UL 1889

STANDARD FOR SAFETY

Commercial Filters for Cooking Oil

UL Standard for Safety for Commercial Filters for Cooking Oil, UL 1889

Second Edition, Dated August 12, 2024

Summary of Topics

This new Second edition of ANSI/UL 1889 dated August 12, 2024 incorporates editorial changes including renumbering and reformatting to align with current style.

The new requirements are substantially in accordance with Proposal(s) on this subject dated December 29, 2023.

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Standard for Commercial Filters for Cooking Oil

Prior to the first edition, the requirements for the products covered by this Standard were included in the Standard for Commercial Electric Cooking Appliances, UL 197, the Standard for Motor-Operated Appliances, UL 73, and the Standard for Motor Operated Water Pumps, UL 778.

First Edition August 1996

Second Edition

August 12, 2024

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 1889 as an American National Standard (ANSI) occurred on August 12, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover commercial filters for cooking oil rated 600 volts or less and intended for use in accordance with the National Electrical Code, NFPA 70. These requirements cover both portable filters and fixed filters intended to be used with a specific fryer or fryers or with any fryer or fryers.

1.2 These requirements cover oil filters used to filter cooking oil used in deep fat fryers usually found in commercial kitchens, restaurants, or other business establishments where food is dispensed. The filters consist of a pump motor to pump oil to and/or from a deep fat fryer and are capable of including an integral oil heater. The requirements are also applicable to filters built into a fryer.

1.3 When a filter is provided as part of a larger appliance, these requirements cover the filter and related components. The other portions of the appliance are to be evaluated in accordance with the requirements that normally apply to that type of equipment. However, consideration shall be given to the interaction between the two portions of the appliance; for example, to the possibility that the entire appliance is capable of being exposed to hot cooking oil.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this Standard shall comply with the requirements for that component. See 2.3 for a list of standards covering components used in the products covered by this Standard.

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

a) Involves a feature or characteristic not required in the application of the component in the product covered by this Standard; or

b) Is superseded by a requirement in this Standard.

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

2.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.2 Units of measurement

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

2.3 Referenced publications

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

2.3.2 The following publications are referenced in this Standard:

ANSI Z97.1, *Safety Performance Specifications and Methods of Test for Glazing Materials Used in Buildings*

ASTM E230, *Standard Specification For Temperature-Electromotive Force (EMF) Tables For Standardized Thermocouples*

NFPA 70, *National Electrical Code*

UL 1, *Flexible Metal Conduit*

UL 20, *General-Use Snap Switches*

UL 44, *Thermoset-Insulated Wires and Cables*

UL 62, *Flexible Cords and Cables*

UL 83, *Thermoplastic-Insulated Wires and Cables*

UL 157, *Gaskets and Seals*

UL 496, *Lampholders*

UL 498, *Attachment Plugs and Receptacles*

UL 499, *Electric Heating Appliances*

UL 508, *Industrial Control Equipment*

UL 514A, *Metallic Outlet Boxes*

UL 514B, *Conduit, Tubing, and Cable Fittings*

UL 514C, *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 817, *Cord Sets and Power-Supply Cords*

UL 969, *Marking and Labeling Systems*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

UL 1004-2, *Impedance Protected Motors*

UL 1004-3, *Thermally Protected Motors*

UL 1030, *Sheathed Heating Elements*

UL 1059, *Terminal Blocks*

UL 1446, *Systems of Insulating Materials – General*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-4, *Fuseholders – Part 4: Class CC*

UL 4248-5, *Fuseholders – Part 5: Class G*

UL 4248-6, *Fuseholders – Part 6: Class H*

UL 4248-8, *Fuseholders – Part 8: Class J*

UL 4248-9, *Fuseholders – Part 9: Class K*

UL 4248-11, *Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse*

UL 4248-12, *Fuseholders – Part 12: Class R*

UL 4248-15, *Fuseholders – Part 15: Class T*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3*

UL 60691, *Thermal-Links – Requirements and Application Guide*

UL 60947-1, *Low-Voltage Switchgear and Controlgear – Part 1: General Rules*

UL 60947-4-1A, *Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters - Electromechanical Contactors and Motor-Starters*

UL 60947-5-2, *Low-Voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches*

UL 61058-1, *Switches for Appliances – Part 1: General Requirements*

UL 61131-2, *Programmable Controllers - Part 2: Equipment Requirements and Tests*

3 Glossary

For the purpose of this Standard the following definitions apply.

3.1 ATTACHMENT PLUG – A male contact device for the temporary connection of a flexible cord or cable to a receptacle, cord connector, flanged equipment power outlet, or other outlet device.

3.2 CORD CONNECTOR – A female contact device to be wired on a flexible cord for use as an extension from an outlet to make a detachable electrical connection to an attachment plug or as an appliance coupler to an equipment inlet.

3.3 FILTER, CENTRAL – A unit that filters oil from one or more fryers (or other appliances) from a stationary position. Central filters may derive their power from another appliance or directly from the building supply. These filters form an integral part of a larger appliance.

3.4 FILTER, PORTABLE – A unit that is intended to be moved from place to place for filtering oil from multiple fryers (or other appliances), one at a time. These filters do not form part of and are not connected electrically, physically, or by permanent plumbing to any other appliance.

3.5 FILTER, STATIONARY – A unit that filters oil from one or more fryers (or other appliances) from a stationary position. These filters do not form part of and are not connected electrically or physically to any fryer or other appliance. However, they are not prohibited from being interconnected to another appliance or appliances by plumbing.

3.6 FILTER, UNDER-FRYER – A unit that is located below the oil kettle of a fryer or bank of fryers (or other appliances), and is intended to filter cooking oil used by that appliance. An under-fryer filter obtains electrical power from the appliance being serviced and forms an integral part of that appliance. However, a unit that is constructed to be removable from the appliance without the use of tools for the purposes of cleaning or servicing another appliance specifically designed for use with that filter is considered to be an under-fryer filter.

3.7 NOZZLE – A device connected to the end of the oil hose for the purpose of removing and/or returning oil to the intended appliance (fryer). The nozzle is intended to be held by the operator during use.

3.8 SAFETY CIRCUIT – A primary or secondary circuit that is relied upon to prevent a risk of fire, electric shock, or injury to persons; for example, an interlock circuit.

3.9 USER SERVICING – Any servicing that is capable of being performed by personnel other than those who are trained to maintain the particular appliance. Some examples of user servicing are:

a) Attaching an accessory by means of an attachment plug and receptacle or by means of other separable connectors;

b) Resetting or replacing any protective device in an appliance, or its receptacle circuit, that are capable of being overloaded by the user;

c) Resetting a circuit breaker or replacing a fuse;

d) Making a routine operating adjustment required to adapt the appliance for a different intended function;

e) Routine cleaning.

CONSTRUCTION

4 Accessories

4.1 An appliance having provisions for the use of an electrical accessory intended to be attached in the field shall comply with the requirements in this Standard, with or without an accessory installed.

4.2 Electrical connection of an accessory by the user shall be by means of a receptacle and plug-in connector. See 14.2.

4.3 The installation of an accessory by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals. Receptacles, when used, shall be located and protected in accordance with 14.2.

4.4 With regard to 4.3, an installation shall not require the cutting of wiring or the soldering of connections by the installer. Installations shall not require cutting, drilling, or welding in electrical

enclosures and in other areas where such operations are capable of damaging electrical components and wiring within the enclosure.

4.5 A means for strain relief shall be provided for the wiring in the accessory when there is a possibility of transmitting stress to the terminal connections during installation.

4.6 All terminals and wiring intended to be field connected shall be identified on the accessory, on the appliance when connections are made between the accessory and the appliance, and on a wiring diagram provided with the accessory unless they are obvious.

4.7 The mounting location of the accessory shall be indicated on the appliance.

Exception: When the mounting location is obvious due to the function of the accessory and arrangement of the appliance, and instructions are provided covering the installation and location for the accessory, the mounting location of the accessory is not required to be indicated on the appliance.

4.8 As part of the investigation, an accessory is to be trial-installed to determine whether:

a) The installation is feasible;

b) The instructions are detailed and correct; and

c) The use of the accessory does not introduce a risk of fire, electric shock, or injury to persons.

5 Frames and Enclosures

5.1 General

5.1.1 An appliance shall be formed and assembled so that it has the strength and rigidity required to resist the abuses to which it is subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

5.1.2 The enclosure of an appliance shall be of a material capable of being used for the application and shall house all electrical parts, except a supply cord, that are capable of presenting a risk of fire, electric shock, or injury to persons under any condition of use. An adjacent wall or adjacent equipment shall not be depended upon to complete an enclosure.

5.1.3 Among the factors included in the evaluation of an enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Resistance to combustion;

e) Resistance to corrosion; and

f) Resistance to distortion at temperatures to which the enclosure is capable of being subjected under conditions of normal or abnormal use.

For a nonmetallic enclosure, all of these factors are to be evaluated with regard to thermal aging.

5.1.4 An enclosure of polymeric material shall comply with the applicable requirements in UL 746C. A polymeric enclosure part that is capable of coming in contact with hot oil – that is, a part that is not shielded to prevent contact with hot oil – shall be evaluated in accordance with the test for Parts Subject to Contact with Oil or Other Liquids, Section 59.

5.1.5 The minimum thickness of cast metal shall be in accordance with Table 5.1.

Exception: Thinner metal complies with the intent of this requirement when the metal is evaluated in accordance with the Enclosure Strength Test, Section 54, and the Impact Test, Section 55, with acceptable results.

Table 5.1
Minimum Thicknesses of Cast Metal

Metal	Minimum thickness, mm (inch)			
	At reinforced surfaces [a]		At unreinforced flat surfaces	
Die-cast metal	1.2	3/64	2.0	5/64
Cast malleable iron	1.6	1/16	2.4	3/32
Other cast metal	2.4	3/32	3.2	1/8

[a] Includes surfaces that are curved, ribbed, and similar designs, or that are otherwise of a shape or size to provide intended mechanical strength.

5.1.6 In addition to being evaluated with regard to the factors specified in 5.1.3, an enclosure of sheet metal is to be evaluated with regard to its size and shape, the thickness of metal, and its acceptability for the particular application. Sheet steel having a thickness less than 0.66 mm (0.026 inch) when uncoated or 0.74 mm (0.029 inch) when galvanized, or of nonferrous sheet metal having a thickness of less than 0.91 mm (0.036 inch) shall not be used except for a small area or for a surface that is curved or otherwise reinforced.

5.1.7 Sheet metal to which a wiring system is to be connected in the field shall have a thickness of no less than 0.81 mm (0.032 inch) when of uncoated steel, no less than 0.86 mm (0.034 inch) when of galvanized steel, and no less than 1.14 mm (0.045 inch) when of nonferrous metal.

Exception: Sheet steel no less than 0.66 mm (0.026 inch) thick when uncoated steel or no less than 0.74 mm (0.029 inch) thick when galvanized steel meets the intent of the requirement when the area surrounding a knockout has a thickness of no less than 1.35 mm (0.053 inch).

5.2 Openings

5.2.1 An opening in the bottom of an appliance shall not be located below an electrical part unless a solid, noncombustible pan complying with Figure 5.1 is interposed between the electrical part and supporting surface. The pan is to have a rim, lip, or other raised edge that is in a horizontal plane and extends all the way around the pan. The bottom of the pan is not required to be flat or any regular shape and the transition from the bottom to the rim, lip, and similar raised edges are allowed to have any convenient shape, but at every point directly below the electrical part, the floor of the pan is to be 3.2 mm (1/8 inch) or more below the plane of the rim, lip, and similar raised edges.

Exception: The use of a pan constructed from noncombustible material under a motor is not required when:

a) The motor has no openings below a horizontal plane through the center of the motor;

b) The structural parts of the motor or of the appliance provide the equivalent of the described barrier;

c) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the appliance when the motor is energized under each of the following fault conditions:

1) Open main winding;

2) Open starting winding;

3) Starting switch short-circuited; and

4) For a permanent-split capacitor motor, capacitor short-circuited. The short circuit is to be applied before the motor is energized and the rotor is to be locked;

d) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – so that the temperature of the motor windings does not exceed 125 °C (257 °F) at the maximum load under which the motor is capable of running without causing the protector to cycle and does not exceed 150 °C (302 °F) with the rotor of the motor locked; or

e) The motor is impedance-protected and the locked-rotor temperature of the motor winding is no more than 150 °C (302 °F) with the appliance otherwise operating as intended.

5.2.2 The structure of the part or appliance is not prohibited from providing the equivalent of the pan described in 5.2.1 when it complies with Figure 5.1. The raised edge is capable of being incorporated in the opening.

5.2.3 An appliance shall be constructed so that, with the appliance in any normal position of operation, cooking oil and cleaning solution do not contact electrical parts, including internal wiring, during operation, user servicing, or cleaning under any of the following conditions:

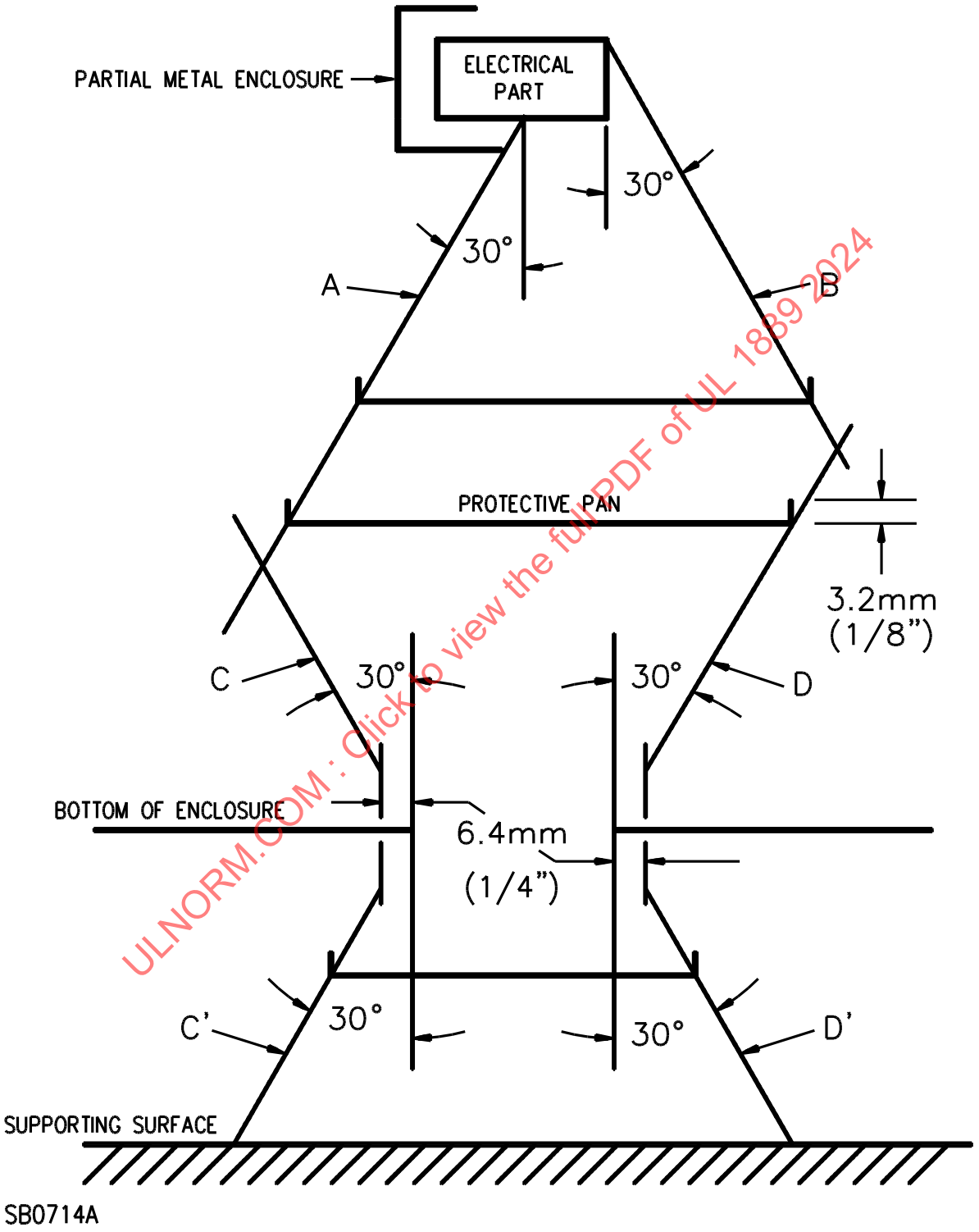
a) In the as-received condition;

b) With any fitting that is intended to be loosened during user servicing or cleaning loosened or damaged; and

c) After deterioration or breakdown of a timer switch, a float- or pressure-operated switch, a hose, flexible tubing, a gasket, a boot, a seal, a diaphragm, or similar parts.

