UL 621

STANDARD FOR SAFETY

Ice Cream Makers

UL Standard for Safety for Ice Cream Makers, UL 621

Seventh Edition, Dated May 7, 2010

SUMMARY OF TOPICS

This revision to ANSI/UL 621 dated September 16, 2020 includes the withdrawal and replacement of UL 508C with UL 61800-5-1; Table 17.2, 19.2.2, and 19.4.1

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated July 17, 2020.

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ANSI/UL 621-2020

UL 621

Standard for Ice Cream Makers

The First and Second editions were titled Ice Cream Freezers and Soda Fountain Units.

First Edition – January, 1961
Second Edition – April, 1973
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Seventh Edition

May 7, 2010

This ANSI/UL Standard for Safety consists of the Seventh Edition including revisions through September 16, 2020.

The most recent designation of ANSI/UL 621 as an American National Standard (ANSI) occurred on September 9, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 621 on February 25, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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INTRODUCTION

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INTRODUCTION

1 Scope

1.1 These requirements cover unitary ice cream makers designed for connection to alternating current circuits rated not more than 600 volts. For the purposes of this standard, ice cream makers include equipment for preparing products such as hard ice cream, soft serve ice cream, milk shakes, and sherbets and may include means for dispensing the product directly into containers.

1.2 Ice cream makers covered by these requirements employ sealed (hermetic type) motor compressors and air-cooled or water-cooled condensers.

1.3 These ice cream makers are intended to be installed in accordance with the National Electrical Code, NFPA 70, and the Safety Standard for Refrigeration Systems, ASHRAE 15.

2 General

2.1 Terminology

2.1.1 The term “ice cream maker” refers to any equipment covered by this standard unless specifically noted otherwise.

2.2 Components

2.2.1 *Deleted.*

2.2.2 *Deleted.*

2.2.3 *Deleted.*

2.2.4 *Deleted.*

2.3 Units of measurement

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

2.4 Undated references

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

3 Glossary

3.1 For the purpose of these requirements, the following definitions apply.

3.2 ACCESSORY – An optional electrical device or other component, intended for installation in or connection to an ice cream maker for the purpose of modifying or supplementing the functions of the ice cream maker. It may be factory installed or intended for installation by the user or service personnel.

3.2.1 CAPILLARY TUBE – Device made of tubing with an outer diameter of less than 3/16 in. (4.7 mm) and used to reduce the pressure of the refrigerant between the condenser and evaporator. It also regulates the refrigerant flow.

3.3 CIRCUITS, ELECTRICAL:

a) High-Voltage – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage circuit.

b) Low-Voltage (Class 2) – A circuit involving a potential of not more than 30 volts alternating current, 42.4 volts peak or 60 volts direct current, and supplied by:

1) A primary battery,

2) A standard Class 2 National Electrical Code, NFPA 70, transformer, or

3) A combination of a transformer and fixed impedance that, as a unit, complies with all performance requirements for a Class 2 transformer.

3.3.1 COMPONENT – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to the purpose. When incorporated in an appliance, equipment otherwise typically field installed (e. g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as thermoplastic or copper, are not considered components.

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

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

3.4 ENCLOSURE– That part of an appliance that by itself or in conjunction with barriers:

a) Renders inaccessible all or any part of the unit that may otherwise present risk of electric shock,

b) Reduces the risk of contact with parts that may cause injury to persons, and/or,

c) Prevents propagation of flame initiated by electrical disturbances occurring within the unit.

A unit cabinet that serves as sole enclosure for ignition sources is considered to be a group 1 enclosure. Separate enclosures located within or mounted on the outer surface of the unit cabinet are considered group 1 enclosures if they serve as a sole enclosure for ignition sources.

3.5 FUNCTIONAL/STRUCTURAL PART – A part used to maintain the intended relative physical position of fixed or moving parts, or maintain the integrity of the structure. A cabinet liner that supports an electrical component is considered to be a functional part.

3.6 NONFUNCTIONAL PART – A part, such as thermal insulation or decorative material, that does not serve as electrical insulation or to support or enclose electrical components, maintain electric spacings, or protect against injury to persons.

3.7 OPERATING CONTROL – A control intended to start, regulate, or operate the appliance during normal operation. An example would be a thermostat or temperature controller.

3.8 PROTECTIVE (SAFETY) CONTROL – A control intended to prevent the risk of electric shock, fire, or injury to persons, typically during abnormal operation of the appliance. Examples would be a pressure limiting control (pressure cut-out) or a temperature limiting control (thermal cut-out).

3.9 SELF-CONTAINED ICE CREAM MAKER – Unitary equipment consisting of a complete factory-assembled and factory-tested refrigerating system in which all of the refrigerant-containing parts are permanently connected at the factory.

3.10 ULTIMATE STRENGTH – The highest stress level that a refrigerant-containing component can tolerate without rupture.

3.11 UNITARY ICE CREAM MAKER – Equipment consisting of a complete factory-assembled and factory-tested refrigerating system comprising one or more assemblies that:

a) May be shipped separately, but

b) Are intended to be used together.

3A Definitions Relating To Classes Of Control Functions

3A.1 For the evaluation of protective measures for fault tolerance and avoidance of hazards it is necessary to classify control functions with regard to their fault behavior.

3A.2 At the classification of control functions their integration into the complete safety concept of the appliance shall be taken into account.

3A.3 A control function consists of the entire loop beginning with the sensing means through the processing circuitry (hardware and software if used) and including the actuator drive.

3A.4 For the purpose of evaluating the design of a control function, present requirements recognize three distinct classes:

3A.5 CLASS A CONTROL FUNCTION – Control function which is not intended to be relied upon for the safety of the application. Examples include room thermostats and temperature control.

3A.6 CLASS B CONTROL FUNCTION – Control function which is intended to prevent an unsafe state of the appliance. Failure of the control function will not lead directly to a hazardous situation. Examples include temperature limiting control (thermal cut-out) and pressure limiting control (pressure cut-out).

NOTE This equates to Software Class 1 in UL 1998.

3A.7 CLASS C CONTROL FUNCTION – Control functions which is intended to prevent special hazards such as explosion or whose failure could directly cause a hazard in the appliance. Examples include burner control systems and thermal cut-outs for closed water systems (without vent protection).

CONSTRUCTION

4 General

4.1 Ferrous metal parts used to support or retain electrical components in position shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting.

Exception: This requirement does not apply to parts, such as washers, screws, bolts, and the like, where corrosion of such unprotected parts would not affect compliance with the requirements of this standard.

4.2 Lead base paints, cadmium, antimony, bismuth, and similar toxic materials shall not be employed on parts that come in contact with the ingredients or end-product of an ice cream maker.

4.3 A component shall:

a) Comply with the safety standard covering that component;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability;

d) Comply with the applicable requirements of this end product standard; and

e) Not contain mercury.

Exception: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product, or

b) Is superseded by a requirement in this standard, or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

4.4 A component that is also required to perform other necessary functions, such as overcurrent protection, ground-fault circuit interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) covering products that provide those functions.

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

5 Assembly

5.1 General

5.1.1 If an ice cream maker is provided in more than one assembly, the separate assemblies shall be constructed to be used together, and the requirements of this standard are based on the use of matched assemblies. Interconnection of the assemblies shall result in a complete factory-charged refrigerating system.

5.1.2 An ice cream maker incorporating a condensing unit of the pull-out type shall be constructed so that the condensing unit can be pulled out and reinserted without kinking or otherwise damaging the refrigerant tubing; and without pinching, abrading, or stressing electrical wires and cords.

5.1.3 An ice cream maker shall be assembled so that removal and replacement of tanks and containers, replenishment of the product, and the like, will not result in damage to electrical components and wiring, or to refrigerant-containing components.

5.1.4 An ice cream maker having provision for the storage of product cylinders or the like shall be provided with means for securely retaining the cylinders in position.

5.2 Pressurized product system

5.2.1 All parts of a product system pressurized by a pump or by compressed gas provided with an ice cream maker shall comply with the requirement of 57.1.9 or 57.1.10.

5.2.2 A gas pressure regulator or reducing valve shall:

a) Comply with the requirements of 4.3, or

b) Be tested for the application.

5.2.3 A pressure-relief valve shall be installed in the gas pressurized product system of the ice cream maker. There shall be no shutoff valve between the relief valve and any parts of the system under pressure. See 57.1.9.

Exception: A pressure relief valve is not required provided:

a) The system consists only of tubing, or hose, or both, with or without dispensing valves,

b) The ice cream maker is marked in accordance with 67.24, and

c) The system complies with the strength requirement of 57.1.9.

5.2.4 Pressure relief devices in a pressurized product system shall be positioned, located, or baffled so that moisture discharged through the relief device will not wet uninsulated live parts.

5.3 Mechanical protection

5.3.1 A slideout product storage component, such as a drawer or shelf shall be restrained to prevent its being unintentionally pulled free of supporting means. See Component Restraint Test, Section 59.

5.3.2 Electrical components shall be located or enclosed so that live parts will not be wetted by liquids due to accumulation, overflow, splashing, leakage, or cleaning.

5.3.3 A drippage or drain pan shall be constructed and located so that overflow due to a blocked drain will not wet live parts or film-coated wire.

5.3.4 An overflow spout, drain hole, cutout, or the like, in the drippage or drain pan may be acceptable for preventing dripping of liquid on electrical parts. The Overflow Test, Section 47, is to be conducted if it is not evident that the ice cream maker complies with the requirements of 5.3.3.

5.3.5 A switch, lampholder, an attachment-plug receptacle, or similar component, shall be secured in position and shall be prevented from rotating. See 5.3.6.

Exception No. 1: The requirement that a switch be prevented from rotating will be waived upon compliance with all of the following conditions:

a) The switch shall be of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to rotate the switch during the operation of the switch.

b) Means of mounting the switch make it unlikely that operation of the switch will loosen it.

c) Electrical spacings shall not be reduced below the minimum required values if the switch rotates.

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

Exception No. 2: A lampholder of a type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation cannot reduce electrical spacings below the minimum acceptable values. See Spacings, Sections 29 and 30.

5.3.6 The means for preventing rotation mentioned in 5.3.5 is to consist of more than friction between surfaces. A toothed lock washer that provides both spring takeup and an interference lock is acceptable as means for preventing a small stem-mounted switch or other device intended for single-hole mounting from rotating.

5.3.7 An uninsulated current-carrying part, or a part that supports a live part, shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of electrical spacings below the minimum acceptable values. See Spacings, Sections 29 and 30. Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part, but a lock washer as described in 5.3.6 is acceptable.

5.3.8 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated live parts. See Insulation Resistance Test, Section 54.

6 Accessibility Of Uninsulated Live Parts, Film-Coated Wire, Moving And Hot Parts

6.1 Uninsulated live parts, film-coated wire, moving parts, and hot parts shall be guarded or enclosed. Except as indicated in 6.2 or 6.4, such parts are considered to be enclosed when:

a) An opening has a minor dimension (see 6.7) less than 1 inch (25.4 mm), and such a part or wire is not contacted by the probe illustrated in Figure 6.1, and

b) An opening has a minor dimension of 1 inch (25.4 mm) or more, such a part or wire is spaced from the opening as specified in Table 6.1.

