for the insulating system Class is not exceeded.

41.1.2 All values in the table are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). However, if the operation of an automatic thermal control during the test limits the temperatures under observation, no temperature higher than 25°C (77°F) plus the specified maximum rise is acceptable.

41.1.3 A short length of flexible cord exposed to a temperature higher than the temperature rating of the cord, such as at terminals, but not in a strain-relief or similar location where dependence is placed on the mechanical properties of the insulation, is acceptable if supplementary heat-resistant insulation of

appropriate dielectric strength and temperature rating is employed on the individual conductors of the cord to protect against deterioration of the conductor insulation.

41.1.4 Supply conductors used for the normal temperature test of a permanently connected appliance shall have an ampacity of 125 percent of the current rating of the appliance, when the appliance will operate continuously, or equal to the current rating of the appliance when the load will be intermittent. Also, the conductors shall be acceptable for a temperature in accordance with the temperature marking, if any, on the appliance. See [13.1.2.3](#), [73.2](#), and [73.3](#).

41.2 Temperature measurements

41.2.1 Temperatures are to be measured by thermocouples. The thermocouples shall consist of wires not larger than 24 AWG (0.21 mm²) and not smaller than 30 AWG (0.05 mm²). The thermocouples and related instruments shall be accurate and shall be calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

41.2.2 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material the temperature of which is being measured. In most cases, good thermal contact will result from securely taping or cementing the thermocouple in place; but if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

41.2.3 Whenever referee temperature measurements are necessary, thermocouples consisting of 30 AWG (0.05 mm²) iron and constantan wires and a potentiometer type of indicating instrument shall be employed.

41.2.4 Usually, the temperature of a coil or winding is to be measured by means of thermocouples applied to the outer wrap unless the coil is inaccessible for mounting these devices.

41.2.5 For the thermocouple-measured temperature of a coil of an alternating-current motor (other than an universal motor) having a frame diameter of 7 in (178 mm) or less the thermocouple is to be mounted on the integrally applied insulation of the conductor.

41.2.6 If the coil is operating at a potential over 600 V or inaccessible for mounting thermocouples (for example, an encapsulated coil) or if the coil wrap includes thermal insulation or more than 1/32 in (0.8 mm) of cotton, paper, rayon, or similar insulation, the change-of-resistance method is to be used.

41.2.7 The temperature rise of a winding is to be calculated from the formula (windings are to be at room temperature at the start of the test):

$$\Delta t = \frac{R}{r}(k + t_1) - (k + t_2)$$

in which:

Δt is the temperature rise,

R is the resistance of the coil at the end of the test,

r is the resistance of the coil at the beginning of the test,

t_1 is the room temperature °C at the beginning of the test,

t_2 is the room temperature °C at the end of the test, and

k is 234.5 for copper, 225.0 for electrical conductor (EC) grade aluminum. Values of the constant for other grades of materials must be determined.

41.2.8 If the coil wrap does exceed its temperature limitation because of radiation from an external source, the temperature of the coil may be measured by means of a thermocouple on the integral insulation of the coil conductors.

41.3 Installation

41.3.1 General

41.3.1.1 In a test to determine if an appliance complies with the temperature requirements, it is to be mounted or supported as in actual service and under conditions approximating those of normal operation. Temperatures are to be measured on nearby surfaces, on the supporting surface, at points of support, and at other points as may be necessary.

41.3.2 Countertop cord-connected and permanently connected appliances

41.3.2.1 A counter-top cord-connected appliance is to be supported on a horizontal, black-painted softwood surface. It is to be placed in a wall angle of 90 degrees formed by two black-painted, vertical surfaces of 3/8-in (9.5-mm) thick plywood having such width and height that they extend not less than 2 ft (610 mm) beyond the physical limits of the appliance. The appliance is to be located as closely to the sides of the wall angle as its construction will permit and it is to be so placed relative to the walls that maximum heating will occur on the alcove walls and internal components of the appliance.

41.3.2.2 A permanently connected appliance that is intended to rest on a horizontal surface, such as a floor, counter top, or shelf, is to be tested as described in [41.3.2.1](#).

Exception: The appliance may be spaced away from the sides of the wall angle if marked in accordance with [73.26](#) and provided with instructions in accordance with [74.4](#).

41.3.2.3 A cord-connected or permanently connected microwave cooking appliance intended for use in conjunction with a household electric range shall be installed as indicated in [41.6.5.1.3](#).

41.3.3 Under-cabinet appliances

41.3.3.1 A microwave cooking appliance that may be mounted to the bottom of a cabinet shall be tested with the appliance mounted in accordance with the installation instructions provided with the appliance or a separately available under-cabinet mounting kit. The appliance shall be located in the corner wall angle described in [41.3.2.1](#). The appliance shall be located as close to the back wall as the construction will permit. Unless marked as described in [73.26](#) and provided with instructions as described in [74.4](#), the appliance shall be located as close to the side wall as the construction will permit. The cabinet is to have such width that it extends not less than 2 ft (610 mm) beyond the physical limits of the appliance, is to be of a depth equal to the depth of the appliance, and located 16 in (406 mm) above the counter top.

Exception: An under-cabinet appliance constructed such that the combined height of the appliance and mounting hardware is more than 16 in (406 mm) shall be tested with the cabinet located more than 16 in above the counter top, but with zero clearance between the bottom of the appliance and the counter top.

41.3.4 Wall-mounted appliances

41.3.4.1 A microwave cooking appliance that is intended for wall-mounted installation shall be tested with the appliance mounted to a wall in accordance with the installation instructions provided with the appliance or a separately available wall-mounting kit. The walls of the enclosure in which a wall-mounted appliance is to be tested are to extend from the bottom of the appliance to at least the top of the appliance, and are to project not less than 2 ft (610 mm) in front of the appliance. The walls are to be firmly assembled with 90-degree angles between the back and side walls. Top cabinet and bottom counter panels are to be provided above and below the appliance. Unless marked as described in [73.26](#) and provided with instructions as noted in [74.4](#), a wall-mounted appliance shall be located as close to the walls, the top cabinet and bottom counter panels, as the construction will allow.

41.3.5 Wall-insert and built-in appliances

41.3.5.1 A wall-insert or built-in appliance is to be supported on a base that is to rest on a bench or table. The test enclosure is to be firmly assembled so that the sides, back, and top will provide as close a fit as the construction of the appliance will permit – a sliding fit. The trim around the appliance door is to be mounted in the intended manner. A gasket intended to provide a spacing between the trim and the wall in which the unit is mounted is to be removed before the unit is set in place for the test, unless it is so secured for shipment from the factory that it cannot be separated from the trim. Mounting brackets, slide-in tracks, and the like provided by the manufacturer are to be used in the installation.

41.3.5.2 If the manufacturer's instructions for a wall-insert or built-in appliance indicate that the appliance is suitable for installation with no ventilation in the base, a single sheet of 3/8-in (9.5-mm) thick plywood is to be utilized as the supporting surface.

41.3.5.3 If the manufacturer's instructions specify installation with ventilation in the base of the cabinet for a wall-insert or built-in appliance, the base for supporting the unit is to be as illustrated in [Figure 41.1](#). The sides of the base are to be constructed of boards 2 by 3/4 in (50.8 by 19.1 mm), and of such length as to be flush with the side, front, and back panels shown in [Figure 41.2](#). The diameter of the holes in the sides of the base are to be 1 in (25.4 mm), with each center 1 in from the bottom and 1 in from the nearer end of the board. The slats are to be boards 2 by 3/4 in, and are to be mounted in such position as to line up with the feet or skids on the bottom of the unit. The tops of the slats are to be in the horizontal plane of the top surface of the base. A block with a thermocouple, see [Figure 41.3](#), is to be placed so that the thermocouple side of the block is also in the horizontal plane of the top surface of the base.

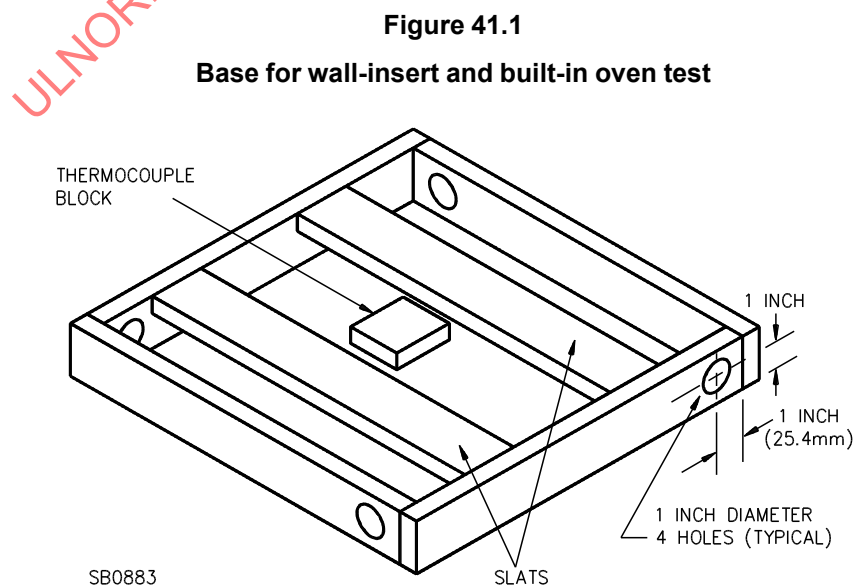


Figure 41.2
Enclosure panels for wall-insert and built-in oven test

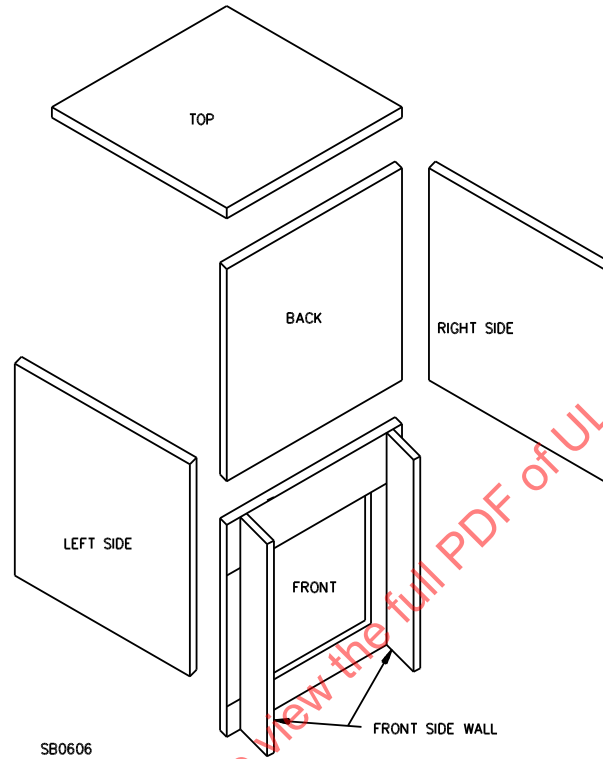
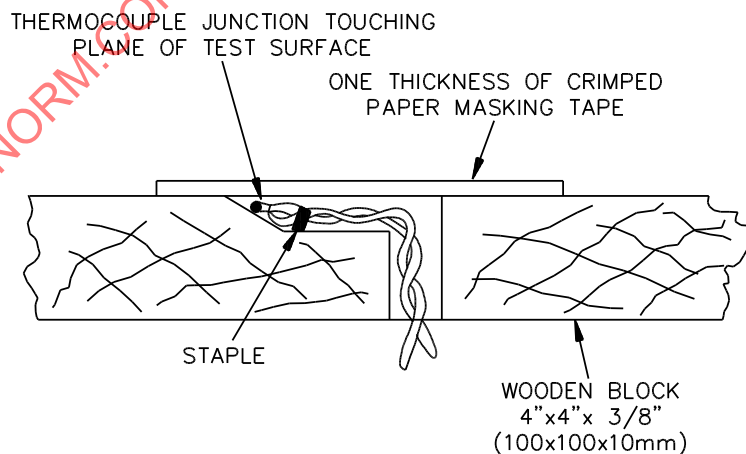


Figure 41.3
Method of mounting thermocouple



41.3.5.4 The front, top, back, side, and front side-wall panels for enclosing the appliance are to be as illustrated in [Figure 41.2](#). They are to be constructed of plywood 3/8-in (9.5-mm) thick, and are to be painted black. The dimensions of the panels are to be as described by the overall outer dimensions of the unit, in accordance with [41.3.5.3](#). The opening in the front panel is to be no larger than necessary to permit the unit to be inserted. The width of the top member of the front panel is to be 12 in (305 mm) and the

width of the other members is to be 6 in (152 mm). The front side-wall panels are to be no less than 12-in wide and, except as noted below, are to extend the full height of the overall front panel and are to be located as close as possible to the trim of the appliance. If the appliance door covers the trim, the front side-wall panels are to be located 1/4 in (6.4 mm) from the edge of the door.

41.3.5.5 A wall-insert or built-in appliance with a bottom-hinged door is first to be tested with both front side-wall panels in place. If temperatures exceeding those specified in [Table 41.1](#) are recorded, the test may be repeated with one front side-wall panel in place followed, if necessary, by a test with the other panel in place. An appliance with a side-hinged door is to be tested with only one front side-wall panel located at the hinged end of the door.

41.3.6 Side-by-side and over-under appliances

41.3.6.1 If the manufacturer wishes an appliance to be investigated for operation installed adjacent to an identical appliance (side by side) or one above the other, the setup for the test is to be as follows. Each of the two units is to be enclosed in the manner described in [41.3.5.1](#) – [41.3.5.5](#) except as noted in this paragraph, and the front of each unit is to be in the same vertical plane as that of the other. For operation side by side, the two assemblies are to be tested on a common horizontal surface, and for operation one above the other, one assembly is to be set on top of the other. In either case, the separation between the two assemblies is to be no larger than that necessary to accommodate the trims, except that the separation may be larger than this minimum value if the appliance is marked in accordance with [73.20](#). If the minimum separation is employed for units mounted one above the other, the height of the base (see [41.3.5.3](#)) for mounting the uppermost unit may be increased from the specified value if necessary to accommodate the trim. If the minimum separation is employed for units mounted side by side, the width of each of the two adjacent front panels may be less than 6 in (152 mm) as specified in [41.3.5.4](#) as may be necessary to bring the two trims into contact with each other. After the assemblies have been mounted as described above, any open space at the top, back, or sides is to be closed with plywood.

41.3.7 Over-the-cooktop appliances

41.3.7.1 General

41.3.7.1.1 An over-the-cooktop microwave oven is to be installed above at least one of the following:

- a) The standard test gas range described in [41.3.7.2.1](#) – [41.3.7.2.5](#).
- b) The standard test electric range described in [41.3.7.3.1](#) – [41.3.7.3.6](#).
- c) The specific appliance or appliances (range or cooktop) marked on the appliance. See [41.3.7.4.1](#), [41.3.7.5.1](#), [73.14](#), and [73.16](#).

41.3.7.1.2 The markings on the appliance determine which of the three options specified in [41.3.7.1.1](#) is to be chosen, as well as the width of the range heat source. If a standard range is chosen, the appliance is to be tested over the widest range recommended.

41.3.7.1.3 If the widest recommended range is wider than the over-the-cooktop microwave oven, the appliance is also to be tested over a range of the same width as the appliance.

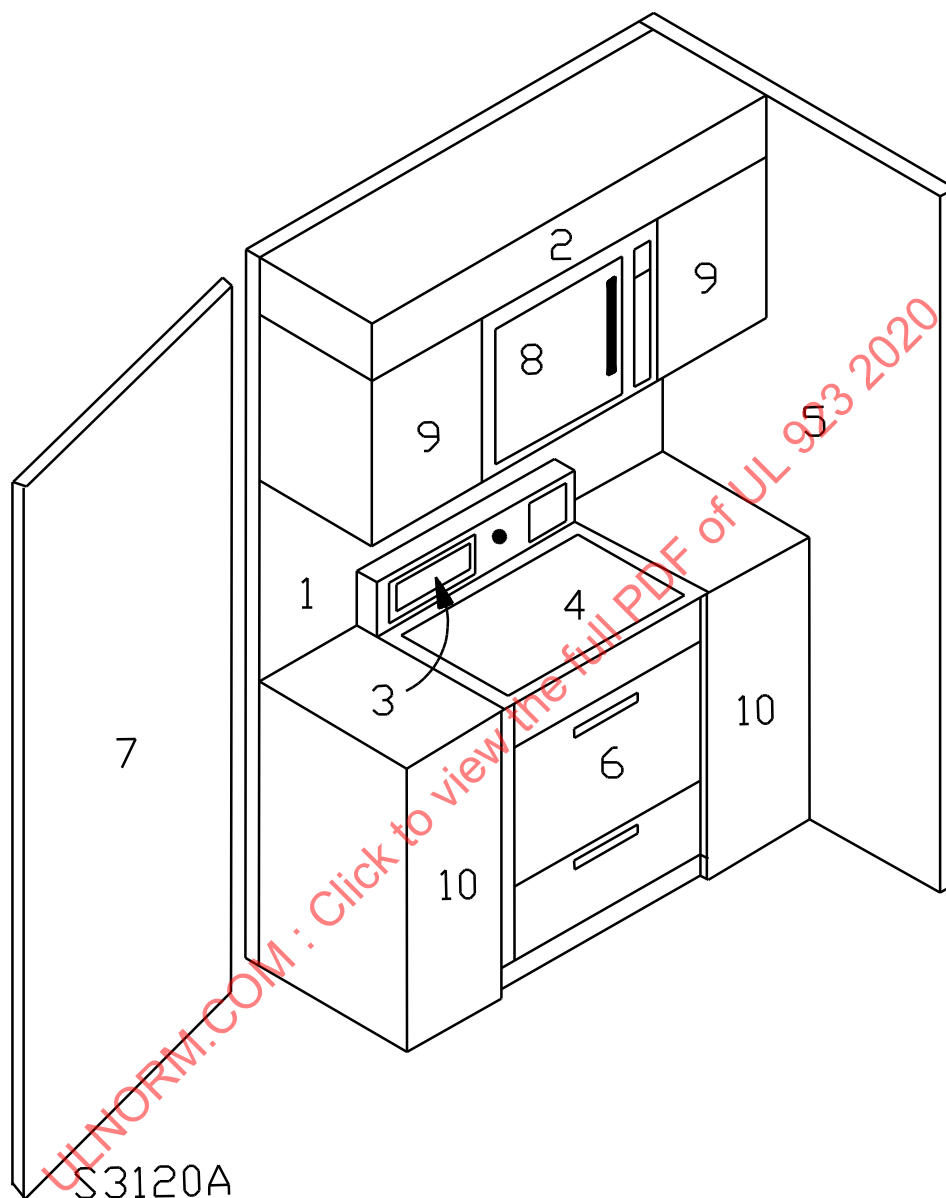
41.3.7.1.4 Testing above the standard test gas range of a specified width qualifies an over-the-cooktop microwave oven for use above any electric, as well as gas, range of that width without the need for further testing with other heat sources.

41.3.7.1.5 The walls of the enclosure are to be made of plywood, 3/8-in (9.5-mm) thick, painted black, and are to extend at least to the top of the cabinet and are to project at least 1 ft (305 mm) in front of the installed range and over-the-cooktop microwave oven. The enclosure is to be firmly assembled with 90-

degree angles between the back and the side walls. The walls of the enclosure are to be located as close to the assembly as construction will permit, a sliding fit. The side walls are then to be adjusted at the front until contact is established between the test enclosure and the front edges of the appliance assembly at its widest point. See [Figure 41.4](#).

41.3.7.1.6 The over-the-cooktop microwave oven and range are to be installed in contact with the back wall with the over-the-cooktop microwave oven installed at the manufacturer's minimum recommended height above the cooktop, consistent with [73.28](#) and [74.5](#). The top cabinet is to be installed immediately above the appliance. The top cabinet is to be 12-in (305-mm) high, a width sufficient to extend to the side walls of the test enclosure and 13-in (330-mm) deep, except that it may be of a lesser depth if an integral cabinet stop is provided on the over-the-cooktop microwave oven, in which case the cabinet is to be of sufficient depth to extend to the cabinet stop. If the appliance (over-the-cooktop microwave oven) is narrower than the range (or cooktop), the appliance is to be centered over the range width, and upper side cabinets are to be installed on each side of the appliance to fill the spaces between the sides, the test enclosure walls, and the top cabinet. The base surfaces of the upper side cabinets are to be at the same height above the range as the appliance base. If the appliance is wider than the range (or cooktop), the range is to be centered under the appliance width, and lower side cabinets are to be installed on each side of the range to fill the spaces between the range sides, the test enclosure walls, and the floor. The top surfaces of the lower side cabinets are to be at the same height as the range top. All cabinets are to have a solid front panel. See [Figure 41.4](#).