Figure 5.1

Minimum Extent of Baffle for Opening in Bottom of Enclosure



A, B, C, and D are projections that define a volume between an electrical part and an opening; C' and D' are projections that define a volume between an opening and the supporting surface. A protective pan in any horizontal plane between the part and the opening in the supporting surface shall be larger than the area defined by projections A, B, C, and D, or projections C' and D', respectively. Three samples of protective pans are illustrated in the figure; two are above the opening and one is below it.

5.2.4 An appliance is determined to comply with 5.2.3(c) when no oil leaks when the appliance is operated with the part in question removed, as described in Deterioration of Parts, Section 49. When oil leaks during the test, the appliance shall be examined to determine whether oil has contacted, or is capable of contacting, electrical parts. Consideration shall be given to any possible spraying or dripping that occurs upon partial deterioration of the part. In addition, when any of the components or connections described in 5.2.3 (b) and (c) are located within the enclosure, a guard shall be provided to prevent oil from contacting electrical components in case of failure or poor operation of such components.

Exception: Parts as described in 5.2.3(c) that are not subject to flexing and that have been evaluated for exposure to hot oil in accordance with Parts Subject to Contact With Oil or Other Liquids, Section 59, are not required to be further evaluated.

5.2.5 A pump motor with supports of polymeric material shall be tested in accordance with Polymeric Motor Supports, Section 60.

5.2.6 An opening in a surface other than the bottom of an enclosure that contains electrical parts shall be provided with a baffle, such as the one illustrated in Figure 5.2, that prevents the emission of flame, molten metal, burning insulation, or similar occurrences.

Exception: A baffle is allowed to be omitted from an enclosure that contains electrical parts other than an overcurrent-protective device such as a fuse or circuit breaker when:

a) The structure of the part provides the equivalent of a baffle;

b) The distance from the electrical part to the plane of the enclosure is greater that 305 mm (12 inches);

c) For ventilating openings in a vertical wall, no opening is more than 9.5 mm (3/8 inch) wide, and the total area of such openings located less than 305 mm (12 inches) from the floor in any 0.3 m^2 (1 ft^2) area of the enclosure does not exceed 52 cm^2 (8 square inches); or

d) All openings in a vertical wall are protected by louvers, as long as the louvers allow an opening no more than 6.4 mm (1/4 inch) wide and are shaped to deflect external falling objects outward. See Figure 5.3.

Figure 5.2

Relationship of Baffle and Electrical Part to Prevent Emission

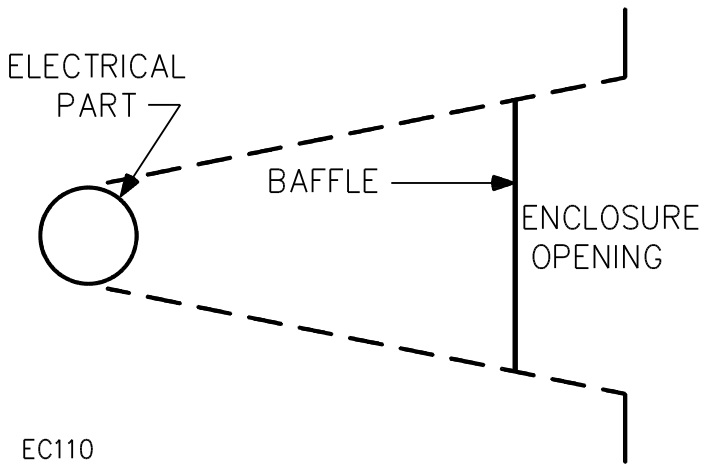
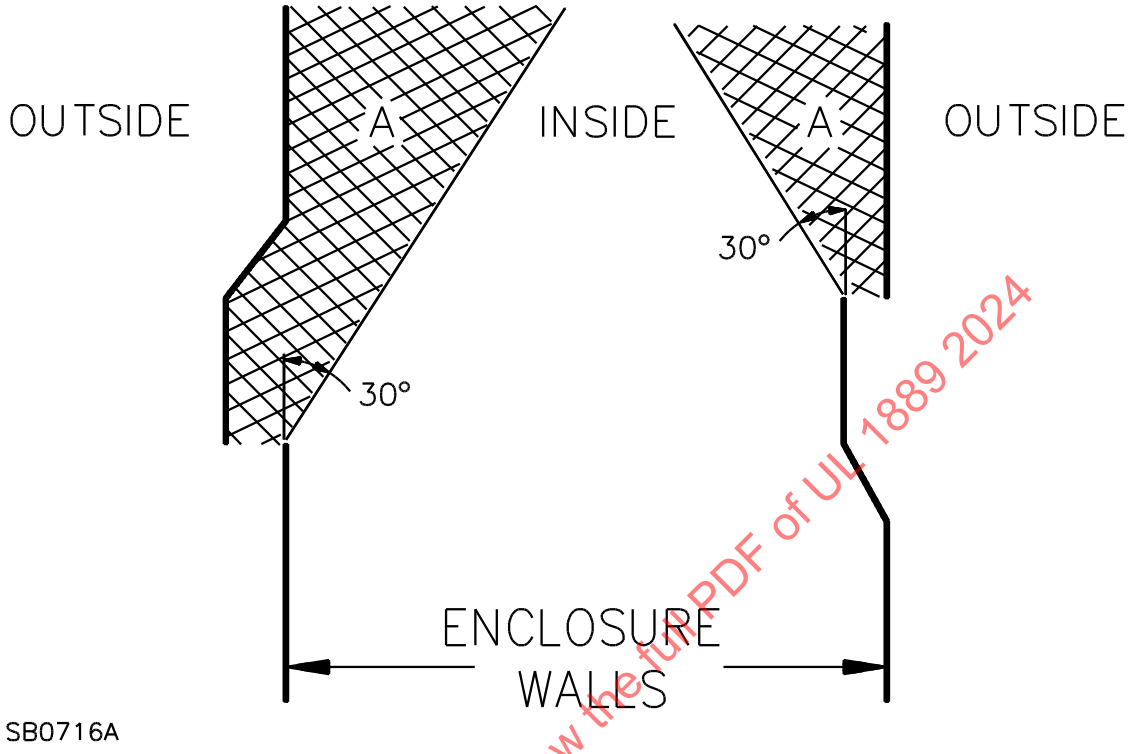


Figure 5.3

Louver Constructions



6 Accessibility of Live Parts

6.1 General

6.1.1 The electrical parts of an appliance shall be located or enclosed so that persons are protected against unintentional contact with uninsulated live parts involving a risk of electric shock.

6.1.2 A risk of electric shock is determined to exist when the available open-circuit potential is more than 42.4 volts peak, and the available current through a 1500-ohm resistance is more than 5 milliamperes.

6.1.3 The following are not uninsulated live parts:

a) A coil of a controller;

b) A relay;

c) A solenoid; and

d) A transformer;

when they are provided with insulating overwraps at least 0.8 mm (1/32 inch) thick; enclosed motor windings; insulated terminals and splices; and insulated wire.

6.1.4 An uninsulated live part, such as a terminal bus bar, and similar parts, not including film-coated wire, shall be no less than 25.4 mm (1 inch) from any opening in the enclosure of an appliance.

6.1.5 An opening that will not permit the entrance of a 19.1-mm (3/4-inch) diameter rod is allowed, except as noted in 6.1.4, when a probe as illustrated in Figure 6.1 cannot be made to touch any uninsulated live part or film-coated wire when inserted into the opening.

6.1.6 An opening that permits entrance of 19.1-mm (3/4-inch) diameter rod is allowed when there are no uninsulated live parts:

a) Less than X inches from the perimeter of the opening; and

b) Within the volume generated by projecting the perimeter X inches normal to its plane;

X equals five times the diameter of the largest diameter rod that is capable of being inserted through the opening, and no less than 102 mm (4 inches). See Figure 6.2.

6.1.7 An uninsulated live part shall not be located behind an opening that is used to make an adjustment determined to be a function of user servicing when a 3.2-mm (1/8-inch) diameter straight rod can be made to touch the part when the rod is inserted through the opening and moved to all positions possible without producing an angle of more than 30° between the rod and the line drawn between the center of the opening and the center of the face of the adjusting mechanism. The length of the rod beyond the opening is not to exceed the distance between the opening and the face of the adjusting mechanism by more than 76 mm (3 inches). See Figure 6.3.

6.1.8 During the examination of an appliance in connection with the requirements in 6.1.5 – 6.1.7, a part of the outer enclosure that is capable of being removed without the use of tools, or that must be opened or removed for user servicing, is to be disregarded – that is, it is not assumed that the part in question affords protection against the risk of electric shock. A warning marking is not determined to reduce the risk of electric shock.

Figure 6.1

Accessibility Probe

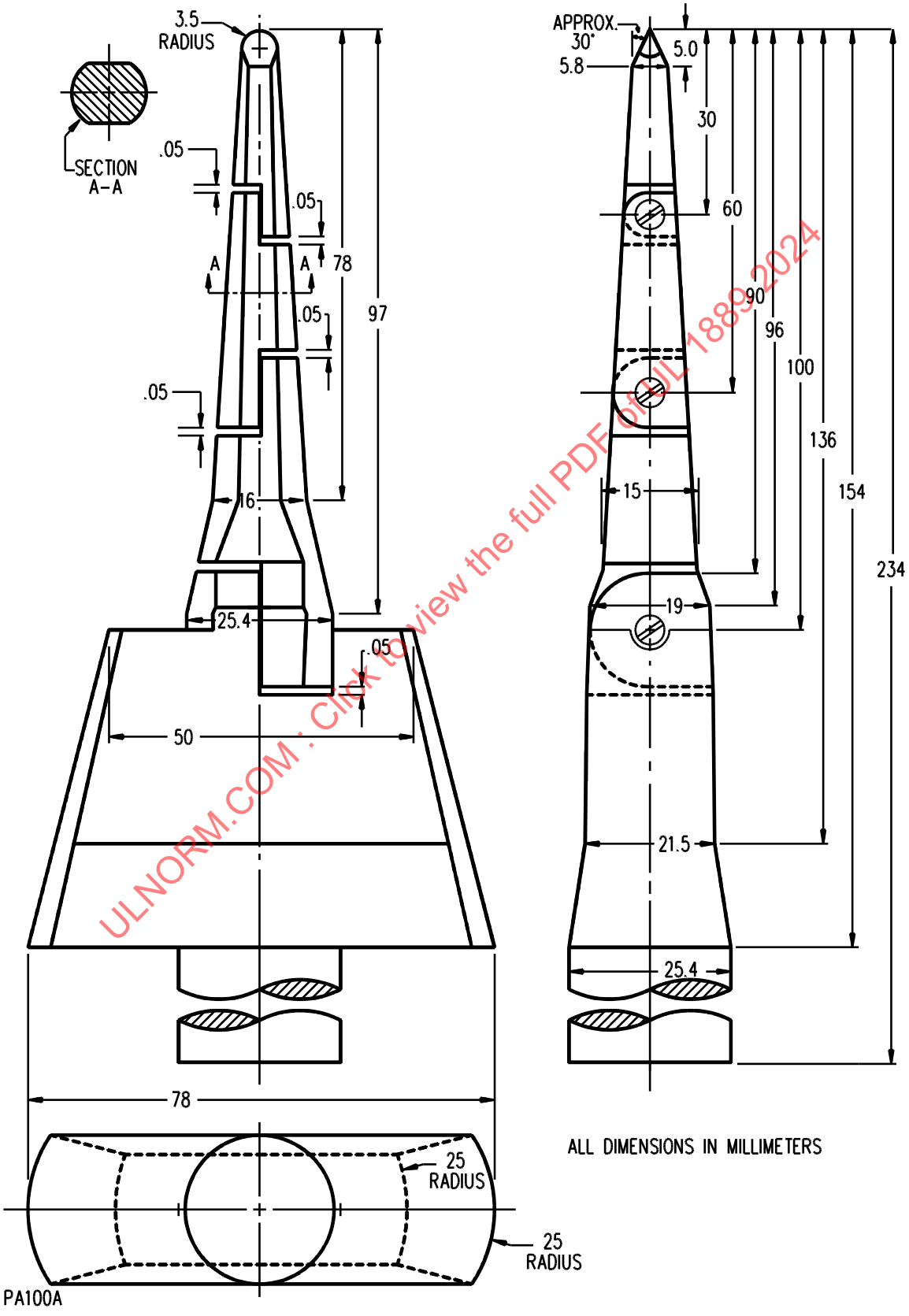


Figure 6.2

Opening in Enclosure – Proportions Exaggerated for Clarity

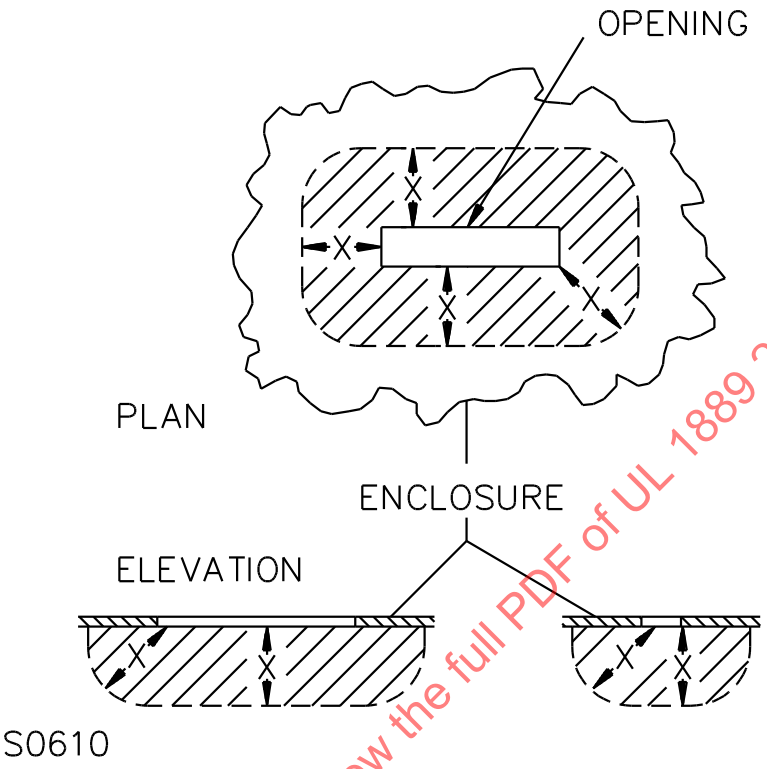
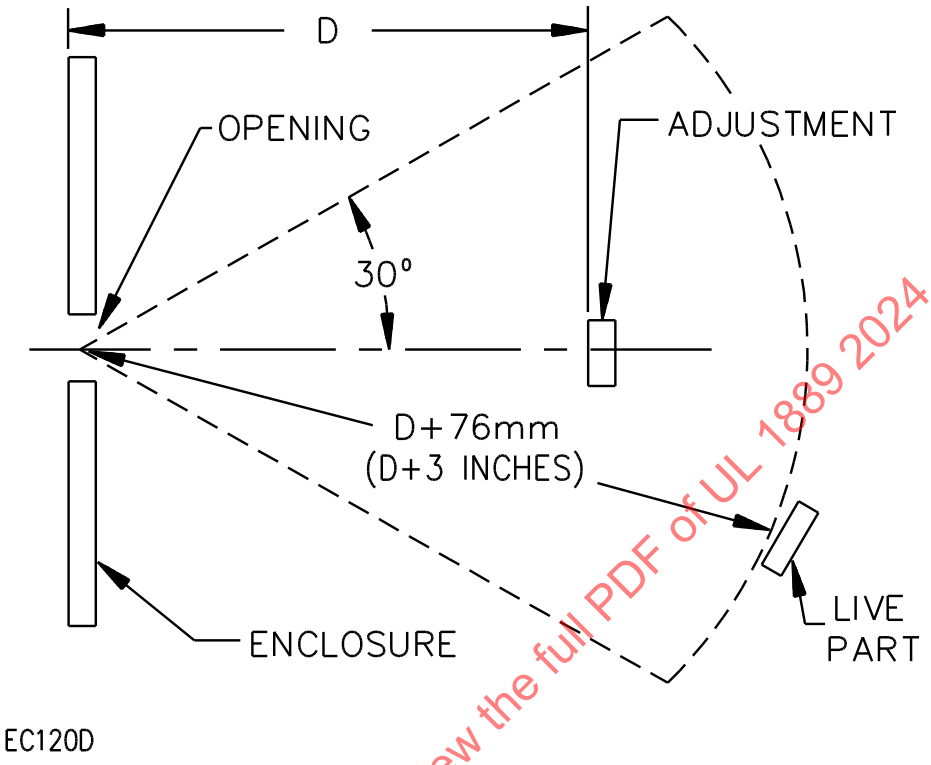


Figure 6.3

Accessibility of Live Part Through Adjustment Opening



6.1.9 A fuseholder or a circuit breaker shall not be accessible from outside the appliance without opening a door or a cover.