Exception: A product fill or discharge opening located in the front of a dispensing type ice cream maker is considered to comply when:

a) The diameter of the opening is less than 2-1/2 inches (63.5 mm) or the maximum diagonal dimension of the opening is less than 3 inches (76.2 mm),

b) The distance form a moving part that can cause injury to persons to the nearest edge of the plane of the opening is at least 4 inches (101.6 mm),

c) The opening is closed except when filling or discharging the product, and

d) A warning marking, as described in 67.18, is located on the ice cream maker.

6.2 Moving parts that are necessarily exposed to perform the work function are not required to be enclosed but, where necessary, shall be provided with guarding. The degree of protection shall be based upon the construction and intended use of the machine.

6.3 In accordance with 6.2 the extent of guarding shall be based on the following factors:

a) The degree of exposure necessary to perform the intended function;

b) The sharpness of the moving part;

c) The likelihood of unintentional contact with the moving part;

d) The speed of the moving part; and

e) The risk:

1) That a part of the body could be endangered; or

2) That clothing could be entangled, resulting in injury to persons.

The above factors are to be considered with respect to both intended operation and reasonable foreseeable misuse of the machine.

Figure 6.1

Articulate probe with web stop

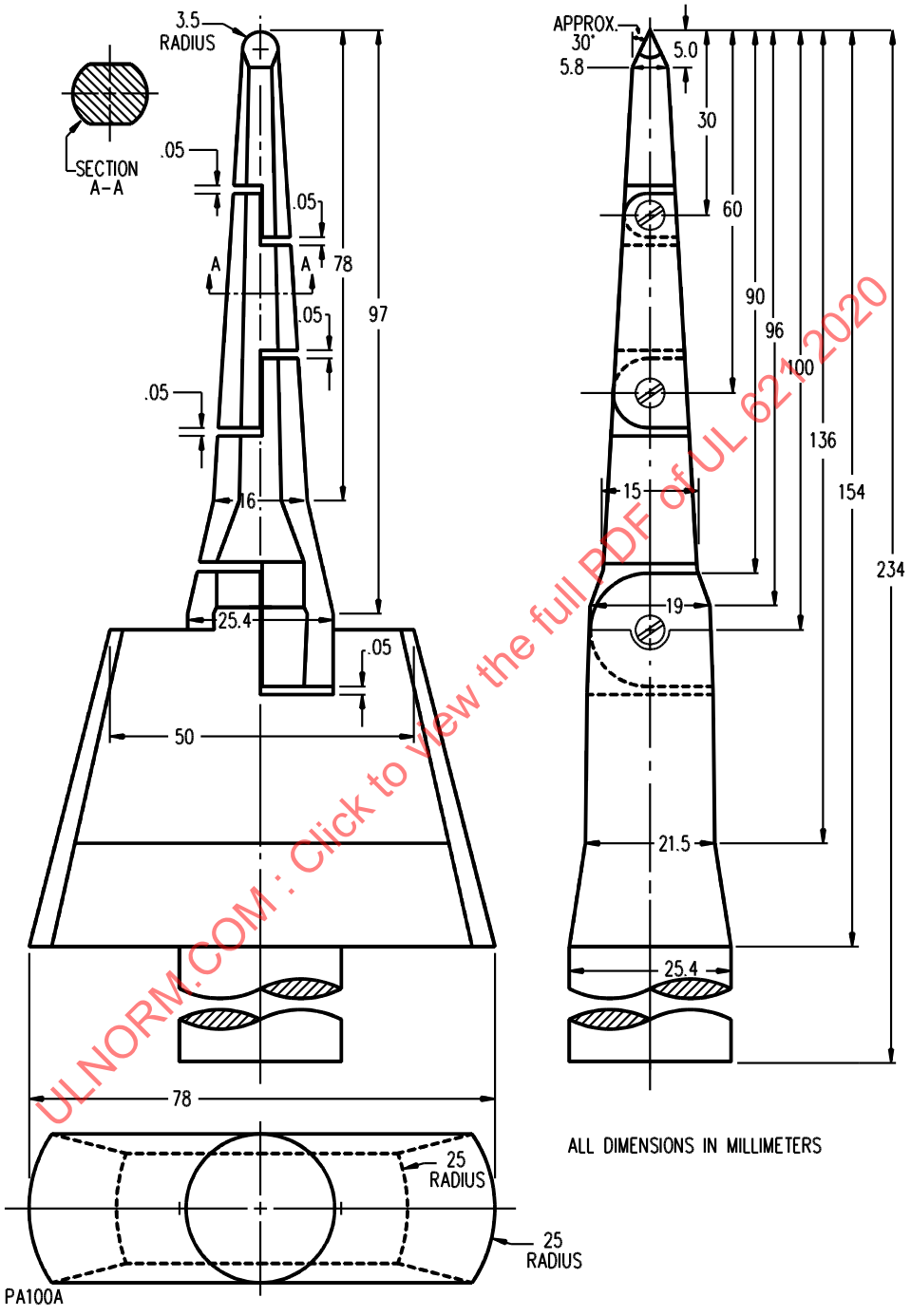


Table 6.1
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension[a] of opening,		Minimum distance from opening to part,	
inches	(mm)[b]	inches	(mm)[b]
3/4[c]	(19.1)	4-1/2	(114.0)
1[c]	(25.4)	6-1/2	(165.0)
1-1/4	(31.8)	8-1/2	(190.0)
1-1/2	(38.1)	10-1/2	(267.0)
2[e]	(50.8)	14-1/2	(388.0)
2-1/4[d]	(57.2)	16-1/2	(419.0)
2-1/2[d]	(63.5)	18-1/2	(470.0)
2-3/4[d]	(69.9)	20-1/2	(521.0)
3[d]	(76.2)	22-1/2	(572.0)
Over 2[e]	(over 50.8)	30	(762.0)

[a] See 6.6.

[b] For an opening between two of the values shown, the distance from the opening to the part shall be not less than that found by interpolation between the corresponding values shown in the applicable column.

[c] Any dimensions less than 1 inch (25.4 mm) applies to a motor only.

[d] These values apply to openings at the base of the ice cream makers where the upper edge of the opening is less than 8 inches (203 mm) above the floor. The ice cream maker shall be in its intended operating position.

[e] More than 2 inches (50.8 mm), but not more than 3 inches (76.2 mm).

6.4 With regards to an integral enclosure of a motor:

a) An opening that has a minor dimension (see 6.7) less than 3/4 inch (19.1 mm) is acceptable if:

1) A moving part cannot be contacted by the probe illustrated in Figure 6.2;

2) Film-coated wire cannot be contacted by the probe illustrated in Figure 6.3;

3) In a directly accessible motor (see 6.8), an uninsulated live part cannot be contacted by the probe illustrated in Figure 6.4; and

4) In an indirectly accessible motor (see 6.8), an uninsulated live part cannot be contacted by the probe illustrated in Figure 6.2.

b) An opening that has a minor dimension of 3/4 inch (19.1 mm) or more is acceptable if a part or wire is spaced from the opening as specified in Table 6.1.