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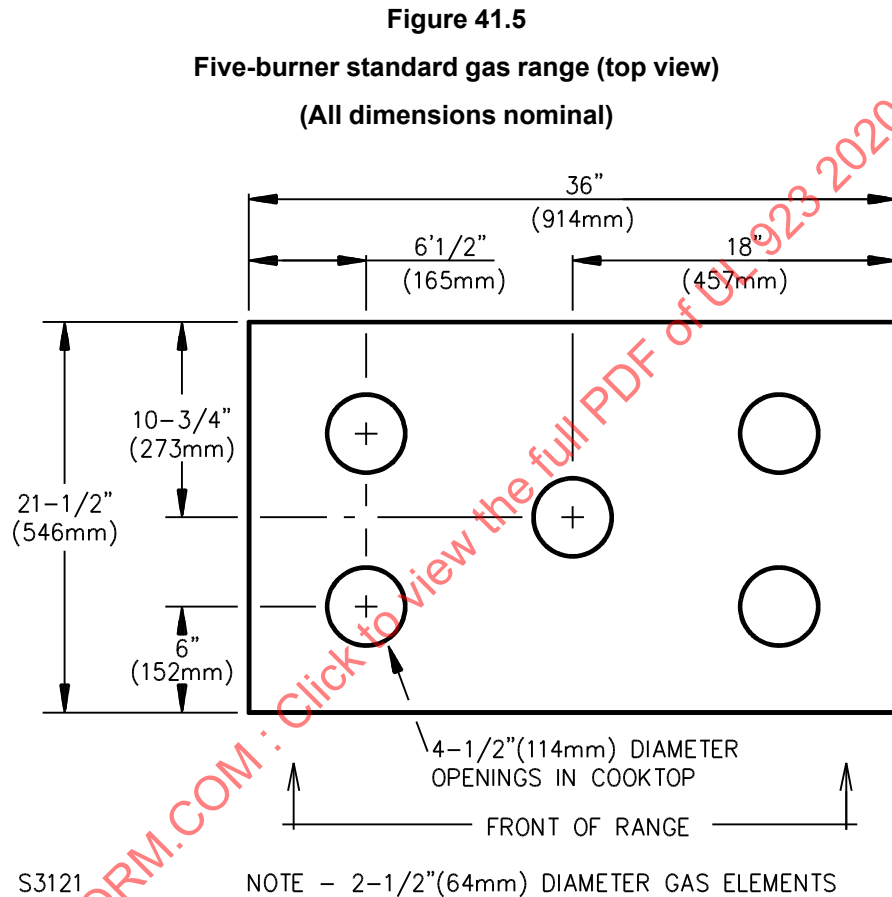
Figure 41.4**Test enclosure for over-the-cooktop microwave oven over a counter level range****NOTES –**

- | | |
|-------------------------|-------------------------------------|
| 1. Building back wall | 6. Range |
| 2. Top building cabinet | 7. Building side wall |
| 3. Control panel | 8. Microwave oven |
| 4. Cooking surfaces | 9. Upper side cabinet ^a |
| 5. Building side wall | 10. Lower side cabinet ^a |

^a Panels 9 and 10 will not normally be used at the same time. Panel 9 will be used if the appliance width is less than the range width and panel 10 will be used if the appliance width is more than the range width.

41.3.7.2 Standard test gas range

41.3.7.2.1 The standard test gas range to be used is to have an oven capable of maintaining an average temperature of 246°C (475°F) at the center of the oven. The range is to have surface burners rated 10,000 Btu/h (2930 W) each when supplied with natural gas. The over-the-cooktop microwave oven is to be installed over the widest range specified by the manufacturer. A range 30 in (762 mm) or less in width is to have four surface burners. A range wider than 30 in is to have five surface burners as described in [Figure 41.5](#).



41.3.7.2.2 A stove plate is to be placed on each of the two front surface burners if a five burner range is used. If a four burner range is used, either front burner is to be covered by the stove plate. A pan of water is to cover each of the remaining surface burners.

41.3.7.2.3 The stove plate in [41.3.7.2.2](#) is to be circular, cast iron or steel, have a diameter of 7-1/2 in (191 mm), and is to weigh approximately 3 lb (1.36 kg). The plate is to be flat, but may be ribbed on one side to prevent warping and is to be free from rust or other foreign material.

41.3.7.2.4 The pans mentioned in [41.3.7.2.2](#) are to be of aluminum and are to have approximately vertical sides. The diameter of the bottom plane surface of each pan is to be 7-1/2 in (191 mm).

41.3.7.2.5 The controls for the surface burners covered with a steel plate are to be adjusted to result in a temperature of 246°C (475°F) at the center of the top surface of the steel plate. The control for each surface burner covered with a pan of water is to be adjusted to 3,032 Btu/h (888 W).

41.3.7.3 Standard test electric range

41.3.7.3.1 The standard test electric range to be used is to have an oven capable of maintaining an average temperature of 246°C (475°F) at the center of the oven cavity. An over-the-cooktop microwave oven is to be installed over the widest range specified by the manufacturer. A range less than 36-in (914-mm) wide is to have four surface elements. If a standard test electric range 36 in or wider is to be used, it is to have four surface elements, and a griddle.

41.3.7.3.2 The surface units are to consist of two elements, 6 inches (152 mm) in diameter, rated 1500 W minimum; and two elements, 8 inches (203 mm) in diameter, rated 2600 W minimum. At least one of the elements rated 2600 W minimum is to be located at the front of the range cooktop. Each element is to be controlled by a control that satisfies the test conditions.

41.3.7.3.3 A stove plate is to be constructed as described in [41.3.7.2.3](#), except that it is to be 10-1/2 inches (267 mm) in diameter, and weigh 7 lb (3.18 kg). A stove plate is to be placed on the front element rated 2600 W. A pan of water is to be placed on each of the remaining elements. A pan is to be of aluminum and is to have approximately vertical sides. The diameter of the bottom plane surface of a pan is to be no less than the maximum diameter of the active part of the surface unit on which the pan is used, but no more than 1 in (25.4 mm) larger than that diameter.

41.3.7.3.4 The control for the element rated 2600 W and covered with a stove plate is to be adjusted so that the average steady-state temperature at the center of the top surface of the stove plate is 246°C (475°F). If necessary, the surface unit is to be connected to an external power supply adjusted so that the average temperature at the center of the top surface of the stove plate is 246°C.

41.3.7.3.5 The griddle of a range 36 in (914 mm) or wider is to be operated with its control set so that the average steady-state temperature at the center of the griddle plate is 246°C (475°F). The griddle is to have a surface area of $200 \pm 30 \text{ in}^2$ ($1290 \pm 194 \text{ cm}^2$). If necessary, the griddle is to be connected to an external power supply adjusted so that the average temperature at the center of the top of the griddle is 246°C.

41.3.7.3.6 The control for each element rated 1500 W is to be set so that the average power input is 650 W. The control for the element rated 2600 W on which a pan of water is placed is to be set so that the average power input is 833 W.

41.3.7.4 Specific range – electric

41.3.7.4.1 If an over-the-cooktop microwave oven is intended for use only with a specific electric range or ranges (or cooktops), the specific range or ranges are to be installed and operated as specified in [41.3.7.3.1](#) – [41.3.7.3.6](#). If the range cooktop surface elements are rated other than as specified in [41.3.7.3.2](#), or if the cooktop employs a grill, griddle, deep-fat fryer, or the like, the elements are to be loaded and adjusted as specified for the Temperature Test in the Standard for Household Electric Ranges, UL 858.

41.3.7.5 Specific range – gas

41.3.7.5.1 If an over-the-cooktop microwave oven is intended for use only with a specific gas range or ranges (or cooktops), the range or ranges are to be operated using the stove plates and pans of water noted in [41.3.7.2.3](#) and [41.3.7.2.4](#) and positioned as specified in [41.3.7.2.2](#). The control for each surface burner covered with a stove plate is to be adjusted to result in a temperature of 246°C (475°F) at the center of the top surface of the stove plate. The control for each burner covered with a pan of water is to be adjusted so that the power input to the burner is not less than:

- a) 50 percent of the power output for a burner with a maximum output of 4096 Btu/h (1200 W) or less, or

b) 1365 Btu/h (400 W) plus one-sixth of the power output of the burner in Btu/h for a burner with a maximum output of more than 4096 Btu/h (1200 W).

41.3.8 Over-the-built-in wall oven

41.3.8.1 A built-in microwave oven intended for use over a conventional built-in gas or electric oven is to be tested with a commercially available 30-in (76.2 cm) wide gas wall oven. A built-in microwave oven intended for use only over a conventional built-in electric oven is to be tested with a commercially available 30-in (76.2 cm) wide electric wall oven. The standard test built-in wall oven to be used is to have an oven capable of maintaining an average temperature of 246°C (475°F) at the center of the oven cavity.

41.3.8.2 The built-in microwave oven is to be installed over the conventional built-in wall oven using the spacings between the appliances as specified by the manufacturer, however, the test enclosure specified in [41.3.5](#) is to be used. If no spacing between the ovens are specified by the manufacturer, the built-in microwave oven is to be installed in as close proximity as the construction of the appliances will allow.

41.4 Supply voltage

41.4.1 The supply voltage for the temperature test is to be as specified in [40.2.1](#).

41.5 Cavity load

41.5.1 During the temperature test a heat-resistant glass or plastic electrically nonconductive container is to be placed in the center of the load carrying surface of the cavity containing enough water so that at the conclusion of the final cooking cycle there is as close to 1 L of water remaining as possible, but not less than 1 L. Initially, the water load shall be of such quantity as to enable completion of a complete cooking cycle without necessitating replenishment. At no time during a cooking cycle shall the water load be less than 1 L. If necessary, the water load may be replenished at the completion of a cooking cycle. Microwave appliances employing solid-state controls shall be tested until stabilized temperatures are obtained with a water load of 1 L.

41.6 Operating conditions

41.6.1 Commercial appliances

41.6.1.1 The microwave generating part of a commercial appliance is to be operated for the maximum setting of any timer followed by an off period not to exceed 10 s to simulate removal and replacement of food. The cooking cycle is to be repeated until constant temperatures are attained.

41.6.2 Household appliances

41.6.2.1 The microwave generating part of a household appliance is to be operated continuously for a period of 2 h, if a continuous operating feature is provided. If resetting a timer is necessary, the timer is to be set for the maximum cooking cycle, reset after a timer off period of 30 s, and this cycle repeated until a total cooking time of 2 h has been accumulated on the appliance.

Exception: An appliance relying upon an electronic timing circuit to turn the unit off after a prescribed time period shall be operated continuously until temperatures stabilize, unless the electronic timing circuit has been evaluated. The appliance shall be off only for the time necessary to replenish the water load. The initial water load shall be of such quantity as to enable 1 h of continuous operation without necessitating replenishment.

41.6.2.2 The temperature test for a microwave cooking appliance employing a general-use attachment plug receptacle is to be tested with the receptacle loaded resistively to the maximum current for the receptacle configuration employed. If a provision is made to prevent energizing the receptacle during microwave generation, separate tests are to be conducted in each operating mode.

41.6.3 Over-the-cooktop appliances

41.6.3.1 The test installation for an over-the-cooktop appliance is to be as described in [41.3.7.1.5](#) and [41.3.7.1.6](#). The test is to be conducted in each of the applicable conditions specified in [41.6.3.2](#) (a) – (e). Wall temperatures surrounding the gas or electric range (or cooktop) need not be measured. All tests are to be continued as specified in [41.6.1.1](#) and [41.6.2.1](#).

41.6.3.2 The test for an over-the-cooktop appliance is to be conducted in each of the following applicable conditions:

a) Microwave oven, vent hood fan, all range cooktop elements, and the range oven operating. The range oven is to be set in the bake mode with the center of the oven maintained at an average temperature of 246°C (475°F).

b) Only microwave oven and vent-hood fan operating.

c) Microwave oven not operating, range cooktop elements not operating, and vent hood fan operating. The specific range oven operating in the self-clean mode if it is provided with a self-clean feature.

Exception: This condition does not apply to the standard gas range or standard electric range. See [41.3.7.2.1](#) – [41.3.7.3.6](#).

d) The conditions specified in (a), (b), and (c), with the vent hood fan not operating. A thermostat that is provided to automatically energize a vent-hood fan shall be allowed to function if the user cannot turn the fan off while the microwave oven is energized because of an interlocking device or an automatic thermostat, the interlocking device or automatic thermostat withstands 100,000 c of intended operation without impaired performance while making and breaking the maximum rated current and rated voltage, and the thermostat complies with the requirements, including calibration verification, applicable to appliance limit controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, or with the requirements of operating type 2 action control in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

e) The conditions specified in (a), (b), and (c) for each intended speed of the vent hood fan.

f) The conditions specified above in the ducted position and ductless position if the appliance is intended for such operation.

41.6.4 Over-the-built-in wall oven

41.6.4.1 The test installation for a built-in microwave oven installed over a conventional built-in wall oven is to be as described in [41.3.8.1](#) and [41.3.8.2](#). The test is to be conducted in each of the applicable conditions specified in [41.6.4.2](#) (a) – (d). Wall temperatures surrounding the gas or electric wall oven need not be measured. All tests are to be continued as specified in [41.6.1.1](#) and [41.6.2.1](#).

41.6.4.2 The test for a built-in microwave oven installed over a conventional built-in wall oven is to be conducted in each of the following applicable conditions:

- a) Microwave oven and the wall oven operating. The wall oven is to be set in the bake mode with the center of the oven maintained at an average temperature of 246°C (475°F).
- b) Only microwave oven.
- c) Microwave oven not operating. The specific wall oven operating in the self-clean mode if it is provided with a self clean feature.
- d) The conditions specified above in the ducted position and ductless position if the appliance is intended for such operation.

41.6.5 All appliances

41.6.5.1 General

41.6.5.1.1 A microwave cooking appliance with a thermal element in the cavity is to have the thermal element operating at the same time, if simultaneous operation of the microwave generator and thermal element is possible.

41.6.5.1.2 A microwave appliance with an integral thermal element, in which simultaneous operation of the microwave generator and thermal element is not possible, is to be subjected to a separate temperature test with the thermal element energized at maximum heat until thermal equilibrium is attained. The appliance shall be tested with the load described in [41.5.1](#).

41.6.5.1.3 A combination microwave and thermal cooking appliance other than those described in [41.6.5.1.1](#) and [41.6.5.1.2](#) where the microwave and thermal cooking functions are separate and distinct, for example a household microwave oven intended for use over an electric range, is to be operated simultaneously with the range for 2 h, after the electric range has attained thermal equilibrium. The manner of installation of the combination, and the operation of the electric range, shall be in accordance with the Standard for Household Electric Ranges, UL 858.

41.6.5.1.4 For the tests of [41.6.1.1](#) – [41.6.5.1.3](#) the sequence of the microwave and thermal cooking operations shall be representative of the most severe condition that may be encountered during intended use, with consideration given to the manufacturer's operating instructions.

41.6.5.1.5 A temperature-regulating thermostat or a temperature-regulating and -limiting thermostat is to be shunted out of the circuit, unless the control has been shown, in accordance with [Table 59.1](#), to be rugged, reliable, and unlikely to be defeated by the user. The control is considered to be unlikely to be defeated if tools are required to gain access to the control, or a positive stop is incorporated in the control.

41.6.5.1.6 An overload, overcurrent-protective or temperature-limiting device shall not open the circuit to interrupt normal operation during the temperature test.

41.6.5.1.7 With reference to the test of [41.6.1.1](#), [41.6.2.1](#), and [41.6.5.1.2](#), thermal equilibrium is considered to exist when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test indicate no change. No interval is to be shorter than 5 min.

41.6.5.2 Preheat operation

41.6.5.2.1 An appliance employing a thermal element shall be operated without load under maximum thermal heating conditions for a period of 10 min, or the maximum time for preheat operation specified in the instructions provided with the appliance, whichever is longer. At all times during the test the appliance shall comply with [41.1.1](#). This test shall be conducted in addition to the tests described in [41.1.1](#) – [41.6.5.1.7](#), and may precede the test described in [41.6.5.1.1](#) – [41.6.5.1.4](#).

41.7 Motors used with solid-state controls

41.7.1 In addition to the conditions described in [41.1.1](#) – [41.6.5.2.1](#), an appliance that includes a motor that is intended for use with a solid-state control is to be operated under each of the following conditions:

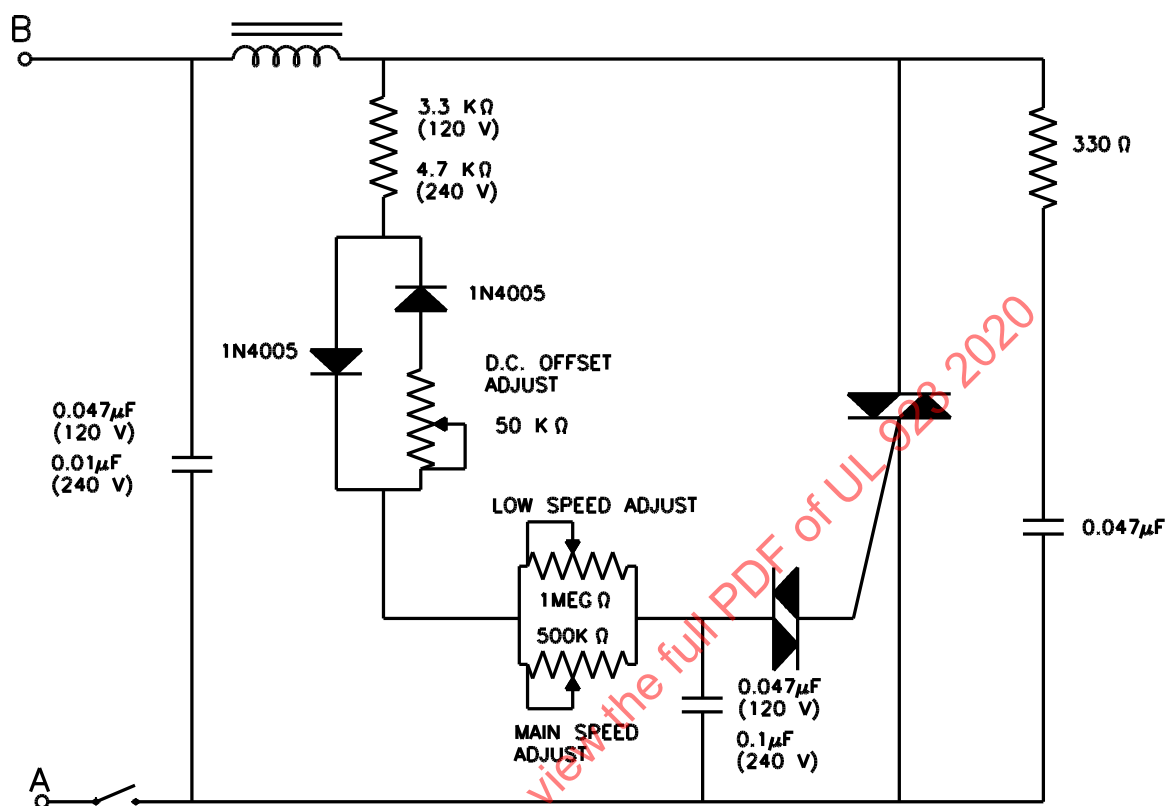
a) At the intended speed resulting in maximum motor winding temperatures. If the control is such that the motor speed may be continuously variable (that is, an infinite number of speeds), during this test the motor is to be connected to the load side of a triac. The triac is to be provided with associated circuitry allowing it to be triggered during each half-cycle of the ac input to the motor. Speed control is to be accomplished by varying the trigger points.

b) Connected and tested as described in (a) with an offset potential of 2 V dc applied to the ac motor input voltage by a suitable method. The offset potential may be obtained by using a modified speed control having routing diodes and dual triggering circuits to allow independent adjustment of the positive and negative half-cycle triac triggering points. See [Figure 41.6](#). The triggering points are to be adjusted so that a bias of 2 V dc is measured on the switched ac output waveform. The dc bias may be measured by a dc voltmeter having a frequency damped response in the range of 0 to 120 Hz. However, if the control has a maximum dc offset potential of less than 2 V, the maximum dc offset potential of the control is to be used.