Exception: The operating handle of a circuit breaker or the insulating cap of an extractor-type fuseholder is allowed to project outside the enclosure when a shield or guard is provided to reduce the risk of spillage of hot oil on the handle or cap.

6.1.10 Except as indicated in 6.1.11 and 6.1.12, the door or cover of an enclosure shall be hinged:

a) When it gives access to any fuse, circuit-breaker handle, or manually resettable lever of a temperature control in other than a low-voltage circuit; and

b) When uninsulated live parts are exposed during the replacement of the fuse or resetting of the manually resettable device.

Such a door or cover shall also be provided with an automatic latch or the equivalent, and, when live parts other than the screw shell of a plug fuseholder are exposed inside the enclosure, shall be provided with a captive screw or equivalent means, requiring the use of a tool to open, and to reliably secure the door or cover in place. See 6.1.13 and 6.1.14.

6.1.11 A hinged cover is not required for a device in which the only fuses enclosed are:

a) Control circuit fuses, as long as the fuses and control circuit loads (other than a fixed control circuit load, such as a pilot lamp) are within the same enclosure; or

b) An extractor type fuse with its own enclosure that is accessible without exposing live parts other than a fuse contact of the fuseholder.

6.1.12 The removable portion of a fused pullout switch that complies with the requirements in 6.1.1 – 6.1.7, 6.1.16, and 6.1.17. is determined to be a reliable cover for the fuseholder and is not required to comply with the requirements in 6.1.11.

6.1.13 A spring latch, a magnetic latch, a dimple, or other mechanical arrangement that holds the door closed and requires effort on the user's part to open is determined to provide the "automatic latching means" for holding the door closed as required in 6.1.11.

6.1.14 A cover interlocking mechanism that:

a) Must be engaged in the closed position of the cover before any uninsulated live part is energized; and

b) Secures the cover in the closed position, when provided as the sole means for securing the door or cover closed;

is determined to comply with the requirement for an automatic latch in 6.1.10.

6.1.15 A screw with a knurled and slotted head (for securing with a screwdriver) and that is capable of being manually turned shall not be provided as a required enclosure securing means.

6.1.16 A door or cover giving direct access to fuses in other than a low-voltage circuit shall shut closely against a 6.4 mm (1/4 inch) rabbet or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges and angle strips shall fit closely with the outside of the wall of the box proper and shall overlap the edges of the box no less than 12.7 mm (1/2 inch).

Exception: A construction that affords equivalent protection or a combination of flange and rabbet is permitted.

6.1.17 A strip used to provide a rabbet and an angle strip fastened to the edges of a door shall be secured:

a) At no less than two points;

b) No more than 38 mm (1-1/2 inches) from each end of each strip; and

c) At points between these end fastenings no more than 152 mm (6 inches) apart.

6.2 Protection of service personnel

6.2.1 An uninsulated live part involving a risk of electric shock and a moving part within the enclosure that involves a risk of injury to persons shall be located, guarded, or enclosed in accordance with 6.1.1 – 6.1.7, 28.1 – 28.3, 29.1, and 29.2 when the service function is being performed, to reduce the risk of unintentional contact by service personnel performing electrical or mechanical service functions that have to be performed with the equipment energized.

6.2.2 Mechanical service functions that are capable of being performed with the equipment energized include:

a) Adjusting a valve;

b) Adjusting the setting of a temperature or a pressure control with or without marked dial settings;

c) Resetting a control trip mechanism; and

d) Operating a manual switch.

A factory-set-and-sealed control is not determined to be adjustable.

6.2.3 Electrical service functions that are capable of being performed with the equipment energized include examination, adjustment, servicing, or maintenance (not including measuring voltage) of fuses, adjustable or resettable pressure or temperature controllers, manual switching devices, and clock timers.

7 Adhesives Used to Secure Parts

7.1 An adhesive that is relied upon to reduce a risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in UL 746C. When an adhesive is located where it is capable of coming in contact with cooking oil, it shall be evaluated to determine the long-term effects of such contact.

7.2 The requirement in 7.1 also applies to an adhesive used to secure a conductive part including a nameplate, that is capable of, when loosened or dislodged:

a) Energizing an accessible dead metal part;

b) Making a live part accessible;

c) Reducing spacings below the minimum values specified in Table 26.1; or

d) Short-circuiting live parts.

8 Protection Against Corrosion

8.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, painting, plating, or other equivalent means when corrosion of such parts results in a risk of fire, electric shock, or injury to persons.

Exception No. 1: Surfaces of sheet steel and cast iron parts within an enclosure are not required to be so protected when the oxidation of iron or steel due to the exposure of the metal to air and moisture is not appreciable – thickness of metal and temperature also being factors.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and similar parts are not required to be so protected.

Exception No. 3: A sheath of a heating element of other than an immersion-type heater is not required to be so protected.

9 Mechanical Assembly

9.1 General

9.1.1 An appliance shall be assembled so that it is not adversely affected by the vibration of normal operation.

9.1.2 A switch, a fuseholder, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or other component that is handled by the user shall be mounted securely and shall be prevented from turning.

Exception: A switch that complies with (a) – (d) is not required to be prevented from turning:

a) The switch is of a plunger, slide, or other type that does not tend to rotate when operated. A toggle switch is subjected to forces that tend to turn the switch during operation of the switch;

b) The method used to mount the switch is such that operation of the device does not loosen the switch;

c) Spacings are not reduced below the minimum values specified in Table 26.1 when the switch rotates;

d) Operation of the switch is by mechanical means rather than by direct contact by persons.

9.1.3 The means to prevent turning required by 9.1.2 shall consist of more than friction between surfaces – for example, a lock washer, properly applied, is allowed to be used as the means to prevent turning of a device having a single-hole mounting means.

9.1.4 Uninsulated live parts shall be secured to the base or surface so that they are prevented from turning or shifting in position when such motion is capable of resulting in a reduction of spacing below the minimum values specified in Spacings, Section 26.

9.2 Shipping

9.2.1 An appliance shall be completely assembled when it leaves the factory.

Exception No. 1: Components that are capable of being assembled without the use of tools, and parts that are not required to prevent a risk of fire, electric shock, or injury to persons during operation of the appliance are not required to be assembled.

Exception No. 2: A heating element with integral blades for plugging into a receptacle, and the legs or the mounting brackets of an appliance are allowed to be shipped detached from the remainder of the appliance when packed in the same overall carton, or when the separate cartons are secured together – such as by steel strapping or strong tape – so that they do not become separated during the shipment. See 72.2.

10 Supply Connections

10.1 Permanently-connected appliances

10.1.1 An appliance intended for permanent connection to the power supply shall be constructed so that it is capable of being readily and permanently connected to one of the wiring systems covered in Chapter 3 of NFPA 70.

10.1.2 An appliance intended for permanent connection to the building structure shall be provided with means for permanent connection to the branch-circuit supply.

10.1.3 Filters that are permanently connected to an electrical source of supply shall not be provided with casters nor require movement of the supply connections during the filtering process or routine cleaning.

10.1.4 There shall be a flat surface surrounding a knockout. The flat surface shall have an area for assembly to the appliance of a length of standard rigid metallic conduit of a size corresponding to the size of the knockout, and shall have a minimum diameter in accordance with Table 10.1. For metal thickness at a knockout or opening, see 5.1.7.

Table 10.1
Dimensions Associated with Openings for Conduit

Unthreaded openings					Threaded openings			
Trade size of conduit	Nominal knockout diameter		Minimum diameter of flat surface at knockout		Throat diameter, mm (inches)			
					Minimum		Maximum	
inches	mm	(inches)	mm	(inches)				
1/2	22.2	(7/8)	28.96	(1.140)	14.22	(0.560)	15.80	(0.622)
3/4	27.8	(1-3/32)	36.07	(1.420)	18.85	(0.742)	20.93	(0.824)
1	34.5	(1-23/64)	44.96	(1.770)	23.98	(0.944)	26.64	(1.049)
1-1/4	43.7	(1-23/32)	57.94	(2.281)	31.55	(1.242)	35.05	(1.380)
1-1/2	50.0	(1-31/32)	65.99	(2.598)	36.80	(1.449)	40.89	(1.610)
2	62.7	(2-15/32)	80.65	(3.175)	47.24	(1.860)	52.50	(2.067)
2-1/2	76.2	(3)	90.47	(3.562)	56.44	(2.222)	62.71	(2.469)

10.1.5 The diameter of a knockout shall accommodate conduit of the trade size for which the knockout is intended. See Table 10.1.

10.1.6 A terminal compartment intended for permanent connection to the power supply shall be attached to the appliance so as to be prevented from turning with regard thereto.

10.1.7 A wiring compartment for field-wiring connections shall be of a volume that accommodates the wiring of the size indicated in 10.1.17, and conduit and fittings sized for the wire in accordance with NFPA 70.

10.1.8 A terminal compartment shall be located so that when conduit connections are made, internal wiring and electrical components shall not be exposed to mechanical abuse and strain. After the unit has been installed as intended, supply connections shall be accessible for inspection without exposing internal wiring and electrical components to mechanical abuse or strain.

10.1.9 Provision for inspection of connections on the rear or bottom of a floor-mounted appliance is not allowed. Access is to be determined when the appliance is installed in accordance with the manufacturer's instructions.

10.1.10 No electrical component shall be mounted on a part that must be removed for the examination or installation of field-wiring connections unless the internal wiring is provided with a method of quick disconnection.

10.1.11 A field-wiring terminal is a terminal to which a supply or other wire is capable of being connected by an installer in the field, unless the wire is provided as part of the appliance and a pressure terminal connector, soldering lug, soldered loop, crimped eyelet, or other means for making the connection is factory-assembled to the wire.

10.1.12 Ampacity of field wiring conductors is to be determined using the appropriate tables in NFPA 70. Wire smaller than the uncorrected values for 60 °C (140 °F) conductors (for appliances rated 100 amperes or less) or 75 °C (167 °F) conductors (for appliances rated more than 100 amperes) shall not be used. See 10.1.15 and 72.5.

10.1.13 A permanently-connected appliance shall be provided with wiring terminals or leads for the connection of conductors having an ampacity no less than 125 % of the current input of the appliance when tested in accordance with 40.2 or 40.3, whichever causes the higher input. See 10.1.12.

Exception: An appliance is allowed to be provided with terminals or leads for the connection of conductors having an ampacity not less than the current input of the appliance when it complies with the Average Current Input Test, Section 41.

10.1.14 Pigtail leads provided for connection to the branch-circuit supply shall have an ampacity rating no less than that of a conductor of the next smaller size than that intended for the rating of the appliance.

See 10.1.12 and 10.1.15.

10.1.15 It is to be assumed that wire having the specified temperature rating is intended to be installed for the power-supply conductors to an appliance marked in accordance with 72.3 and 72.4. Otherwise, it is to be assumed that 60 °C (140 °F) wire shall be used for connection to an appliance rated 100 amperes or less and that 75 °C (167 °F) wire shall be used for an appliance rated more than 100 amperes.

10.1.16 When terminals of unequal sizes are provided because of unbalanced loads, each terminal shall be sized to accept a conductor having an ampacity of at least 125 % of the total current that will be carried by the conductor connected to that terminal as determined by 10.1.13. See 10.1.12 and 72.4.

Exception: An appliance is allowed to be provided with terminals or leads for the connection of conductors having an ampacity not less than the current input of the appliance when it complies with the Average Current Input Test, Section 41.

10.1.17 The free length of a lead intended to be field connected to the supply lead inside an outlet box or field-wiring compartment shall be 152 mm (6 inches) or greater.

Exception: Field-wiring supply connections enclosed in a motor terminal box or wiring compartment is allowed to have a free length of less than 152 mm.

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

10.1.19 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 is allowed to be used at a wiring terminal intended to accommodate a 5.3 mm^2 (10 AWG) or smaller conductor when upturned lugs, cupped washers, or the equivalent are provided to hold the wire in position.

10.1.20 Each upturned lug or cupped washer referred to in the Exception to 10.1.19 shall be capable of retaining a power-supply conductor corresponding in size to that specified in 10.1.13, and no smaller than 2.1 mm^2 (14 AWG), under the head of the screw or the washer.

10.1.21 A wire-binding screw at a wiring terminal shall be no smaller than 4.8 mm diameter (No. 10 diameter), with no more than 32 threads per inch.

Exception No. 1: A 4.2 mm diameter (No. 8) screw is allowed to be used at a terminal intended only for the connection of a 2.1 mm^2 (14 AWG) conductor.

Exception No. 2: A 3.5 mm diameter (No. 6) screw is allowed to be used for the connection of a 1.3 or 0.82 mm^2 (16 or 18 AWG) control-circuit conductor.

10.1.22 It shall be noted that 2.1 mm^2 (14 AWG) is the smallest conductor that is allowed to 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.

10.1.23 A terminal plate tapped for a wire-binding screw shall be of metal no less than 0.76 mm (0.030 inch) thick.

10.1.24 There shall be no less than two full threads in the metal of the terminal plate tapped for a wire-binding screw. The metal is allowed to be extruded at the tapped hole to provide two full threads.

10.1.25 A permanently-connected appliance rated 125 or 125/250 volts (3-wire) or less, provided with a single-pole switch or a single-pole overcurrent-protective device other than an automatic control without a marked "off" position, shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit.

10.1.26 A field-wiring terminal intended for the connection of a grounded-supply conductor shall be identified by means of a metallic coating that is 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 wring diagram.

10.1.27 When wire leads are provided instead of terminals, the surface of the lead intended to be connected to the grounded conductor of the supply circuit shall be finished to show white or gray color and shall be easily distinguishable from the other leads.

10.2 Cord-connected appliances

10.2.1 A power-supply cord shall be Type SO, SOO, STO, STOO, SEO, SJO, SJOO, SJTO, SJTOO, SJEO, HSO, HSOO, HSJO, or HSJOO.

Exception: Type HPN cord is allowed to be used when:

a) The appliance is intended for counter-top use; and

b) The weight of the appliance is not more than 15 pounds (6.8 kg).

10.2.2 Where the individual conductors of a power supply cord of a type other than SOO, STOO, SJOO, SJTOO, HSOO, or HSJOO are separated from the outer jacket within the appliance, they are to be treated as non-oil resistant internal wiring. See 15.2.1.

10.2.3 The length of a power supply cord shall be as shown in 10.2. A separable cord set shall not be used on central and stationary filters.

Table 10.2
Length of Attached Cord

Appliance type	Minimum length		Maximum length	
	mm	(feet)	mm	(inches)
Stationary filters	914	(3)	3048	(120)
Central filters	a		3048	(120)
Under-fryer filters	b		457	(18)

Table 10.2 Continued on Next Page

Table 10.2 Continued

Appliance type	Minimum length		Maximum length	
	mm	(feet)	mm	(inches)
Portable filters	c		152	(6)

[a] Filters intended for connection to the appliance being filtered: Minimum length not specified, except that the cord shall be of sufficient length to allow connection to in the intended manner without strain on the cord or fittings. filters intended for connection to a building receptacle: minimum length 914 mm (3 feet).

[b] Minimum length not specified, except that the cord shall be of sufficient length to allow connection to the appliance being serviced in the intended manner without strain ont he cord or fittings.

[c] Minimum length not specified.

10.2.4 When a separable cord set is used, it shall comply with the following:

a) No live parts are exposed to contact when the cord is disconnected from the appliance; and

b) The connection point to the appliance is located, protected, or both to reduce the risk of spillage of heated oil on live parts of the receptacle and attachment plug.

10.2.5 The cord of a portable filter shall be located so that the attachment plug (and, when connected, the cord connector of an extension cord used with the filter) is not capable of touching the supporting surface when the appliance is in any intended position of use, transport, or storage.

10.2.6 A cord-connected appliance provided with casters shall also be provided with a cord spool, brackets, or equivalent means for storing the cord when not in use. A cover or enclosure shall protect the cord from contact with oil when the cord is stored.

Exception No. 1: When a separable cord set is used, the cord spool/brackets are not required when an enclosed compartment is provided for cord storage.

Exception No. 2: A cord on an under-fryer filter is not required to be provided with a cover or enclosure when equivalent protection is provided by the structure of the fryer. When the filter (or a portion of the filter including both the oil reservoir and power supply cord) is removable from the fryer without tools and is capable of being used to transport oil, a cover or enclosure shall be provided for the cord or oil vessel to limit cord contact with oil during this operation. When the cord is capable of reaching the bottom of the casters of the filter, a hook or similar part shall be provided for cord storage.

Exception No. 3: A cord on a portable filter is not required to be provided with a cord spool or brackets. A cover or enclosure shall be provided for the cord or oil vessel to limit cord contact with oil during transport and storage of the filter.

10.2.7 Where the outer jacket has been removed from Type HSOO or HSJOO cord within the appliance, a close-fitting oil-resistant sleeving rated for the temperature shall be provided around the asbestos insulation.