Figure 6.2

Probe for moving parts and uninsulated live parts

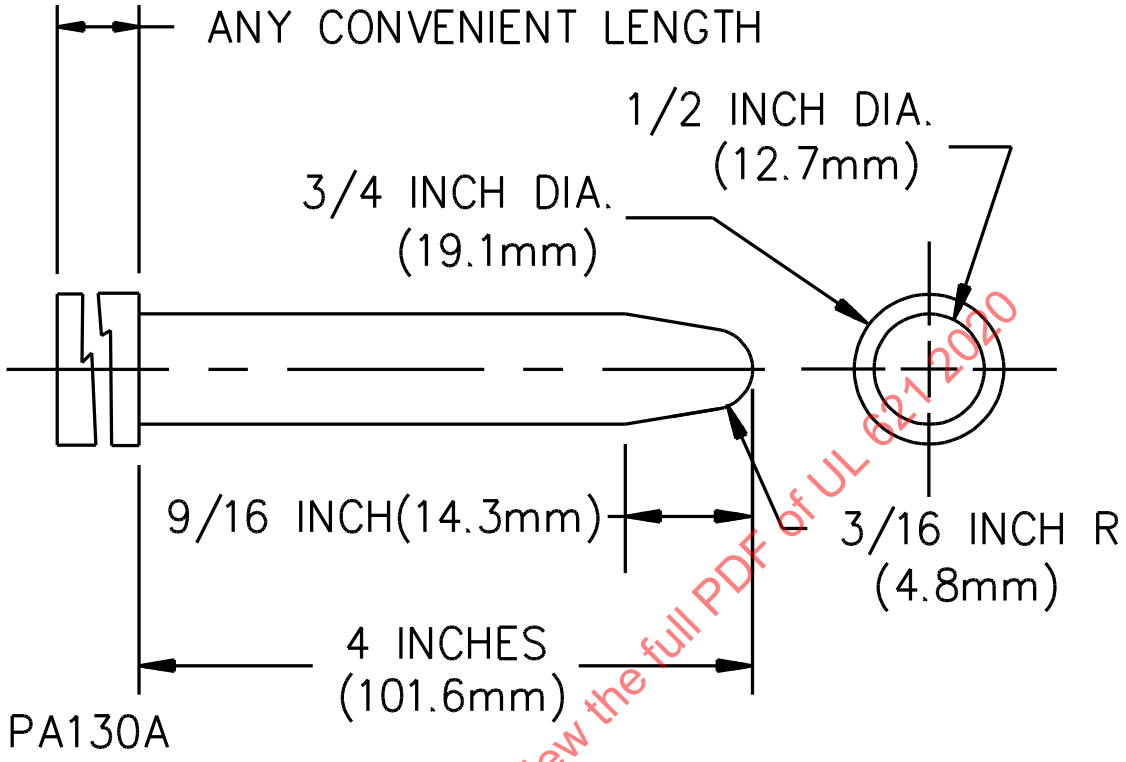


Figure 6.3

Probe for film-coated wire

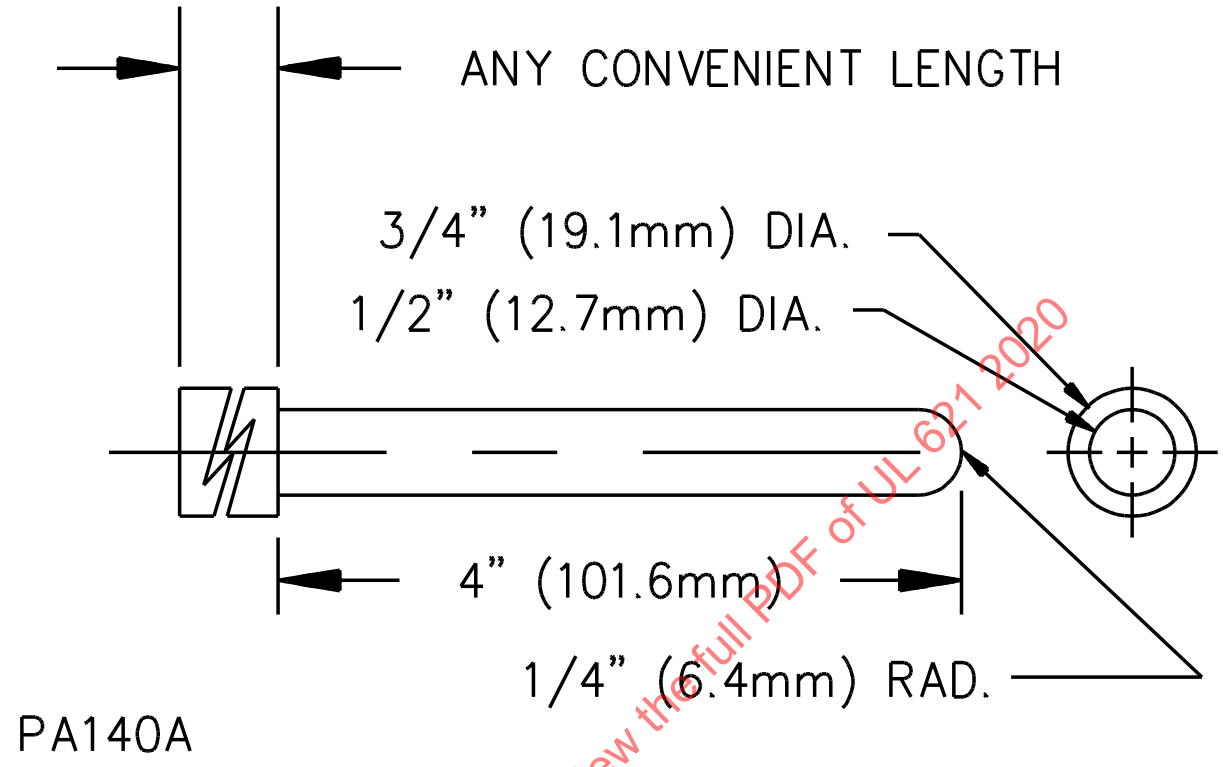
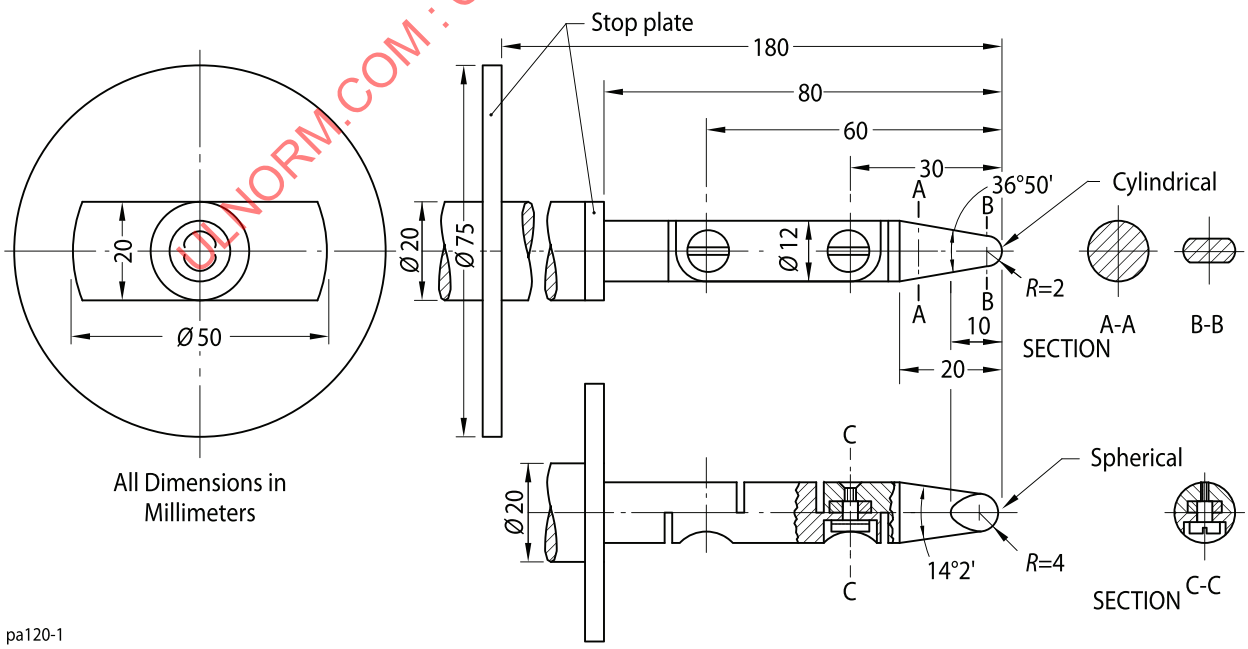


Figure 6.4

IEC articulate probe



6.5 The probes mentioned in 6.1 and 6.4 and illustrated in Figure 6.1 – Figure 6.4 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figure 6.1 and Figure 6.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

6.6 The probe mentioned in 6.5 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

6.7 With reference to the requirement in 6.1 and 6.4, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening with a 2-1/2 pound-force (11.1 N).

Exception: No force is applied to the probe to determine the minor dimension of openings in a motor.

6.8 With reference to the requirements in 6.4, an indirectly accessible motor is a motor:

a) That is accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool, or

b) That is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A directly accessible motor is a motor:

a) That can be contacted without opening or removing any part, or

b) That is located so as to be accessible to contact.

6.9 During the examination of the ice cream maker to determine whether it complies with the requirements in 6.1 or 6.4, a part of the enclosure that may be opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

Exception: A freezing cylinder cover plate, that is, the plate in direct contact with the product chamber need not be opened or removed provided that:

a) Moving parts within the freezing cylinder do not present the risk of injury due to pinching or shearing action with the cover plate removed, such as may occur with counter-rotating mixer blades,

b) Product dispensing openings through the cover plate comply with 6.1 with the cover plate in place, and

c) A warning marking, as described in 67.16 is located on or adjacent to the freezing cylinder cover plate where it will be visible before removal of the cover plate.

6.10 With reference to the requirements in 6.1 and 6.4, insulated brush caps are not required to be additionally enclosed.

6.11 When tested according to the Temperature-Pressure Test, Section 43, surfaces that exceed the temperature rise of Table 43.1 D(2) and D(3) shall be guarded as specified in 6.1.

6.12 A moving or hot part is not to be considered when determining compliance with 6.1 and 6.4 if:

a) The part is unlikely to be contacted through the opening because of the location of fixed components, including baffles, or

b) The part is made inoperative when exposed, through the use of interlocking devices.

6.13 A live part is not to be considered when determining compliance with 6.1 and 6.4 if the part is made inoperative when exposed, through the use of interlocking devices.

6.14 Uninsulated high-voltage live parts located inside the enclosure that are likely to be contacted by persons performing operations such as refilling, relamping, replacing fuses, resetting manual-reset devices, oiling motors, or other such intended service operations, shall be located, guarded or enclosed, to reduce the risk of unintentional contact unless tools are required to expose the live part.

7 Accessories

7.1 An ice cream maker having provisions for the use of electrical accessories to be attached in the field shall comply with all requirements of this standard with or without the accessory installed.

7.2 Installation of accessories by the user shall be restricted to an arrangement that can be accomplished by means of receptacles and plug-in connectors.

7.3 Installation of accessories by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals.

7.4 Installation of accessories shall not require the cutting of wiring or the soldering of connections by the installer. Installation shall not require cutting, drilling, or welding either in (1) electrical enclosures or (2) other areas where such operations may result in damage to electrical or refrigeration components and wiring within the enclosure.

7.5 Strain-relief means shall be provided for the wiring in the accessory if there is a possibility of transmitting stress to the terminal conditions during installation. See 10.4.9.

7.6 All terminals and wiring intended to be field connected shall be identified on the:

a) Accessory,

b) Ice cream maker if connections are made between the accessory and the ice cream maker, and

c) Wiring diagram.

7.7 The mounting location of the accessory shall be indicated on the ice cream maker.

Exception: If the mounting location is fixed due to the function of the accessory and arrangement of the ice cream maker, and instructions are provided covering the installation and location for the accessory, the mounting location of the accessory need not be indicated on the ice cream maker.

7.8 As part of the investigation, accessories are to be trial-installed to determine that their installation is feasible, and that the instructions are detailed and correct.

8 Enclosures

8.1 General

8.1.1 An enclosure shall be formed and assembled so that it will have the strength and rigidity necessary to resist the conditions of intended use without total or partial collapse and the resulting reduction of spacings, loosening or displacement of parts, or other defects. Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be considered in determining compliance with this requirement.

8.1.2 Among the factors that are taken into consideration when judging the acceptability of an enclosure are:

a) Mechanical strength,

b) Resistance to impact,

c) Moisture-absorptive properties,

d) Flame resistance,

e) Resistance to distortion at temperatures to which the material may be subjected under conditions of use, and

f) Resistance to corrosion.

For a nonmetallic enclosure or part of an enclosure, all of these factors are to be considered with respect to aging.

8.1.3 The enclosure(s) of an ice cream maker shall reduce the risk of mechanical damage to wiring, electrical components, and refrigerant tubing.

8.1.4 The enclosure shall reduce the risk of emission of molten metal, burning insulation, flaming particles, or the like, through openings onto flammable material, including the surface over which the ice cream maker is mounted.

8.1.5 Components, such as controls, solenoids, starting relays, and switches, shall be individually enclosed except as terminals, unless it can be determined that malfunction of an electrical component will not result in:

a) Emission of flame or molten metal from the ice cream maker, or

b) Glowing or flaming of flammable material. See Burnout Tests – Components, Section 49.

Exception: Electrical parts within the outer cabinet need not be individually enclosed if the assembly complies with (a) – (c).

a) Their design and location with respect to openings in the outer cabinet will not result in the emission of flame or molten metal through openings in the cabinet, or if it can be shown that failure of the component would not result in:

1) Emission of flame or molten metal, or

2) Glowing or flaming of flammable material.

b) There are no openings in the bottom of the compartment in which the part is located that would permit dropping of molten metal, or the like onto flammable material, and

c) The part is not in proximity to flammable material other than electrical insulation.

8.1.6 A sheet metal enclosure is to be evaluated with respect to its size, shape, metal thickness, and use in a particular application. Sheet steel shall be not less than 0.026 inch (0.66 mm) thick if uncoated or 0.029 inch (0.74 mm) thick if galvanized, and nonferrous sheet metal shall be not less than 0.036 inch (0.91 mm) thick, except for relatively small areas or for surfaces that are curved or corrugated or otherwise reinforced such as by angles, channels, flanges, or ribs.

8.1.7 Sheet metal to which a wiring system is to be connected in the field shall be not less than 0.032 inch (0.81 mm) thick if uncoated steel, not less than 0.034 inch (0.86 mm) thick if galvanized steel, and not less than 0.045 inch (1.14 mm) thick if nonferrous.

8.1.8 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed, there shall be not less than three or more than five threads in the metal, and the construction of the device shall be such that a conduit bushing can be attached. If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall be not less than 3-1/2 threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors that shall:

a) Afford protection to the conductor equivalent to that provided by a standard conduit bushing and

b) Have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

8.1.9 A knockout in a sheet metal enclosure shall be secured in place, but shall be capable of being removed without deformation of the enclosure that would result in damage to electrical components, reduction in electrical spacings, or both. See 8.1.10.