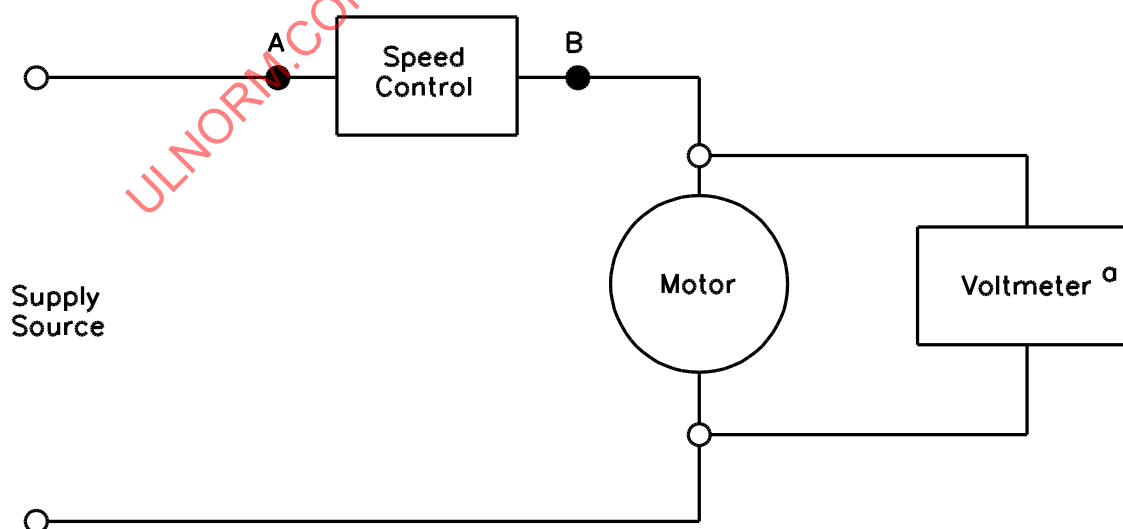
c) With the motor connected to an ac supply modified to produce half-wave output. The supply is to be switched from sinusoidal to half-wave output after the motor is operating at steady-state speed. This test is to be conducted in the rotating direction, if reversible, and speed control setting resulting in maximum motor winding temperatures. If the motor shaft will not continue to rotate in a manner considered to be a possible normal condition after the supply is switched from sinusoidal to half-wave operation and such malfunction would be obvious to persons operating the appliance, the locked rotor temperature requirements described in [41.7.2](#) shall be used instead of the maximum temperature rises specified in [Table 41.1](#). Prior to such time that such malfunction becomes obvious to the user, temperature requirements specified in [Table 41.1](#) shall be applicable.

Figure 41.6

Typical solid-state motor speed control with routing diodes for dc offset



Circuit 1 is connected
at points A and B to
produce a 2 Volt DC offset



a Voltmeter capable of
measuring DC offset
voltages on a sine wave

41.7.2 If the motor shaft does not rotate or rotates in a manner not considered to be normal after the supply is switched from sinusoidal to half-wave operation as described in [41.7.1\(c\)](#), the motor shall comply with the applicable temperature requirements as follows:

- a) An impedance-protected motor shall comply with the Locked-Rotor Temperature Test requirements in the Standard for Overheating Protection for Motors, UL 2111 or with the Standard for Impedance Protected Motors, UL 1004-2; or
- b) A thermally-protected motor shall comply with the Locked-Rotor Temperature Test requirements in the Standard for Overheating Protection for Motors, UL 2111 or with the Standard for Thermally Protected Motor, UL 1004-3, except that the temperatures measured during the initial cycle of the thermal protector operation shall be disregarded.

41.7.3 During the tests described in [41.7.1](#) and [41.7.2](#), the appliance is to be installed and operated as described in [41.1.1](#) – [41.6.5.2.1](#), but only motor winding temperatures are to be recorded.

42 Surface Temperature Tests

42.1 General

42.1.1 An appliance employing a thermal element, such as a resistive element, halogen or quartz lamp for browning or convection cooking, shall not attain temperatures at specific points greater than those indicated in [Table 42.1](#) and [Table 42.2](#). The appliance is to be completely assembled for this test, with all handles, knobs, guards, and the like, mounted in place. See [42.1.6](#).

Exception: The temperature of surfaces of a commercial use appliance that is intended only for use by professional cooks and chefs in a commercial kitchen may exceed the limits specified in [Table 42.1](#), if the appliance is marked in accordance with [71.1.5](#) and [72.3](#).

Table 42.1
Maximum acceptable temperatures of surfaces as measured by the probe illustrated in [Figure 42.1](#)

	Surfaces 3 ft (914 mm) or less above floor level		Surfaces more than 3 ft above floor level	
	°C	(°F)	°C	(°F)
Bare or painted metal	67	(152)	84	(183)
Porcelain enamel	71	(159)	88	(190)
Glass or ceramic	78	(172)	95	(203)
Plastic ^a	83	(181)	100	(212)
NOTE – An appliance is to be installed in accordance with the manufacturer's instructions to determine which areas will be more than 3 ft (914 mm) above the floor.				
^a Includes plastic with a metal plating not more than 0.005-in (0.13-mm) thick; and metal with a plastic or vinyl covering not less than 0.005-in thick.				

Table 42.2
Maximum acceptable temperatures of handles and knobs

Materials	°C	(°F)
Bare or painted metal	55	(131)
Glass	65	(149)
Plastic ^a	75	(167)

NOTE – For a microwave oven employing a self-cleaning feature, the temperature limits shall be in accordance with the Standard for Household Electric Ranges, UL 858, as applicable to self-cleaning ovens.

^a Includes plastic with a metal plating not more than 0.005-in (0.13-mm) thick; and metal with a plastic or vinyl covering not less than 0.005-in thick.

42.1.2 The appliance is to be installed, connected, and loaded as described in [41.3.2.1](#) – [41.3.6.1](#), [41.3.7.1.3](#) – [41.3.7.1.6](#), and [42.4.1.1](#) – [42.4.5.4](#). See [73.14](#) and [73.16](#).

42.1.3 The supply voltage for the surface temperature test is to be as specified in [40.2.1](#).

42.1.4 During the test the cavity of the microwave cooking appliance is to be loaded as specified in [41.5.1](#).

42.1.5 An appliance employing a resistance-type heating element is to be operated with the temperature regulating control set to maintain the oven temperature at $204 \pm 3^{\circ}\text{C}$ ($400 \pm 5^{\circ}\text{F}$). If not provided with a temperature regulating control, the appliance is to be operated at full heating-element power. In any case, the surface temperatures are to be measured 1 h after an oven temperature of $204 \pm 3^{\circ}\text{C}$ is attained.

42.1.6 The temperature of a surface that may be contacted by the user shall not be more than the applicable value specified in [Table 42.1](#) or [Table 42.2](#), unless otherwise specified. If the test is conducted at a room temperature of other than 25°C (77°F), the results are to be corrected to that temperature. If the appliance employs a thermostat that cycles during the test, each surface temperature is to be measured at the point in the thermostat cycle that results in maximum temperature of the surface.

42.2 Measurement of surfaces

42.2.1 The temperature of any external surface, including the appliance exterior, the bottom surface of the door, and any surface adjacent to or surrounding a handle, knob, grip, or the like, that can be fully contacted by the tip of the probe illustrated in [Figure 42.1](#) shall not exceed the applicable temperature limits in [Table 42.1](#). The test is to be repeated, as necessary, with the alcove walls arranged in the positions resulting in maximum temperatures on all surfaces that may be exposed to contact in any installation configuration recommended by the manufacturer and with the back wall of the alcove removed and the other alcove wall arranged to result in maximum temperatures on the back surface of the appliance (that is, the test is to be conducted with one side alcove wall in place, whichever configuration represents the most severe condition).

Exception No. 1: Temperatures need not be measured on a surface that cannot be contacted after the appliance is installed in accordance with the manufacturer's installation instructions (for example, an external surface of a built-in appliance that is within the building structure).

Exception No. 2: Temperatures need not be measured on a surface protected from unintentional contact (for example, covered) by a knob, guard, or the like, but not a handle.

Exception No. 3: Temperatures need not be measured on a surface within 0.4 in (10.2 mm) of a perforated or louvered oven cavity vent opening.

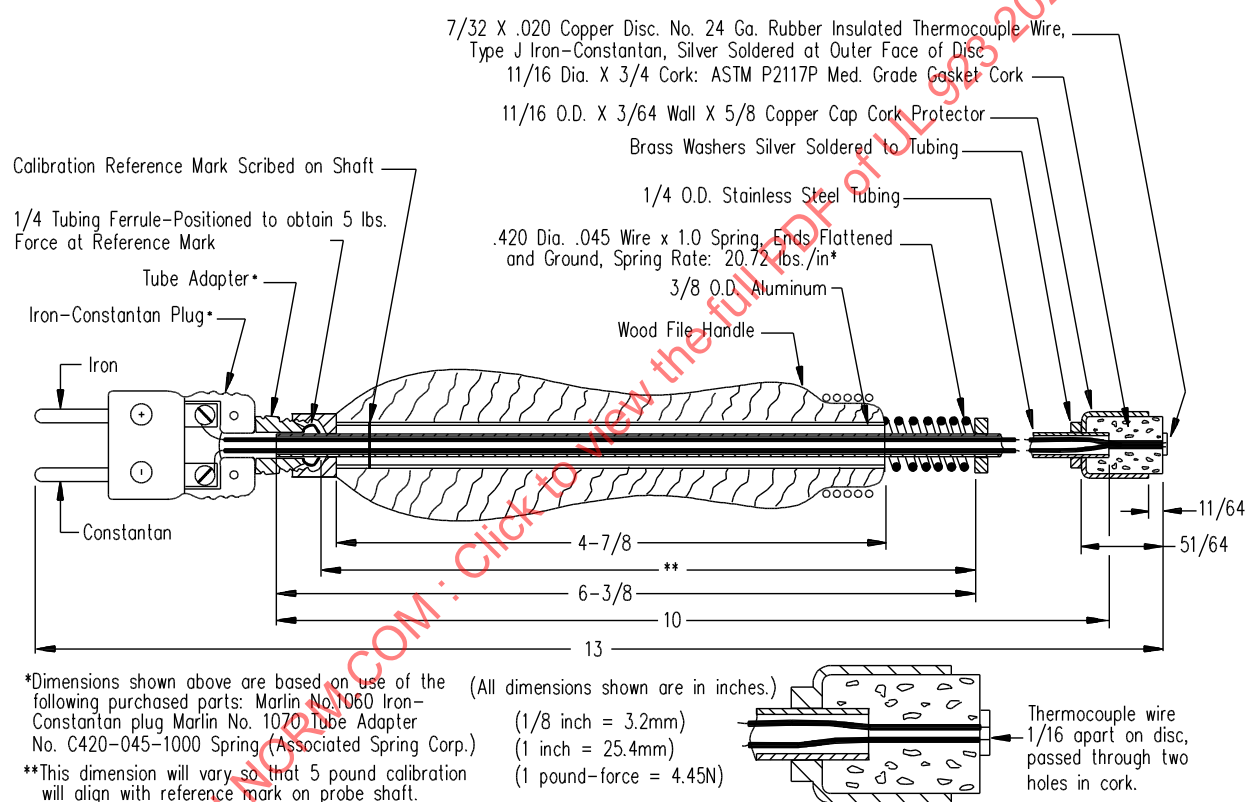
Exception No. 4: For other than an under cabinet-mounted appliance, temperatures need not be measured on the bottom of the appliance exterior.

Exception No. 5: For a built-in or wall-mounted appliance installed at the minimum height specified in the installation instructions, surfaces higher than 5 ft (1.52 m) above the floor are exempt from the limits specified.

Exception No. 6: Temperatures need not be measured on surfaces within 0.4 in (10.2 mm) of the gap between the appliance door and its mating surface.

Figure 42.1

Temperature-measuring and accessibility probe



42.2.2 The temperature of a rounded corner, decorative trim, or other external surface that cannot be fully contacted by the tip of the probe is to be measured using thermocouples held in intimate contact with the surface and the temperature limits specified in [Table 42.1](#) applied.

42.2.3 With reference to [42.2.1](#), surfaces that can be fully contacted by the tip include corrugated, dimpled, and similarly finished surfaces.

42.2.4 For each measurement, the probe is to be at the ambient temperature, and then is to be heated for 15 s to approximately the temperature of the surface under consideration. The probe is then to be applied to the surface under consideration with a force of 5 lbf (22 N) for 10 s. The probe is to be moved from the preheat position to the surface as quickly as possible, and is to be applied so that the tip will fully contact the surface. The tip is considered to be the disc and the flat surface of the cork surrounding the disc.

42.2.5 A surface is to be clean when temperatures are measured.

42.3 Measurement of handles and knobs

42.3.1 The temperature of a handle, knob, grip, or the like, shall not exceed the maximum acceptable limits specified in [Table 42.2](#) when measured by thermocouples held in intimate contact with the part in question. Temperatures are to be measured at all points that may be grasped during normal use.

Exception: A handle, knob, grip, and the like, the touching of which is not necessary or likely during the normal functioning and operation of the appliance, shall be considered as an exterior surface and subjected to the requirements in [42.2.1](#) – [42.2.5](#) and [Table 42.1](#).

42.4 Over-the-cooktop appliances

42.4.1 General

42.4.1.1 An over-the-cooktop appliance is to be installed and tested over one of the appliances described in [42.4.2.1](#) – [42.4.5.1](#). The markings on the appliance determine which appliance is to be chosen for the test as well as the width of the range heat source. If a standard range is chosen, the appliance is to be tested over the widest range recommended.

42.4.2 Standard test gas range

42.4.2.1 The standard test gas range to be used is to have an oven capable of maintaining an average temperature of 204°C (400°F) at the center of the oven. The range is to have surface burners rated 10,000 Btu/h (2930 W) each when supplied with natural gas. The over-the-cooktop microwave oven is to be installed over the widest range specified by the manufacturer. A range 30 in (762 mm) or less in width is to have four surface burners. A range wider than 30 in is to have five surface burners as described in [Figure 41.5](#).

42.4.2.2 A pan of water is to cover each of the surface burners. See [41.3.7.2.4](#) for description of pans.

42.4.2.3 The control for each surface burner covered with a pan of water is to be adjusted to 3,032 Btu/h (888 W).

42.4.3 Standard test electric range

42.4.3.1 The standard test electric range to be used is to have an oven capable of maintaining an average temperature of 204°C (400°F) at the center of the oven cavity. An over-the-cooktop microwave

oven is to be installed over the widest range specified by the manufacturer. A range less than 36-in (914-mm) wide is to have four surface elements. If a standard test electric range 36 in or wider is to be used, it is to have four surface elements, and a griddle. See [41.3.7.3.2](#) for a description of the surface elements.

42.4.3.2 A pan of water is to be placed on each of the elements. The pan is to be of aluminum and is to have approximately vertical sides. The diameter of the bottom plane surface of the pan is to be no less than the maximum diameter of the active part of the surface unit on which the pan is used, but no more than 1 in (25.4 mm) larger than that diameter.

42.4.3.3 The control for each element on which a pan of water is placed is to be set so that the average power input is 833 W.

42.4.4 Specific range – electric

42.4.4.1 If an over-the-cooktop microwave oven is intended for use only with a specific electric range or ranges (or cooktops), the specific range or ranges are to be installed and operated as specified in [42.4.3.2](#) and [42.4.3.3](#). If the range cooktop surface elements are rated other than as specified in [41.3.7.3.2](#), or if the cooktop employs a grill, griddle, deep-fat fryer, or the like, the elements are to be loaded and adjusted as specified in the Temperature Test section of the Standard for Household Electric Ranges, UL 858.

42.4.5 Specific range – gas

42.4.5.1 If an over-the-cooktop microwave oven is intended for use only with a specific gas range or ranges (or cooktops), the range or ranges are to be operated using the pans of water noted in [41.3.7.2.4](#) and positioned as specified in [42.4.2.2](#). The control for each burner is to be adjusted so that the power input to the burner is not less than:

- a) 50 percent of the power output for a burner with a maximum output of 4096 Btu/h (1200 W) or less, or
- b) 1365 Btu/h (400 W) plus one-sixth of the power output of the burner in Btu/h for a burner with a maximum output of more than 4096 Btu/h (1200 W).

42.4.5.2 The test installation for an over-the-cooktop appliance is to be as described in [41.3.7.1.5](#) and [41.3.7.1.6](#). The test is to be conducted in each of the applicable conditions specified in [42.4.5.3](#) (a) – (g). Wall temperatures surrounding the gas or electric range (or cooktop) need not be measured. All tests are to be continued as specified in [41.6.1.1](#) and [41.6.2.1](#).

42.4.5.3 The test for an over-the-cooktop appliance is to be conducted in each of the following applicable conditions:

- a) Microwave oven, vent-hood fan, and the range oven operating. The range oven is to be set in the bake mode with the center of the oven maintained at an average temperature of 204°C (400°F). The range cooktop elements are not to be operating.
- b) Microwave oven, vent-hood fan, and all range cooktop elements operating. The range oven is not to be operating.
- c) Only microwave oven and vent-hood fan operating.
- d) Microwave oven not operating, range cooktop elements not operating, and vent-hood fan operating. The specific range oven operating in the self-clean mode if it is provided with a self-clean feature.

Exception: This condition does not apply to the standard gas range or standard electric range. See [42.4.2.1](#) – [42.4.3.3](#).

e) The conditions specified in (a), (c), and (d) with the vent-hood fan not operating. A thermostat that is provided to automatically energize a vent-hood fan shall be allowed to function if the user cannot turn the fan off while the microwave oven is energized because of an interlocking device or an automatic thermostat, the interlocking device or automatic thermostat withstands 100,000 c of intended operation without impaired performance while making and breaking the maximum rated current and rated voltage, and the thermostat complies with the requirements, including calibration verification, applicable to appliance limit controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or with the requirements of operating type 2 action control in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

f) The conditions specified in (a), (c), and (d) for each intended speed of the vent hood fan.

g) The conditions specified above in the ducted position and ductless position if the appliance is intended for such operation.

42.4.5.4 The maximum temperature rises specified in [Table 41.1](#) shall not be applied to the range oven, the range cooktop elements, and the underside of the over-the-cooktop microwave cooking appliance.

43 Insulation Resistance and Leakage Current Test as a Result of Moisture

43.1 A microwave cooking appliance employing insulating material likely to be affected adversely by moisture under conditions of normal use shall be conditioned for 24 h in moist air having a relative humidity of 85 ± 5 percent at a temperature of $32 \pm 2^\circ\text{C}$ ($90 \pm 4^\circ\text{F}$). After the conditioning:

a) A portable, stationary, or fixed cord-connected appliance rated 120, 208, or 240 V nominal shall comply with the requirement in [38.1](#) in a repeat leakage-current test. The test shall be discontinued when the leakage current stabilizes.

b) An appliance other than mentioned in (a) shall have an insulation resistance of not less than 50,000 ohms between live parts and interconnected dead metal parts.

43.2 Usually, insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms and using a circuit rated 250 V dc.

44 Dielectric Voltage-Withstand Test

44.1 General

44.1.1 The insulation and spacings of a microwave cooking appliance shall withstand without breakdown for a period of 1 min the application of the test potential described in [44.2.1.1](#), [44.2.1.2](#), or [44.2.1.3](#) – [44.2.3.1](#) and [44.3.1](#) – [44.3.5](#) with the appliance in a well-heated condition.

44.1.2 Where a separate source is employed to supply the required test potential, the source is to have capacity to maintain the potential indicated, except in the case of breakdown. The test potential is to be increased from zero, until the prescribed test potential is reached or until breakdown occurs. The increase in the test potential is to be at a substantially uniform rate as rapid as is consistent with correct indication of its value by a voltmeter.

44.1.3 Breakdown will usually be indicated by the tripping of an overload protector in the test equipment, but an abrupt decrease or retarded advance of the voltmeter reading could also be indicative of insulation breakdown. Particular attention is to be paid to high-impedance circuits in the appliance to detect any breakdowns resulting in risk of fire, electric shock, injury to persons, or excessive radiation emission.

44.1.4 During the test, a sufficient number of switching components (triacs, relay contacts, and the like) are to be closed or electrically bypassed such that all primary circuits are subjected to the dielectric potential.

44.2 Primary circuits

44.2.1 General

44.2.1.1 An essentially sinusoidal potential with a frequency of 60 Hz is to be applied between live parts conductively connected to the supply circuit and dead metal parts, and across each capacitor, winding separation, or other insulation in the primary circuit that is required because of risk of an electric shock or, if short-circuited, would involve a risk of fire either directly or indirectly. The test potential is to be as specified in [Table 44.1](#).