Exception: A glass string, tape wrap, a close-fitting fiber sleeving, or equivalent means rated for the temperature is allowed to be used in lieu of oil-resistant sleeving to retain the asbestos insulation on the individual conductors when:

a) The portion of the conductors without the outer jacket is not located within 51 mm (2 inches) of enclosure openings; and

b) No more than 76 mm (3 inches) of the asbestos insulation is exposed on any one conductor.

10.2.8 The jacket of Type HSO or HSJO cord is not to be removed within the strain relief.

10.2.9 The voltage rating of the cord and the fittings shall be no less than that of the appliance.

10.2.10 The current rating of the attachment plug of an appliance shall be no less than 125 % of the maximum current input of the appliance when tested in accordance with 40.2 or 40.3, whichever causes the higher input.

Exception: The current rating of the attachment plug shall not be less than the current input of the appliance when the appliance complies with the Average Current Input Test, Section 41.

10.2.11 Supplementary insulation provided on a flexible cord shall not extend under the strain relief and shall be prevented from fraying or raveling.

10.2.12 A cord-connected filter shall employ an attachment plug of the grounding type for connection of an extension cord. The attachment plug shall comply with the requirements of 10.2.10.

10.2.13 An attachment plug of the locking type shall not be used on a portable filter.

10.2.14 A filter shall not be provided with terminal pins that would accommodate a standard flatiron or appliance plug.

10.2.15 An attachment plug on the supply cord of a portable filter shall be constructed so that, when inserted in the connector of an extension cord, the blades are not energized until they are inaccessible to contact by persons. See the Attachment Plug Test, Section 65.

10.2.16 Strain relief shall be provided so that a mechanical stress on an attached flexible cord is not transmitted to terminals, splices, or internal wiring. Means shall be provided for preventing the cord from being pushed into the appliance when such displacement:

a) Subjects the cord to mechanical damage;

b) Subjects the cord to a temperature higher than its rated temperature; or

c) Is capable of reducing spacings, such as to a metal strain-relief attachment, below the minimum required values.

10.2.17 Any nonmetallic portion of a strain relief bushing that is capable of being exposed to contact with spilled cooking oil during use or storage shall be subjected to the test described in Parts Subject to Contact With Oil or Other Liquids, Section 59.

10.2.18 A knot shall not be used to provide strain relief.

10.2.19 At the 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 is substantial, secured in place, and has a smooth, rounded surface against which the cord shall bear. The heat-, oil-, and moisture-resistant properties of the bushing material shall be such that the bushings are capable of being used for the application.

10.2.20 Ceramic materials and some molded compositions are capable of being used for insulating bushings; however, separate bushings of wood or rubber materials are not acceptable.

Exception: A separate soft-rubber, neoprene, or polyvinyl chloride bushing is allowed to be used:

a) Anywhere in an appliance where it is not exposed to cooking oil, when it is used in conjunction with a type of cord for which an insulating bushing is not required, and the edges of a hole in which such a bushing is used are free from burrs, fins, and other conditions that are capable of damaging the bushing; or

b) In the frame of a motor or in the enclosure of a capacitor attached to a motor when:

1) The bushing is no less than 1.2 mm (3/64 inch) thick; and

2) The bushing is located so that it is not exposed to oil, grease, oil vapor, or other substances that are capable of having a deleterious effect on the compound used.

10.2.21 Vulcanized fiber is allowed to be used when the bushing is no less than 1.2 mm (3/64 inch) thick and is formed and secured in place so that it is not adversely affected by conditions of moisture, temperature, and exposure to cooking oil.

10.2.22 An insulated metal grommet is allowed to be used in place of an insulating bushing when the insulating material used is no less than 0.8 mm (1/32 inch) thick, has been evaluated for oil-resistant properties, and completely fills the space between the grommet and the metal in which it is mounted.

10.2.23 The power-supply cord of an appliance shall include a grounding conductor.

10.2.24 The grounding conductor of a flexible cord shall be:

a) Green with or without one or more yellow stripes;

b) Connected to the grounding blade of an attachment plug of the grounding type; and

c) Connected to the enclosure of the appliance by means of a screw, terminal, or nut that is not removed during any servicing not involving the supply cord, or by other similar means. Solder alone cannot be used for making this connection.

10.2.25 The requirement in 10.2.24(c) necessitates the use of a dedicated grounding screw, terminal, or nut for the grounding connection. When both the power supply cord grounding lead and other bonding leads are connected to the same stud, they shall be placed so that the power supply cord grounding connection is made first, with a dedicated nut, and removed last.

11 Grounding and Bonding

11.1 A permanently-connected appliance shall be provided with a field-wiring terminal or lead for connection of an equipment-grounding conductor.

11.2 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size intended for the application. See 11.4. and 11.12.

11.3 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.

11.4 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 such a conductor shall be plainly identified as such by being marked "G," "GR," "GND," "Ground," "Grounding," or a similar designation, or by a similar marking located on the wiring diagram provided on the appliance.

11.5 The wire binding screw or pressure wire connector intended for the connection of an equipment-grounding conductor shall be located so that it is not removed during servicing of the appliance.

11.6 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 are capable of becoming energized shall be electrically connected:

a) To the equipment grounding terminal;

b) To any metal enclosure surrounding a knockout, hole, or bushing provided for field connection of the power supply system; or

c) To the grounding conductor of a supply cord.

See the Grounding and Bonding Test, Section 43.

11.7 With regard to the requirements in 11.6, the following dead metal parts are not determined to be parts that are capable of becoming energized:

a) A small metal part, such as an adhesive-attached foil marking, screw, handle, and a similar part that is:

1) On the exterior of the enclosure and separated from all electrical components by grounded metal; or

2) Positively separated from all electrical components;

b) A panel or a cover that is insulated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material no less than 0.8 mm (1/32 inch) thick and reliably secured in place;

c) A panel or a cover that does not enclose uninsulated live parts and is positively separated from other electrical components.

d) A core and assembly screws of a relay, a solenoid, and similar parts;

e) Any portion of the appliance that is shielded from all live parts, insulated or uninsulated, by grounded metal, minimum 0.66 mm (0.026 inch) thick. The grounded metal part or parts used for this purpose shall not be removable without the use of tools.

11.8 The dead metal parts described in 11.6 shall be reliably bonded together by mechanical fasteners or by an individual bonding conductor or strap.

11.9 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.

11.10 Bonding around a resilient mounting shall not depend on the clamping action of rubber or similar material.

Exception: The clamping action of rubber or similar material is allowed to be depended upon when the construction has been shown by investigation to be capable of being used for the purpose.

11.11 A bonding conductor shall be of material complying with the requirements for an electrical conductor and protected from corrosion unless inherently resistant thereto. An individual bonding conductor or strap shall be installed so that it is protected from mechanical damage.

11.12 The size of an individual conductor or strap used 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 is connected in accordance with Table 250-95 of NFPA 70.

Exception No. 1: A bonding conductor to a motor is not required to be larger than the motor-circuit conductors.

Exception No. 2: A conductor smaller than that specified in Table 250-95 of the National Electrical Code is allowed to be used when the bonding connection does not open when tested as described in 43.2.1.

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

12 Polarization

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

a) For a permanently-connected appliance, to the conductor or terminal intended to be grounded; or

b) For a cord-connected appliance, to the conductor of the supply cord intended to be grounded.

12.2 When there is no grounded conductor, as specified in 12.1, and when 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.

12.3 A fuseholder, a single-pole switch, a single-pole overcurrent-protective device or an automatic control with a marked "off" position shall be connected to an ungrounded conductor of the supply circuit.

13 Current-Carrying Parts

13.1 The metal used for a current-carrying part shall be capable of being used for the particular application.

13.2 Plated iron or steel is allowed to be used for a current-carrying part the temperature of which is higher than 100 °C (212 °F) during normal operation.

13.3 Unplated iron or steel is allowed to be used only for a terminal rod or a terminal plate of a heating element.

13.4 Stainless steel and other corrosion-resistant alloys are allowed to be used for current-carrying parts regardless of temperature.

14 Attachment-Plug Receptacles

14.1 An attachment-plug receptacle intended for general use shall not be provided.

14.2 An attachment-plug receptacle intended for connection of an accessory as described in 4.2 or 4.3 shall be located in a vertical surface or in a surface angled such that the openings point downward. A shield or guard shall be provided to reduce the risk of spillage of hot oil on the receptacle or the attachment plug.

14.3 A 125-volt, single-phase, 15- or 20-ampere receptacle intended for general use shall have ground-fault circuit-interrupter protection for personnel. In addition, the receptacle shall be located in an enclosure that is suitable for use in damp or wet locations.

15 Internal Wiring

15.1 General

15.1.1 Wire used for the internal wiring of an appliance shall be suitable for the application. Asbestos-insulated wire shall not be used.

15.1.2 Among the factors to be determined when evaluating the internal wiring are the temperature and voltage to which it is capable of being subjected during normal operation.

15.2 Insulation

15.2.1 Internal wiring that is not completely enclosed shall have insulation of a type that has been evaluated for exposure to oil.

Exception No. 1: Integral leads provided as a part of components used in the appliance and individual insulated conductors of power supply cord Types SO, STO, SEO, SJO, SJEO, HSO, and HSJO when separated from the outer jacket within the appliance are not required to comply with this requirement when the leads and conductors are no more than 152 mm (6 inches) long and are not located within 50.8 mm (2 inches) of enclosure openings.

Exception No. 2: There is no temperature limit applicable to glass fiber, beads of inorganic material, or the equivalent, used as conductor insulation.

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

15.2.3 The wall thickness of insulation on internal wiring shall be no less than 0.71 mm (0.028 inch).

Exception No. 1: Secondary circuits not required to be investigated in accordance with 25.1.1 are not required to comply with this requirement.

Exception No. 2: The thickness of cross-linked synthetic polymer, polytetrafluoroethylene, or fluorinated ethylene propylene insulation shall be no less than 0.38 mm (0.015 inch).

15.3 Protection

15.3.1 The wiring and electrical connections between parts of an appliance shall be protected or enclosed, except that a length of flexible cord of a type specified in 10.2.1 is allowed to be used for external connections between parts when flexibility is essential. Wiring and connections in circuits other than those covered in 25.1.1 shall not be subject to handling during user servicing or maintenance.

15.3.2 With regard to exposure of internal wiring, the protection of wiring required by 15.3.1 is determined to exist when, while investigated as film-coated wire, the wiring is capable of being used in accordance with 6.1.4 – 6.1.8.

15.3.3 Internal wiring not so protected is allowed when it is secured within the enclosure so that neither it nor related electrical connections are capable of being subjected to stress or mechanical damage. All

wiring that is accessible to the operator shall be clamped or otherwise secured to prevent it from being unintentionally hooked, or similar occurrences.

15.3.4 No wiring shall be located where it must be moved to replace a fuse, operate a circuit-breaker handle, or adjust a manually reset control.

Exception: This requirement does not apply to wiring protected in accordance with 10.1.10.

15.3.5 No open wiring – that is, wiring that is not separately and immediately enclosed in conduit, armored cable, metal raceway, or similar parts – shall be located where it is contacted during operation or user servicing.

15.3.6 Wiring shall be protected from sharp edges, including screw threads, burrs, fins, moving parts, and similar edges that are capable of abrading the insulation on conductors or otherwise damaging the wiring.

15.3.7 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 are capable of lying to prevent abrasion of the insulation.

15.3.8 A bushing as specified in 15.3.9 shall be constructed of a material that is not adversely affected by exposure to cooking oil when the bushing is located within 50.8 mm (2 inches) of enclosure openings. When the bushing is located where it is capable of being exposed to spillage of hot oil, it shall be subjected to the aging test described in Parts Subject to Contact With Oil or Other Liquids, Section 59.

15.3.9 A flexible cord used for external interconnection as specified in 15.3.1 shall be provided with bushings and strain relief in accordance with 10.2.16 – 10.2.22 unless the construction is such that the cord is protected from stress or motion.

15.3.10 Insulated wires are allowed to be bunched and passed through a single opening in a metal wall within the enclosure of the appliance.

15.4 Splices and connections

15.4.1 A splice and a connection shall be mechanically secure and shall provide electrical contact. A soldered connection shall be mechanically secured before being soldered when breaking or loosening of the connection is capable of resulting in a risk of fire or electric shock.

15.4.2 Flexing or movement of internal wiring that occurs during the intended use of any cleaning function shall not result in stress on any electrical connection.

15.4.3 A splice shall be provided with insulation equivalent to that required on the wires involved.

Exception: The requirement does not apply when permanence of spacing between the splice and other metal parts of the appliance are maintained.

15.4.4 In evaluating splice insulation consisting of coated-fabric, thermoplastic, or other tubing, consideration is to be given to such factors as its dielectric properties, heat-resistance, moisture-resistance, and oil-resistance. Thermoplastic tape wrapped over a sharp edge shall not be used. An insulated splicing device is allowed to be used within the limits of its voltage and temperature ratings, as long as its oil resistance is equivalent to that required for wiring in the same location. See 15.2.1.

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

15.4.6 Compliance with the requirement in 15.4.7 is to be accomplished by:

a) Use of pressure terminal connectors, soldering lugs, or crimped eyelets;

b) Soldering all strands of the wire together; or

c) Means determined to be equivalent.

15.4.7 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method that is capable of being used for the combination of metals involved at the connection point.

15.4.8 With regard to 15.4.6, a wire-binding screw or a pressure terminal connector, or other type of connector used as a termination device shall be investigated and found capable of being used with aluminum under the conditions involved – for example, temperature, heat cycling, and vibration.

16 Heating Elements

16.1 A heating element shall be supported in a substantial and reliable manner.

16.2 A moveable heating element shall be protected against damage caused by contact with other parts of the appliance when the element is moved.

16.3 The marked voltage rating of a heating element shall be no less than the voltage rating of the circuit in which the heating element is connected.

Exception No. 1: A heating element having a marked voltage rating within an applicable range of voltages specified in 69.2 is capable of being used when the voltage rating of the appliance is within that range.

Exception No. 2: The marked voltage rating of an element that is connected in series is to be not less than the applied voltage.

16.4 A sheathed heating element shall comply with UL 1030 or with UL 499.

17 Electrical Insulation

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

17.2 Insulating material is to be evaluated with regard to its acceptability for the particular application. Materials such as mica, some molded compounds, and certain refractory materials are capable of being used as the sole support of live parts.

17.3 Some materials that are not intended for general use, such as magnesium oxide, are allowed to be employed when used in conjunction with other insulating materials which are capable of being used, or when located and protected so that mechanical damage is prevented and the absorption of moisture is reduced.

17.4 When evaluating a material in accordance with 17.1 – 17.6, consideration is to be given to its mechanical strength, dielectric properties, insulation resistance, heat-resistant and oil-resistant qualities,

the degree to which it is enclosed or protected, and any other features having a bearing on the risk of fire, electric shock, or injury to persons involved, in conjunction with conditions of actual service. All of these factors are to be evaluated with regard to thermal aging.

17.5 An insulating material of polymeric composition shall comply with the applicable requirements in UL 746C.

17.6 Screws or other fasteners 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. Such parts shall be slightly loose.

18 Thermal Insulation

18.1 Thermal insulating material shall be suitable for the application.

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

18.3 Mineral-wool thermal insulation that contains conductive impurities in the form of slag shall not contact uninsulated live parts.

18.4 Except where specifically allowed elsewhere in this Standard, a material of asbestos composition shall not be used.

18.5 Thermal insulation shall not be located where it is capable of being exposed to spillage of cooking oil during use or storage of the appliance.

Exception: Thermal insulation that has been tested and found suitable for exposure to cooking oil is not required to comply with this requirement. This evaluation shall include an investigation of its oil-absorbing properties, as well as the effect of oil on the insulation itself.

19 Motors

19.1 General

19.1.1 A motor shall be capable of being used for the particular application and shall be capable of handling its maximum normal load without creating a risk of fire, electric shock, or injury to persons.

19.1.2 A motor winding shall resist the absorption of moisture.

19.1.3 With regard to the requirement in 19.1.2, film-coated wire is not required to be additionally treated to prevent absorption of moisture, however, fiber slot liners, cloth coil wrap, and similar moisture-absorbent materials shall be impregnated or otherwise treated to prevent moisture absorption.

19.1.4 The diameter of the motor is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and similar parts used solely for motor mounting, cooling, assembly, or connection.

19.2 Motor protection

19.2.1 A motor shall be provided with one of the following types of overload protection:

a) Thermal protection complying with UL 1004-3;

b) Impedance protection complying with UL 1004-2, when tested as used in the application; or

c) Other protection that tests show is equivalent to the protection specified in (a) or (b).

Exception No. 1: A motor that is used for a direct-drive of a blower or fan, which is the only load, is determined to have the required overload protection when it is protected against locked-rotor conditions only.

Exception No. 2: A motor located in a limited-energy secondary circuit, as defined in 25.2.1, is not required to be further protected.