8.1.10 A knockout shall remain in place when a force of 10 pounds (44.5 N) is applied at right angles to the knockout by a 1/4-inch (6.4-mm) diameter mandrel with a flat end. The mandrel shall be applied at the point most likely to cause movement of the knockout.

8.1.11 A knockout shall be provided with a flat surrounding surface for seating of a conduit bushing and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those required.

8.1.12 In measuring a spacing between an uninsulated live part and a bushing installed in a knockout, it is to be assumed that a bushing having the dimensions indicated in Table 8.1 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 8.1
Knockout or hole sizes and dimensions of bushings

Trade size of conduit,		Knockout or hole diameter,		Bushing dimensions			
				Overall diameter,		Height,	
inches	mm O.D.	inches	(mm)	inches	(mm)	inches	(mm)
1/2	21.3	7/8	(22.2)	1	(25.4)	3/8	(9.5)
3/4	26.7	1-3/32	(27.8)	1-15/64	(31.4)	27/64	(10.7)

Table 8.1 Continued on Next Page

Table 8.1 Continued

Trade size of conduit,		Knockout or hole diameter,		Bushing dimensions			
				Overall diameter,		Height,	
inches	mm O.D.	inches	(mm)	inches	(mm)	inches	(mm)
1	33.4	1-23/64	(34.5)	1-19/32	(40.5)	33/64	(13.1)
1-1/4	42.3	1-23/32	(43.7)	1-15/16	(49.2)	9/16	(14.3)
1-1/2	48.3	1-31/32	(50.0)	2-13/64	(56.0)	19/32	(15.1)
2	60.3	2-15/32	(62.7)	2-45/64	(68.7)	5/8	(15.9)

8.1.13 Steel enclosures shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting.

8.2 Doors and covers

8.2.1 A service cover or panel in the outer enclosure shall require the use of tools for removal or shall be provided with an interlocking mechanism if it gives access to unenclosed uninsulated live parts or moving parts that may cause injury to persons.

8.2.2 An interlocking mechanism that:

a) Must be engaged in the closed position of the cover before parts are energized and

b) Will secure the cover in the closed position when engaged is considered to comply with the requirements of 8.2.1.

8.2.3 A hinged or pivoted panel or cover shall be positioned or arranged so that when it is in an open position, it is not subject to falling or swinging due to gravity or vibration that can cause injury to persons from:

a) The panel or cover,

b) Moving parts, or

c) Uninsulated live parts that can cause a risk of electric shock.

8.2.4 The assembly shall be arranged so that an overcurrent protective device, such as a fuse, can be replaced and manual-reset devices can be reset:

a) Without removing parts other than a service cover(s) or panel(s), and

b) By opening the cover or door enclosing the device.

8.2.5 A required protective device shall not be accessible from outside the enclosure except by opening a door or cover.

Exception: The operating handle of a circuit breaker, the reset button of a manually resettable motor protector, the reset button of a manually resettable pressure switch, and similar parts may project outside the enclosure.

8.2.6 An opening in an outer enclosure around a handle, reset button, or other control member is acceptable if the clearance between the control member and the edge of the opening is not more than 1/8 inch (3.2 mm) for any setting or position of the control member.

8.2.7 Covers for enclosures of fuses in high-voltage circuits shall be hinged. Covers for manual-reset overload protective device enclosures shall be hinged if it is necessary to open the cover to reset the device.

Exception: A hinged cover is not required where the only fuses enclosed are:

a) Supplementary type control circuit fuses, provided that 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) Supplementary type fuses of 2 amperes or less for small auxiliary resistance heaters, such as crankcase heaters, with a maximum rating of 100 watts; or

c) An extractor-type fuse with its own enclosure; or

d) Fuses in low-voltage circuits.

8.2.8 Hinged covers, where required, shall not depend solely upon screws or other similar means to hold them closed, but shall be provided with a latch or the equivalent.

8.2.9 A spring latch, magnetic latch, dimple, or any other mechanical arrangement that will hold the door in place and will require some effort on the user's part to open it is acceptable for holding the door in place as required in 8.2.8. When provided as the sole means for securing the cover or panel, a cover interlocking mechanism as described in 8.2.2 is considered to comply with the requirements of 8.2.8.

8.2.10 A door or cover giving direct access to fuses in other than low-voltage circuits shall shut closely against a 1/4-inch (6.4-mm) rabbet or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the wall of the box and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A special construction, such as a fuse enclosure, located within an outer enclosure, or a flange and rabbet combination that affords the equivalent protection is acceptable.

8.2.11 Strips used to provide rabbets, or angle strips fastened to the edges of a door, shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

9 Nonmetallic Materials

9.1 General

9.1.1 The requirements in 9.1.2 – 9.3.5 cover polymeric and wood materials used to form outer enclosures, nonfunctional or functional parts, and miscellaneous parts for indoor use only. Nonmetallic materials for outdoor use shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Table 62.1 indicates the properties to be evaluated. These requirements do not apply to materials used as electrical insulation, or as a direct support of an uninsulated live parts, nor small nonfunctional parts, such as control knobs, buttons, insulating bushings, resilient mounts, clamps and wiring straps. As a guide, small nonfunctional parts may be considered as those having an area of less than 1 square foot (0.0903 m^2).

9.1.2 Nonmetallic materials that serve as electrical insulation or direct support of live parts shall comply with the requirements for electric insulation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

9.1.3 Wood or wood composite materials used to form outer enclosures, structural or functional parts shall be evaluated for the equivalent flammability characteristics as described in 9.2.1 and shall be separated from ignition sources.

Exception: Wood or wood composite materials having a minimum thickness of 0.5 inch (12.7 mm) are considered to comply with the HB flammability rating.

9.1.4 Ignitions sources within the unit are considered to be:

a) High voltage uninsulated terminals,

b) High voltage printed circuit board traces,

c) High voltage open coils/windings,

d) High voltage open contacts, and

e) High voltage wiring not employing VW-1 insulation.

Exception No. 1: High voltage Type S, SE, SO, SOO, ST, STO, STOO, SJ, SJE, SJO, SJOO, SJT, SJTO, AND SJTOO power cords not located within the group 1 enclosure are not considered ignition sources.

Exception No. 2: Impedance protected motors employing open-coil or exposed winding constructions need not be separated as indicated in 9.3.1 and 9.3.3 if they comply with the Burnout Test – Impedance Protected Motors, Section 61.

Exception No. 3: Thermally protected motors having openings in their enclosures need not be separated as indicated in 9.3.1 and 9.3.2 if they comply with the requirements in 18.3.

Exception No. 4: Transformers complying with the requirements in Section 27 need not be separated.

9.1.5 Polymeric parts shall not be molded from polymeric material that contains more than 25 percent thermoplastic regrind by weight and that has been dry blended by the molder with the same grade of virgin material, unless the material complies with these requirements to indicate acceptable performance for the specific part.

Exception: Parts that are formed from HB or HBF materials need not comply.

9.2 Classification

9.2.1 Materials are classified with respect to flammability characteristics that are established by the tests specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. Materials are assigned flammability ratings based on greatest to least resistance to flame and are identified as: 5VA, 5VB, V-0, V-1, V-2, HF-1, HF-2, HB, and HBF.

9.3 Application

9.3.1 A nonmetallic enclosure isolating an ignition source(s) shall be evaluated in accordance with Group 1 of Table 62.1. A nonmetallic enclosure not isolating an ignition source shall be evaluated in accordance with Group 2.

9.3.2 Nonmetallic functional and nonfunctional parts located within or mounted to the outer unit cabinet shall be evaluated in accordance with Groups 3 and 4 of Table 62.1.

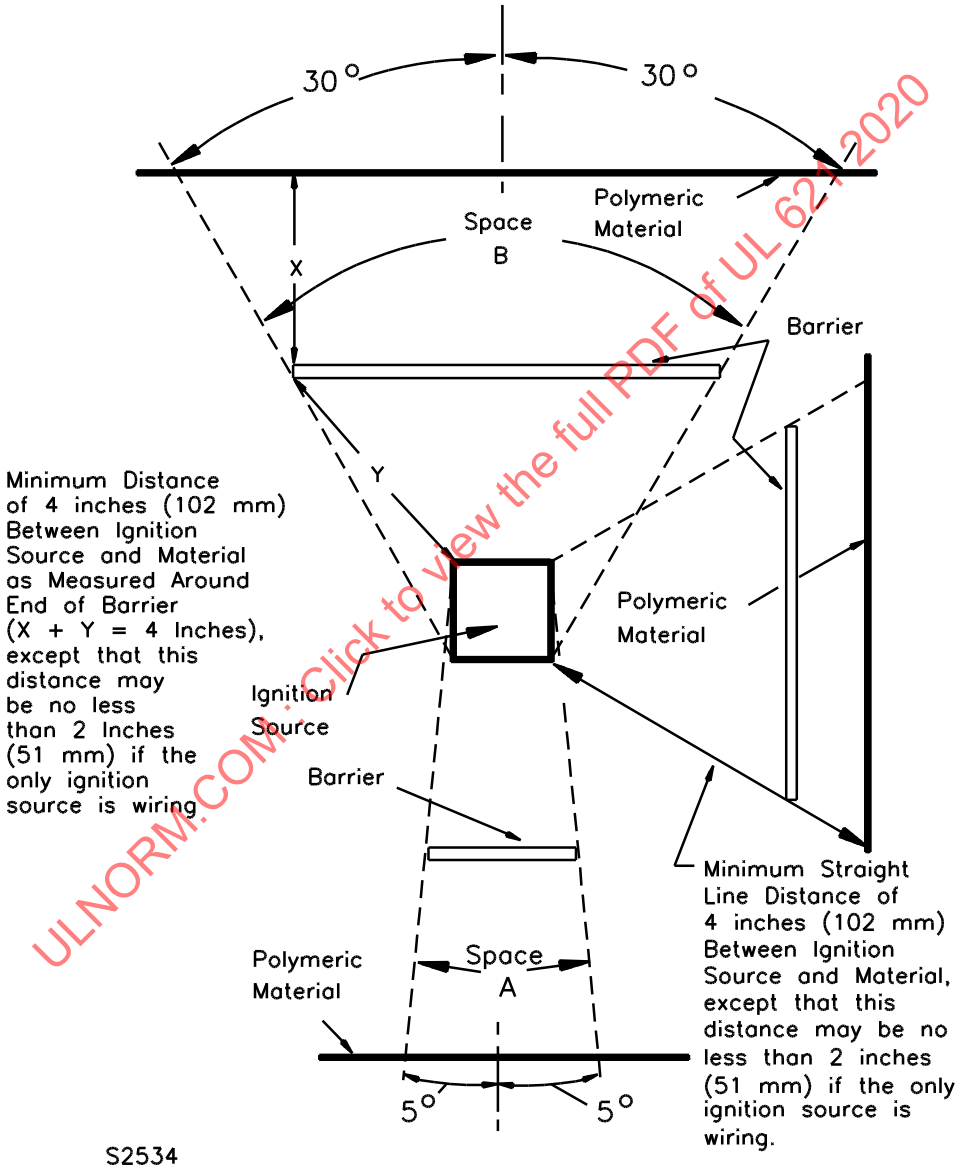
9.3.3 With respect to footnotes c, d, and h of Table 62.1 a nonmetallic material located below the ignition source and within Space A of Figure 9.1 shall be isolated by means of a barrier, extending at least to the boundary surface of the space. A V-2, V-1, or V-0 nonmetallic material located above the ignition source and within Space B of Figure 9.1 shall be isolated by means of a barrier, extending at least to the boundary

surface of the space and so located that the minimum distance between the nonmetallic material and ignition source is 4 inches (102 mm).