Table 44.1
Potentials for dielectric voltage-withstand tests

Method	Rating of appliance, V	Test potential, V
Quadrature ^a or with appliance not energized	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 44.2.2.1 . ^b V is the voltage determined in accordance with 40.2.1 . ^c The single-phase method is described in 44.2.3.1 .		

44.2.1.2 An essentially sinusoidal potential with a frequency of 60 Hz is to be applied between any live or current-carrying parts of the primary or power-supply circuit and live or current-carrying parts of the secondary circuit of an isolating transformer. An isolating transformer is one where the primary and secondary windings are not conductively connected. The test potential is to be as indicated in [44.2.1.1](#), based on the highest voltage involved, when the secondary circuit voltage is 600 V or less. The test potential is to be as indicated in [Table 44.2](#), based on the highest voltage involved, when the secondary circuit voltage is more than 600 V. The secondary circuit voltage of the magnetron heater circuit is greater than 600 V, as applied with respect to ground.

Table 44.2
Potentials for dielectric voltage-withstand test for circuits where secondary voltages are greater than 600 V

Maximum peak voltage (E) in circuit ^a	Test potential (V – peak)
0 – 1000 V	3E (500 V minimum)
over 1000 V	1.25 E plus 1750
^a Voltage measured with the appliance under the test conditions described in the temperature test.	

44.2.1.3 Each power transformer where the secondary circuit voltage is greater than 600 V shall operate without breakdown while the potential indicated in [Table 44.2](#) is induced for 1 min in the secondary winding. One side of the primary is to be grounded, as in the normally grounded side of the secondary. This test may be combined with the test for [44.3](#).

44.2.1.4 An essentially sinusoidal source is to be used. The frequency of the source is to be such that the required secondary voltage is obtained without being limited by the saturation of the transformer core.

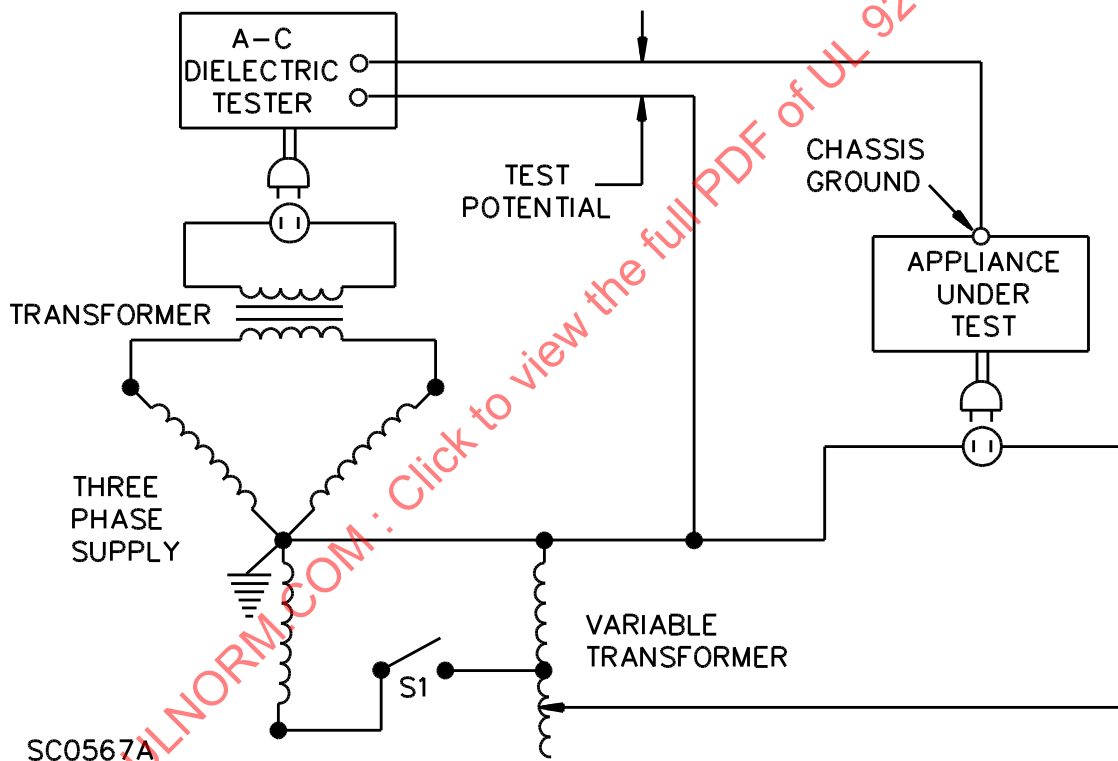
44.2.1.5 Primary- and secondary-circuit wiring connected to a transformer is to be disconnected for the test mentioned in [44.2.1.3](#), if the transformer is to be tested separately.

44.2.2 Quadrature method

44.2.2.1 QUADRATURE METHOD – As an alternate to the requirement in [44.1.4](#), the appliance may be tested using the quadrature method. The appliance is to be connected to a test circuit as illustrated in [Figure 44.1](#) and energized at rated voltage as described in [40.2.1](#). At stabilized temperature, the dielectric withstand test potential specified in [Table 44.1](#) is to be applied in quadrature. After 45 s, the appliance is to be de-energized – switch S1 in [Figure 44.1](#) is to be opened – and the test potential is to be applied for an additional 15 s.

Figure 44.1

Typical circuit diagram for quadrature dielectric test



44.2.3 Single-phase method

44.2.3.1 SINGLE-PHASE METHOD – If a 3-phase source of supply is not available, and if it is agreeable to those concerned, the single-phase test may be conducted instead of the test described in [44.2.2.1](#). The appliance is to be energized at rated voltage as described in [40.2.1](#). At stabilized temperatures, the test potential specified in [Table 44.1](#) from a single-phase source of supply is to be applied. After 45 s, the appliance is to be de-energized and the application of the test potential is to be continued for an additional 15 s.

44.3 Secondary circuits

44.3.1 The test potential indicated in [Table 44.2](#) is to be applied between secondary circuits and grounded metal, between secondary parts of opposite polarity, and between different secondary circuits. See [30.3](#).

Exception: Energy limiting secondary circuits as described in Secondary Circuits, Section 32, need only be tested between different secondary circuits.

44.3.2 A dc source is to be used for a dc circuit. A sinusoidal voltage is to be used for an ac circuit. For a circuit that has a composite (ac plus dc) peak potential, either an equivalent waveshape potential is to be used or a sinusoidal potential is to be used that has a peak value equal to the composite test peak potential. These test voltages may be obtained using the appliance transformer or transformers and components. If the appliance transformers are employed, the variable frequency supply is to be referenced to chassis ground.

44.3.3 For a grounded secondary circuit, the test between grounded metal and the secondary circuit is to be the opposite polarity test, that is, the grounded side of the secondary is to remain grounded.

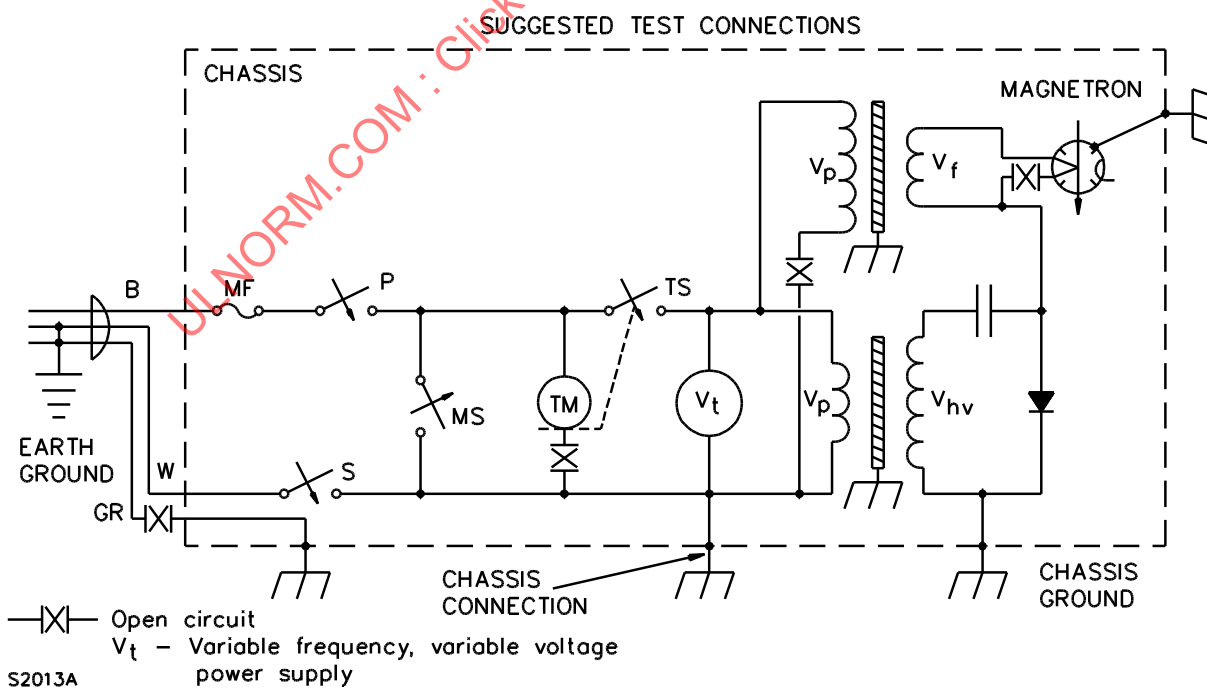
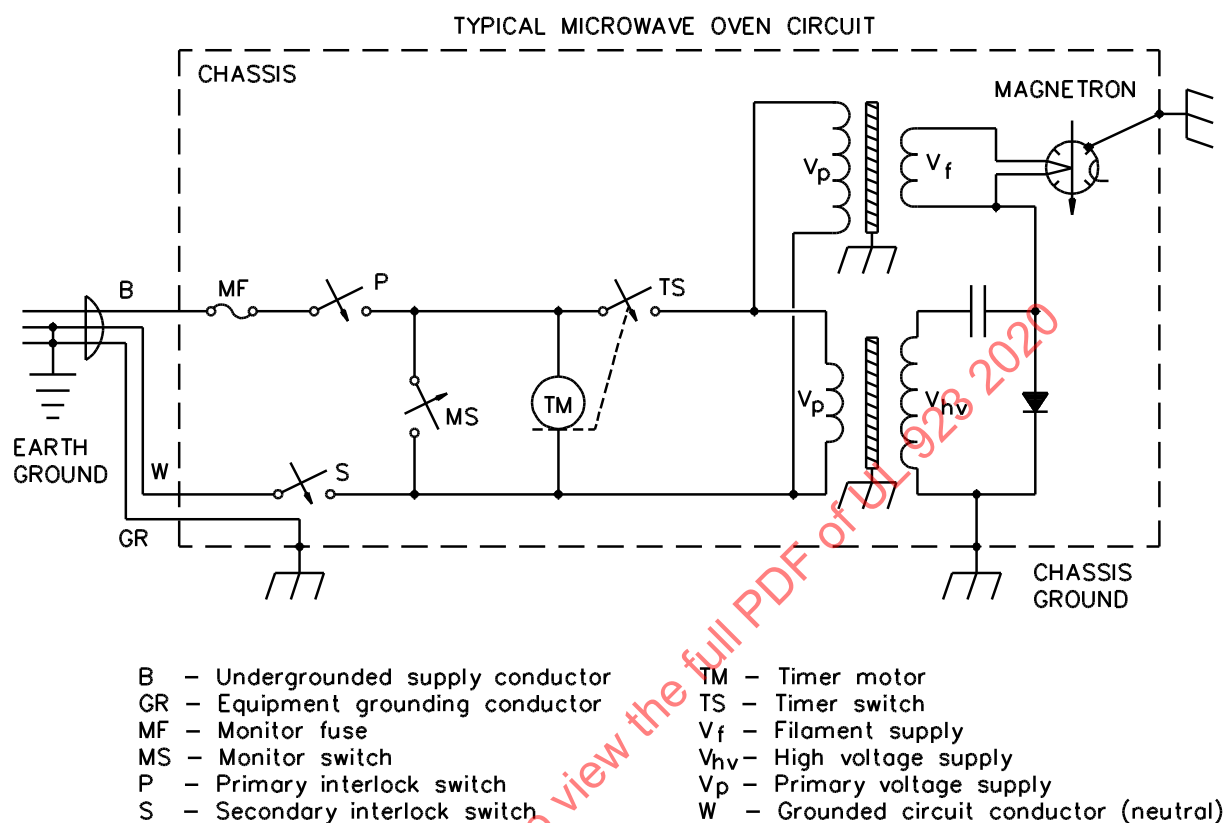
44.3.4 All lamps and tubes are to be removed, and automatic regulating devices are to be rendered inoperative, if necessary to carry out the test. All selector or other operating switches are to be tested in the various possible operating positions in order that these parts are in the circuit under test. Bleeder resistors, electrolytic capacitors, transistors, and other power consuming devices may be opened at the common return side of the circuit, if necessary to conduct the test.

44.3.5 [Figure 44.2](#) illustrates typical circuit connections using the appliance transformer and a variable frequency supply to combine tests. The circuit shown combines:

- a) The transformer induced voltage between primary and secondary windings,
- b) Opposite polarity for both magnetron secondary circuits,
- c) Secondaries to grounded metal, and
- d) Primary to secondary circuits. The variable frequency supply is grounded, loading components are open, and the appropriate primary switches are closed (P, S, and T).

If a test is needed between an additional secondary winding and the magnetron secondary circuits, this can be accomplished by grounding that secondary in order to indicate breakdown.

Figure 44.2
Typical microwave oven circuit



44.3.6 In the testing of a power transformer as specified in [44.2.1.5](#), a high-voltage rectifier and capacitor may be substituted for the rectifier and capacitor of the appliance if necessary to obtain the appropriate test potentials. In the testing of secondary circuits, the high-voltage rectifier and capacitor of the appliance shall remain in the circuit as intended.

45 Door Assembly Tests

45.1 Door operation

45.1.1 The door assembly shall withstand the forces expected during intended usage without affecting the seal to the extent that the equivalent plane wave power density of microwave radiation emitted exceeds 5 mW/cm^2 at any point 5 cm or more from the external surface of the enclosure when subjected to the test in Microwave Radiation Emission Test, Section [39](#), with all interlocks in the circuit. The door shall remain intact and in place after each applicable test.

45.1.2 To determine compliance with [45.1.1](#), a complete sample is to be subjected to the applicable tests described in [45.2.1](#) – [45.5.7](#) and the microwave radiation emitted then measured as described in [39.2.1](#) – [39.5.3](#) after each procedure. Following the appropriate series of impact tests, on inner and outer viewing screen barriers and door seals, the appliance shall be examined for compliance with [5.9](#). A new sample may be used for each procedure or the same sample may be used with the applicable tests performed in the sequence given. If an unacceptable result occurs on any subsequent test after the first test on a given sample, the test is to be repeated on a new sample and if the results are acceptable, the series of tests continued until all the required tests have been completed or another unacceptable result occurs.

45.1.3 When applying the requirements of [45.3.1](#) and [45.4.1](#) consideration is to be given to the effect of different installation arrangements (counter-top supported, built-in, and the like), recommended by the manufacturer, upon the maximum force that can be applied to the door without tilting the appliance.

45.2 All doors

45.2.1 Starting at a point midway between the fully open and closed position, the door is to be moved to its fully open position by means of a force equal to 1.5 times the force necessary to open the door from its closed position, 15 lbf (66 N) minimum, applied to the inside surface of a hinged door at a point 1 in (25.4 mm) from the free edge, or to the handle of a sliding door in the direction of intended travel. The opening operation is to be performed ten times on a household appliance and 50 times on a commercial appliance.

45.2.2 Starting at a point midway between the fully open and closed position, the door is to be moved to its fully closed position by means of a force equal to two times the force necessary to close the door to its fully closed and latched position, 20 lbf (89 N) minimum, applied to the outside surface of a hinged door at a point 1 in (25.4 mm) from the free edge or the handle of a sliding door in the direction of intended travel. The closing operation is to be performed ten times on a household appliance and 50 times on a commercial appliance.

45.2.3 In performing the tests described in [45.2.1](#) and [45.2.2](#) the force for opening and closing the door is to be obtained by means of a spring scale or equivalent having a spring constant of 6 lbf/in (1.05 N/mm). The force is to be applied to the designated location on the door with a restraining force applied opposite and collinear with the actuating force. The restraining force is then removed to allow the door to complete its opening or closing by means of the spring-applied impulse.

45.3 Side-hinged doors

45.3.1 A side-hinged door is to be moved to its fully open position and then closed with a force equal to 50 lbf (222 N), or the maximum force that can be applied to the door without tilting the appliance,

whichever is smaller, supported at the free edge of the door. The opening and closing operation is to be performed five times for a household appliance and ten times for a commercial appliance.

45.4 Bottom-hinged doors

45.4.1 A bottom-hinged door of a counter- or table-supported appliance is to be subjected for 15 min to a force of 50 lbf (222 N) or the maximum force that can be applied without tilting the appliance, whichever is smaller, applied to the inside surface of the open door at a point 1 in (25.4 mm) from the free edge. For a floor-supported household appliance, the applied force is to be 100 lbf (445 N) or the maximum weight the appliance can support without tilting, whichever is smaller. For a floor-supported commercial appliance the applied force is to be 150 lbf (667 N) or the maximum force that can be applied without tilting, whichever is smaller.

45.4.2 A bottom-hinged door is to be closed as far as possible with a 3/8-in (9.5-mm) diameter hardwood dowel placed between the lower inside surface of the door and the mating surface of the enclosure below the oven cavity. The dowel is to be oriented in the position that will cause the most adverse effect. The closing force is to be 20 lbf (89 N) for a household oven and 30 lbf (133 N) for a commercial oven and is to be applied to the door handle for 5 s.

45.5 Impact tests

45.5.1 The inside surface of a bottom-hinged door is to be subjected to five impacts as indicated below.

- a) Two impacts are to be applied to the central area of the door on any viewing screen and barrier, if provided. The impact applied is to be 2 ft-lbf for each ft³ (2.7 J for each 0.0283 m³) of usable oven space calculated to the nearest 1/2 ft³ (0.0142 m³).
- b) Three impacts are to be made at different locations near the edges of the door that form the microwave radiation seal. The impact applied is to be 2 ft-lbf (2.7 J).

45.5.2 For a door incorporating a viewing-screen assembly, three impacts of 2 ft-lbf (2.7 J) are to be made to the outside surface of the assembly with the door closed.

45.5.3 For a side hinged door three impacts of 2 ft-lbf (2.7 J) are to be made to the inside surface of the viewing-screen assembly (if provided), and three impacts are to be made to the inside surfaces of the door that form the microwave radiation seal, with the door open.

45.5.4 The mating surface of the door seal of a sliding, side, or bottom hinged door that is on the oven body is to be subjected to three impacts of 2 ft-lbf (2.7 J).

45.5.5 The impact is to be obtained by means of a steel ball, 2 in (50.8 mm) in diameter, weighing approximately 1.18 lb (535 g).

45.5.6 The impact applied to a vertical surface is to be obtained from a solid, smooth steel sphere as described in [45.5.5](#). The sphere is to be suspended by a cord and allowed to fall as a pendulum through a distance required to strike the surface with the specified impact. The appliance is placed so that the surface tested is vertical and in the same vertical plane as the point of support of the pendulum.

45.5.7 The impact applied for a horizontal surface is to be obtained by allowing the sphere to fall freely from rest through a distance required to cause it to strike the surface with the specified impact. The sphere is to be dropped vertically through a cylindrical guide.

46 Glass Control Panel Test

46.1 A glass control panel that serves as part of the enclosure of live parts shall comply with the impact test described in [46.2](#).

46.2 Three samples of the glass control panel are each to withstand an impact of 5 ft-lbf (6.8 J) without any breakage that would expose live parts. Exposure of live parts is to be determined by applying the requirements in [6.1](#) – [6.6](#). The impact is to be applied by means of a solid, smooth, steel sphere 2 in (50.8 mm) in diameter, weighing 1.18 lb (535 g). For horizontal enclosure surfaces, the sphere is to fall freely from rest through a vertical distance of 51 in (1.3 m). For vertical surfaces, the sphere may be swung as a pendulum from rest through a vertical distance of 51 in (1.3 m).

46.3 An adhesive system that (for example, adhesive backed tape or film) is relied upon to preserve the integrity of a glass part under the test conditions of [46.2](#) shall not be adversely affected by thermal conditioning.