19.2.2 Fuses are allowed to be used to provide the required overcurrent protection when compliance with the requirements is provided by the largest ampere-rated time-delay type fuse that is capable of being mounted in the fuseholder or when a non-interchangeable fuse is used. The fuse used to provide this protection is not required to be evaluated for branch-circuit protection.

20 Limiting Controls

20.1 A thermal cutoff shall be secured in place.

20.2 A thermal cutoff that is depended upon to reduce the risk of overheating of an appliance during abnormal operation shall comply with the requirements in UL 60691, in addition to the requirements specified in this Standard. The operation of a thermal cutoff shall not involve a risk of fire, electric shock, or injury to persons as described in 50.1.3 – 50.1.5.

20.3 When malfunction of a combination temperature-regulating and -limiting control for a heating element is capable of resulting in a risk of fire or electric shock due to overheating of the appliance, a back-up protective device shall be provided to limit temperature. See the abnormal heating test described in 50.2.3(b).

20.4 With regard to 20.3, each control shall be evaluated individually in an appliance provided with more than one separately controlled heating element.

21 Short-Circuit and Ground-Fault Protection

21.1 The overcurrent protection specified in 21.5 shall be located in each ungrounded conductor, and shall comply with the requirements for branch-circuit protection.

21.2 A fuse used for the overcurrent protection referred to in 21.1 shall be a Class CC, G, H, J, K, L, RK, or T cartridge fuse, a Type S, or Edison-base plug fuse, or a fuse that has been determined to be equivalent.

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

21.4 It is assumed that the rating of the branch-circuit overcurrent-protective device is to be 150 % 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, and 30. When 150 % of the rating of the appliance does not equal one of the standard overcurrent-protective device ratings specified above, it is to be assumed that the next higher rating or setting of overcurrent-protective device shall be employed.

21.5 A motor or transformer in an appliance rated more than 16 amperes shall be protected by an overcurrent-protective device incorporated in the appliance. The overcurrent-protective device shall have a maximum ampere rating in accordance with NFPA 70.

Exception No. 1: An overcurrent-protective device is not required as a part of the appliance when it is determined that the overcurrent-protective device of the branch-circuit through which the appliance is intended to be supplied provides equivalent or better protection.

Exception No. 2: The overcurrent protection is allowed to be omitted from the primary of a Class 2 transformer, and is allowed to be omitted from the primary of any other transformer when the transformer complies with the requirements in the Transformer Burnout Test, Section 57.

Exception No. 3: A motor having an inherent thermal protector that complies with the requirements of such devices does not require an additional overcurrent-protective device when, in the appliance, it is 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 which the motor-protector combination was tested during the investigation of the protector.

Exception No. 4: An overcurrent-protective device is not required for an appliance that complies with the Exception to 10.2.10 and is provided with an attachment plug rated 20 ampere or less, or the Exception to 10.1.13 and is marked for connection to a branch-circuit with an overcurrent-protective device rated 20 amperes or less. See 71.12.

22 Thermostats

22.1 A manually reset thermostat 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.

22.2 The reset button of a manually reset thermostat shall be protected from mechanical abuse. The reset button shall not extend more than 12.7 mm (1/2 inch) beyond the surface of the outer enclosure of the appliance, unless protected.

22.3 A manually reset thermostat shall be constructed so that it is not disabled by holding the reset button in any position. A manually reset thermostat that becomes an automatically resetting thermostat when the reset button is held in a closed position is allowed to be used, as long as the appliance complies with the requirements in this Standard with the reset button in either position.

22.4 When a thermostat in fixed or stationary equipment has a marked "off" position, when thermostat is set to the "off" position:

a) Lowering of temperature or loss of capillary tube pressure shall not result in the closing of the contacts; and

b) heating element circuit shall not produce heat.

"No heat," "Cold," and similar phrases are determined to be "off" markings.

22.5 The temperature sensing element and the sensor connection to the thermostat of an appliance shall be located or shielded so as to be protected from mechanical damage.

22.6 A temperature control shall have a rating appropriate for the load it controls.

23 Capacitors

23.1 A capacitor provided with a liquid dielectric medium more combustible than askarel shall not expel the dielectric medium when tested in accordance with the applicable performance requirements in this Standard, including faulted-overcurrent conditions based on the branch circuit on which it is used.

23.2 A capacitor provided as a part of a permanent split capacitor motor, or 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 protects the plates against mechanical damage and that prevents the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The container shall be of metal providing strength and protection no less than that of uncoated steel having a thickness of 0.51 mm (0.020 inch) or the equivalent. A nonmetallic or magnesium enclosure shall comply with requirements in 5.1.3.

Exception No. 1: An individual container of a capacitor is allowed to be made of sheet metal thinner than that specified, or is allowed to be made of other similar material when the capacitor is intended to be mounted in an enclosure that houses other parts of the pump, and when such an enclosure is capable of being used to enclose live parts.

Exception No. 2: An individual enclosure of an electrolytic capacitor with means for venting is required to provide protection against mechanical damage only, and the requirement for minimum enclosure thickness does not apply. An individual enclosure of an electrolytic capacitor not provided with means for venting and with an opening more than 1.6 mm (1/16 inch) wide between the capacitor enclosure and motor is not required to comply with the enclosure thickness requirement when it successfully completes the test described in 61.2.

Exception No. 3: The individual container of a capacitor is allowed to be made of sheet metal less than 0.51 mm (0.020 inch) thick or is allowed to be made of material other than metal when the capacitor is mounted in an enclosure that houses other parts of the appliance and when such housing is capable of being used for the enclosure of live parts.

23.3 When a capacitor that is not a part of a capacitor motor or a capacitor-start motor is connected in an appliance that is intended to be automatically or remotely controlled so that malfunction or breakdown of the capacitor results in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the appliance to prevent such a condition.

23.4 A capacitor connected from one side of the line to the frame or enclosure of an appliance shall have a capacitance rating of no more than 0.10 microfarad. See 38.2.

23.5 An appliance that is intended to be controlled by or operated in conjunction with a capacitor or a capacitor/transformer unit shall be supplied with such capacitor or unit.

24 Switches

24.1 A switching device shall have a current and voltage rating no less than that of the load that it controls when the appliance is operated as described in 40.2 or 40.3, whichever creates the higher load.

24.2 The current rating of a switching device that controls a solenoid, a magnet, a transformer, or another inductive load shall be at least twice the rated full-load current of the component that it controls unless the switching device has been found capable of being used for the control of an inductive load at least equal to the rated full-load current of the component.

24.3 A switching device provided as part of an appliance intended to be connected to a power-supply circuit involving a potential to ground of more than 150 volts shall be capable of being used for the maximum potential to ground of the circuit. See 69.3.

24.4 A switching device shall be evaluated with regard to the temperature limitations of the materials used.

24.5 A switching device shall be located or protected so that it is not subjected to mechanical damage during its intended use.

24.6 All switching devices shall be of the indicating type. The indicating means shall be incorporated on the switching device or knob, on an attached plate, or on the panel on which the switching device is mounted. A pilot light that complies with the requirements in 24.7 is also allowed to be used as a means of indication.

24.7 A filament or signal lamp used as a means of indication shall:

a) Have an estimated life at the operating voltage of no less than 20,000 hours; and

b) Be connected in a circuit in which the increased voltage incident to switching or any operational characteristic of the appliance does not exceed 120 % of the voltage specified to provide the required estimated life.

24.8 A manual switching device in a fixed or stationary appliance that controls a heating element and has a marked "off" position shall open all ungrounded conductors of the heating-element circuit or result in the opening of the conductors.

24.9 A switching device controlling one or more plug-in or moveable surface heating elements of a permanently-connected appliance shall open all ungrounded conductors of the heating element or elements that it controls or result in the opening of the conductors.

24.10 When the appliance is provided with a switching device with a marked "off" position that controls the flow of oil, or a momentary contact switching device intended to stop the flow of oil upon release of the device, the switching device shall result in the flow of oil being stopped as close to the pump (or similar device) as possible, and, in any case, upstream of any flexible hose provided for transport of oil under positive pressure. A switching device that disconnects power to the pump complies with this requirement.

25 Secondary Circuits

25.1 General

25.1.1 Each secondary circuit is to be investigated under the requirements for line-voltage circuits.

Exception: A secondary circuit is not required to be investigated when:

a) It is not a safety circuit and

b) It complies with the requirements for a limited-energy secondary circuit as described in 25.2.1 – 25.2.9.

25.1.2 A wiring compartment or the equivalent for field-wiring terminals for a secondary circuit shall be separate from wiring compartments for other terminals.

25.1.3 Secondary circuits are allowed to be connected to the frame of the appliance. Except as noted in 25.1.4 and 25.2.6, the connection shall be made at only one point in the appliance or system.

25.1.4 A grounding bus of adequate ampacity that is used as the return for a secondary circuit other than as covered by 25.2.6 is allowed to be connected to the frame at more than one point.

25.1.5 When any secondary circuit having an open-circuit potential of more than 42.4 volts peak is connected to the frame of an appliance, all exposed dead metal parts that are capable of becoming energized, and all dead metal parts within the enclosure that are capable of being touched by a person during operator servicing and that are capable of becoming energized, shall be reliably connected together.

25.2 Limited-energy secondary circuits

25.2.1 A limited-energy secondary circuit shall be supplied from:

a) A Class 2 transformer complying with UL 5085-1 and UL 5085-3; or

b) An isolating transformer having an open-circuit sinusoidal potential of 30 volts, rms (42.4 volts, peak) or less, and that includes at least one of the following means, that limits the power available to the levels specified for a Class 2 transformer:

1) A reliable fixed impedance;

2) A noninterchangeable fuse – the largest fuse that fits in the fuseholder provided;

3) A nonadjustable manually reset circuit protector; or

4) A reliable regulating network.

25.2.2 The impedance, the fuse, the protector, or the regulating network, and the wiring between them and the isolating transformer described in 25.2.1, shall be evaluated for use as part of a line-voltage circuit.

25.2.3 A fuse or a circuit protector used to limit the power as specified in 25.2.1 shall be rated or set at no more than 3.2 amperes for a circuit operating between 15 and 30 volts, and at no more than 5.0 amperes for a circuit operating from 0 to 15 volts.

25.2.4 An impedance or a regulating network that is used to limit the current shall be of such value or construction as to limit the current under short-circuit conditions to no more than 8.0 amperes measured after 2 minutes.

25.2.5 The performance of a regulating network used to limit the power in accordance with 25.2.1 shall not be adversely affected by either short circuit or open circuit between any two terminals of any single rectifier, capacitor, transistor, or similar component in the network.

25.2.6 The frame is allowed to be used as the return for a limited-energy secondary circuit.

25.2.7 The wiring in a limited-energy secondary circuit shall be routed away from the wiring of other circuits or shall be provided with insulation that is for use at the highest of the voltages in the other circuits.

25.2.8 The wiring in a limited-energy secondary circuit shall be routed away from uninsulated live parts located in other circuits. Wiring in other circuits shall be routed away from uninsulated live parts located in limited-energy secondary circuits.

25.2.9 Wires and cables that are part of a limited-energy secondary circuit shall be provided with strain relief in accordance with 10.2.16 – 10.2.18. and the Strain Relief Test, Section 48, when stress on the wire or cable results in the internal wiring of the circuits contacting uninsulated live parts of other circuits.

26 Spacings

26.1 In primary circuits, other than at field-wiring terminals and except as noted in 26.2 – 26.6, the spacings between uninsulated live parts of opposite polarity, and between an uninsulated live part and a dead metal part shall be no less than specified in Table 26.1 and Table 26.2.

Table 26.1
Minimum Spacings Other Than at Field-Wiring Terminals and in Motors

Potential involved, volts	Minimum spacings[a]			
	Over surface		Through air	
	mm	(inch)	mm	(inch)
0 – 50	1.6	(1/16)	1.2	(3/64)
51 – 125	2.4	(3/32)	1.6	(1/16)
126 – 250	3.2 [b,c]	(1/8)	2.4[b,c]	(3/32)
	4.0[b,d]	(5/32)	3.2[b,d]	(1/8)
251 – 480	6.4[b]	(1/4)	4.0[b]	(5/32)
481 – 600	9.5[b,e]	(3/8)	6.4[b]	(1/4)

[a] At heating elements, these spacings shall be no less than 1.6 mm (1/16 inch) up to 300 volts.

[b] Film-coated wire is to be evaluated in the same manner as an uninsulated live part. However, 2.4 mm (3/32 inch) and greater spacings over surface and through air are allowed between dead metal parts and film-coated wire that is rigidly supported and held in place on a coil.

[c] Between uninsulated live parts and grounded metal.

[d] Between uninsulated live parts of opposite polarity.

[e] At heating elements, this spacing shall be no less than 6.4 mm (1/4 inch).

Table 26.2
Minimum Spacings within Motors

Potential involved, volts	Parts involved	Minimum spacings							
		Motor diameter 178 mm (7 inches) or less[a]				Motor diameter more than 178 mm (7 inches)[a]			
		Over surface,		Through air,		Over surface,		Through air,	
		mm	(inch)	mm	(inch)	mm	(inch)	mm	(inch)
0 – 125	Between commutator bars or collector rings of a motor and the motor shaft and laminations	1.6	(1/16)	1.6	(1/16)	4.8[b]	(3/16)	3.2[b]	(1/8)
	Elsewhere in the motor	2.4[c]	(3/32)	2.4[c]	(3/32)	6.4[b,d]	(1/4)	3.2[b,d]	(1/8)
126 – 250	Between commutator bars or collector rings of a motor and the motor shaft and laminations	1.6	(1/16)	1.6	(1/16)	4.8[b]	(3/16)	4.8[b]	(3/16)
	Elsewhere in the motor	2.4	(3/32)	2.4	(3/32)	6.4[b,d]	(1/4)	6.4[b,d]	(1/4)

Table 26.2 Continued on Next Page

Table 26.2 Continued

Potential involved, volts	Parts involved	Minimum spacings							
		Motor diameter 178 mm (7 inches) or less[a]				Motor diameter more than 178 mm (7 inches)[a]			
		Over surface,		Through air,		Over surface,		Through air,	
		mm	(inch)	mm	(inch)	mm	(inch)	mm	(inch)
251 – 600	Between commutator bars or collector rings of a motor and the motor shaft and laminations	6.4	(1/4)	6.4	(1/4)	9.5	(3/8)	6.4	(1/4)
	Elsewhere in the motor	6.4[d]	(1/4)	6.4[d]	(1/4)	9.5[d]	(3/8)	9.5[d]	(3/8)

[a] See 19.1.4.

[b] Spacings of no less than 2.4 mm (3/32 mm) are allowed throughout a universal motor.

[c] For a motor rated 1/3 horsepower (250 W output) or less, these spacings shall be no less than 1.6 mm (1/16 inch).

[d] Film-coated wire is determined to be an uninsulated live part. However, a spacing of no less than 2.4 mm (3/32 inch) over surface and through air is allowed between film-coated wire rigidly supported and held in place on a coil and a dead metal part.

26.2 The acceptability of the inherent spacings of a component, such as a switch, is to be based on the requirements that cover the component.

26.3 Within a thermostat, the spacing – except at contacts – between uninsulated live parts on opposite sides of the contacts shall be no less than 0.8 mm (1/32 inch) through air and 1.2 mm (3/64 inch) over the surface of insulating material. The construction shall be such that the spacings are maintained permanently.

26.4 At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, in an appliance rated 250 volts or less, a spacing of 1.2 mm (3/64 inch) is allowed.

26.5 The spacings through air between an uninsulated live part and an enclosure panel when tested as described in the Enclosure Strength Test, Section 54, and the Impact Test, Section 55, shall be no less than:

a) 12.7 mm (1/2 inch) for a flat panel having an unsupported area greater than 929 cm^2 (1 square foot); or

b) The minimum through-air spacing that is otherwise allowed between an uninsulated live part and dead metal for smaller areas.

Exception: This requirement does not apply to the inherent spacing between an uninsulated live part of a component complying with 2.1.1 and an enclosure panel on which the component is mounted.

26.6 When an uninsulated live part is not rigidly fixed in position by a means other than friction between surfaces, or when a moveable dead metal part is in proximity to an uninsulated live part, the construction shall be such that the spacing shall be no less than the minimum allowable spacing with the moveable part in any position.

26.7 Requirements for primary circuit spacings apply to all secondary circuits that are safety circuits and to all secondary circuits supplied by a transformer winding of 200 volt-amperes or a higher capacity – maximum available power – at a potential higher than 100 volts. Except as noted in 26.1, the spacings in all other secondary circuits are evaluated on the basis of the test described in 45.2.1.

26.8 At terminal screws and studs to which connections are capable of being made in the field by means of wire connectors, eyelets, and similar methods as described in 11.10, spacings shall be no less than as

specified in Table 26.1 and Table 26.2 with such connectors, eyelets, and similar parts in positions so that minimum spacings – opposite polarity and to dead metal – exist.