Exception: When the only ignition source is wiring not employing VW-1 insulation the minimum distance between the nonmetallic material and the ignition source may be 2 inches (51 mm). See 9.3.5.

Figure 9.1

Separation of ignition sources from nonmetallic materials



Notes:

Space A – Represents the volume below the ignition source determined by a straight line that moves about the ignition source while remaining at an angle of 5 degrees from the vertical and is always so oriented that the volume is maximum.

Space B – Represents the volume above the ignition source determined in the same manner as Space A, except that the angle is 30 degrees from the vertical.

9.3.4 With respect to footnotes c, d, and h of Table 62.1 a nonmetallic material located in the vertical plane is considered isolated from the ignition source if it is separated by a distance of 4 inches (102 mm). A barrier shall be used for isolation when the size of the barrier is such that the minimum straight-line distance between the nonmetallic material and ignition source is 4 inches (102 mm).

Exception: When the only ignition source is wiring not employing VW-1 insulation the minimum distance between the nonmetallic material and the ignition source may be 2 inches (51 mm). See 9.3.5.

9.3.5 When required by 9.3.3 or 9.3.4, a barrier shall be formed from a minimum 0.005 inch (0.13 mm) thick metal, a minimum 0.5 inch (12.7 mm) thick fiberglass, a 5VA material, or a material that complies with the 5-inch end product flame test described in UL 746C. The barrier shall be secured in place to the mounting surface.

9.3.6 *Deleted.*

10 Field Supply Connections

10.1 General

10.1.1 If an ice cream maker is intended to be connected to the conductor identified as the grounded conductor of a power-supply circuit, a lampholder with a screw-shell base shall be wired so that the screw shell will be connected to that conductor.

10.1.2 A single-pole switching device shall not be connected to the grounded conductor.

10.1.3 An automatic control that does not have a marked “OFF” position is not required to comply with 10.1.2.

10.2 Permanently connected ice cream makers

10.2.1 Ice cream makers of the following types shall have provision for permanent connection to the power supply:

a) Units rated in excess of 250 volts.

b) Units having a rated-load current as determined by the largest sum of concurrent loads shown on the nameplate exceeding 16 amperes.

Exception: An ice cream maker complying with 10.4.4 may employ a power supply cord.

c) Units other than of the self-contained type.

10.2.2 As used in 10.2.3 – 10.3.12, field-wiring terminals are considered to be the terminals to which power supply, control, or equipment grounding connections will be made in the field when the ice cream maker is installed.

10.2.3 An ice cream maker shall have provision for connection of one of the wiring systems, in accordance with the National Electrical Code, NFPA 70, that would be acceptable for it.

10.2.4 A knockout for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 10.1.

10.2.5 Space shall be provided in the field-wiring compartment or outlet box for installation of conductors of the number and size required by 10.2.8. The space provided shall permit the required number and size

of at least 6-inch (150-mm) lengths of Type TW or THW wire to be brought into the wiring compartment. If necessary, a trial installation is to be made.

Exception: Conductors other than Type TW or THW may be used if specified in the installation instructions.

10.2.6 The location of a terminal box or compartment in which power supply connections are to be made shall permit these connections to be inspected after the ice cream maker is installed. The connections are to be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

10.2.7 A terminal compartment intended for the connection of a supply raceway shall be secured in position and shall be prevented from turning.

10.2.8 The ice cream maker shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity of not less than that indicated in 68.9. It is to be assumed that branch circuit conductors rated 60°C will be used.

Table 10.1
Trade size of conduit in inches (mm OD)

Wire size,		Number of wires									
AWG	(mm^2)	2		3		4		5		6	
14	(2.1)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)
12	(3.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
10	(5.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)
8	(8.4)	3/4	(26.7)	3/4	(26.7)	3/4	(26.7)	1	(33.4)	1	(33.4)
6	(13.3)	3/4	(26.7)	1	(33.4)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)
4	(21.2)	1	(33.4)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)
3	(26.7)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)	1-1/2	(48.3)
2	(33.6)	1	(33.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)	2	(60.3)
1	(42.4)	1-1/4	(42.3)	1-1/4	(42.3)	1-1/2	(48.3)	2	(60.3)	2	(60.3)

NOTE – This table is based on the assumption that all conductors will be of the same size and there will be no more than six conductors in the conduit. If more than six conductors will be involved of if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of type THW wire.

10.3 Terminals and leads

10.3.1 A field-wiring terminal shall be secured in position and prevented from turning or shifting by means other than friction between surfaces. This may be accomplished by means such as two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part.

10.3.2 For 8 AWG (5.3 mm^2) and larger conductors, pressure wire connectors shall be used. For 10 AWG (3.3 mm^2) and smaller conductors, the parts to which wiring connections are to be made may consist of clamps or wire binding screws with cupped washers, terminal plates, or the equivalent to hold the wire in position.

10.3.3 A wire binding screw at a field-wiring terminal shall be not smaller than No. 8 (4.2 mm diameter), except that a No. 6 (3.5 mm diameter) screw may be used for the connection of one 14 AWG (2.1 mm^2) or smaller conductor.

10.3.4 It should be noted that according to the National Electrical Code, NFPA 70, 14 AWG (2.1 mm^2) is the smallest conductor that the installer may use for branch circuit wiring and thus is the smallest conductor that may be anticipated at a terminal for the connection of a power-supply wire.

10.3.5 A terminal plate for a wire binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick for a 14 AWG (2.1 mm^2) or smaller wire and not less than 0.050 inch (1.27 mm) thick for a wire larger than 14 AWG. In either case, there shall be not less than two full threads in the metal.

10.3.6 A terminal plate formed from stock having the minimum required thickness may have the metal extruded at the hole tapped for the binding screw to provide two full threads.

Exception: Two full threads are not required if a lesser number of threads results in a connection in which the threads will not strip when tightened in accordance with the torques indicated in the Standard for Wire Connectors, UL 486A-486B, as applicable.

10.3.7 Upturned lugs or a cupped washer shall retain a conductor of the size mentioned in 10.2.8 and 68.12, but no smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

10.3.8 A wire binding screw shall thread into metal.

10.3.9 A field-wiring terminal intended for the connection of a grounded conductor shall be made of, or plated with, a metal substantially white in color and shall be readily distinguishable from the other terminals, or identification of that terminal shall be shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded conductor shall be finished to show a white or gray color, shall be readily distinguishable from other leads, and no other lead shall be so identified.

10.3.10 The length of a lead inside an outlet box or wiring compartment shall be 6 inches (152 mm) or more if the lead is intended for field connection to an external circuit.

Exception: The lead may be less than 6 inches in length if it is evident that the use of a longer lead may result in damage to the lead insulation.

10.3.11 Leads intended for connection to an external circuit shall be provided with strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 63.

10.3.12 Leads provided for spliced connections to an external high-voltage circuit shall not be connected to wire binding screws or pressure wire connectors located in the same compartment as the splice unless the screws or connectors are rendered unusable for field-wiring connections or the leads are insulated at the unconnected ends.

10.4 Cord-connected ice cream makers

10.4.1 An ice cream maker intended for cord connection to the power supply shall be equipped with a flexible cord having a grounding conductor of acceptable ampacity and with a grounding-type attachment plug. See 10.4.3.

10.4.2 The marked rating of a cord-connected ice cream maker, see 69.1, shall not exceed 80 percent of the rating of the attachment plug.

10.4.3 On a cord-connected ice cream maker, provision for a drain connection or connection to a water supply shall require the use of flexible tubing only. The supply cord shall employ an attachment plug that complies with the American National Standards designated in Table 10.2.

Exception: Ice cream makers rated 250 volts or less and intended for connection to circuits rated:

a) Other than 60 hertz,

b) Other than the voltages specified in the first column of Table 39.1, or

c) Both, may employ a grounding-type attachment plug acceptable for the circuit involved.

10.4.4 An ice cream maker rated over 16 amperes may be provided with a supply cord if it is intended to be moved for cleaning and if the ice cream maker complies with (a) – (c).

a) The ice cream maker is of the self-contained type (see 3.7),

b) The ice cream maker is permanently equipped with castors,

c) The electrical rating of the ice cream maker does not exceed 40 amperes, 250 volts.

10.4.5 The ampacity of a power supply cord on a ice cream maker intended for connection to a branch circuit which exceeds the limitations specified in the exception to 19.4.2 shall be not less than 80 percent of the maximum continuous current of the motor-compressor determined in accordance with Compressor Protective Device, Section 56, plus the sum of all other loads, including accessories, which may operate concurrently.

Exception: The ampacity of the power supply cord need not be greater than the ampere rating of the attachment plug.

Table 10.2
Attachment plugs

Nameplate rating			Attachment plug	
Volts	Phase	Amperes[a]	Rating	ANSI designation[b]
110 – 120	1	12.0	15 amperes, 125 volts	5-15P
110 – 120	1	16.0	20 amperes, 125 volts	5-20P
110 – 120	1	24.0	30 amperes, 125 volts	5-30P
110 – 120	1	40.0	50 amperes, 125 volts	5-50P
200 – 240	1	12.0	15 amperes, 250 volts	6-15P
200 – 240	1	16.0	20 amperes, 250 volts	6-20P
200 – 240	1	24.0	30 amperes, 250 volts[c]	6-30P
200 – 240	1	40.0	50 amperes, 250 volts[c]	6-50P
110 – 120/200 – 240	1	12.0	15 amperes, 125/250 volts	14-15P
110 – 120/200 – 240	1	16.0	20 amperes, 125/250 volts	14-20P
110 – 120/200 – 240	1	24.0	30 amperes, 125/250 volts[c]	14-30P
110 – 120/200 – 240	1	40.0	50 amperes, 125/250 volts[c]	14-50P
200 – 240	3	12.0	15 amperes, 250 volts	15-15P

Table 10.2 Continued on Next Page

Table 10.2 Continued

Nameplate rating			Attachment plug	
Volts	Phase	Amperes[a]	Rating	ANSI designation[b]
200 – 240	3	16.0	20 amperes, 250 volts	15-20P
200 – 240	3	24.0	30 amperes, 250 volts[c]	15-30P
200 – 240	3	40.0	50 amperes, 250 volts[c]	15-50P

[a] Ampere rating is maximum permitted to be marked on ice cream maker nameplate for attachment plug indicated. See 10.4.2.

[b] Standard for wiring devices – dimensional requirements, NEMA WD6.

[c] 30 and 50 ampere attachment plugs permitted on ice cream makers intended only to be moved for cleaning as specified in 10.4.4.