46.4 Compliance with the requirement of [46.3](#) is determined by placing three samples of the enclosure part or subassembly employing the adhesive system in an air circulating oven for 30 days maintained at a temperature in accordance with [Table 46.1](#). Following the conditioning period, the samples are to be installed on the overall appliance and subjected to the impact test described in [46.2](#).

Table 46.1
Test temperature for thermal conditioning

Maximum adhesive operating temperature		Oven temperature	
°C	(°F)	°C	(°F)
Less than 40	(104)	No conditioning required	
60	(140)	100	(212)
70	(158)	105	(221)
80	(176)	112	(234)

47 Metal Enclosure Impact Test

47.1 A metal enclosure part shall comply with the tests outlined in [47.2](#) – [47.5](#).

47.2 A metal enclosure part shall withstand the ball impact, with the appliance restrained, as described in [47.3](#) without occurrence of any one of the following conditions:

- a) Making live parts accessible to contact with the articulate probe, see [6.1](#) and [6.2](#).
- b) Producing any other condition that results in damage of the enclosure so as to adversely affect the function of any safety or constructional feature, such as thermostats, overload protective devices or strain relief.
- c) Producing other conditions so that the appliance does not comply with the dielectric voltage withstand requirements in Dielectric Voltage-Withstand Test, Section [44](#) after being subjected to the impact.

47.3 Each of three samples of the appliance is to be subjected to one impact. This impact is to be imparted by dropping or swinging a 2-in (50.8-mm) diameter steel sphere, weighing 1.18 lb (0.535 kg) from a height that will produce an impact of 1.5 ft-lbf (2.03 N·m). The sample is to be rigidly supported and the impact is to be made perpendicular to the most vulnerable spots on the appliance enclosure that are exposed to a blow during intended use. A different spot on the enclosure is to be selected for each impact.

Refer to [Figure 47.2](#) with respect to the ball drop impact test and to [Figure 47.3](#) for the ball pendulum impact test.

Exception: If the manufacturer elects, fewer than three samples may be used for the test in accordance with [Figure 47.1](#) wherein each series consists of one impact. The overall performance is acceptable upon completion of any one of the procedures represented in [Figure 47.1](#).

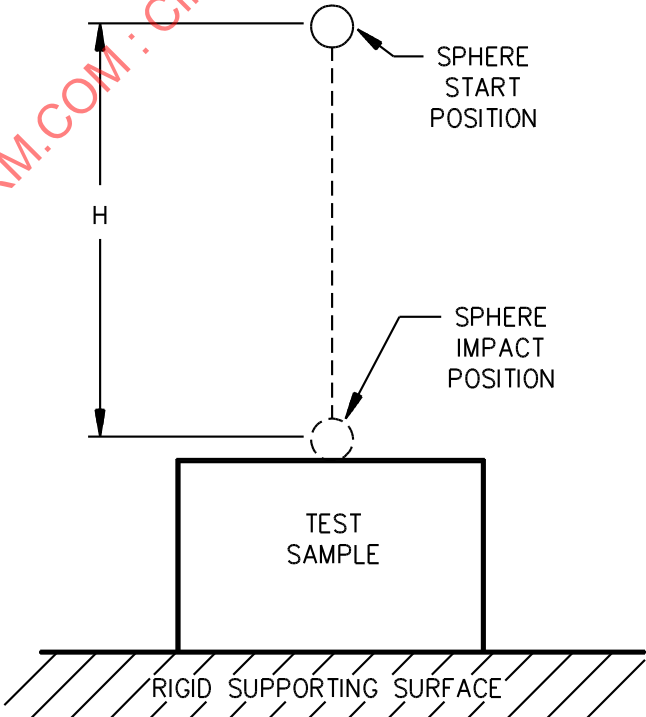
Figure 47.1
Procedure for impact test

Series Number	Sample Number											
	1	2	3	1	2	3	1	2	3	1	2	3
1	↓ A	N	N	↓ A	N	N	↓ A	N	N	↓ A	N	N
2	↓ A	N	N	↓ A	N	N	↓ U	↓ A	N	↓ U	↓ A	N
3	↓ A	N	N	↓ U	↓ A	N	↓ A	N		↓ U	↓ A	

Arrows indicate sequence of test procedure
A – Acceptable results from drop
U – Unacceptable results from drop
N – No test necessary

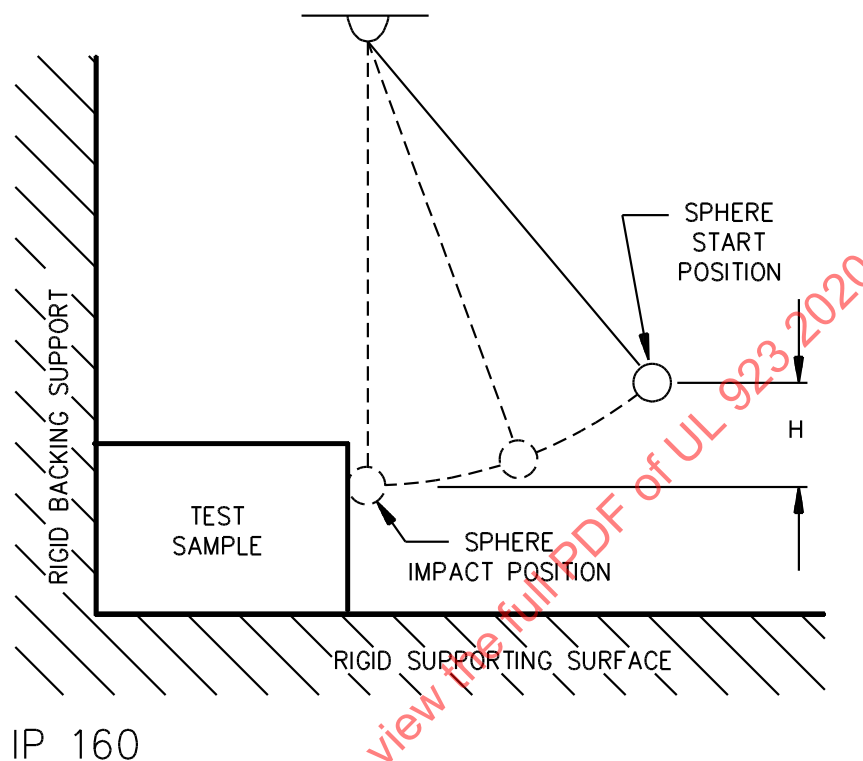
SA1162

Figure 47.2
Ball drop impact test



IP120

Figure 47.3
Ball pendulum impact test



47.4 With reference to [Figure 47.2](#) and [Figure 47.3](#), the "H" designation represents the vertical distance the sphere must travel to produce the desired impact. For the pendulum impact, the sphere is to contact the test sample when the string is in the vertical position. The supporting surface is to be as described in [47.5](#). The backing surface for the pendulum impact is to consist of 3/4-in (18-mm) plywood over a rigid surface of concrete or an equivalent nonresilient backing surface may be used.

47.5 The supporting surface mentioned in [47.4](#) is to consist of a layer of tongue-and-groove oak flooring mounted on two layers of 3/4-in (18-mm) thick plywood. The oak flooring is to be nominally 3/4 in by 2-1/4 in (actual size 3/4 by 2-1/4 in – 18 by 57 mm). The assembly is to rest on a concrete floor or an equivalent nonresilient surface.

48 Interlock System Endurance Test

48.1 General

48.1.1 The door and door interlock system, in conjunction with the complete appliance, shall complete 100,000 c of operation (opening and closing the door) for a household microwave cooking appliance and 200,000 c for a commercial microwave cooking appliance. During and at the conclusion of the test the performance of the system shall meet the following criteria:

- a) There shall be no electrical or mechanical malfunction that could result in the likelihood of fire, electric shock, injury to persons, or excessive radiation emission. Only parts that fail safe and prevent completion of the test may be replaced or repaired.

b) There shall be no loosening or shifting of adjustments or parts that could result in the likelihood of fire, electric shock, injury to persons, or excessive radiation emission.

c) Radiation emission shall not exceed 5 mW/cm^2 at any point 5 cm or more from the external surface of the enclosure.

48.1.2 Compliance with the requirement in [48.1.1](#) is to be determined by subjecting two complete samples of the appliance to the test described in [48.2.1](#) – [48.4.2](#). Following the test, all samples shall be subjected to the tests in Interlock Monitor Circuit Test, Section [49](#).

48.2 Appliance connections

48.2.1 The appliance is to be connected to a voltage source as prescribed in [40.2.1](#) for the input test. Any timers incorporated in the appliance are to be bypassed to facilitate uninterrupted operation of the appliance. The door interlock switches shall be operational during the test except that external controls (such as externally operated switches wired in parallel with the interlock switches) may be provided in order to bypass each door interlock while microwave radiation emission measurements are being taken. The external controls are not to affect nor take part in the operation of the appliance in any other way.

48.3 Test equipment

48.3.1 The microwave cooking appliance door is to be cycled by an automatic device attached to the door handle or in the operating area of the door handle. The door closure force is to be predetermined so as to simulate intended operation. In no case is the cycling mechanism to apply a closure force greater than 20 lbf (89 N) unless agreed to by the manufacturer. The door is to be swung open from the closed position to any angle within 135 degrees to 180 degrees, or to within 10 degrees, of its maximum travel, whichever is the smaller angle. A sliding door shall be opened to within 1 in (25.4 mm) of its full travel. The cycling rate is not specified, but there shall be sufficient on time to permit generation of microwave energy that may be delayed by warm-up time of the magnetron, a time delay circuit, and so forth. To facilitate automated testing, the two action door opening requirement of [36A.1](#) may be disabled.

48.4 Operating sequence

48.4.1 The appliance shall be operated in accordance with the following sequence:

a) An initial microwave radiation emission measurement is to be made as described in Microwave Radiation Emission Test, Section [39](#).

b) A fresh coating of corn oil is then to be applied to all door sealing surfaces and a microwave absorbing load (such as a dry brick load) is to be placed and maintained in the oven cavity. The appliance is to be energized and the door operated for 10,000 c of operation.

c) Following the 10,000 c of operation, the cycling load is to be removed. Microwave radiation emission measurements are to be made as described in [39.2.1](#) – [39.5.3](#). A microwave cooking appliance incorporating an integral resistance element, or a self-cleaning feature, is in addition, to be operated as described in the temperature test until temperatures stabilize. Following the operation, microwave radiation emission measurements are to be repeated.

d) After the microwave radiation emission measurement is made, the door sealing surfaces are to be cleaned of the corn oil with a soft cloth.

e) The above procedure (steps b – d) is to be repeated until a total of 100,000 c of operation are accumulated on a household appliance, and 200,000 c of operation on a commercial appliance.

48.4.2 Constructions employing a cooking mode other than by microwave radiation (such as resistance-type heating element, quartz and/or halogen lamps), and that subject the interlock switching components to a higher current load during the auxiliary cooking mode(s) than during microwave cooking are to have two additional samples subjected to a second door interlock endurance test, as described in this section, consisting of 100,000 c for a household appliance and 200,000 c for a commercial appliance, with the appliance operating in the auxiliary cooking mode that results in the greatest current through the door interlock components. In such cases, it is not necessary to measure microwave radiation after every 10,000 c of operation, nor to coat the surfaces with oil. The appliance need not be operated until thermal stabilization. Microwave radiation is to be measured at the start of the test and at the conclusion of the test. The samples are to comply with the criteria described in [48.1.1](#).

Exception: The endurance test on the door interlock system switching components (interlocks and interlock monitor) in the auxiliary cooking mode may be conducted separate from the appliance as described in [48.4.3](#).

48.4.3 With respect to the Exception to [48.4.2](#), the endurance test on the interlock system switching components and switch mounting assembly in the auxiliary cooking mode may be conducted separate from the appliance provided that the test is conducted using a power supply and test load with equivalent current, power factor, and inrush characteristics and the switches are actuated with forces representative of actual use. In such cases, the test shall be conducted in the following sequence:

- a) The interlock and interlock monitor devices, together with their mounting bracket(s), are to be placed for 300 h in a forced-draft air circulating oven maintained at the maximum switch ambient temperature attained during the test in Temperature Test, Section [41](#).
- b) The switching devices, together with their mounting bracket(s), are to be allowed to cool to room temperature and then be subjected to the specified number of endurance test cycles.
- c) The switching devices, together with their mounting bracket(s), are to be installed in samples of the microwave oven and the microwave radiation emission measured as described in [48.1.1](#) and [48.2.1](#) and Microwave Radiation Test, Section [39](#).
- d) The microwave oven samples are to be subjected to the test in Interlock Monitor Circuit Test, Section [49](#).

49 Interlock Monitor Circuit Test

49.1 An interlock monitor circuit shall render the microwave oven incapable of generating microwave energy in the event the designated primary or secondary door interlock(s) being monitored does not perform its intended function. An interlock monitor circuit incorporated in a microwave cooking appliance shall, in addition, operate in its intended manner without creating a risk of fire, electric shock, injury to persons, or excessive radiation emission.

49.2 Two complete samples of the appliance that have undergone the door endurance tests described in [48.1.1](#) – [48.4.1](#) are to be tested in accordance with [49.3](#) – [49.7](#).

49.3 For an appliance incorporating a monitor circuit of the crowbar type, and rated 20 A or less, the supply circuit is to deliver at least 1000 A. For an appliance incorporating a crowbar-type circuit and rated at more than 20 A, the supply circuit is to deliver 5000 A.

49.4 The appliance is to be connected to a voltage supply and employ a water load as specified in [40.2.1](#) and [39.3.1](#). A fuse rated 3 A, other than the time-delay type, is to be connected in series with the grounding conductor of the appliance.

49.5 A test shall be performed consisting of mechanically defeating the number of door interlock switches necessary to cause the monitor circuit to function. With the oven energized, and generating microwave energy, the door is to be opened. The procedure is to be repeated three times for each sample. Any thermal or overcurrent device requiring replacement or resetting as the result of performing in its intended manner shall be serviced in accordance with the manufacturer's service instructions, prior to repeating the test procedure.

49.6 Following the three operations of the monitor circuit, the appliance circuitry is to be checked for electrical continuity and subjected to the applicable primary circuit dielectric voltage-withstand test, described in [44.2.1.3](#) – [44.2.3.1](#).

49.7 The performance of a monitor circuit is acceptable if:

- a) The grounding fuse is not opened;
- b) The dielectric voltage-withstand test is completed without breakdown;
- c) The continuity check indicates that all circuitry is still functional; and
- d) With the appliance restored to operation in accordance with the manufacturer's service instructions, microwave radiation emission shall not exceed 5 mW/cm² at any point 5 cm or more from the external surface of the enclosure when tested in accordance with Microwave Radiation Emission Test, Section [39](#).

Exception: The intended operation of a fuse or similar one-time device that is part of the appliance is considered acceptable.

49.8 The malfunction (such as welding) of switching components of the interlock system or monitor circuit due to impressed overloads is considered acceptable provided that:

- a) The malfunction of such components does not introduce a risk of fire, electric shock, injury to persons, or excessive radiation emission and a nonuser serviceable overcurrent device disables the microwave generating portion of the circuit;
- b) The serviceman instructions clearly state that the specific components involved must be replaced; and
- c) Each component, or component package, is provided with a marking as described in [76.9](#) and [76.10](#).

50 Mechanical Endurance Test

50.1 If the normal operation of a movable part of an appliance – for example, a movable browning element – affects mechanically the electrical wiring or other live parts, the movable part shall withstand an endurance test as described in [50.2](#). There shall be no electrical or mechanical malfunction of the movable part or wiring and, after the test, the appliance shall comply with Dielectric Voltage-Withstand Test, Section [44](#), and the grounding continuity requirements in [31.12](#) and [31.13](#) if grounding of the part is required.

50.2 To determine if an appliance complies with [50.1](#), a mechanical arrangement is to be employed to operate the movable member in the intended manner at the rate of approximately 12 c of operation per minute. The movable member is to be so operated that during each cycle it will reach the actual limits of travel in both directions. Ordinarily, the endurance test will consist of 10,000 c of operation, but this figure may be reduced if it appears that it does not represent the usage that would occur during the life of the appliance. The test is to be conducted with maximum normal current flowing in the movable connections, unless the construction is obviously such that a person is likely to be burned if he attempts to move the part while it is energized.

51 Moisture Conditioning Test

51.1 To determine compliance with Exception No. 6 to [16.1.11](#), a microwave cooking appliance is to be tested as described in [51.2](#) and [51.3](#).

51.2 A microwave cooking appliance is to be operated continuously in the cooking mode that results in the maximum microwave power for 30 min with a 1000 mL water load in the oven cavity. At the end of the 30 min, the appliance is to be turned completely off for 15 min. During the off period, the water load is to be replenished. This procedure is to be repeated until a total of ten operating cycles have been completed. Leakage current or insulation resistance measurements and dielectric voltage-withstand tests are to be performed as follows:

- a) A cord-connected appliance rated 120, 208, or 240 V nominal shall comply with the applicable requirements in [38.1](#). The leakage current is to be measured during each operating cycle.
- b) An appliance, other than mentioned in (a), is to have an insulation resistance of not less than 50,000 ohms between live parts and interconnected dead metal parts. The insulation resistance is to be measured at the completion of the final cycle.
- c) At the completion of the final cycle, following the leakage current or insulation resistance measurements, an appliance shall comply with Dielectric Voltage-Withstand Test, Section [44](#).

51.3 The supply voltage for the moisture conditioning test is to be as specified in [40.2.1](#).

52 Spill Test

52.1 A microwave cooking appliance that employs electrical components or internal wiring located beneath openings in the oven cavity shall be subjected to the test specified in [52.2](#). At no time during the test shall the leakage current to ground exceed 5 mA. Following the test, the appliance shall withstand the specified dielectric potential.

52.2 An appliance is to be connected to a source of supply as specified in [40.2.1](#), and the grounding conductor shall be open-circuited at the supply. At all times during the test, the leakage current between all dead metal parts and ground is to be monitored through a resistor rated 500 ohms connected between the dead metal parts and ground, and the maximum value is to be recorded. A water load consisting of 275 mL of tap water initially at 20°C (68°F), and contained in a low form 600 mL glass beaker is to be placed in the center of the load-carrying surface of the oven cavity. A solution of 500 mL of distilled water containing approximately 1 percent by weight dissolved NaCl is to be poured at random over the bottom of the oven cavity. See [52.3](#). The appliance is then to be operated at full microwave power for a period of 5 min. The appliance is then to remain connected to the source of supply and leakage current is to be monitored for a period of 7 h. The appliance is then to be subjected to a dielectric voltage-withstand test, in accordance with [44.2](#).

Exception: The test may be terminated after 5 min of operation at full microwave power if the appliance does not employ any seal or gasket constructed of a material that is susceptible to moisture penetration, or if the construction of the appliance is such that moisture is precluded from contacting the live parts or internal wiring located below the oven cavity. In such cases, the test in accordance with [44.2](#) is to be conducted immediately following the 5 min of operation.

52.3 For appliances with a tray or other receptacle for collecting spilled liquid, the capacity of the receptacle is to be measured and the test is to be conducted by pouring a quantity of the salt water solution equal to the capacity of the receptacle plus 500 mL into the receptacle, causing it to overflow.

53 Spill Test for Horizontally-Mounted Openings

53.1 A countertop microwave cooking appliance that employs electrical components or internal wiring located beneath openings in the top of the enclosure shall be subjected to the test specified in [53.2](#). At no time during the test shall the leakage current to ground exceed 5 mA. Following the test, the appliance shall withstand the specified dielectric potential.

53.2 The appliance is to be connected to a source of supply as specified in [40.2.1](#), and the grounding conductor shall be open-circuited at the supply. At all times during the test, the leakage current between all dead metal parts and ground is to be monitored through a resistor rated 500 ohms connected between the dead metal parts and ground, and the maximum value is to be recorded. A water load consisting of 275 mL of tap water initially at 20°C (68°F), and contained in a low form 600 mL glass beaker is to be placed in the center of the load-carrying surface of the oven cavity. A solution of 350 mL of distilled water containing approximately 1 percent by weight dissolved NaCl is to be poured at random over the top of the oven directed into the openings. The appliance is then to be operated at full microwave power for a period of 5 min. The appliance is then to remain connected to the source of supply and leakage current is to be monitored for a period of 7 h. The appliance is then to be subjected to a dielectric voltage-withstand test, in accordance with [44.2](#).

Exception: The test may be terminated after 5 min of operation at full microwave power if the appliance does not employ any seal or gasket constructed of a material that is susceptible to moisture penetration, or if the construction of the appliance is such that moisture is precluded from contacting the live parts or internal wiring located below the oven cavity. In such cases, the dielectric voltage-withstand test in accordance with [44.2](#) is to be conducted immediately following the 5 min of operation.