26.9 Film-coated wire is determined to be an uninsulated live part when spacings are being evaluated.

26.10 With regard to Table 26.1 and Table 26.3, the measurement of spacings over surface shall include the walls of a groove wider than 2.0 mm (5/64 inch).

Table 26.3
Minimum Spacings at Field-Wiring Terminals

Parts involved	Minimum spacings[a]							
	0 – 250 volts				251 – 600 volts			
	Through air		Over surface		Through air		Over surface	
	mm	(inch)	mm	(inch)	mm	(inch)	mm	(inch)
Between live parts of opposite polarity and between a live part and a dead metal part other than the enclosure	6.4	(1/4)	9.5	(3/8)	9.5	(3/8)	12.7	(1/2)
Between a live part and an enclosure	12.7	(1/2)	12.7	(1/2)	12.7	(1/2)	12.7[b]	(1/2)

[a] These spacings do not apply to connecting straps or buses extending away from wiring terminals; such spacings are evaluated under the requirements in Table 26.1.

[b] A spacing of no less than 9.5 mm (3/8 inch), over surface, is allowed at wiring terminals in a wiring compartment or terminal box that is integral with a motor.

26.11 An insulating lining or barrier of vulcanized fiber or similar material used where spacings are otherwise unacceptable shall be no less than 0.8 mm (1/32 inch) thick, and shall be so located or of such material that it will not be adversely affected by arcing.

Exception No. 1: Vulcanized fiber no less than 0.4 mm (1/64 inch) thick is allowed to be used in conjunction with an air spacing of no less than 50 % of the spacing required for air alone.

Exception No. 2: An insulating liner or barrier is allowed to be less than 0.4 mm thick when the material is determined to be capable of being used for the application in accordance with Electrical Insulation, Section 17.

PROTECTION AGAINST INJURY TO PERSONS

27 Scope

27.1 The performance and construction requirements in Sections 28 – 36 are applicable to appliances covered by this Standard that are capable of involving a risk of injury to persons in intended operation.

27.2 There are risks of injury to persons inherent in some appliances that, when completely eliminated, defeat the utility of the appliance. The requirements in this section are intended to reduce such risks, while retaining the intended function of such an appliance.

28 General

28.1 When operation, maintenance, or reasonably foreseeable misuse of an appliance by the user involves a risk of injury to persons, protection shall be provided for the reduction of such risk.

28.2 Among the factors to be evaluated in determining the acceptability of an exposed moving part are:

a) Degree of exposure required to perform its intended function;

b) Sharpness of the moving part;

c) Risk of immediate unintentional contact;

d) Speed of the moving part;, and

e) Risk of a part of the body being endangered or of clothing being entangled by the moving part.

These factors are to be evaluated with regard to both intended operation of the appliance and its reasonably foreseeable misuse.

28.3 The acceptability of a guard, a safety release, an interlock, and similar devices and whether or not such a device is required, are to be determined from a study of the complete appliance, its operating characteristics, and the likelihood of a risk of injury to persons resulting from a cause other than gross negligence. The investigation is to include an evaluation of the results of breakdown or malfunction of any one component; and no more than one component at a time, unless one event contributes to another. When the study shows that malfunction of a particular component is capable of resulting in a risk of injury to persons, that component is to be investigated.

28.4 Specific tests, constructions, markings, guards, and other requirements are detailed for some appliances. Such detailed requirements apply to common constructions; specific features and appliances not covered herein are to be given an appropriate evaluation.

29 Enclosures and Guards

29.1 Moving parts capable of causing injury to persons shall be enclosed.

29.2 An opening in a guard or enclosure around a moving part that involves a risk of injury to persons shall not permit the probe illustrated in Figure 6.1 to contact the part.

29.3 An enclosure, an opening, a frame, a guard, a knob, a handle, and similar parts shall not be so sharp as to result in a risk of injury to persons in normal maintenance or use.

Exception: A sharp edge that must be exposed to enable the appliance to perform its intended function is not required to comply with this requirement.

30 Material

30.1 When the breakage or damage of a part such as an enclosure, a frame, a guard, or a similar part results in a risk of injury to persons, the material shall have such properties as to meet the demand of expected loading conditions. See the Impact Test, Section 55.

30.2 The requirements in 30.1 apply to those portions of a part adjacent to a moving part or an exposed live part determined to present a risk of injury to persons.

31 Hoses and Handles

31.1 The distance between the discharge opening of the nozzle for the oil return hose and the point of the handle grip of the nozzle closest to the discharge opening shall be between 25.4 cm (10 inches) and 71.1 cm (28 inches). The distance shall be measured on a straight line from the areas described above.

31.2 A hose intended to carry or hold heated oil shall comply with the test for Parts Subject to Contact With Oil or Other Liquids, Section 59, and the Hydrostatic Pressure Test, Section 62.

31.3 A hose intended to carry or hold oil under positive pressure shall comply with the Hydrostatic Pressure Test, Section 62. See Parts Subject to Pressure, Section 34.

31.4 The nozzle noted in 31.1 shall not be constructed with a hook or similar piece that is capable of being used to secure the nozzle onto a fryer so that it is capable of being used without the operator present.

31.5 Insulating material used for a handle as specified in 31.1 shall comply with the Aging/Impact of Handles, Section 58.

31.6 The length of a hose used to pump oil into or out of a fryer shall be limited to the length required for use in accordance with the manufacturer's instructions. See 73.7.

31.7 Compliance with 31.6 shall be determined based upon the individual construction, as follows:

a) When the appliance is intended to be moved from fryer to fryer for filtering, or is intended to filter only one fryer, the hose shall be long enough to conveniently reach a fryer in the intended filtering position, and not long enough to reach an adjacent fryer;

Exception: When the intended operation of the appliance requires a hose long enough to reach an adjacent fryer, the hose shall be the minimum length required for proper operation. See the Operation Test, Section 39.

b) When the appliance is intended to filter multiple fryers from a stationary position, the length of hose shall be determined by the number and size of fryers to be filtered. When this number is unspecified, the hose is allowed to be any convenient length, and in no case more than 3.66 m (12 feet) long from the appliance outlet to the handle. See 73.7.

32 Switches, Controls, and Interlocks

32.1 Switches and controls

32.1.1 When unintentional operation of a switch is capable of resulting in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation does not occur.

32.1.2 With regard to the requirement in 32.1.1, a switch that is located or guarded so that it is not capable of being turned on by being struck with the palm of the hand is capable of being used.

32.1.3 The actuator of a switch shall be guarded by recessing, ribs, barriers, or similar means.

32.1.4 An appliance shall be provided with a switching device having a marked "off" position that de-energizes, or cause to be de-energized, each heating element and the pump motor, as applicable.

Exception: For under-fryer filters which are removable from the appliance the filter is intended to service, it is acceptable to locate the switching device on the serviced appliance. The filter shall be provided with a twist-lock or non-standard attachment plug and marked in accordance with 73.9.

32.1.5 All operating controls of an appliance, or the actuating mechanisms for such controls, shall be mounted on the appliance in a location that is readily accessible when the appliance is located in any position anticipated during intended use.

32.2 Interlocks

32.2.1 An automatically reset protective device shall not be used when its automatic resetting is capable of resulting in injury to persons.

32.2.2 The requirement in 32.2.2 necessitates the use of an interlock in an appliance when moving parts are capable of causing injury to persons upon the automatic restarting of a motor.

33 Oil Drain

33.1 A means for draining or pumping oil from a filter shall be provided. A drain, when provided, shall be constructed so that drainage is not directed toward the operator. The oil drain shall not be caused to open without an intentional operation. For example, unintentional contact or unplugging the appliance shall not result in the opening of the drain.

34 Parts Subject to Pressure

34.1 Pressure tests

34.1.1 A part or an assembly that is subject to liquid oil, air, or vapor pressure, including the vapor pressure in a vessel containing only a superheated fluid, during normal or abnormal operation (such as a blocked filter, blocked hose, and the conditions simulated during the Abnormal Heating Test, Section 50) shall be subjected to the Hydrostatic Pressure Test, Section 62.

Exception No. 1: A section of a pressure system constructed of tubing is determined to comply with the requirements when the maximum pressure obtained during normal or abnormal operation is no greater than the values specified in Table 34.1 for a given diameter and thickness. The tubing is to be continuous or lengths of tubing are to be connected by hard-soldered, brazed, welded joints, or threaded fittings.

Exception No. 2: A pressure vessel bearing the American Society of Mechanical Engineers (ASME) code inspection symbol, when that vessel is marked with a value of working pressure no less than that to which it is subjected during normal or abnormal operation, is not required to comply with this requirement.

Table 34.1
Maximum Pressure for Tubing

Outside diameter		Minimum wall thickness		Maximum pressure to which tubing is subjected					
				Seamless copper		Butt-welded steel		Seamless steel	
mm	(inch)	mm	(inch)	MPa	(Psig)	MPa	(Psig)	MPa	(Psig)
9.5 or smaller	(3/8 or smaller)	.041	(0.016)	3.45	(500)	4.14	(600)	6.90	(1000)
12.7	(1/2)	0.41	(0.016)	2.76	(400)	3.31	(480)	5.52	(800)
15.9	(5/8)	.041	(0.016)	2.21	(320)	2.65	(384)	4.42	(640)
15.9	(5/8)	0.53	(0.021)	2.90	(420)	3.48	(504)	5.80	(840)
19.0	(3/4)	0.53	(0.021)	2.48	(360)	2.98	(432)	4.97	(720)
19.0	(3/4)	0.64	(0.025)	2.90	(420)	3.48	(504)	5.80	(840)
25.4	(1)	0.53	(0.021)	1.79	(260)	2.65	(312)	3.59	(520)
25.4	(1)	0.64	(0.025)	2.21	(320)	2.65	(384)	4.42	(640)

34.2 Pressure relief means

34.2.1 A part in which pressure is capable of being generated by an external fire shall be provided with a means for safely relieving pressure such as a pressure-relief device (see 34.3), a fusible plug, a soldered joint, nonmetallic tubing, or other equivalent pressure-relief means.

34.2.2 There shall be no shut-off valve between the pressure-relief means and the parts that it is intended to protect.

34.3 Pressure relief devices

34.3.1 A vessel having an inside diameter of more than 76 mm (3 inches) and subject to air or steam pressure generated or stored within the appliance shall be protected by a pressure-relief device.

34.3.2 A gasket shall not be used as the pressure-relief device required by 34.3.1.

34.3.3 The start-to-discharge pressure setting of the pressure-relief device shall be no higher than the working pressure marked on the vessel. The device shall have a discharge rate that relieves the pressure.

34.3.4 A pressure-relief device shall:

a) Be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect;

b) Be installed so that it is readily accessible for inspection and repair and cannot be readily rendered inoperative; and

c) Have its discharge opening located and directed so that:

1) The risk of scalding is reduced to a level that does not result in injury to persons; and

2) Operation of the device does not deposit moisture on bare live parts or on insulation or components detrimentally affected by moisture.

34.3.5 A pressure-relief device having an adjustable setting is to be evaluated on the basis of its maximum setting unless the adjusting means is acceptably sealed at a lower setting.

34.3.6 A pressure-relief device is determined to be a pressure-actuated valve or rupture member intended to relieve excessive pressures automatically.

34.3.7 When a pressure-relief device is required, the control responsible for limiting the pressure in the vessel shall perform under rated load for 100,000 cycles of operation and shall prevent the pressure from exceeding 90 % of the relief-device setting under any condition of intended operation. See the Pressure Controls Test, Section 63.

35 Oil Reservoir

35.1 The oil reservoir of a filter shall have a capacity sufficient to hold 110 % of the rated oil capacity of the largest fryer for which the filter is intended. See 73.8.

36 Stability

36.1 An appliance not intended to be permanently anchored to a wall or similar structure shall be subjected to the Stability Test, Section 47.

36.2 A portable filter equipped with wheels, casters, or similar parts shall be provided with means to stabilize the appliance during intended use, cleaning, and user servicing operations. This means shall consist of at least two manually operated locks for the wheels, a floor lock, or the equivalent.

PERFORMANCE

37 General

37.1 The performance of an appliance shall be investigated by subjecting the requisite number of samples to all the applicable tests described in Sections 40 – 63. Insofar as is practicable, the tests shall be conducted in the order in which they are presented.

37.2 An appliance intended for operation on direct current as well as on alternating current is to be tested with a direct-current supply.

37.3 A pressure gauge is to be attached so as to prevent leakage. Special fittings for direct connection to the system or commercial tubing or pipe are allowed to be used for gauge connections. Volume of the pressure-measure gauge and lines shall be held to a minimum relative to pressure vessel size.

37.4 Unless otherwise specified, the test voltage is to be the higher of the voltages specified in 40.2 and 40.3, as applicable.

37.5 Unless otherwise specified, where cooking oil is required for a test, fresh, unused corn oil shall be used.

38 Leakage Current Test

38.1 The leakage current of a single-phase, cord-connected appliance rated for a nominal 120-, 208-, or 240-volt supply when tested in accordance with 38.3 – 38.8 shall be no more than:

a) 0.5 milliampere for a portable appliance; and

b) 0.75 milliampere for a cord-connected product intended to be fastened in place or located in a dedicated space and provided with a standard attachment plug rated 20 amperes or less.

Exception: Where a filter is provided as part of another appliance in accordance with 1.3 and is not intended to be operated independently, the leakage current test shall be conducted on the overall appliance, with the filter installed, in accordance with the requirements for that appliance.

38.2 Leakage current refers to all currents, including capacitively coupled currents, that are capable of being 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 when simultaneously accessible and from one surface to another when simultaneously accessible. Parts are determined to be exposed surfaces unless guarded by an enclosure that provides for protection against electric shock as described in 6.1.1 – 6.1.8. Surfaces are determined to be simultaneously accessible when they are capable of being 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 not determined to present a risk of electric shock. See 6.1.2.

38.4 When a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil having an area of 10 by 20 centimeters in contact with

the surface. When the surface is less than 10 by 20 centimeters, 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 illustrated in Figure 38.1. The measurement instrument is defined in items (a) – (c). The meter that is actually used for a measurement is only required to indicate the same numerical value for a particular measurement as the defined instrument. The meter used is not required to have all the attributes of the defined instrument.

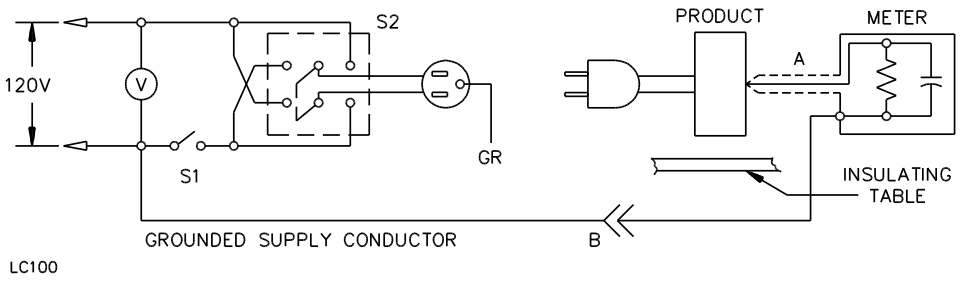
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad;

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

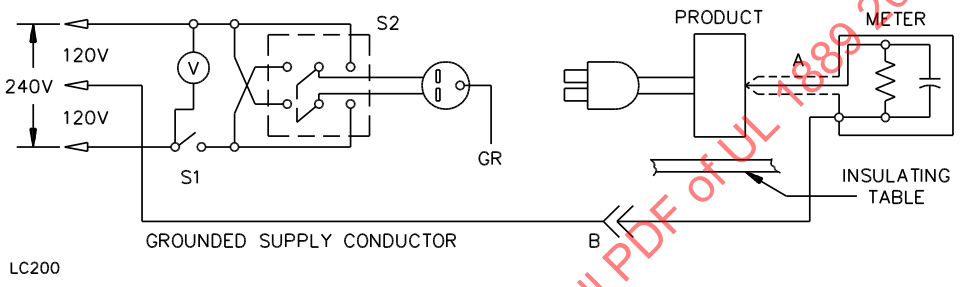
c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response – ratio of indicated to actual value of current – that is equal to the ratio of impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of no more than 5 % at 60 hertz.