10.4.6 A cord-connected ice cream maker shall employ a Type S, SO, SOO, ST, STO, STOO, SJ, SJE, SJO, SJOO, SJT, SJTO, or SJTOO power-supply cord having a voltage rating not less than that of the ice cream maker. The power supply cord shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817. The ampacity of the cord, as given in the National Electrical Code, NFPA 70, shall not be less than that required by the ampere input measured in the Temperature and Pressure Test, Section 43. The ampere input value shall include the loads for convenience outlets and the current drawn by accessories intended for use with the ice cream maker.

10.4.7 The length of a power-supply cord shall be no less than 4 feet (1.2 m) nor more than 10 feet (3.05 m). The length is to be measured between the attachment plug and:

a) Any point at which the cord exits the ice cream maker cabinet or

b) The last strain relief, whichever is shorter.

10.4.8 The power-supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 63. If the strain relief is metallic, it shall not contact uninsulated live parts or reduce spacings within the enclosure if the cord is moved inward. The cord shall not be subject to damage by moving parts if it can be moved inward.

10.4.9 The edges of the entry hole for the power-supply cord, including the cord entry hole in a bushing, shall be smooth and rounded without burrs, fins, or sharp edges that might damage the cord insulation. The power-supply cord shall be routed to reduce the risk of damage to the cord insulation.

10.4.10 An ice cream maker shall have provision for grounding as follows:

a) For a permanently connected ice cream maker, there shall be an equipment grounding terminal or lead.

b) For a cord-connected ice cream maker, there shall be an equipment grounding conductor in the power-supply cord terminating in an identified grounding terminal. See 10.4.14.

10.4.11 A terminal intended solely for the connection of an equipment-grounding conductor shall be capable of securing a conductor of the size required by the National Electrical Code, NFPA 70.

10.4.12 A soldering lug, a push-in connector, a screwless connector, or a quick connector or similar friction-fit connector shall not be used for the grounding terminal.

10.4.13 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 such as by being marked “G,” “GR,” “Ground,” or “Grounding.” or by a marking on a wiring diagram provided on the ice cream maker. The wire binding

screw or pressure wire connector shall be secured to the frame or enclosure of the ice cream maker and shall be located so that it is unlikely to be removed during service operations, such as replacing fuses, resetting manual-reset devices, or oiling motors.

10.4.14 If a pressure wire connector intended for grounding is located where it could be mistaken for the neutral conductor of a grounded supply, it shall be identified by a marking “EQUIPMENT GROUND”, by a green color identification, or by both.

10.4.15 On a permanently connected ice cream maker, the surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green color or a continuous green color with one or more yellow stripes, and no other lead shall be so identified.

10.4.16 On a cord-connected ice cream maker, the grounding conductor of the flexible cord shall be finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the ice cream maker by a positive means, see 14.6, that is not likely to be removed during any servicing operation not involving the power-supply cord. The grounding conductor shall be connected to the grounding blade of the attachment plug.

10.4.17 Cord connected equipment may be provided with more than one power supply cord.

11 Internal Wiring And Wiring Methods

11.1 General

11.1.1 Wiring shall have insulation for the potential involved and the temperatures to which it may be subjected. Compliance is to be determined on the basis of the temperatures measured during the temperature test specified in Section 43.

Exception: If it can be determined that the wiring will not be exposed to heat from radiating sources or heated components, and if the ampacity of the conductors is in accordance with Table 11.1, the temperature tests on the wiring may be waived.

11.1.2 With reference to the Exception to 11.1.1, high-voltage circuit conductors supplying one motor shall have an ampacity not less than 125 percent of the motor full load current rating. Conductors supplying more than one motor shall have an ampacity not less than 125 percent of the full load current rating of the largest motor plus the full load current rating of any other motors supplied. Conductors supplying a motor load and other loads shall have an ampacity not less than 125 percent of the motor full load current rating plus the marked current ratings or measured inputs of the additional loads supplied. See also 11.5.1.

11.1.3 Wiring that is color-coded green or green with one or more yellow stripes shall be used only for grounding conductors. Wiring used for other purposes shall not be identified with the color codes mentioned in the previous sentence.

Table 11.1
Wiring materials ampacities

Wire size		
mm^2	AWG	Ampacity
0.41	22	4
0.66	20	7
0.82	18	10
1.3	16	13
2.1	14	18
3.3	12	25
5.3	10	30
8.4	8	40
13.3	6	55
21.2	4	70
33.6	2	95
42.4	1	110

NOTE – The ampacities shown apply to appliance wiring materials. For types of wires other than appliance wiring materials, the ampacity shall be determined from Table 310-16 and 310-17 in the National Electric Code, ANSI/NFPA 70, for the type of wire employed. The correction factors of the referenced tables need not be applied.

11.2 High voltage circuits

11.2.1 Internal Wiring shall comply with the Standard for Thermoplastic-Insulated Wires and Cables, UL 83; the Standard for Thermoset-Insulated Wires and Cables, UL 44; the Standard for Appliance Wiring Material, UL 758; or the Standard for Flexible Cords and Cables, UL 62.

11.2.2 Wiring material shall be suitably enclosed so as to reduce the risk of damage to the wiring, or emission of flame or molten metal through openings in the cabinet. The wiring is considered suitably enclosed when all of the following conditions are met:

a) Where practicable, individual leads are bunched together to form a cable;

b) Wiring is secured to fixed panels or other surfaces at intervals to assure proper routing and to reduce the likelihood of hooking of slack during routine service, such as replacing air filters, operating reset mechanisms, oiling motors, replacing fuses, adjusting the settings of controls, or the like;

c) Wiring is located in a compartment which is provided with a complete base pan or similar bottom enclosure;

d) Wiring cannot be contacted through openings in the outer enclosure or cabinet by the probe illustrated in Figure 6.3; and

e) Wiring is not located in a compartment where plumbing connections are made at the point of installation.

11.2.3 Cords or appliance wiring material of a type indicated in Table 11.2 need not be enclosed as indicated in 11.2.2 if the wiring is:

a) Arranged so that burning insulation or molten material will not fall onto flammable material within or under the enclosure, and

b) Cord type indicated in 10.4.6 or protected from physical damage by baffles, barriers, or the like so that the wiring cannot be contacted by a 1/2 inch (12.7 mm) diameter rod inserted vertically downward into the wiring compartment.

Table 11.2
Additional wiring

Type of wire cord, or cable	Wire size		Insulation Thickness	
	AWG	(mm^2)	inch	(mm)
Appliance wiring material having thermoplastic or neoprene insulation, with insulation thicknesses shown at right corresponding to the wire sizes indicated; or cord Type S, SE, SEO, SEOO, SO, SOO, ST, STO, STOO; SJ, SJE, SJO, SJOO, SJT, SJTO, SJTOO, SP-3, SPE-3, SPT-3	18	(0.82)	4/64	(1.6)
	16	(1.3)	4/64	(1.6)
	14	(2.1)	5/64	(2.0)
	12	(3.3)	5/64	(2.0)
	10	(5.3)	5/64	(2.0)
	8	(8.4)	6/64	(2.4)
	6	(13.3)	8/64	(3.2)
	4	(21.2)	9/64	(3.6)
	2	(33.6)	10/64	(4.0)

11.2.4 Parallel conductor appliance wiring material of the integral type shall not be ripped more than 3 inches (76.2 mm) unless the thickness of conductor insulation after ripping is at least 0.058 inch (1.47 mm). If the material has conductor insulation not less than 0.028 inch (0.71 mm) after ripping and is within a separate metal enclosure, conduit, electrical metallic tubing, or metal raceway, the length of rip is not limited.

11.2.5 Thermoplastic-insulated high voltage wiring materials that have an insulation thickness of 1/32 inch (0.8 mm) nominal for sizes 16 and 18 AWG, and 3/64 inch (1.2 mm) for sizes 14, 12, 10, and 8 AWG, are considered to be equivalent to the wiring materials referenced in Table 10.2 when the conductors are covered with thermoplastic insulating tubing that has a wall thickness of 2/64 inch (0.8 mm) and is of a type rated for the purpose from the standpoint of electrical, mechanical, and flammability properties.

11.2.6 Where cords or appliance wiring material are employed in a user accessible refrigerated compartment, such wiring shall be of a type as indicated in Table 10.2 and shall be located or protected so as not to be damaged by product containers, removable shelves, or similar parts.

11.2.7 The insulation of wires or cords connected to a fan motor or other auxiliary motor that requires lubrication shall be of an oil resistant type, such as Type SJO, SJT, SPT-3, or appliance wiring materials having oil resistant insulation.

11.3 Low voltage circuits

11.3.1 If grounding, short-circuiting, or damaging of low-voltage wiring may cause malfunctioning of a pressure-limiting device, motor overload protective device or other protective device that may result in a risk of fire, electric shock, or injury to persons, such wiring shall be enclosed as indicated in 11.2.2 or shall be Type SPT-2 or SP-2 cord or one of the types indicated in 11.2.3.

11.3.2 Low voltage (Class 2) non-safety circuit wiring requirements are not specified.

11.4 Wiring method

11.4.1 All wires and cords shall be routed and supported to reduce the risk of damage due to:

a) Sharp edges,

b) Surfaces and parts that operate at temperatures in excess of that for which the wire insulation is rated,

c) Moving parts, and

d) Parts that can be expected to vibrate, such as motors, motor compressors, refrigerant lines, and similar parts.

Clamping means shall have smooth, rounded surfaces.

Exception: Wires and cords may contact a vibrating part when:

a) The wiring is securely fastened to the part at the point of contact so as to restrict movement,

b) The part does not have burrs, fins, or sharp edges, that might abrade the insulation, and

c) Vibration does not place a strain on the wiring or wiring connections.

11.4.2 All wires and cords shall be routed and supported so that they will not be immersed in water unless the insulation is specifically intended for this purpose. Wiring shall be arranged to prevent water caused by condensation, defrosting, or when intended for outdoor use, rain exposure, from entering wiring enclosures and electrical enclosures.

Exception: Water may enter an enclosure when:

a) The point of entrance is not in proximity to live electrical parts, and

b) The live parts are not wetted.

11.4.3 Each splice and connection shall be mechanically secured and electrically bonded. A soldered connection shall be made mechanically secure before being soldered.

11.4.4 Splices shall be located within the ice cream maker enclosure. They shall be secured in position or located in a separate enclosure so that they are not subject to flexing, motion, or vibration due to air movement, and similar occurrences. Strain relief shall be provided on the conductors if the wiring may be moved during servicing operations, such as replacing fuses, resetting manual-reset devices, or oiling motors.

11.4.5 A splice shall be provided with electrical insulation equivalent to that of the conductor insulation if permanence of spacing between the splice and other metal parts is not maintained. Thermoplastic tape wrapped over the sharp ends of conductors is not acceptable.

11.4.6 Splicing devices, such as fixture-type splicing connectors and pressure wire connectors, may be employed if they provide mechanical security and insulation rated for the voltage to which they are subjected. Among the factors that are taken into consideration when judging the acceptability of splice insulation are electrical, mechanical, and flame resistance properties. Splicing devices that comply with the Standard for Wire Connectors, UL 486A-486B, are considered acceptable

11.4.7 A quick-connecting assembly shall:

a) Comply with the Standard for Electrical Quick-Connect Terminals, UL 310; or

b) Form a secure electrical connection, such as by detents in the mating parts, and shall be acceptable for carrying the current involved during the Temperature and Pressure Test, Section 43. Securement of connections may be determined by engagement/disengagement tests as specified in the Standard for Electrical Quick-Connect Terminals, UL 310.