54 Abnormal Operation Tests

54.1 General

54.1.1 Operation of a microwave cooking appliance under any abnormal conditions specified in [54.1.2](#) – [54.5.2](#) shall not result in:

- a) A risk of fire, electric shock, or injury to persons,
- b) Emission of flame or molten material from the appliance enclosure, or
- c) An equivalent plane-wave power density of microwave radiation in excess of 5 mW/cm² at any point 5 cm or more from the external surface of the enclosure when subjected to Microwave Radiation Emission Test, Section [39](#), with all interlocks in the circuit. See [54.4.7](#).

54.1.2 Compliance with [54.1.1](#) is determined by subjecting a representative sample of the complete appliance to the test conditions described in [54.2.1](#) – [54.5.2](#). During these tests the appliance is to be installed in accordance with [41.3.1.1](#) – [41.3.6.1](#), as applicable, except that an appliance intended to rest on a horizontal surface, such as a floor, counter top, or shelf, is to be supported on a softwood surface covered by a double layer of tissue paper.

54.2 Appliance connections

54.2.1 The appliance shall be connected to a voltage supply source as indicated in [40.2.1](#), and the water load described in [41.5.1](#) used, unless otherwise specified. The supply circuit for the appliance is to be provided with a time-delay fuse of the maximum rating for the branch circuit to which the appliance can properly be connected. A fuse rated 3 A, other than the time-delay type, is to be connected in series with the grounding conductor of the appliance.

54.3 Appliance configuration

54.3.1 Any barriers, shields, covers, and the like, that may be removed or opened without the use of tools, or that are user serviceable, shall be removed or positioned in such a way as to create the most severe condition that may occur during actual usage.

54.3.2 An appliance that may be installed in built-in, wall-mounted, under-cabinet or similar configurations; or may be operated above or adjacent to another heating appliance, shall be operated in the installation or configuration, of those described in Temperature Test, Section [41](#), and recommended by the manufacturer, which represents the worst-case installation for each abnormal condition.

54.4 Test duration

54.4.1 Unless ultimate results are obtained (such as an open circuit) in less time, the tests are to be continued for at least 1 h, or for the maximum setting of any timer (if one is provided), whichever is longer. If during or at the end of the above mentioned time period there is an indication of a possible impending condition of fire or electric shock (for example, the generation of smoke, deterioration of insulation, and the like), the test is to be continued until ultimate results are obtained, but no longer than 7 h for an appliance that can operate continuously or a maximum of 4 cooking cycles for an appliance with a timer (or more cooking cycles if necessary to obtain a minimum of 1 h operation).

Exception: An electronic timer or other solid-state device whose malfunction may cause the appliance to operate continuously is to be defeated and the appliance operated 7 h or until ultimate results are obtained, whichever comes first, unless the device has been shown to be acceptable by an investigation.

54.4.2 Microwave radiation emission measurements are to be made following each of the abnormal conditions in accordance with the procedure described in [39.2.1](#) – [39.5.3](#), except that all interlocks are to be permitted to function during the microwave radiation emission measurement procedure.

54.4.3 With reference to [54.4.2](#), parts that malfunction during the test are to be replaced, if necessary, in order to render the appliance operable to facilitate the microwave radiation emission measurements. However, such measurements are to be made with the appliance configured in the intended initial abnormal operating condition, except that the oven cavity load shall be as specified in [39.3.1](#).

54.4.4 Abnormal operating conditions to be considered, individually, are the following:

- a) Any fan or pump motor utilized to remove heat is to be stalled;
- b) The stirrer motor (if provided) is to be stalled;
- c) The oven is to be operated with no load added in the cavity; and
- d) An appliance rated and constructed as noted in [37.2](#) and provided with instructions as noted in [73.11](#) is to be operated with the most unfavorable combination of supply voltage, supply frequency, and internal adjustments.

54.4.5 Abnormal conditions involving circuit component malfunctions to be considered are as indicated below. Only one malfunction shall be simulated at a time. Short circuiting of:

- a) Any two terminals of a vacuum tube or solid state device, such as a transistor, rectifier, triac, and the like,
- b) An electrolytic or electrostatic capacitor, or
- c) Cathode to anode of a magnetron.

54.4.6 The test described in [54.4.5](#) is to be conducted on two additional samples if the abnormal condition results in open circuiting of circuit elements, such as resistors, capacitors, or copper on printed wiring boards, and the like. Operation of a reliable thermal or overcurrent device (see [Table 59.1](#)) shall not necessitate repeating the test.

54.4.7 The performance of an appliance subjected to the abnormal tests of [54.4.3](#) – [54.4.6](#) shall be considered acceptable if all of the conditions below are met:

- a) The grounding fuse rated 3 A shall not open;
- b) There shall be no emission of flame or other indication of a risk of fire;
- c) Microwave radiation emission shall not exceed the level specified in [54.1.1](#); and
- d) A cord-connected microwave cooking appliance shall not involve an electric shock, that is, the current measured through a resistor rated 500 ohms between an accessible part and ground shall not be more than 5 mA. The current need not be measured at terminals operating at voltage levels less than 42.4 V peak.

54.4.8 The operation of the supply circuit overcurrent protection is acceptable provided no likelihood of fire, electric shock, injury to persons, or excessive radiation emission exists.

54.5 Shorted thermostat test

54.5.1 During the test specified in [54.5.2](#), the temperature at the geometric center of the oven cavity shall not exceed 316°C (600°F), the temperature of adjacent walls, cabinets and the like shall not exceed 175°C (347°F), and the appliance shall comply with the conditions specified in [54.4.7](#).

Exception: The temperature of adjacent surfaces may temporarily exceed 175°C provided:

- a) The temperature does not exceed 200°C (392°F), and*
- b) The appliance is de-energized by a thermal cutoff, manual-reset temperature limit control, fuse, or similar one-time device requiring a service operation to restore the appliance to an operable state.*

54.5.2 An appliance constructed as noted in [17.5](#) shall be installed, connected, and operated as specified in Temperature Test, Section [41](#) except that:

- a) All temperature regulating devices that do not comply with the requirements for appliance temperature limiting controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, or with the requirements of operating type 2 action control in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, shall be bypassed. Controls that have been subjected to calibration verification and endurance tests of 100,000 c in accordance with UL 873, or UL 60730-1 and UL 60730-2-9, shall remain operable;
- b) The appliance shall be operated continuously until constant temperatures are obtained, or until a thermal cutoff, manual-reset temperature limiting device, or fuse functions to de-energize the appliance;
- c) The appliance shall be operated only in the mode or modes of operation that cause resistance-type heating elements, or similar auxiliary heating element, to become energized; and
- d) The appliance shall be provided with a grounding-conductor fuse rated 3 A as noted in [54.2.1](#).

55 Abnormal Operation Tests on Motors Used With Solid-State Controls

55.1 These tests apply to motors that are intended for use with a solid-state control where motor current is controlled by a triac or other solid-state device.

55.2 A thermally protected motor shall comply with the requirements for the Locked-Rotor Endurance Test in the Standard for Thermal Overheating Protection, UL 2111 or with the Standard for Thermally Protected Motor, UL 1004-3, and an impedance-protected motor shall comply with the requirements for the Locked-Rotor Endurance Test in the Standard for Overheating Protection Motors, UL 2111 or with the Standard for Impedance Protected Motors, UL 1004-2, except:

- a) No winding temperature requirements are applicable; and
- b) The duration of the test shall be 15 days in each condition. Separate samples may be used for each condition described in [55.3](#).

55.3 During the tests required in [55.2](#), the power supply is to be modified to provide:

- a) Half-wave output, and
- b) An offset voltage of 2 Vdc imposed on an ac voltage wave form as described in [41.7.1](#)(b).

56 Abnormal Operation – Fire Isolation Test

56.1 An appliance that is intended to be installed above a range or counter-mounted cooking unit shall be tested as described in [56.2](#) – [56.9](#).

a) During the test:

- 1) The surface temperature of any point of the top building cabinet shall not exceed 300°C (572°F); and
- 2) A fuse rated 3 A connected between exposed dead-metal parts of the microwave cooking appliance and ground shall not open.

b) After the test:

- 3) The current measured through a resistor rated 500 ohms connected between accessible-metal parts of a cord-connected appliance and ground shall not exceed 5 mA; and
- 4) If the microwave cooking appliance is operational, the microwave radiation emission shall not exceed 5 mW/cm² when tested in accordance with Microwave Radiation Emission Test, Section [39](#), with all door interlocks operational.

56.2 The microwave cooking appliance and range (or counter-mounted cooking unit, as applicable) are to be installed in accordance with [41.3.7.1.1](#) – [41.3.7.5.1](#) and [Figure 41.4](#), except the building back wall, building side walls, and lower side cabinets, as applicable, may be constructed of a minimum 3/8-in (9.5-mm) thick gypsum wallboard (so that these areas will not be contributing factors). A microwave cooking appliance intended to be installed on a ventilating-hood-fan shelf (VHFS) is to be located on the VHFS in accordance with the instructions provided with the VHFS. The grounding conductor of the microwave cooking appliance power supply is to be disconnected and all exposed dead-metal parts of the microwave cooking appliance are to be connected to ground through a non-time-delay fuse rated 3 A.

56.3 A cast iron skillet containing 8 fl oz (237 mL) of previously unused corn oil is to be placed on the front surface burner or element that would be most likely to result in ignition of combustible materials located on the exterior surface of the microwave cooking appliance using the dimensions outlined for the

Standard Test Gas Range illustrated in [Figure 41.5](#). However, the test may be conducted with less than 8 fl oz of corn oil if, when a trial test is conducted without the microwave oven installed, the temperature of the unprotected top building cabinet located not less than 30-in (762-mm) above the cooktop exceeds 275°C (527°F). In such cases, the amount of corn oil is to be reduced in 0.5 fl oz (14.8 mL) increments and the trial test repeated until the cabinet temperature does not exceed 275°C. The test is then to be conducted with the microwave oven installed using this reduced amount of oil. The skillet is to have approximately vertical sides, and the diameter of the bottom plane surface of the skillet is to be 10 ±1 in (254 ±25.4 mm). All other cooktop burners or elements may be covered as necessary to protect the range or cooktop.

Exception: In place of the skillet with corn oil, a sand burner that produces 25 kW of heat at a steady rate for 9.5 min may be used. The sand burner is to be constructed as illustrated in [Figure 56.1](#) or an equivalent construction may be used. The top surface of the sand burner is to be located 30-in (762-mm) below the bottom surface of the top building cabinet and is to be located in the horizontal position that represents the range or cooktop front burner or element that would be most likely to result in ignition of combustible materials located on the exterior surface of the microwave cooking appliance. To determine that 25 kW of steady heat is produced, a trial test is to be conducted or an electronic mass flow controller is to be used. For the trial test, thermocouples are to be placed at 15-in (381-mm) and 30-in above the sand burner. During the trial test the flame is to be adjusted so that the average steady-state temperatures attained are 250°C (482°F) at 30 in and 590°C (1094°F) at 15 in above the surface of the burner.

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56.4 The microwave cooking appliance is to be loaded as specified in [41.5.1](#). The microwave cooking appliance is to be operated in the condition, of those specified in Temperature Test, Section [41](#), that results in maximum temperatures of any combustible materials (thermoplastic and the like) located on the exterior surface of the microwave cooking appliance, except that the water load is not to be replenished after the corn oil or sand burner is ignited.

56.5 The control for the surface-burner or -element covered with the skillet containing the corn oil is to be adjusted to the position or setting resulting in maximum intended heating conditions. The corn oil is to be ignited when the temperature of the corn oil reaches 300° C (572° F), as measured by a type K thermocouple located at the top surface of the corn oil in the pan. All other burner and oven controls are to be in the off position.

Exception: For an application in which the microwave cooking appliance is intended for installation above only specific range or cooktop constructions and the burner or element would be unable to attain temperatures high enough to ignite 8 fl oz (237 mL) of corn oil in a skillet having a diameter of 10 in (254 mm), the amount of corn oil is to be reduced, 1 fl oz (29.6 mL) at a time, until ignition occurs.

56.6 The microwave cooking appliance and range (or cooktop) are both to be operated continuously until ultimate results have been attained or 7 h, whichever occurs first. If a sand burner is used, the microwave cooking appliance is to be operated continuously, but the sand burner is to be ignited only for the period of time specified in the Exception to [56.3](#).

56.7 A microwave cooking appliance that is provided with or intended for use with a vent-hood fan, ventilating-hood-fan shelf, or the like is to be tested twice for each type of venting provided:

- a) With the vent fan adjusted to result in maximum airflow through the vent fan, and
- b) With the vent fan control in the off position.

56.8 With respect to [56.7](#), a vent fan provided with an automatic thermostat or an equivalent device that energizes the vent fan under conditions of elevated temperatures when the primary fan control is in the off position is to be modified as necessary to prevent the vent fan motor from becoming energized, unless:

- a) The thermostat withstands 100,000 c of intended operation without impaired performance while making and breaking the maximum normal current at rated voltage; and
- b) The contact closing set point of the thermostat complies with the calibration verification requirements applicable to appliance limit controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or with the requirements of operating type 2 action control in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

In such cases, an automatic fan control is to be allowed to function as intended.

56.9 If an upper side cabinet filler kit is made available by the manufacturer, and if the filler kit employs potentially combustible materials, consideration is to be given to the need for repeating the Fire Isolation Test with the filler kit installed as intended.

57 Magnetically Operated Interlock Test

57.1 These requirements apply to a magnetically operated switch that functions as one of the door interlocks required in Interlock Monitors, Section [11](#). A magnetically operated interlock is considered to be concealed, or its actuation is considered to be prevented, if it does not operate when tested in accordance with [57.2](#) and [57.3](#).

57.2 A test magnet as described in [57.3](#) is to be applied to any appliance surface to which it will remain in place by the force of gravity or its own attraction.

57.3 The test magnet shall provide a magnetic force capable of lifting vertically a mass of at least 9.92 lb (4.5 kg) at a zero air gap, and at least 0.992 lb (450 g) at a 0.39 in (10 mm) air gap. These forces are to be determined by locating the operative face of the magnet (the face that is toward the interlock switch while the magnet is in the test position) parallel to, and pulling against, one of the large faces of a mild steel armature having dimensions of 3.15 by 1.97 by 0.31 in (80 by 50 by 8 mm).

58 X-Radiation Test

58.1 General

58.1.1 The x-radiation of an appliance when measured as described in [58.1.3](#) and [58.2.1](#), shall not exceed 0.5 mR/h at any external location 5 cm or greater from the outside surface of the enclosure of the appliance.

58.1.2 The x-radiation measurement is to be made only if the high voltage in a microwave cooking appliance exceeds 5 kV peak under normal conditions.

58.1.3 X-radiation measurements are to be made with the Victoreen X-Radiation Survey Meter, Model 440RFC or equivalent, under the following conditions:

a) The appliance is to be complete, except that mechanical parts that need to be removed during user servicing may be omitted if they are:

- 1) Not necessary for the functioning of the appliance,
- 2) Not exposed to view during intended operation, and
- 3) Not held captive by a chain, hinge, loose rivet, or the like.

b) The voltage of the supply circuit is to be 130 V if the rating of the appliance is within the range 105 – 130 V and 260 V if the rating of the appliance is within the range 210 – 260 V. The oven is to be loaded as described in [39.3.1](#).

c) After the measurement has been made with the supply voltage specified in (b), the supply voltage is to be adjusted to any of the voltages within the mentioned ranges of (b), to see if it results in greater x-radiation.

d) Unless investigated and found to be acceptable, a rectifier tube, protective device (such as a fuse or circuit breaker), electrolytic capacitor, and transistor or other solid-state device is to be disabled singly (short-circuited for electrolytic capacitor, open for protective device, and short-circuited or opened for others), unless disabling the component causes the appliance to stop operating.

58.2 X-radiation under servicing conditions

58.2.1 Unless there is a marking to warn service personnel of potential x-radiation risks, the appliance shall comply with [58.1.1](#) under all conditions of a serviceman's servicing.

59 Temperature Control Tests

59.1 A temperature control shall be rated for the load it controls, and shall be subjected to an endurance test that shall consist of the number of cycles indicated in [Table 59.1](#).

Exception: An automatic reset temperature-limiting magnetron thermostat may be endurance tested in accordance with [Table 59.1](#) using a resistive load (power factor of 100 percent), provided that a separate 6000 c are performed on an additional sample using one of the following loads:

- a) Inductive load at power factor of 75 – 80 percent and full load current,*
- b) Resistive load at power factor of 100 percent and twice full load current, or*
- c) Actual appliance load.*

Table 59.1
Number of cycles of operation for endurance test

Type of control	Automatically reset control	Manually reset control
Temperature-regulating	A number of cycles equivalent to 1000 h of intended operation of the appliance, but not less than 6000 if a household appliance, or 30,000 if a commercial appliance. However, the test may be omitted if, with the thermostat short-circuited, no temperature higher than the limits given in Table 41.1 are attained during the temperature test of the appliance.	To be made the subject of investigation for the particular application.
Temperature-limiting	A number of cycles equivalent to 100 h of operation of the heating appliance under any condition that causes the thermostat to function, or 100,000 c whichever is greater. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of a risk of fire, electric shock, or excessive radiation emission as described in 54.4.7 during the abnormal operation of the appliance.	1000 c under load and 5000 c without load. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of a risk of fire, electric shock, or excessive radiation emission as described in 54.4.7 during continuous abnormal operation of the appliance.
Combination Temperature-regulating and -limiting	100,000 c if, with the thermostat short-circuited, there is evidence of a risk of fire, electric shock, or excessive radiation emission as described in 54.4.7 . If there is no evidence of a risk of fire, electric shock, or excessive radiation emission with the thermostat short-circuited, the thermostat is to be tested as a temperature-regulating control (see above).	To be made the subject of investigation for the particular application.

59.2 If a temperature control is used in connection with a magnetic contactor or other auxiliary equipment, the endurance test requirements apply to the control and contactor functioning as a unit.

60 Temperature Probe Test

60.1 A microwave cooking appliance incorporating a temperature probe (an accessory intended to sense or regulate food temperatures) shall be so constructed that if unintentional entrapment of a portion of the probe assembly by the oven door is likely, then such entrapment shall not result in excessive microwave emission.

60.2 Compliance with the requirement of [60.1](#) is determined as follows. The probe assembly is to be connected to its associated receptacle. A counter supported appliance is to be positioned either flush with or recessed from the edge of the supporting surface, whichever produces the most adverse condition. With the door open, the probe assembly is to be placed in any rest position that will result in entrapment between the oven and oven door. The position of the cable is not to be artificially maintained, that is, it is not to be held or supported by any means other than the structure of the appliance itself, the supporting surface, or an item in the cavity simulating food. The appliance is then to be subjected to the door closure operation described in [60.3](#).

60.3 The oven door is to be moved towards the closed position up to the point where initial contact with the probe assembly is made. A gradually increasing force is to be applied in a direction perpendicular to the plane of the face of the door. The force is to be applied to any point on an integral door handle, if provided, or to any point 1 in (25.4 mm) or more from the free edge of a door, not provided with an integral handle. The force is to be increased until either the door closes and latches or 50 lbf (222 N) is attained, whichever comes first, after which the applied force is to be removed. The performance of the appliance is to be evaluated in accordance with [60.4](#).

60.4 When subjected to the test described in [60.3](#), microwave emission is not to exceed 5 mW/cm² when measured in accordance with [39.2.2](#) – [39.5.4](#), except that interlock switches shall not be bypassed. If the oven door closes and latches and the appliance operates with the probe trapped as a result of the test described in [60.3](#), then microwave emission is to be measured first with the probe trapped and secondly after removal of the probe. If the door does not close, latch, and the appliance does not operate with the probe trapped, the measurement shall be made without the probe trapped.

61 Motor Switch Test

61.1 A switch that controls a motor and that does not have a horsepower rating acceptable for that motor shall perform acceptably when subjected to an overload test consisting of 50 c of making and breaking the stalled-rotor current of the motor. There shall be no electrical or mechanical malfunction of the switch, nor any undue pitting or burning of the contacts.

61.2 To determine if a switch complies with [61.1](#), it is to be tested with the appliance connected to a supply circuit of rated frequency and maximum rated voltage, and with the rotor of the motor locked. During the test, exposed dead metal parts of the appliance are to be grounded, and the electrical connections are to be such that a single-pole switch will be connected in the ungrounded conductor of the supply circuit.