Figure 38.1

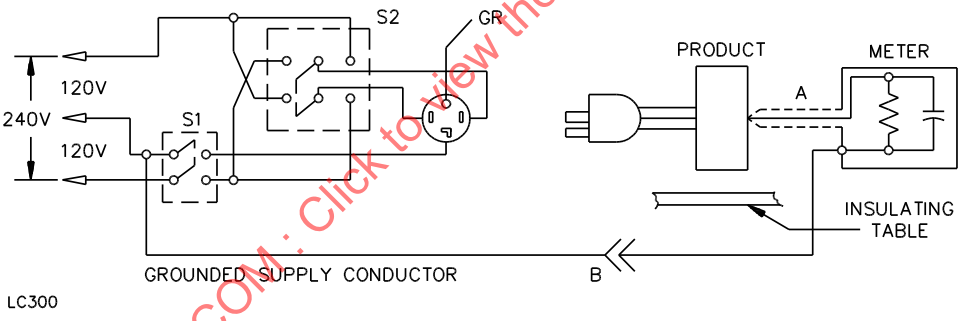
Leakage Current Measurement Circuits



Product intended for connection to a 120-volt power supply



Product intended for connection to a 208- or 240-volt, 3-wire, grounded power supply



Product intended for connection to a 208- or 240-volt, 4-wire grounded power supply

NOTES:

A – Probe with shielded lead.

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

38.6 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.

38.7 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, and with its grounding conductor, when provided, open at the attachment plug. The as-received condition is without prior energization except when energized as part of the production-line testing. The supply voltage is to be adjusted to 120, 208, or 240 volts, based on product rating. The test sequence, with regard 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;

b) With the appliance controls at the maximum heat setting, switch S1 is to be closed, energizing the appliance, and within 5 seconds the leakage current is to be measured using both positions of switch S2;

c) Leakage current is to be monitored until thermal stabilization under the maximum-heat conditions. Both positions of switch S2 are to be used. The equivalent of thermal stabilization is determined to be obtained as in the Normal Temperature Test, Section 44. When the 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 thermostat, when provided, open and closed. Normally following the 5-second measurements, as specified in (b), the first monitoring reading is taken 10 minutes after energizing. Upon evidence of stabilizing readings, monitoring periods are allowed to be increased;

d) When the appliance is provided with a single-pole switch or a thermostat having an "off" position, monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the appliance is turned off.

38.8 The complete leakage current test program as described in 38.7 is to be conducted without interruption for other tests. With the concurrence of those concerned, however, the leakage current tests are allowed to be interrupted for the purpose of conducting other nondestructive tests.

39 Operation Test

39.1 Operation of an appliance as described in 39.2 shall not increase the risk of fire, electric shock, or injury to persons.

39.2 With regard to 39.1, an as-received sample (except for the Leakage Current Test, Section 38, as applicable) of the appliance is to be set up or installed in accordance with the manufacturer's instructions. The sample is to be operated in accordance with manufacturer's instructions with regard to the intended uses of the appliance, including maintenance and cleaning specified by the manufacturer. The appliance is to be operated with or without all accessories specified by the manufacturer for use with the appliance, as required to determine compliance in all cases. The appliance is also to be operated with consideration given to possible lack of the maintenance and cleaning specified by the manufacturer. The appliance is to be manipulated as intended in actual use, including manipulation of all controls and operation under the various loading conditions that are to be expected. The appliance is to be operated only for the length of time or number of cycles required to determine the appropriateness of the manufacturer's instructions.

40 Power Input Test

40.1 The power input to an appliance shall not exceed 110 % of its marked rating.

40.2 To determine whether an appliance complies with the requirement in 40.1, the power input is to be measured with the appliance at intended operating temperature under full-load conditions and while

connected to a power-supply circuit of rated voltage. The rated voltage of an appliance having a marked voltage range, such as 110 – 120 volts, is determined to be the mean of the range.

40.3 In addition to the test required by 40.2, when the marked voltage rating of an appliance falls within a voltage range specified in 69.2, the input is to be determined at the maximum voltage of the range. Provisions for connection to the source of supply are to be evaluated by the input current determined at this voltage or the input current determined in accordance with 40.2, whichever is higher. See 10.1.13, 10.1.16, and 10.2.10.

41 Average Current Input Test

41.1 An appliance, as referenced in the Exceptions to 10.1.13, 10.1.16, and 10.2.10, is to be subjected to the following test. The appliance is to be determined to comply with the requirement in the Exception to 10.1.13, 10.1.16, or 10.2.10, as applicable, when, while being tested in accordance with 41.2 and 41.3, the average current input is 80 % or less of the rating of the appropriate power supply connection means.

41.2 Starting at room temperature, the appliance is to be operated continuously for three hours, unless the worst-case anticipated actual use of the appliance, as described in 44.5.7, is less than three hours, in which case the appliance is to operated for the length of time specified in 44.5.7. The current input of the appliance is to be continuously monitored throughout the test.

41.3 The time-average current input is to be calculated over the three-hour operating time. When the unit is operated for less than three hours, the remaining time is to be averaged in at a zero current input. The resulting figure is determined to be the "average current input" for the purpose of this test.

42 Starting Current Test

42.1 An appliance shall be capable of starting and operating normally on a circuit protected by a non-time-delay branch circuit type fuse having a current rating corresponding to that of the branch circuit to which the appliance is intended to be connected.

Exception: An appliance that meets all three of the following conditions is not required to comply with this requirement:

a) The construction of the appliance or the nature of its use is such that the appliance is to be used continually on the same branch circuit after installation;

b) The appliance starts and operates normally on a circuit protected by a time-delay fuse; and

c) The appliance is marked in accordance with 72.15.

42.2 To determine compliance with the requirement in 42.1, the appliance is to be started three times from a standstill without opening the fuse. The pump is to be at room temperature at the beginning of the test. The test is to be conducted at rated frequency and at the voltage specified in 40.2. Each start is to be made under conditions representing the beginning of normal operation – the beginning of the normal operating cycle in the case of an automatic appliance – and the motor is to be allowed to come to rest between successive starts. Tripping of an overload protector provided as part of the appliance, or opening of the fuse is not allowed. The test is to be conducted under both no load (for example, no oil being pumped) and loaded (oil being pumped) conditions. The oil is not required to be heated for this test.

42.3 When the construction of the appliance is such that solid animal shortening is capable of being trapped in the pump mechanism, this test is to be repeated using animal shortening at room temperature, as described in 42.4.

42.4 The shortening is to be heated, run through the pumping system, and allowed to solidify in this system at an ambient of 25 °C (77 °F) for a minimum of four hours. The test described in 42.2 is then to be repeated.

43 Grounding and Bonding Test

43.1 Grounding

43.1.1 The point of connection of the equipment grounding means for permanently-connected appliances, or the grounding blade of the attachment plug for cord-connected appliances, shall be conductively connected to the exposed metal parts specified in 11.6, as determined by test.

43.1.2 The resistance shall be no more than 0.1 ohm between any point required to be grounded, as specified in 11.6, 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 in the case of a cord-connected appliance.

43.1.3 Except as noted in 43.1.4, any indicating device, such as an ohmmeter, a low-voltage battery-and-buzzer combination, or similar devices, is to be used in the test required by 43.1.2.

43.1.4 With regard to 43.1.3, the resistance is to be determined by any convenient method except that when unacceptable results are obtained, either a direct or alternating current equal to the current rating of the maximum-current-rated branch-circuit overcurrent-protective device that is capable of being used with the appliance is to be passed from the equipment grounding terminal or the point of attachment of the wiring system to the dead metal part, and the resulting drop in potential is to be measured between these two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

43.2 Bonding

43.2.1 A conductor smaller than that specified in 11.12 is allowed to be used when the bonding connection does not open when carrying (for the interval specified in Table 43.1) twice the current equal to the rating of the branch-circuit overcurrent device.

Table 43.1
Duration of Current for Bonding-Conductor Test

Rating of overcurrent devices, amperes	Minimum duration of current flow, minutes
30 or less	2
31 – 60	4
61 – 100	6

44 Normal Temperature Test

44.1 General

44.1.1 When an appliance is tested under the conditions described in 44.4.1 – 44.5.8, the temperature at any point shall not adversely affect any materials used in the appliance, and at any time during the test temperature rises shall not exceed those specified in Table 44.1.

Exception: A short length of flexible cord exposed to a temperature higher than the temperature rating of the cord, such as at terminals, and not in a strain relief or similar location where dependence is placed on the mechanical properties of the insulation, is allowed to be used when supplementary heat- and oil-resistant insulation rated for the appropriate dielectric strength and temperature is provided on the individual conductors of the cord, so that it protects the conductor insulation against deterioration.

Table 44.1
Maximum Temperature Rises

	Materials and components	Degrees, °C	Degrees, (°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 73.3.	35	(63)
2.	Any point on a surface adjacent to an appliance, including the surface on which the appliance is mounted.	65	(117)
3.	Fuse	65[a]	(117[a])
4.	Vulcanized fiber used as electrical insulation or as a cord bushing	65	(117)
5.	Wood or other combustible material	65	(117)
6.	Class 105 insulation systems on windings of a relay or a solenoid:		
	Thermocouple method	65[b]	(117[b])
	Resistance method	85	(153)
7.	Class 105 insulation systems on coil windings of an ac motor having a frame diameter of more than 178 mm (7 inches) and of a dc and a universal motor [d]:		
	a) In an open motor:		
	Thermocouple method	65[b]	(117[b])
	Resistance method	75	(135)
	b) In a totally enclosed motor:		
	Thermocouple method	70[b]	(126[b])
	Resistance method	80	(144)
8.	Class 105 insulation system on coil windings of an ac motor – not including a universal motor – having a frame diameter of 178 mm (7 inches) or less – thermocouple or resistance method:		
	a) In an open motor	75[b]	(135[b])
	b) In a totally enclosed motor	80	(144)
9.	Class 105 insulation systems on a vibrator coil – thermocouple or resistance method	75[b]	(135[b])
10.	Class 130 insulation systems, other than as indicated in items 12, 13, and 14:		
	Thermocouple method	85	(153)
	Resistance method	105	(189)

Table 44.1 Continued on Next Page

Table 44.1 Continued

Materials and components	Degrees, °C	Degrees, (°F)
11. Class 130 insulation systems on coil windings of an ac motor having a frame diameter of more than 178 mm (7 inches) and of a dc and a universal motor [e]:		
a) In an open motor:		
Thermocouple method	85[b]	(153[b])
Resistance method	95	(171)
b) In a totally enclosed motor:		
Thermocouple method	90	(162)
Resistance method	100	(180)
12. Class 130 insulation systems on coil windings of an ac motor – not including a universal motor – having a frame diameter of 178 mm (7 inches) or less – thermocouple or resistance method:		
a) In an open motor	95[b]	(171[b])
b) In a totally enclosed motor	100[b]	(180[b])
13. Class 130 insulation systems on a vibrator coil – thermocouple or resistance method	95[b]	(171[b])
14. Phenolic composition used as electrical insulation or relied upon to prevent a hazardous condition	125[c]	(225[c])
15. A copper conductor (bare or insulated) without a nickel coating or similar protection	125	(225)
16. Termination of a copper conductor and a pressure terminal connector without a nickel coating or other similar protection	125	(225)
17. Insulated wire or cord	25 °C less than its melting point	(77 °F)
18. Sealing compound	44 °C less than its melting point	(104 °F)
19. On the surface of a capacitor casing:		
Electrolytic	40[d]	(72[d])
Other types	65[f]	(117[f])
20. Diodes, silicon	75	(135)
21. Class 105 insulation systems on transformers		
Thermocouple method	65	(117)
Resistance method	75	(135)

[a] A fuse that has been investigated and determined to be capable for use at a higher temperature is allowed to be used at that temperature.

[b] 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 is allowed to be higher than the maximum specified by the following amount, when the temperature rise of the coil measured by the resistance method in not higher than the maximum specified:

15 °C (27 °F) for items 7 and 8(a);

5 °C (9 °F) for items 9(a) and 10;

20 °C (36 °F) for item 12(a); and

10 °C (18 °F) for items 13(a) and 14.

[c] The limitation on phenolic does not apply to a compound that has been investigated and rated for higher heat-resistant properties.

[d] The temperature rise on insulating material integral with the enclosure of a electrolytic capacitor that is integral with or attached to a motor shall be no higher than 65 °C (117 °F).

[e] See 19.1.4.

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

44.1.2 All values in Table 44.1 are based on an assumed ambient temperature of 25 °C (77 °F), however, a test is allowed to be conducted at any ambient temperature within the range of 10 – 40 °C (50 – 104 °F). However, when the operation of an automatic thermal control during the test limits the temperatures under observation, no temperature higher than 25 °C plus the specified maximum rise is allowed.

44.2 Test equipment

44.2.1 Supply conductors used for the normal temperature test of a permanently-connected appliance shall have an ampacity (see 10.1.12) of 125 % of the current input of the appliance when tested in accordance with 41.2 or 41.3, whichever results in the higher input; and shall be capable of being used for a temperature in accordance with the temperature marking, when provided, on the appliance. See 10.1.15, 72.3, and 72.4.

44.2.2 Temperatures are to be measured by thermocouples except as indicated in 44.3.4. The thermocouples are to consist of wires no larger than 0.21 mm^2 (24 AWG) and no smaller than 0.05 mm^2 (30 AWG). The thermocouples and related instruments are to be accurate and are to be calibrated in accordance with accepted laboratory practice. The thermocouple wire is to conform with the requirements specified in the appropriate table of ASTM E230.

44.2.3 Whenever referee temperature measurements are required, thermocouples consisting of 0.05 mm^2 (30 AWG) iron and constantan wires and a potentiometer-type indicating instrument are to be used.

44.3 Method

44.3.1 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in reliable thermal contact with the surface of the material the temperature of which is being measured. In most cases, thermal contact results from securely taping or cementing the thermocouple in place; and when a metal surface is involved, brazing or soldering the thermocouple to the metal may be required.

44.3.2 The temperature of a coil or winding is intended to be measured by means of thermocouples applied at points accessible to a mercury bulb thermometer. In considering the accessibility of the various parts of a coil, the enclosure is to be disregarded because it is cut away where necessary to accommodate a thermometer when one is used. This limitation on thermocouple location is intended to prevent insertion of the thermocouple into cracks, and the like, of the coil assembly.

44.3.3 Thermocouples used to measure the coil temperature of an AC-rated motor other than a universal motor having a frame with a maximum diameter of 178 mm (7 inches) are to be mounted on the integral insulation of the motor coils.

44.3.4 When the coil is inaccessible for mounting thermocouples – for example, an encapsulated coil or when the coil wrap includes thermal insulation or more than 0.8 mm (1/32 inch) of cotton, paper, rayon, or similar insulation – the change-of-resistance method is to be used.

44.3.5 In using the change-of-resistance method, the windings are to be at room temperature at the start of the test. The temperature rise of a winding is to be calculated from the formula:

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

in which:

t is the temperature rise in °C;

R is resistance of the coil at the end of the test in ohms;

r is resistance of the coil at the beginning of the test in ohms;

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

t_1 is room temperature at the beginning of the test in °C; and

t_2 is room temperature at the end of the test in °C.

44.4 Procedure

44.4.1 In a test to determine whether an appliance complies with the temperature requirements, the appliance is to be mounted or supported as in actual service and tested under conditions approximating those of normal operation, except as otherwise noted. Temperatures are also to be measured on nearby surfaces, on the supporting surface, at points of support, and at other points as is required.

44.4.2 A cord-connected appliance is to be supported on a horizontal, softwood surface covered with two layers of white tissue paper. The appliance is to be installed and tested in accordance with the manufacturer's instructions.

Exception: A filter provided as part of another appliance, either a built-in filtering system or a free-standing filter, is to be tested in accordance with the requirements for the appliance.

44.4.3 An automatic temperature-regulating or -limiting control or other protective device is to be shunted out of the circuit, unless the control has been shown in accordance with 53.2.1 and 53.2.2, to be reliable, rugged, and unlikely to be defeated by the user. The control is determined to be unlikely to be defeated when a tool is required to gain access to the control, or a positive stop is incorporated in the control.

44.4.4 Unless otherwise specified in 44.4.3, temperature-regulating controls that are adjustable are to be set for maximum temperatures.

44.4.5 When the coil wrap exceeds its temperature limitation because of radiation from an external source, the temperature of the coil is allowed to be measured by means of a thermocouple on the integral insulation of the coil conductors.

44.4.6 Feet, or any parts thereof, that are made of a material not evaluated for the temperature attained during the test and as specified in 44.4.7, are to be removed for the temperature test. Metal studs or other means used to retain the material are not to be removed.

44.4.7 The material specified in 44.4.6. is to be evaluated in terms of the mechanical strength, temperature, and moisture resistant criteria specified in 5.1.3, and also for resistance to hot oil, as determined by Parts Subject to Contact With Oil or Other Liquids, Section 59.

44.4.8 A thermal- or overcurrent-protective device for a motor shall not open the circuit during the intended use of the appliance.

44.4.9 An appliance that is capable of operating either open or closed in actual service is to be tested both open and closed to determine which condition produces the higher operating temperatures.

44.5 Normal test conditions

44.5.1 In determining whether an appliance complies with the requirements in 44.1.1, actual service conditions or an approximation thereof are to be used as described in 44.5.4 – 44.5.8. For appliances other than those for which test conditions are specified, any condition of actual operation is determined to be normal.