11.4.8 Wire binding screws shall thread into metal. At terminals, stranded conductors shall be secured by soldered or pressure-type terminal connectors or the conductors shall be soldered or otherwise assembled to prevent loose strands after assembly. Soldered connections shall be made mechanically secure before being soldered.

11.4.9 Open-slot type connectors shall not be used unless they are constructed to prevent disconnection resulting from loosening of the clamping means. When required spacings are reduced below the minimum acceptable values by movement of the connector, the shanks of terminal connectors shall be protected by electrical insulation secured in position and not less than 0.028 inch (0.71 mm) thick, except as permitted by 29.9.

11.4.10 Holes for passage of wires and cords through walls, panels, or barriers shall have one of the following:

a) Smooth, rounded surfaces;

b) Be provided with smoothly rounded bushings fabricated from materials, such as ceramic, phenolic, cold-molded composition, or fiber; or

c) Be provided with wire insulating bushings that comply with the Standard for Insulating Bushings, UL 635.

11.4.11 A wiring enclosure formed between the cabinet shell, liner, molding, trim strips, or the like shall be constructed of metal or of nonmetallic material, see 8.1.3, and shall provide a smooth wireway with no sharp edges or sharp projecting screws that might damage the wire insulation.

11.4.12 Wiring shall be separated from HB and HBF materials in accordance with Table 62.1 and Section 9.

Exception: Wiring employing VW-1 insulation need not be separated.

11.5 Short circuit protection

11.5.1 A conductor of a motor circuit having two or more thermal- or overcurrent-protected motors wired for connection to one supply line shall comply with one or more of the following:

a) Have an ampacity of not less than one-third the ampacity of the branch circuit conductors as determined in 10.2.8, or

b) Be 18 AWG (0.82 mm^2) or larger and not more than 4 feet (1.2 m) in length, provided that the circuit will be protected by a fuse or circuit breaker rated not more than 60 amperes, or

c) Serve as a jumper lead between controls, provided that either the length of the lead does not exceed 3 inches (76.2 mm), or the conductor is located in an electrical control enclosure.

d) Withstand the conditions of the Limited Short-Circuit Test, Section 55.

12 Secondary Circuits

12.1 General

12.1.1 Each secondary circuit shall comply with the requirements for high-voltage circuits.

Exception: A secondary circuit is not required to comply with the requirements for high-voltage circuits when all of the following conditions are met:

a) The circuit is not relied upon to reduce the risk of fire, electric shock, or injury to persons;

b) The circuit complies with the requirements for one of the types of secondary circuits referenced in 12.2 and 12.3; and

c) The circuit is separated from other circuits as required in Section 13, Separation of Circuits.

12.1.2 A secondary circuit is a circuit that is isolated at all points from the high-voltage primary branch circuit. This isolation shall be provided by means of a transformer, optical isolator, limiting impedance, or electromechanical relay.

12.1.3 Moving parts are to be evaluated with regard to their potential for personal injury regardless of the circuit in which they are located.

12.1.4 When a secondary circuit is connected to the frame of the appliance, the connection shall be made at only one point in the appliance or system.

Exception: A Class 2 circuit (see 12.2) and a Limited Voltage/Current Circuit (see 12.3) are not prohibited from being connected to the frame at more than one point.

12.1.5 A waveform is considered to be direct-current (dc) when the amplitude of the voltage ripple is not more than 10 percent of the peak voltage.

12.2 Class 2 circuits

12.2.1 A Class 2 circuit shall be supplied by an isolating source that complies with the following:

a) The Standard for Class 2 Power Units, UL 1310;

b) The requirements for Class 2 transformers in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

12.2.2 A Class 2 transformer that is not inherently limited shall be provided with a means to limit the available power in accordance with 12.3.3.

12.3 Limited voltage/current circuits

12.3.1 A limited voltage/current circuit shall be supplied by an isolating source (for example, the secondary winding of an isolating type transformer) having a maximum open circuit voltage potential available to the circuit of not more than 30 volts rms/42.4 volts peak, or 60 volts dc; and having at least one of the following means that limits the power available to the levels specified for a Class 2 transformer:

a) A fixed impedance;

b) A fuse;

c) A nonadjustable manual reset circuit protector; or

d) A regulating network.

12.3.2 A limited voltage/current circuit may also be a circuit that complies with the requirements for a Limited Power Source as described in Clause 2.5 in the Standard for Information Technology Equipment Safety – Part 1: General Requirements, UL 60950-1.

12.3.3 When a secondary fuse or other such secondary circuit protective device is used to limit the available current in accordance with 12.3.1, it shall be rated in accordance with Table 12.1.

Table 12.1
Rating for fuse or circuit protective device

Maximum available voltage (rms)[a]	Amperes
0 – 20	5.0
Over 20 – 30	100/V[b]
[a]Includes open circuit voltage. [b]V is defined as the maximum available rms voltage, including open circuit voltage.	

12.3.4 When a primary circuit protective device is used to limit the available current in accordance with 12.3.1, there are no restrictions on the current rating of the protective device as long as it limits the available secondary current in accordance with Table 12.1.

12.3.5 A fuse used in accordance with 12.3.3 and 12.3.4 shall be one of the following:

a) A non-interchangeable fuse;

b) The largest fuse that fits in the fuseholder provided; or

c) Not subject to user servicing and marked as indicated in 12.3.6.

12.3.6 When a protective device is used as specified in 12.3.3 or 12.3.4, the device shall comply with the requirements of this Standard and shall be provided with an adjacent replacement marking in accordance with 67.19.

12.3.7 An impedance or regulating network used to limit the power in accordance with 12.3.1 shall limit the current under short-circuit conditions to not more than 8.0 amperes measured after 2 minutes.

12.3.8 When a fixed impedance (such as a component or grouping of components in the same circuit) or a regulating network (such as used in a switching type power supply) is provided to limit the voltage and/or the available current in accordance with 12.3.1, the fixed impedance or regulating network shall function to limit the voltage to the values given in 12.3.1 and limit the current to the value given in 12.3.7 under single fault conditions.

12.3.9 The impedance, the fuse, the protector, or the regulating network, and the wiring between it and the isolating transformer mentioned in 12.3.1 shall be judged as if it were a part of a high-voltage circuit.

12.3.10 Wires and cables that are part of a low-voltage circuit shall be provided with strain relief if stress on the wire or cable would cause the internal wiring of the circuits to contact an uninsulated live part of another circuit.

13 Separation Of Circuits

13.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of different circuits (internal wiring including wires in a wiring compartment) shall be separated by barriers or shall be segregated, and shall, in any case, be so separated or segregated from uninsulated live parts connected to different circuits.

13.2 Segregation of insulated conductors may be accomplished by clamping, routing, or other means that maintains permanent separation from insulated or uninsulated live parts of a different circuit.

13.3 Field-installed conductors of any circuit shall be segregated or separated by barriers from field-installed and factory-installed conductors connected to any other circuit unless the conductors of both circuits are or will be insulated for the maximum voltage of either circuit.

13.4 Field-installed conductors of a high-voltage circuit or a low-voltage circuit with National Electrical Code, NFPA 70, Class 1 wiring shall be segregated or separated by barriers as specified in (a) and (b):

a) From uninsulated live parts connected to a different circuit, other than wiring terminals, and

b) From any uninsulated live parts of electrical components, such as a pressure-limiting device, motor overload protective device, or other protective device, where short-circuiting or grounding may result in a risk of fire, electric shock, or injury to persons.

Exception: Segregation or separation by barriers is not required at wiring terminals.

13.5 Field-installed conductors of a low-voltage circuit with National Electrical Code, NFPA 70, Class 2 wiring shall be segregated or separated by barriers as specified in (a) and (b):

a) From uninsulated live parts connected to a high-voltage circuit, and

b) From wiring terminals and any other uninsulated live parts of low-voltage electrical components, such as a pressure-limiting device, motor overload protective device, or other protective device, where short-circuiting or grounding may result in a risk of fire, electric shock, or injury to persons.

13.6 If a barrier is used to provide separation between the wiring of different circuits, it shall be of metal or of a rigid insulating material secured in place.

14 Bonding For Grounding

14.1 An ice cream maker shall have provision for the grounding of all exposed or accessible noncurrent-carrying metal parts that are likely to become energized and that may be contacted by the user or by service personnel during service operations that are likely to be performed when the ice cream maker is energized.

14.2 Uninsulated metal parts, such as cabinets, electrical enclosures, motor frames and mounting brackets, controller mounting brackets, heater element sheaths, capacitors and other electrical components, interconnecting tubing and piping, valves and plumbing accessories, and refrigerant-containing parts are to be bonded for grounding if they may be contacted by the user or service personnel.

Exception: The following metal parts need not be grounded:

a) Adhesive-attached, metal-foil markings, screws, handles, or the like, that are located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized.

b) Isolated metal parts, such as motor controller magnet frames and armatures or small assembly screws, that are positively separated from wiring and uninsulated live parts.

c) Cabinets, panels, and covers that do not enclose uninsulated live parts if wiring is positively separated from the cabinet, panel, or cover so that such parts are not likely to become energized.

d) Panels and covers that are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar materials not less than 1/32 inch (0.8 mm) thick, 0.028 inch (0.71 mm) minimum, and secured in place. If material having a lesser thickness is used, consideration is to be given to such factors as its electrical, mechanical, and flame resistance properties when compared with materials in thicknesses specified above.

14.3 Metal-to-metal hinge bearing members for a door or cover are considered to be a means for bonding a door or cover for grounding if a multiple-bearing pin-type hinge(s) is employed.

14.4 A separate component bonding conductor shall be of copper, a copper alloy, or other material acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings such as enameling, galvanizing, or plating. A separate bonding conductor or strap shall:

a) Be protected from mechanical damage or be located within the confines of the outer enclosure or frame, and

b) Not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

14.5 An internal connection for bonding internal parts to the enclosure for grounding, but not for a field-installed grounding conductor or for the grounding wire in a power-supply cord, may employ a quick-connect terminal of the specified dimensions if the connector is not likely to be displaced and the component is limited to use on a circuit having a branch circuit protective device rating listed in Table 14.1:

Table 14.1
Branch circuit protective device ratings

Terminal dimensions inches (mm)	Rating of protective device amperes
0.020 by 0.187 by 0.250 (0.51 by 4.75 by 6.4)	20 or less
0.032 by 0.187 by 0.250 (0.81 by 4.75 by 6.4)	20 or less
0.032 by 0.205 by 0.250 (0.81 by 5.2 by 6.4)	20 or less
0.032 by 0.250 by 0.312 (0.81 by 6.4 by 7.9)	60 or less

14.6 The bonding shall be by a positive means such as clamping, riveting, bolted or screwed connection, welding, or soldering and brazing materials having a softening or melting point greater than 851°F (455°C). The bonding connection shall penetrate nonconductive coatings such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or other nonmetallic material except as indicated in 14.8.