62 Interlock Malfunction Test

62.1 The malfunction of any single electrical, mechanical, or electrical-mechanical component shall not cause all interlocks to become inoperative.

62.2 Mechanical component malfunctions encompass the breaking, bending, shearing, shifting, loosening, and the like of structural parts, such as actuators, or springs, that may or may not be a part of the interlocking system, but which may have an effect on the function of the interlocking system.

62.3 Only one malfunction at a time shall be considered.

Exception: Several simultaneous malfunctions may be considered if such an occurrence is likely due to a single malfunction.

62.4 Determination as to whether a mechanical component malfunction can defeat the function of the door interlock system may be made by an inspection of the construction. In cases of questionable constructional features, mechanical malfunctions of the types described in [62.2](#) may be simulated.

62.5 Components, including interlocks, relays and wiring, of an appliance shall be so arranged that any single malfunction or failure of electrical insulation resulting in a live part contacting an earth-grounded part shall not permit operation of the microwave generator with the door open under conditions of both normal and reverse polarity of the power supply conductors.

62.6 To determine compliance with [62.5](#), a microwave oven is checked by inspection and if necessary, by simulating relevant faults to ground. Faults are conducted using both normal and reverse polarity.

63 Salt Spray Corrosion Test

63.1 In a test for compliance with the requirement in [14.2](#)(e), a part shall exhibit no visible evidence of corrosion following exposure to a salt spray (fog) for 240 h in accordance with the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117. The test is to be conducted on six samples of the part with the minimum coating thickness specified.

Exception: A part may exhibit visible evidence of corrosion provided it complies with the requirements in [63.2](#).

63.2 To determine compliance with the Exception to [63.1](#), six samples of the plated part with the minimum coating thickness specified, together with six samples of the part made of solid copper, are to be exposed to a salt spray (fog) in accordance with the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117. In addition, an identical set of samples is to be exposed to air at $60 \pm 1^{\circ}\text{C}$ ($140 \pm 2^{\circ}\text{F}$) and a relative humidity of 95 ± 2 percent. During these tests, the samples are to be examined for evidence of visible corrosion, such as discoloration, and then subjected to a mV drop measurement as described in [63.3](#) at least once every 168 h, and more often (for example, once every 24 h) if any sample exhibits evidence of corrosion. When compared with the solid copper samples, the plated samples shall not exhibit a greater amount or degree of visible corrosion or percent change in mV drop over the "as received" values as a result of these tests. The tests are each to be continued for 2000 h but may be discontinued if the plated samples exhibit a greater percent change in mV drop.

63.3 Each sample, in turn, is to be connected in series with a dc ammeter and a slide-wire variable resistor. The assembly is to be connected across a dc source of supply and the variable resistor adjusted so that a current of 5 A flows through the circuit. The voltage drop across the sample is then to be measured using a mV potentiometer.

64 Cavity Fire Containment Test

Section 64 deleted.

64A Forced Failure Fire Containment Tests

64A.1 General

64A.1.1 Operation of a microwave cooking appliance shall not result in a risk of fire, electric shock, or injury to persons, and the microwave radiation emission shall not exceed 5 mW/cm^2 at any point 5 cm or more from the external surface of the enclosure when tested in accordance with Microwave Radiation Emission, Section [39](#), as the result of being operated under the conditions described in [64A.1.2](#) – [64A.4](#).

64A.1.2 The performance of an appliance subjected to these tests shall be considered acceptable if all of the following conditions are met:

- a) There is no emission of fire, flame, or molten metal outside the appliance nor glowing or ignition of the cheesecloth, tissue paper, or wood surfaces;
- b) The fuse rated 3 A does not open;
- c) Following the tests specified in [64A.2](#) – [64A.4](#), the appliance complies with the requirements of Leakage Current, Section [38](#), and Dielectric Voltage-Withstand Test, Section [44](#), as applicable to primary circuits; and
- d) Following the test and following 10 c of operation (opening and closing the door), the appliance complies with the requirements in [64A.1.9](#). The radiation emission shall not exceed 5 mW/cm^2 .

64A.1.3 The operation of the supply circuit overcurrent protection, a thermal cutoff or a temperature limiting device is acceptable provided no likelihood of fire, electric shock, injury to persons, or excessive radiation emission exists. If a user serviceable overtemperature or overcurrent device functions during the test, such a device is to be reset or replaced prior to conducting the Radiation Emission, Leakage Current, and Dielectric Voltage-Withstand Tests.

64A.1.4 The appliance shall be connected to a voltage supply source as indicated in [40.2.1](#). The supply circuit for the appliance is to be provided with a time delay fuse of the maximum rating for the branch circuit to which the appliance is intended to be connected. A fuse rated 3 A, other than the time-delay type, is to be connected in series with the grounding conductor of the appliance.

64A.1.5 The duration for this test shall be as specified in [54.4.1](#).

64A.1.6 The appliance shall be mounted as specified in [41.3.2.1](#), [41.3.2.2](#), and [41.3.5.1](#) – [41.3.6.1](#). In addition, for an appliance intended to rest on a floor, counter top, shelf, or the like, the supporting surface is to be covered with a double layer of white tissue paper. For an appliance intended to be wall or cabinet mounted, the surface below the appliance is to be covered with a double layer of white tissue paper. Depending upon the mounting configuration, the appliance is to be completely or partially draped with a single layer of cheesecloth.

64A.1.7 The cheesecloth specified in [64A.1.6](#) is to be bleached cotton cloth running 14 – 15 yd²/lb (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 cm, 13 threads in one direction and 11 threads in the other direction). Tests involving cheesecloth are to be conducted in a closed, draft-free room.

64A.1.8 The appliance is to be operated at full microwave power. In the case of an appliance with a thermal element, operation is to be representative of the most severe condition that may be encountered during intended use, consistent with the highest microwave power setting.

64A.1.9 Microwave radiation emission measurements are to be made following the test in accordance with the procedure described in [39.2.1](#) – [39.5.3](#), except that all interlocks are to be permitted to function during the microwave radiation emission measurement procedure.

64A.2 Potato fire containment test

64A.2.1 The test load for this test is to consist of one or more potatoes placed in the cavity. Each potato shall weigh between 5.3 oz (150 g) and 7.1 oz (200 g), have a volume between 4.7 oz (140 mL) and 6.1 oz (180 mL), and have a moisture content of 80 ±5 percent. The number of potatoes used is to be the maximum number obtained in [Table 64A.1](#), when both output rating and cavity size are considered.

64A.2.2 If an appliance is provided with a limit control or thermal cutoff that is responsive to oven cavity temperatures, the test is to be conducted with the number of potatoes indicated in [Table 64A.1](#) and also with a single potato.

Table 64A.1
Cavity fire containment test load

Output rating of oven in watts, W		Usable volume of cavity, ft ³	Number of potatoes
W < 500	or	Vol < 0.5	1 ^a
500 ≤ W ≤ 600	or	0.5 ≤ Vol ≤ 1.0	2 ^b
W > 600	or	Vol > 1.0	4 ^b
^a If a fire will not start using one potato, the potato is to be ignited by artificial means such as inserting a metal wire through the potato, stalling the stirrer fan in the position that will cause microwave energy to be focused at the potato, preheating the potato with another heat source, or some other means. ^b If a fire will not start using the maximum number of potatoes specified in the chart for the output rating and cavity size involved, reduce number by one and retest. If necessary, continue to retest until the appliance has been tested with one potato.			

64A.2.3 The load described in [64A.2.1](#) and [64A.2.2](#) is to be placed in the most severe position in the cavity in relation to plastic or other flammable materials. Such positioning may include locating the load adjacent to the door or side stirrer shield or on a rack adjusted to the most severe position in relation to an overhead stirrer shield.

64A.2.4 The test is concluded when ultimate results are obtained.

64A.3 Waveguide and stirrer fire containment test

64A.3.1 This test does not apply to models with a waveguide on the bottom of the oven cavity where the waveguide is sealed to prevent moisture or food debris.

64A.3.2 A mixture of 0.53 oz (15g) peanut butter, 0.28 oz (8g) water, 0.35 oz (10g) chicken broth, 0.28 oz (8g) salt and 0.07 oz (2g) finely crushed carbonized wood (charcoal/carbon powder) is to be well mixed and applied evenly to the inside edges of the waveguide (or stirrer). Once applied, the waveguide cover is to be replaced to the position of normal operation.

64A.3.3 The appliance is to be operated at full microwave power without load until ultimate results are obtained or the test duration as specified in [54.4.1](#). In the case of an appliance with a thermal element, operation is to be representative of the most severe condition that may be encountered during intended use, consistent with the highest microwave power setting.

64A.3.4 If ultimate results are not obtained after the test duration as specified in [54.4.1](#), the microwave cooking appliance is to be cleaned and cooled to room temperature or a new sample can be used. The steps described in [64A.3.2](#) and [64A.3.3](#) are to be repeated until ultimate results have been obtained.

64A.3.5 This test is to be repeated on the stirrer on models that also contain a stirrer.

64A.4 Popcorn fire containment test

64A.4.1 The following load placed on a minimum 2.8 in (7 cm) diameter paper plate shall be located in the center of the cooking shelf of the oven cavity. The load shall consist of 7 oz (0.2 kg) of popcorn well-mixed with 0.85 oz (25 mL) of vegetable oil and contained in a clear plastic bag ties with a steel wire twist tie.

64A.4.2 The microwave is to be operated at full power until ultimate results are obtained or for 7h, whichever comes first.

64A.5 Thermally protected AC fan motor ignition test

64A.5.1 The requirements in this section are intended to investigate the risk of fire for fans including the impeller and surrounding materials.

Exception: A motor that is fully enclosed in metal or 5V material is exempt from this test.

64A.5.2 All motor thermal protectors are to be shunted out of the motor winding so that the motor stays continually energized. The rotor is to be locked. The fan is to be positioned as intended in application and is to be energized in a room ambient temperature of 50 to 104°F (10 to 40°C).

64A.5.3 The fan is to be operated at the nominal rated voltage and powered separately from the microwave and held until temperature stabilization.

64A.5.4 The applied voltage shall be increased by 10 V increments and held until temperature stabilization is achieved.

64A.5.5 The test is concluded when ultimate results are obtained.

64A.5.6 As a result of the test, there shall be no evidence of ignition of the external cheese cloth surrounding the appliance.

64A.6 Nichrome wire ignition tests

64A.6.1 If specified by [12.8.4](#), an electrical connection shall be tested as specified in [64A.6.2](#) – [64A.6.9](#). One sample shall be evaluated per connection. Multiple connections may be independently evaluated within the same appliance if they are located such to not influence the outcome or evaluation of the test. As a result of the test, there shall be no evidence of the following conditions:

- a) Ignition of the external cheese cloth surrounding the appliance;
- b) Fracture or shorting of the nichrome wire prior to completion of the test; or
- c) A shift in the position of the nichrome wire sufficient to alter the severity of the test.

64A.6.2 This test intentionally attempts to cause a fire. Appropriate safety precautions to prevent the spread of fire should be taken. The test location shall have sufficient fresh air to sustain the flame. This test shall be conducted at an elevation of less than 2,000 ft (610 m) above sea level.

64A.6.3 All microwave configurations (Counter top, Under-cabinet mounted, Over-the-cooktop, Built-in, etc.) shall be supported on a non-conductive surface. The top, two sides, front and back of appliance shall be completely covered by single-layer cheesecloth panels. A mechanical means, such as small pieces of metal foil adhesive tape shall be used to secure the cheesecloth panels so there are no gaps between the panels. A single layer of cheesecloth slightly larger than the appliance bottom surface shall cover the supporting surface. If agreeable to those concerned, cheesecloth may be placed only in the area of the anticipated breach.

64A.6.4 All labels that are applied by the manufacturer shall be applied to the intended surfaces of the test appliance. Printing on the labels is not required. The manufacturer shall place the wiring diagram in the test appliance as intended.

64A.6.5 The appliance shall be de-energized during the test unless equipped with a protective control or device. The connection under evaluation shall be electrically isolated from the appliance circuitry during the test. If the appliance is energized during the test, a duplicate connection that is electrically isolated

from live parts shall be evaluated. Thermocouples shall be placed around the part (but not in direct contact) such that when ignition occurs, an increase in temperature can be detected. When appropriate, windows made of glass, or other clear non-combustible material may be used in the product to allow viewing of the component being tested. Windows must be 'sealed' to prevent extraneous drafts or air leaks. Windows shall be located in areas not likely to be involved in or influence flame propagation. Video cameras may be employed to assist in verification of ignition. A constant current power supply shall be used and current shall be monitored for evidence of shorting or resistance wire breaks during testing.

64A.6.6 An appliance control or device employed to provide protection from risk of fire shall be evaluated as a protective control and may be used to de-energize the nichrome wire if found to actuate during the test.

64A.6.7 Nichrome wire [20% Chrome, 80% Nickel, 22 AWG, in accordance with ASTM 344-11,] shall be applied to a connector or switching contact such that the adjacent polymeric materials will be ignited during the test.

64A.6.8 A single strand of nichrome wire with an approximate length of 2.0 – 4.0 in (50 mm – 100 mm) shall be formed into a coil with a diameter and length that approximates the connection under evaluation. The coil shall be inserted in place of the connection under evaluation. In the case of a multi-pin connector, a single terminal pin shall be removed from the connector such that the coil can be inserted in the worst case location (typically the lowest position). If worst case position is not obvious, then multiple positions must be evaluated. Insulated wire leads shall be used to supply power to the nichrome wire and shall be supported and strain-relieved to prevent the nichrome wire from shifting during testing. The preferred method of wrapping a coil is wrapping nichrome wire around the threads of a #6-18 wood screw with a root diameter of 0.094 in (2.39 mm) and a thread per inch count of 18. Alternate wrapping methods such as wrapping the connector externally may be employed if it is deemed necessary to achieve complete consumption of the adjacent material. Uninsulated terminals shall be wrapped with a non-flammable tape or sleeve prior to wrapping with nichrome wire to prevent shorting out portions of the nichrome wire. In the case of switching devices, a coil of nichrome wire shall be placed inside the device in the position of the contacts and appropriately supported to prevent movement during the test.

64A.6.9 The nichrome wire shall be energized such that current in the circuit is immediately increased to 11 A. Power shall be held constant until burning of the polymeric material ceases naturally or there is ignition of the cheesecloth. If ignition of the cheesecloth occurs, the fire shall be extinguished as soon as possible. If no ignition is detected, the current shall be held for 20 min. If the nichrome wire fractures prematurely, the test shall be repeated.

64A.6.10 After the appliance has cooled, there shall be no charring, burning, or broken fibers of cheesecloth. Smoke discoloration is acceptable. Upon inspection of the appliance, there shall be no evidence of a shift in the position of the nichrome wire sufficient to influence the test.

65 Strength of Mounting Test

65.1 To determine that a wall-mounted appliance complies with the requirements in [7.2.1](#), the complete appliance is to be mounted on a smooth vertical surface in accordance with the manufacturer's instructions, and using the brackets, hangers, or the like that are provided with the appliance as shipped, or are available as a separate field-installed kit. A force of 50 lbf (222 N) is to be applied to the outer edge of an open door, for 5 min, so as to cause the greatest moment.

65.2 If no wall construction is specified in the installation instructions or if the constructions described do not represent expected wall constructions, then the test shall be conducted with each of the wall constraints as follows:

- a) 3/8-in thick trade size gypsum dry wall fastened to 2- by 4-in trade size wood studs spaced on centers of 16 in (406 mm) is to be used as the support surface. The hardware is to be applied as

specified in the instructions, and the mounting screws (or other fasteners) are to be positioned between the studs and secured into the gypsum dry wall. An adjustable product is to be adjusted to the position that will give the maximum projection from the wall. If the manufacturer's installation instructions indicate the mounting screws are to be secured into wood studs:

1) An appliance less than 32-in (813-mm) wide is to be mounted on one side to a wood stud and on the other side to the dry wall, even if the instructions recommend securement to two studs.

2) An appliance at least 32-in wide is to be mounted to a wood stud on each side.

b) 1/2-in thick trade size gypsum dry wall fastened to 2- by 4-in trade size wood studs spaced on centers of 24 in (610 mm) is to be used as the support surface. The hardware is to be applied as specified in the instructions, and the mounting screws (or other fasteners) are to be positioned between the studs and secured into the gypsum dry wall. An adjustable product is to be adjusted to the position that will give the maximum projection from the wall. If the manufacturer's installation instructions indicate the mounting screws are to be secured into wood studs, then the appliance is to be mounted on the lightest side to a wood stud and on the other side to the dry wall, even if the instructions recommend securement to two studs.

66 Tests on Motors Exposed to Grease or Cooking Vapors

66.1 General

66.1.1 A motor as specified in [20.5\(c\)](#) shall be subjected to the tests specified in [66.2.1](#) and [66.3.1](#).

Exception: A motor that is constructed such that the windings are totally encapsulated need not be subjected to the tests described in this section, provided the encapsulating material has been subjected to a test program equivalent to that described in this section and has been found to be resistant to grease.

66.1.2 As a result of the tests specified in [66.2.1](#) and [66.3.1](#):

a) There shall be no noticeable change or deterioration of the motor insulation with respect to accessibility, mechanical strength, or the like;

b) There shall be no dielectric breakdown when tested in accordance with Dielectric Voltage-Withstand Test, Section [44](#); and

c) The leakage current of a cord-connected appliance shall not exceed the limits specified in [38.1](#) when tested in accordance with Leakage Current Test, Section [38](#). Charring or discoloration of the insulation is acceptable, provided all component materials of the insulation system remain intact.

66.2 Grease conditioning

66.2.1 Three samples of a motor are to be completely coated with a layer of lard, 1/8-in (3.2-mm) minimum thick, and placed for 30 days in a forced-draft air circulating oven maintained at a temperature of 150°C (302°F). At the end of this conditioning, each sample shall be installed in the appliance and shall comply with [66.1.2](#).

66.3 Oven and humidity conditioning

66.3.1 Three samples of the motor shall be placed for 7 h in a forced-draft air circulating oven maintained at a temperature of 100°C (212°F). At the end of 7 h, these samples are to be removed from the oven and conditioned for 48 h in air having relative humidity of 88 ±2 percent and a temperature of 32 ±2°C (90 ±4°F). The cycle is then to be repeated until two complete cycles of conditioning have been conducted. At

the end of the conditioning cycles specified above, each sample shall be installed in the appliance and shall comply with [66.1.2](#).

MANUFACTURING AND PRODUCTION-LINE TESTS

67 Dielectric Voltage-Withstand Test

67.1 Each appliance shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 Hz, between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized, and between primary wiring and accessible low-voltage (42.4 V peak or less) metal parts, including terminals.

67.2 The production-line test shall be in accordance with either the test for 60 s or the test for 1 s in [Table 67.1](#).

Table 67.1
Production-line test conditions

Method ^a	Application time, s	Applied potential, V rms	
		Appliance rating, V	
		0 – 250	251 – 600
1 (Quadrature)	60	1000	1000 + 2V ^b
2 (Single phase)	60	1000 + V ^b	1000 + 3V ^b
3 (Single phase)	1	1200 + 1.2V ^b	1200 + 3.6V ^b
4 (Quadrature)	1	1200	1200 + 2.4V ^b

^a Method 1 is described in [67.3](#); method 2 is described in [67.4](#); method 3 is described in [67.5](#); and method 4 is described in [67.6](#).
^b V is the voltage determined in accordance with [40.2.1](#).

67.3 For the quadrature test for 60 s, the test potential is to be applied using the test circuit illustrated in [Figure 44.1](#). The appliance is to be energized at rated voltage. The appliance is to have a sufficient number of switching components (triacs, relay contacts, and the like) closed or electrically bypassed such that all primary circuits are subjected to the dielectric potential.

67.4 For the single-phase test for 60 s described in [44.2.1.2](#), the appliance is to be unenergized; or for the test described in [44.2.3.1](#), the appliance is to be energized at rated voltage.

67.5 For the single-phase test for 1 s described in [44.2.1.2](#), the potential is to be applied while the appliance is unenergized; or for the test described in [44.2.3.1](#), the potential is to be applied while the appliance is energized.

67.6 For the quadrature test for 1 s, the test potential is to be applied using the test circuit illustrated in [Figure 44.1](#). The test potential is to be applied while the appliance is energized. The appliance is to have a sufficient number of switching components (triacs, relay contacts, and the like) closed or electrically bypassed such that all primary circuits are subjected to the dielectric potential.

67.7 The appliance may be in a heated or unheated condition for the test.

67.8 The test shall be conducted when the appliance is complete (fully assembled). It is not intended that the appliance be unwired, modified, or disassembled for the test.