44.5.2 Except as specified in 44.5.3, the test voltage is to be the higher of the following:

a) The marked voltage rating; or

b) The highest voltage of the applicable range of voltages specified in 69.2 when the marked voltage is within one of the voltage ranges included in 69.2.

44.5.3 The test voltage specified in 44.5.2 is to be increased, when required, until the wattage input to the appliance is equal to the wattage rating marked on the appliance.

Exception: The voltage applied to the motor of an appliance that is provided with a motor in addition to a heating element is to be no more than 120 volts for an appliance rated 100 to 120 volts, and no more than 240 volts for an appliance rated 220 to 240 volts.

44.5.4 For an appliance that pumps the oil into a container through a filter and then into the fryer, the temperature test is to consist of filtering hot oil, as noted in 44.5.8, alternatively into the filter and back into the fryer. Except as noted in 44.5.7, operation is to be continued until thermal equilibrium occurs.

44.5.5 For an appliance that requires the oil to be drained into a container and pumped back to a fryer through a filter, the temperature test is to consist of draining hot oil, as noted in 44.5.8, into the filter and immediately pumping the oil back into the fryer. Except as noted in 44.5.7, this operation is to be repeated until thermal equilibrium. When the appliance is intended for use with multiple fryers, and is capable of pumping oil into one fryer while oil from another fryer is being drained, operation is to be continuous.

44.5.6 Thermal equilibrium is determined to exist when three successive readings, taken at intervals of 10 % of the previously elapsed duration of the test indicate no change. No interval is to be less than 5 minutes.

44.5.7 The appliance is to be tested using a duty cycle approximating that of the worst anticipated actual use, as follows:

a) Portable filters shall be operated continuously until thermal equilibrium is achieved as described in 44.5.6;

b) Under-fryer filters shall be operated for the length of time it takes to filter the oil from the intended appliance and de-energized for a period of time equal to three times that amount, resulting in a 25 % duty cycle. This cycle is to be repeated until thermal equilibrium is achieved as described in 44.5.6. See 73.7(b);

Exception: Under-fryer filters intended to filter from only one appliance or bank of appliances is only required to be operated for the time required to filter the oil from the intended appliance(s). See 73.7(a).

c) Stationary and central filters shall be operated continuously until an amount of oil equal to the capacity of the maximum specified number of fryers has been filtered. See 73.7(b). When no maximum is specified, the filters are to be operated continuously until thermal equilibrium is achieved as described in 44.5.6.

44.5.8 The hot oil used for the temperature test is to be contained in a compatible fryer and maintained at a temperature of 177 ±5 °C (350 ±9 °F) for the duration of the test.

44.6 Surface temperatures

44.6.1 During the temperature test, the temperature of a surface that is capable of being contacted by the user shall be no more than the value specified in Table 44.2. The results of a test that is conducted at a room temperature of other than 25 °C (77 °F) are to be corrected to 25 °C.

Exception: The temperatures of a surface marked in accordance with 73.6 are allowed to exceed the values specified in Table 44.2.

Table 44.2
Maximum Surface Temperature

Location or type of surface	Composition of surface [a]			
	Metallic		Nonmetallic	
	Degrees		Degrees	
	°C	(°F)	°C	(°F)
Handle or knob grasped for lifting, carrying, or holding	50	(122)	60	(140)
Handle or knob contacted, and not involving lifting, carrying, or holding; other surfaces subject to contact in operation and user maintenance	60	(140)	85	(185)
Surface other than a heating function surface, known to be hot due to proximity to the heating function surface	70	(158)	95	(203)

[a] A material other than metal, that is plated or clad with metal having a thickness of 0.13 mm (0.005 inch) or less is determined to be a nonmetallic part.

45 Dielectric Voltage-Withstand Test

45.1 General

45.1.1 An appliance shall withstand for 1 minute without electrical breakdown the application of a 60-hertz essentially sinusoidal potential between live parts and dead metal parts with the appliance at the operating temperature attained in intended use. The test potential shall be 1000 volts for an appliance rated 250 volts or less, and shall be 1000 volts plus twice rated voltage for an appliance rated more than 250 volts.

45.1.2 To determine whether an appliance complies with the requirements in 45.1.1, it is to be tested by means of a 500 volt-ampere or larger capacity testing transformer, the output voltage of which is capable of being regulated. The applied potential is to be increased from zero to the required value at a substantially uniform rate as rapid as is consistent with its value being correctly indicated by a voltmeter. The potential is to be held at that value for 1 minute.

45.1.3 For the dielectric voltage-withstand test of an appliance in which electrical wiring passes through a hinged member or spring, the cover or other moveable member is to be raised and lowered no less than three times while the test potential is being applied in order to determine whether a breakdown is capable of resulting from damaged insulation on the conductors with the cover in other than the closed position.

45.2 Secondary circuits

45.2.1 Secondary circuits of an appliance shall withstand for 1 minute the application of a test potential as specified in Table 45.1 between:

a) Primary and secondary circuits;

b) Secondary circuits and grounded metal with all chassis-connected components disconnected at the chassis; and

c) Secondary circuits supplied from separate transformer windings with common connections disconnected.

The appliance is to be at its maximum intended operating temperature during the test.

Table 45.1
Magnitude of Test Potential

Maximum voltage in the circuit	Test voltage
90 or less	Ten times maximum voltage in circuit
More than 90 and not more than 333	1000
More than 333 and not more than 1000	Three times maximum voltage in circuit
More than 1000	1750 plus 1.25 times the maximum voltage in the circuit

45.2.2 The test potential specified in 45.2.1 is to be obtained from any convenient source having a capacity of at least 500 volt-amperes to maintain the potential specified in Table 45.1 except in case of breakdown. The voltage of the source is to be continuously variable. A direct-current source is to be used for a direct-current circuit. A 60-hertz sinusoidal voltage is to be used for testing alternating-current circuits.

45.3 Transformers

45.3.1 While at its maximum intended operating temperature, each power transformer shall operate without breakdown while the potential specified in Table 45.1 is induced for 1 minute in each secondary winding that normally operates at a higher potential than the primary winding.

45.3.2 A sinusoidal source is to be used for a transformer, and the frequency of the source is to be in the range of 180 to 1000 hertz when required to prevent saturation of the core.

45.3.3 Primary- and secondary-circuit wiring connected to a transformer is to be disconnected for the test required by 45.3.1.

46 Insulation Resistance Test

46.1 Following the temperature test, all appliances not required to be subjected to the leakage current test in accordance with 38.1 shall have an insulation resistance of at least 50,000 ohms between current-carrying parts and noncurrent-carrying parts.

46.2 Insulation resistance is to be measured by:

a) A magneto megohmmeter that has an open circuit output of 500 volts;

b) Two voltmeters having an internal resistance of at least 30,000 ohms. A direct-current potential of 125 volts is to be applied between live parts and the enclosure and other exposed dead metal parts, using two voltmeters – one voltmeter being connected across the supply line and the other connected in series with one of the leads connected to the appliance being tested.

Designating the reading of the line voltage as V_1, the reading of the other voltmeter as V_2, and the resistance of the latter as R, the insulation resistance is to be calculated by the formula:

$$Insulation\ Resistance = \frac{(V_1 - V_2)R_2}{V_2}$$

or

c) Equivalent equipment.

47 Stability Test

47.1 A free-standing appliance shall not overturn when tipped through an angle of 10° from the horizontal as described in 47.2. Spillage of oil is not permitted when the amount of oil in the reservoir is equal to or less than the maximum specified oil capacity of any single appliance the filter is intended to service. See 35.1 and 73.8.

47.2 The appliance is to be both energized and non-energized during the stability test. During this test, the appliance is to be subjected to conditions under which the product is apt to overturn. The following conditions are to be such as to result in the least stability:

a) The position of all doors, drawers, casters, and other moveable or adjustable parts, including that of a supply cord, when provided, resting on the surface supporting the appliance;

b) Connection of, or omission of, any attachment made available by or specified by the manufacturer;

c) Provision of, or omission of, any normal mechanical loads and, when the appliance is intended to contain a liquid, at any liquid level including an overflow condition. Spillage of oil is permitted when the oil level exceeds the manufacturer's specifications;

d) Direction in which the appliance is tipped; and

e) Starting and stopping the pump motor.

47.3 In conducting the stability test, the appliance is to be:

a) Placed on plane inclined at an angle of 10° from the horizontal; or

b) Tipped through an angle of 10° from an at rest position on a horizontal plane.

47.4 With regard to the requirement in 47.3(b), for an appliance that is constructed so that while being tipped through an angle of 10° a part or surface of the appliance not normally in contact with the horizontal supporting surface touches the supporting surface before the appliance has been tipped through an angle of 10°, the tipping is to be continued until the surface or plane of the surface of the appliance originally in contact with the horizontal supporting surface is at an angle of 10° from the horizontal supporting surface.

47.5 A permanently-connected appliance is to be tested when installed in accordance with the manufacturer's instructions.

48 Strain Relief Test

48.1 When tested in accordance with 48.2, the strain relief shall withstand for 1 minute, without displacement, a direct pull of 35 pounds (156 N) applied to the cord with the connections within the

appliance disconnected. The means of affording strain relief is not acceptable when, 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.

48.2 A 35-pound (15.9-kg) weight is to be suspended on the cord and supported by the appliance so that the strain relief is stressed from any angle that the construction of the appliance permits. When required to determine compliance at all possible angles, the test is to be repeated with the cord stressed from other angles.

49 Deterioration of Parts

49.1 Where required by 5.2.3 – 5.2.5, the deterioration of a part made of rubber, plastic, or similar material is to be simulated by operating the pump with the part completely removed. The remaining parts are to be assembled as though the missing part were in place, with no further tightening or adjustment.

49.2 While being tested as described in 49.1, the leakage current of a single-phase, cord-connected appliance, rated for a nominal 120-, 208-, or 240-volt supply, when determined by the method described in the Leakage Current Test, Section 38, shall not exceed the value required by 38.1. A cord-connected appliance shall also comply with the Dielectric Voltage-Withstand Test, Section 45, after the test described in 49.1.

49.3 After being tested in accordance with 49.1, all appliances not covered by 49.2 shall:

a) Have an insulation resistance between live parts and exposed dead metal parts of at least 50,000 ohms, measured as described in the Insulation Resistance Test, Section 46; and

b) Comply with the Dielectric Voltage-Withstand Test, Section 45.

49.4 During and after the test described in 49.1, the appliance is to be examined for evidence of leakage of cooking oil. See 5.2.4.

50 Abnormal Heating Test

50.1 General

50.1.1 When the conditions of normal operation are not representative of abnormal conditions that are capable of occurring in actual service, an appliance shall not present a risk of fire, electric shock, or injury to persons when operated continuously under such abnormal conditions. In addition, the appliance shall comply with 50.1.6, 50.1.8, and 50.1.9.

50.1.2 The functioning of an overcurrent-protective device provided for a motor, whether or not such a device is required, shall not result in a risk of fire, electric shock, or injury to persons. See 32.2.1.

50.1.3 When operated under the abnormal conditions described in 50.2.3, an appliance is determined to involve a risk of fire when there is any emission of flame or molten metal, or when operation of the appliance results in the glowing or flaming of combustible material upon which the appliance is placed or on adjacent wall surfaces.

50.1.4 An appliance is determined to involve a risk of electric shock when the fuse in the grounding connection opens or when an opening is created in an enclosure such that the appliance does not comply with 6.1.1 – 6.1.8.

50.1.5 An appliance is determined to involve a risk of injury to persons when an enclosure, guard, or similar part is distorted in such a way that the appliance does not comply with 29.1 – 29.3, 30.1, and 30.2.

50.1.6 When the appliance is tested in accordance with 50.2.3, the oil temperature shall not exceed 150 °C (302 °F) when the appliance is heating the oil, or 246 °C (475 °F) when the appliance is pumping oil received at 204 ±20 °C (399 ±36 °F). There shall be no ignition of the oil in any case.

50.1.7 The thermocouple for measuring the oil temperature is to be placed in the center of the pool of oil, 25.4 mm (1 inch) below the surface.

Exception No. 1: For oil depths of less than 50.8 mm (2 inches), the thermocouple is to be placed at a point equal to half the depth of the oil.

Exception No. 2: For a thermocouple location that is on or immediately above a heating element, the thermocouple is to be placed in the center of the pool and between elements; and for depths less than 50.8 mm (2 inches) above the elements, halfway between the elements and the surface.

Exception No. 3: No temperature measurement is to be made with only a residual film of oil on the container.

50.1.8 When oil or grease are capable of accumulating as a result of intended use of the appliance, neither normal nor abnormal conditions of use shall result in sparks, flareups, and similar conditions that are capable of igniting the reservoir of oil or grease.

50.1.9 A thermal cutoff shall not open during the abnormal heating tests.

Exception: A thermal cutoff is allowed to open when the regulating control has been disabled. See 50.2.3(b).

50.2 Test procedure

50.2.1 To determine whether a risk of fire, electric shock, or injury to persons exists, a separate burnout or abnormal heating test is to be conducted with the appliance operating continuously until the ultimate result has been determined. Unless otherwise indicated, the test is to be conducted with the applied voltage, method of mounting, and thermostat setting in accordance with 44.4.2 – 44.4.4 and 44.5.4 – 44.5.8, except that a grounding conductor of a supply cord or other connection is to be disconnected. Exposed dead metal parts are to be connected to ground through a 3-ampere fuse. In most cases, continuous operation for 7 or 8 hours is required to make sure that the ultimate result has been observed.

50.2.2 When a manual-reset temperature limiting control operates during any of the abnormal heating tests, the reset button of that control is to be placed in the reset position as soon as is realistically possible after tripping, and held there for the duration of the test. When the control becomes automatically resetting when the reset button is held in the reset position, operation is to be continued under this condition until ultimate results have been observed.

Exception: When additional cycles of operation are possible only when the reset button is released and reset each time, the test shall be continued until ten manual-reset cycles of operation have been completed.

50.2.3 The appliance is to be operated as in the Normal Temperature Test, Section 44, and as described in 50.2.1 except for the following conditions, as applicable. The conditions are not to be combined except with the agreement of all concerned.

a) Test No. 1: For an appliance previously tested using a duty cycle, as described in 44.5.7, the appliance is to be operated continuously, pumping oil;

Exception: An appliance with more than one means of restricting the time of operation, such as markings and a timer requiring an "off" cycle between uses, is to be tested for the maximum length of time or the maximum duty cycle allowed when any one time-restricting means is disabled or ignored.

b) Test No. 2: The regulating control or a single regulating and limiting control controlling an oil heater are to be defeated in such a manner as to result in the heater being operated continuously. The appliance is then to be operated pumping oil, as in the Normal Temperature Test, Section 44, except that when a switch prevents the operation of the heater and the pump simultaneously, the heater is to be operated heating oil starting at room temperature;

c) Test No. 3: The appliance is to be operated as in the Normal Temperature Test, Section 44, with a full load of oil. The pump is then to be stopped at a time when it is pumping oil, and the rotor of the pump motor is to be locked. The appliance is then to be operated continuously, or until a timer or equivalent device de-energizes the motor;

d) Test No. 4: When a heating element is provided that is intended to be immersed in the cooking oil, the appliance is to be operated in the heating mode with oil at various levels in the container, and with only a residual film of oil in the container. When the appliance is wired in such a way that the pump and heater are capable of operating simultaneously, this test is to be performed both with appliance pumping oil as in the Normal Temperature Test, Section 44, and with the heater only, heating oil starting at room temperature.

51 Abnormal Operation Test

51.1 An appliance that is capable of being operated in a dry condition shall not present a risk of fire, electric shock, or injury to persons when operated and tested in accordance with 51.3.

Exception No. 1: Filters provided with a momentary contact switch in accordance with 24.10 are not required to comply with this requirement.

Exception No. 2: An appliance provided with a liquid level switch, or a pressure-sensitive control so that the pump cannot operate with the oil intake supply interrupted is not required to comply with this requirement.

Exception No. 3: An appliance provided with a motor complying with the requirements in UL 1004-3, by means of a manual reset or single-use thermal protector is not required to comply with this requirement.

51.2 It is to be assumed that an appliance is capable of being operated in a dry condition when it does not incorporate a device that opens the supply circuit when the oil level or oil pressure falls below operating limits.

51.3 To determine when an appliance complies with the requirements in 51.1, it is to be installed in a manner representative of typical operation and allowed to pump from a limited oil supply until all oil capable of being removed is gone. Operation is to continue without adding oil for 7 hours or until ultimate results are obtained. Ultimate results are determined to be:

a) Stabilization of pump motor winding temperatures;

b) Burnout of the pump motor winding; or

c) Other results that do not lead to further risks of fire, electric shock, or injury to persons.

After cooling to ambient temperature, the appliance is to be operated for 10 minutes, pumping oil normally unless it is damaged so that oil cannot reach the impeller. The appliance shall comply with the