Exception No. 1: Parts such as snap covers or friction-fit knobs that would interfere with performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed appliance.

67.9 When the appliance employs a solid-state component, which is not relied upon to reduce the risk of electric shock and which can be damaged by the dielectric potential, the test may be conducted before the component is electrically connected provided that a random sampling of each day's production is tested at the potential specified in [Table 67.1](#). The circuitry may be rearranged for the purpose of the test to minimize the likelihood of solid-state-component damage while retaining representative dielectric stress of the circuit.

67.10 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manual-reset device to restore the equipment after electrical breakdown or an automatic-reject feature of any unacceptable unit.

67.11 If the output of the test-equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

67.12 If the output of the test-equipment transformer is 500 VA or larger, the test potential may be indicated by:

- a) A voltmeter in the primary circuit or in a tertiary-winding circuit;
- b) By a selector switch marked to indicate the test potential; or
- c) In the case of equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential. When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manual-reset switch has been reset following a dielectric breakdown.

67.13 Test equipment, other than that described in [67.10](#) – [67.12](#), may be used if found to accomplish the intended factory control.

67.14 During the test a sufficient number of primary switching components shall be in the on position so that all primary circuitry will be stressed. If necessary, triacs, relay contacts, and the like shall be electrically bypassed using jumpers or some other suitable method. Both sides of the primary circuit of the appliance are to be connected together and to one terminal of the test equipment, and the second test equipment terminal is to be connected to accessible dead metal parts of the appliance.

Exception: An appliance having circuitry not subject to excessive secondary-voltage buildup in case of electrical breakdown during the test may be tested with a single-pole primary switch, if used, in the off position, or with only one side of the primary circuit connected to the test equipment when the primary switching components are in the on position, or when a primary switching component is not used.

68 Grounding-Continuity Test

68.1 Each appliance that has a power-supply cord shall be tested, as a routine production-line test, to determine grounding continuity between the grounding blade of the attachment plug and the accessible dead metal parts of the appliance that are likely to become energized.

68.2 Only a single test need be made if the accessible dead metal selected is conductively connected by construction to all other accessible dead metal.

68.3 Any indicating device (an ohmmeter, a battery-and-buzzer combination, or the like) may be used to determine compliance with the grounding-continuity requirement in [68.1](#).

RATING

69 Details

69.1 An appliance shall be rated in volts, amperes or watts, and frequency. The rating shall include the number of phases if the appliance is intended for use on a polyphase circuit. The voltage rating shall be in accordance with an appropriate single voltage or range of voltages such as 110 – 120, 208, 220 – 240, 254 – 277, 416, 440 – 480, 550, 575, and 600. The ampere rating shall be included unless the full-load power factor is 80 percent or more.

69.2 The rating of an appliance having provision for permanent connection of the electrical supply and incorporating a motor load of more than 1/8 horsepower shall include either:

- a) The motor load of the largest motor in amperes and volts, and also the non-motor load in amperes and volts (or watts and volts); or
- b) The minimum supply circuit conductor ampacity and the maximum rating of the circuit overcurrent protective device in amperes.

69.3 If an appliance includes an attachment-plug receptacle that serves as a general-use outlet, the added load that may be imposed on the appliance and its supply connections (1440 W if a receptacle rated 15 A is employed and 1920 W if a receptacle rated 20 A is employed, unless the receptacle is marked for a specific load) shall be taken into consideration in determining the electrical rating of the appliance.

MARKINGS

70 General

70.1 An adhesive-attached marking employed in an application where a durable, securely affixed, or otherwise permanent marking is specified, bearing required markings, and located on the exterior surface of an appliance or inside of the oven cavity, shall comply with the applicable requirements in the Standard for Marking and Labeling Systems, UL 969, for indoor applications.

70.2 Labels rated for indoor dry locations are suitable only for markings located where they will not be subjected to occasional splashing, cleaning, or oven cavity vapors. The bottom and rear panels of an appliance are not considered to be subjected to occasional splashing or cleaning.

70.3 Labels on built-in, under-cabinet, wall-mounted (or the like) appliances or conversion kits may be rated for indoor dry locations if, after installation, the labels will be located within the wall or other locations where they will not be subjected to occasional splashing, cleaning, or cavity vapors.

70.4 A cautionary marking specified in Visible After Installation, Section [71](#), and Visible During Installation and Examination, Section [73](#), shall be in letters not less than 3/32-in (2.4-mm) high with the heading or title emphasized to elicit the attention of the reader.

Exception: The minimum letter height of the markings in [71.1.3](#) is not specified, but the markings shall be legible.

71 Visible After Installation

71.1 General

71.1.1 The marking required by [71.1.3](#) – [71.1.10](#), shall be durable and securely affixed to the appliance and shall be plain, legible, and readily visible after the appliance is installed in the intended manner.

Exception: As provided in [71.1.8](#).

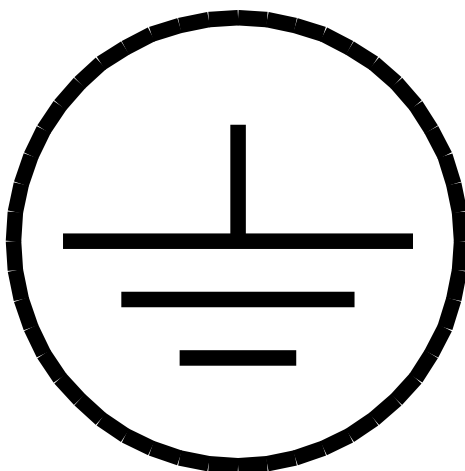
71.1.2 When applying the marking visibility requirement in [71.1.1](#), consideration is to be given to the effect of different installation arrangements (for example, built-in or under cabinet installations) recommended by the manufacturer.

71.1.3 A product shall be legibly and permanently marked with:

- a) The manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product can be identified (hereinafter referred to as manufacturer's name);
- b) The month and year of manufacture without abbreviation, with the year shown as a four digit number as follows: Manufactured: (insert month and year of manufacture);
- c) If the same appliance is produced or assembled at more than one factory, each finished appliance shall have an acceptable distinctive marking, that may be in code, to identify the factory of origin;
- d) A distinctive catalog number or the equivalent;
- e) The electrical rating. See Details, Section [69](#); and
- f) With the statement "household" or "commercial" or an acceptable equivalent wording to indicate the intended use of the appliance.

71.1.4 A pressure wire connector intended for connection of an equipment grounding conductor shall be identified by being marked "G," "GR," "GND," "Ground," "Grounding," with the grounding symbol illustrated in [Figure 71.1](#), a similar marking; or by a marking on the wiring diagram provided on the appliance.

Figure 71.1
Grounding Symbol



71.1.5 A commercial use appliance that is intended for use only by professional cooks or chefs in a commercial kitchen, and that is required to be provided with the marking described in [72.3](#) shall also be marked: "For Use Only In Professionally Staffed Commercial Kitchens. Not For Use In Areas Accessible To The General Public," or equivalent. Such an appliance shall not be provided with any marking indicating that the appliance is intended for household use.

71.1.6 If the currents in ungrounded supply conductors differ to such an extent that proper overcurrent protection, in accordance with the National Electrical Code, ANSI/NFPA 70, would require fuses of different current ratings, the marking shall include the ampere rating of each ungrounded supply conductor.

71.1.7 An appliance having provision for permanent connection to multiple power supplies shall bear a cautionary marking. The marking shall state "CAUTION" and the following or the equivalent: "This appliance has more than one power-supply connection point. Disconnect all power supplies before servicing."

71.1.8 If an interchangeable fuse (a fuse is interchangeable if any fuse of higher ampere rating will fit the fuseholder) is used to limit secondary-circuit power in accordance with [32.1.2](#), there shall be a legible and durable marking indicating the ampere rating of the fuse to be used for replacement and located so that it is obvious to which fuse and fuseholder it applies. In addition, the following prominent marking shall be provided (a single marking is acceptable for a group of fuses). "WARNING – For continued protection against fire, replace only with the same type and rating of fuse."

71.1.9 If the design of an appliance contemplates disassembly by means of a tool for the purpose of cleaning or similar servicing by the user (including replacement of a replaceable overcurrent or over temperature protective device) and, if such disassembly involves the exposure of persons to unintentional contact with any normally enclosed or protected live part, the appliance shall be plainly marked with a warning that such servicing should be done only while the appliance is disconnected from the supply circuit. See also [6.5](#).

71.1.10 A heat sink that is electrically live, likely to be mistaken as dead metal; and likely to be exposed to persons during servicing shall be marked with the word "WARNING" and the following or equivalent: "Risk of Electric Shock – Heat Sink (or other words describing the type of part) may be live. Disconnect power supply before servicing." The marking shall be located on the part or immediately adjacent to the part in a location inside the electrical enclosure such that it is obvious to which part the marking applies, and so as to make the risk known from all approaches to the part before the part is likely to be touched. The word "WARNING" shall be in letters not less than 3/32-in (2.4-mm) high and shall be emphasized to elicit the attention of the reader.

71.2 Combination microwave oven hood fans

71.2.1 A combination microwave oven vent-hood fan shall be provided with a permanent marking that calls attention to:

- a) The need for frequent cleaning of all grease from the fan and from all other grease-laden surfaces;
- b) The need for frequent removal and cleaning of any filter unit provided; and
- c) The need to exercise care when using cleaning agents or detergents. This marking shall be in letters not less than 3/16-in (4.8-mm) high.

71.2.2 A combination microwave oven vent-hood fan provided with an automatic fan-starting feature shall be provided with a marking that is visible to the user prior to the performance of intended maintenance or removal of any guard that would expose a moving part, stating "CAUTION" and the following or equivalent: "Automatically operated device – to reduce the risk of injury, disconnect from power supply before servicing."

Exception: The marking is not required on a combination microwave oven vent-hood fan that is provided with an automatic fan-starting control that:

- a) Will energize the fan motor only when the ambient temperature at the external side of the guard is greater than or equal to 60°C (140°F),*
- b) Withstands 100,000 c of intended operation without impaired performance while making and breaking the maximum rated current and rated voltage, and*
- c) The control complies with the requirements, including calibration verification, applicable to appliance limit controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or with the requirements of operating type 2 action control in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.*

72 Visible to the User During Use

72.1 An appliance that employs an indicator light in accordance with [27.1.7](#) and [27.1.9](#) shall be provided with a permanent marking, located adjacent to the light, that identifies the function of the light. The marking shall consist of the word "WARNING" and the following or the equivalent: "Oven is malfunctioning in self-cleaning mode; turn off or disconnect from power supply. See instruction manual before operating."

72.2 An appliance that employs an audible signal in accordance with [27.1.7](#) and [27.1.10](#) shall be provided with a permanent marking, located in an area readily visible to the user during the operation of the appliance. The marking shall consist of the word "WARNING" and the following or the equivalent: "If (alarm signal, for example, a bell or buzzer) sounds, oven is malfunctioning in self-cleaning mode. Turn off or disconnect from power supply and see instruction manual before operation."

72.3 If, when tested in accordance with the Surface Temperature Test, Section [42](#), the temperature of a surface of a commercial use appliance intended only for use by professional chefs and cooks in a commercial kitchen exceeds the temperature specified in [Table 42.1](#), the surface shall be provided with one or more permanent markings that include the words: "CAUTION – Hot," or equivalent. The marking shall be located on, or immediately adjacent to, the surface involved, and shall be readily visible from all approaches to the surface. See [71.1.5](#).

72.4 All microwave ovens shall be provided with a permanent marking in a location that is clearly visible to the user when the door is open. The marking shall be placed on the vertical surface directly behind the door as shown in [Figure 72.1](#). The wording shall be as shown in [Figure 72.2](#), or the equivalent. The height of the capital letters in the message shall be 0.1 in (2.54 mm) minimum. The height of "WARNING" shall be a minimum of 1.5 times the height of the letters in the message. Lettering shall be black. The background of the message block shall be white or silver, and the background in the warning block shall be orange.

Figure 72.1

Example of acceptable locations for burn hazard marking

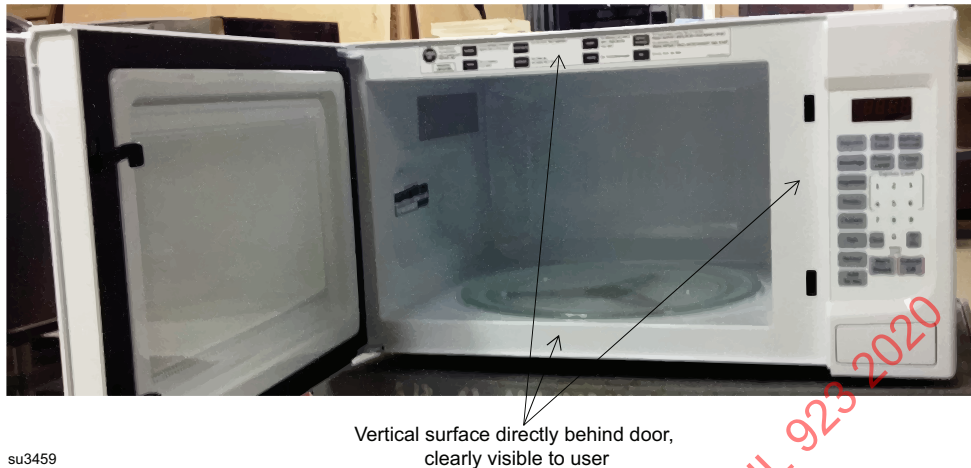
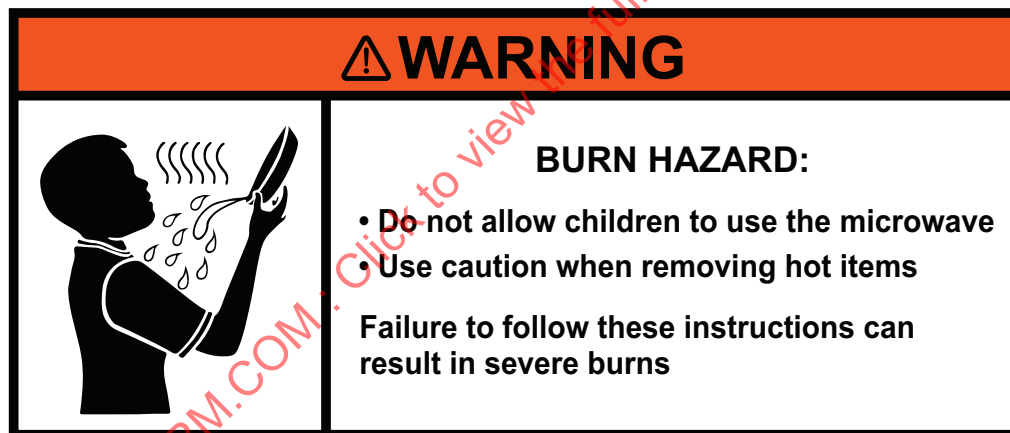


Figure 72.2

Burn hazard marking



73 Visible During Installation and Examination

73.1 The markings required by [73.2](#) – [73.21](#), shall be durable and securely affixed to the appliance and shall be plain, legible, and readily visible during installation and examination of the supply-wiring connections.

Exception: As provided in [73.8](#) and [73.13](#).

73.2 If, during the temperature test, any point within a terminal box or wiring compartment of a permanently-connected appliance in which field-installed conductors are intended to be connected (including such conductors themselves) attains a temperature rise of more than 35° C (63° F), the appliance shall be marked with the following statement or the equivalent: "For supply connection, use . . . AWG or larger wires suitable for at least . . . C (. . . F)." The wire size and temperature used in the preceding statement shall be in accordance with [73.3](#) and [73.4](#).

73.3 The marking of wire size required in [73.2](#) depends on the size of the supply conductors employed for the temperature test (see [41.4](#)).

- a) If the temperature test is conducted using 14 AWG (2.1 mm²) conductors, the wire size marking may be omitted.
- b) If the temperature test is conducted using conductors of all the same size, the marking is to specify that size.
- c) If the temperature test is conducted using conductors of more than one size (because of unbalanced loads, multiple power supplies, or other reason), the marking is to include the following statement or equivalent: "See wiring diagram for wire size."

73.4 The marking of the temperature rating of the supply conductors required in [73.2](#) depends upon the temperature rise in the terminal box.

- a) If, during the temperature test, the temperature rise in the terminal box or wiring compartment is 35°C (63°F) or less, no temperature marking is required.
- b) If, during the temperature test, the temperature rise in the terminal box or wiring compartment is 36 – 50°C (64 – 90°F), the temperature marking is to be "75°C (167°F)."
- c) If, during the temperature test, the temperature rise in the terminal box or wiring compartment is 51 – 65°C (91 – 117°F), the temperature marking is to be "90°C (194°F)."

73.5 The appliance shall be marked with information for the installation and examination of the connections unless the proper connection to field wiring terminals is obvious; for example, phase changing, terminal current or potential rating, multiple supplies, and so forth. If unbalanced supply circuits exist as indicated in [73.3\(c\)](#), each supply terminal shall be marked with its current rating.

73.6 If it is necessary to make field connections between components of an appliance, a marking shall be provided indicating the location of the field connections and any specific requirement for the point of connection, such as the need for moisture-resistant wire insulation, the size of conductor, or temperature rating.

73.7 An appliance having field-wiring terminals shall be marked:

- a) "Use copper conductors only" if the terminal is acceptable only for connection to copper wire;
- b) "Use aluminum conductors only" if the terminal is acceptable only for connection to aluminum wire;
- c) "Use copper or aluminum conductors" or "Use copper, copper-clad aluminum, or aluminum conductors" if the terminal is acceptable only for connection to either copper or aluminum wire; or
- d) "Use copper-clad aluminum or copper conductors" if the terminal is acceptable only for connection to either copper or copper-clad aluminum wire.

73.8 Each individual heating element or unit that is part of an appliance and that is replaceable in the field shall be marked with its electrical rating in amperes or watts, and also in volts, or with the manufacturer's part number.

73.9 An appliance provided with factory installed flexible metal conduit with leads in accordance with [13.1.1.2](#) shall be marked to indicate that the flexible metal conduit and leads are factory installed.

73.10 A cord-connected, microwave appliance shall be plainly marked with the word "WARNING" and the following or the equivalent: "To provide continued protection against electric shock, connect to properly grounded outlets only."

73.11 A microwave cooking appliance that is rated for use at more than one voltage, supply frequency, or for a range of voltages or supply frequencies, and contains a tapped transformer or other means of being adapted in the field to different supply voltages or supply frequencies is to be marked as indicated below:

- a) A clear, permanent marking adjacent to the cord or supply compartment is to be provided to warn the user that internal adjustments may be necessary when the equipment is installed or moved and
- b) Detailed instructions, permanently attached to the equipment, are to clearly show the adjustments that must be made for various voltages or frequencies. The instructions may be on the outside or the inside of the overall enclosure of the unit depending upon the point where adjustments for supply voltages must be made.

Exception: The marking is not required if all tests were performed with the most unfavorable combination of supply voltage, supply frequency, and internal adjustments.

73.12 If the unit has a dual voltage or frequency rating, the unit shall be marked to indicate the particular voltage or frequency for which it is connected when shipped from the factory.

73.13 The marking or instructions required in [Table 13.2](#), note b, are to include the following information:

- a) A short power-supply cord is provided to reduce the risks resulting from becoming entangled in or tripping over a longer cord.
- b) Longer cord sets or extension cords are available and may be used if care is exercised in their use.
- c) If a long cord or extension cord is used:
 - 1) The marked electrical rating of the cord set or extension cord should be at least as great as the electrical rating of the appliance;
 - 2) The extension cord must be a grounding-type 3-wire cord; and
 - 3) The longer cord should be arranged so that it will not drape over the counter top or tabletop where it can be pulled on by children or tripped over unintentionally.

73.14 A microwave cooking appliance intended for field installation directly over a conventional oven, range, or counter-mounted cooking unit shall be marked to indicate the appliance over which it may be mounted. The information shall also be contained in the operating instructions.

Exception No. 1: The marking is not required on the microwave cooking appliance if the conventional unit is provided with a marking that is clear and visible after installation indicating the microwave cooking appliance which may be mounted over it.

Exception No. 2: The marking is not required if the microwave cooking appliance is tested over the standard test wall oven described in [41.6.4](#).

73.15 If an over-the-cooktop microwave oven is intended for use with all gas and electric ranges of a specified maximum width, it shall be marked with the following words, or equivalent: "Suitable for use above gas or electric cooking equipment ___ inches or less wide." The marking shall indicate the maximum width of the range over which the over-the-cooktop appliance is intended to be used. See [41.3.7.1.4](#).