14.7 With reference to 14.6, a bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings. If the bonding

means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

14.8 A connection that depends upon the clamping action exerted by rubber or other nonmetallic material may be acceptable if it complies with the provisions of the Current Overload Test, Section 53, and the Limited Short-Circuit Test, Section 55, under any normal degree of compression permitted by a variable clamping device and also following exposure to the effects of oil, grease, moisture, and thermal degradation that may occur in service. Also, a clamping device is to be considered with particular emphasis on the likelihood of the clamping device being disassembled and reassembled in its intended fashion.

14.9 On a cord-connected ice cream maker, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord. See also 14.12 and 14.13.

14.10 On a permanently connected ice cream maker, the size of a conductor employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. Except as indicated in 14.12, the size of the conductor or strap shall be in accordance with Table 14.2.

14.11 A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in 14.10, is acceptable provided that the minimum cross-sectional conducting area is equivalent to the wire sizes indicated in Table 14.2.

14.12 A smaller conductor may be used if the bonding conductor and connection comply with the provisions of the Current Overload Test, Section 53 and the Limited Short-Circuit Test, Section 55.

14.13 A bonding conductor to a motor or other electrical component need not be larger than the size of the motor-circuit conductors or the size of the conductors supplying the component. See 11.5.1.

Table 14.2
Bonding wire conductor size

Rating of overcurrent device, amperes	Minimum size of bonding conductor[a]			
	Copper wire,		Aluminum wire,	
	AWG	(mm^2)	AWG	(mm^2)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)
200	6	(13.3)	4	(21.2)

[a] Or equivalent cross-sectional area.

14.14 Splices shall not be employed in wire conductors used to bond electrical enclosures, motor frames, or other electrical components.

14.15 If more than one size branch circuit overcurrent device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a motor is individually protected by a branch circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding

conductor for that motor is to be sized on the basis of the overcurrent device intended for ground-fault protection of the motor.

14.16 A secondary circuit of less than 50 volts that is supplied by a transformer having a primary connected to a source of more than 150 volts to ground shall be bonded for grounding.

14.17 With reference to 14.16, the size of the bonding conductor used to bond the secondary circuit conductor that is to be grounded shall be in accordance with 14.13. If one of the secondary circuit conductors is white or gray in color and located in a field wiring compartment, the white or neutral gray conductor shall be the one that is grounded.

ELECTRICAL COMPONENTS

15 Current-Carrying Parts

15.1 All current-carrying parts shall be of silver, copper, a copper alloy, or other material acceptable for use as an electrical conductor.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not be inherently resistant to corrosion.

15.2 Aluminum may be used as a current-carrying part if investigated and found to be treated to resist oxidation and corrosion.

15.3 Iron or steel provided with a corrosion-resistant coating or stainless steel may be used for a current-carrying part:

a) If permitted in accordance with 4.3, or

b) Within a motor, but the use of iron or steel for current-carrying parts elsewhere in the ice cream maker is not acceptable.

16 Insulating Material

16.1 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or other material with equivalent electrical and mechanical properties.

16.2 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock. Polymeric materials may be used for the sole support of uninsulated live parts shall comply with the requirements used as direct support of live parts in the Standard for Polymeric Materials – Use In Electrical Equipment Evaluations, UL 746C.

16.3 Insulating tape required for compliance with this standard shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510.

16.4 Insulating sleeving required for compliance with this standard shall comply with the Standard for Coated Electrical Sleeving, UL 1441.

16.5 Insulating tubing required for compliance with this standard shall comply with the Standard for Extruded Insulating Tubing, UL 224.

16.6 Film-coated wire or materials used in an insulation system that operates above Class 105 (Class A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

17 Switches and Controllers

17.1 A motor controller(s) used for controlling the loads involved shall be provided for all ice cream makers incorporating:

a) Two or more motors, or

b) A motor(s) and other load(s) intended for connection to the same power supply. See 17.3 and 17.4.

17.2 As used in this standard, a motor controller is defined as any switch or device normally used to start and stop a motor.

17.3 The attachment plug and receptacle may serve as the controller on a cord-connected ice cream maker if the marked ampere rating does not exceed the values shown below for the voltage indicated in Table 17.1:

Table 17.1
Ampere rating limits

Amperes	Voltage
7.2	115
4.0	208
3.6	230

17.4 A controller is not required for any supply circuit of a permanently connected ice cream maker where the circuit supplies:

a) Two or more motors, or

b) A motor(s) and other load(s) if, in either case, the marked maximum size of the supply circuit overcurrent protection device for that circuit does not exceed 20 amperes at 125 volts or less, or 15 amperes at 600 volts or less, and if the rating of any motor in the circuit does not exceed 1 horsepower (746 W output) and 6 full-load amperes.

17.5 A cord-connected ice cream maker shall be provided with a manually operable switch that will shut off any motor load exceeding the values indicated in 17.3. Such switches shall:

a) Have a marked OFF position,

b) Indicate which load it controls, such as compressor, fan motor, or the like, and

c) Be accessible without requiring the use of tools.

17.6 On a cord connected ice cream maker, a manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of:

a) The motor-compressor's rated load current, and

b) The rated current for other controlled loads.

17.7 On a permanently connected ice cream maker, a manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of:

a) The motor-compressor's rated load current or branch-circuit selection current, whichever is greater, and

b) The rated current for other controlled loads, as shown on the ice cream maker nameplate. See 17.5.

17.8 A switch or other control device shall be rated for the load it controls as determined by the Temperature and Pressure Test, Section 43.

17.9 If a branch-circuit selection current is marked on a permanently-connected ice cream maker, a controller for a hermetic refrigerant motor-compressor shall have a full-load current rating not less than this marked value plus any additional loads controlled.

17.10 A switch that controls an inductive load, such as a transformer, shall have a current rating of not less than twice the total marked current ratings of the transformer or other equipment that it controls, unless the switch is rated for the particular application.

17.11 A switch that controls a medium-base lampholder of other than a pilot or indicating light shall be rated for use with tungsten-filament lamps.

17.12 A switch is acceptable for use with tungsten-filament lamp loads if it has a “T” or “L” rating equal to the tungsten-filament lamp load. A general-use alternating current (ac) snap switch, a circuit breaker, or a nonautomatic circuit interrupter are considered acceptable for controlling tungsten-filament lamps at their full ampacity. A switch having an AC ampacity of six times or more of the tungsten-filament lamp load is also acceptable for use with that tungsten-filament lamp load without additional test.

17.13 The load controlled by a switch connected in an incandescent lighting system is to be determined by the size and number of lampholders controlled as specified: each intermediate-base lampholder is considered as a 25-watt load, a medium-base lampholder as a 60-watt load, and a mogul-base lampholder as a 500-watt load.

17.14 A switching device that may be called upon to break a motor load under locked-rotor conditions shall have a current interrupting capacity not less than the locked-rotor current of the motor.

17.15 If a switching device controls a compressor motor and fan motor and/or other load, it shall have a current interrupting capacity not less than the locked-rotor load of the compressor motor plus the full load of the fan motor and/or other load.

17.16 Motor controllers shall be arranged so that they will simultaneously open a sufficient number of ungrounded conductors to interrupt current flow to the motor.

Exception: This requirement does not apply to crankcase heating arrangements where the circuit is arranged to permit current flow through a capacitor in series with the start winding of single-phase motors with the motor not operating.

17.17 Coil windings of switching devices shall be impregnated, dipped, varnished, or equivalently treated to resist absorption of moisture.

17.18 Switching devices shall be housed within an enclosure that will protect coils and contacts against mechanical damage, dirt, and moisture. The enclosure of the switching device may be provided by its method of mounting within the ice cream maker enclosure, by inherent construction of the component, or by means of a separate enclosure.

17.19 A circuit breaker shall be connected to open all ungrounded conductors of the circuit. Multipole circuit breakers shall be the common trip type.

Exception: Single-pole circuit breakers with handle ties, the combination of which complies with the applicable requirements in the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489, may be used as the protection for each ungrounded conductor supplying line-to-line connected loads of a product rated for connection to a circuit of a grounded system.

17.20 Switches shall comply with one of the following standards:

a) *Deleted.*

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

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

d) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

e) Standard for Low-Voltage Switchgear and Controlgear, – Part 1: General Rules – UL 60947-1 and the Standard for Low-voltage Switchgear and Controlgear – Part 5-2: Control Circuit Devices and Switching Elements – Proximity Switches, UL 60947-5-2.

17.21 Clock-Operated switches shall comply with one of the following standards:

a) Standard for Clock-Operated Switches, UL 917;

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

17.22 Controls shall comply with Supplement SA or one of the appropriate standards in Table 17.2 for its inherent safety under the specified parameters/conditions noted in Table 17.3.

Exception: An electronic operating control (e.g. a non-protective control), the failure of which would not increase the risk of electric shock, fire, or personal injury, are not required to meet the component control requirements of Clause 17.22, but need only be subjected to the following applicable requirements of this end product standard:

a) Components (4.3, 4.4)

b) Quick-Connects (11.4.7 – 11.4.9)

c) Wiring (11)

d) Secondary Circuits (12)

e) Separation of Circuits (13)

f) Current Carrying Parts (15)

g) Insulating Material (16)

h) Spacings (29 – 31)

i) Printed Wiring Boards (26F)

j) Temperature Test (43)

k) Dielectric Withstand Test (44)

l) Component Failure Test (63A).

Table 17.2
Controls – standards for inherent safety

Purpose of the control	Applicable standards
Temperature sensing control	UL 244A; or
	UL 60730-1 and UL 60730-2-9
Pressure controls	UL 244A; or
	UL 508; or
	UL 60730-1 and UL 60730-2-6
Motor and speed controls	UL 508; or
	UL 61800-5-1; or
	UL 244A; or
	UL 60730-1
Timers	UL 244A; or
	UL 60730-1 and UL 60730-2-7
Liquid level controls	UL 244A; or
	UL 508; or
	UL 60730-1 and UL 60730-2-15
Limit controls	UL 60730-1 and UL 60730-2-6 or UL 60730-2-9

Table 17.3
Required parameters/conditions for controls

Features/conditions	Requirement
Electrical rating	The control shall meet or exceed the electrical ratings of the load it is controlling. Compliance shall be shown by measuring and recording the electrical parameters under all normal modes of operation of the equipment.
Maximum operating ambient, T_{max}	The maximum operating ambient of the control shall be equal to or exceed the manufacturer's specified value or the measured value during the temperature test, whichever is higher.
Number of cycles of manual action (reset)	Operating – 6000 cycles Protective (safety) – 6000 cycles; 1000 with current, 5000 without current
Number of cycles of automatic action	Operating (regulating) – 6000 cycles Protective (safety) – 100,000 cycles[a]
CTI of materials	175 < V < 400
Type of action	A control incorporating Class A control functions are considered to have type 1 action A control incorporating Class B or C control functions are considered to have type 2 action
Reset limits for thermal cut-outs	minus 35 °C
Pollution degree	See Table 31.1

Table 17.3 Continued on Next Page

Table 17.3 Continued

Features/conditions	Requirement
Overvoltage category	See Table 31.2
Type of disconnection	Micro-interruption (1.C) – controls with Class A functions Micro-disconnection (1.B or 2.B) – controls with Class B or C functions Micro-interruption (1.Y) – applies to solid-state switches (ex: SSR, triacs etc.) Full disconnection (1.A or 2.A) – applies to "on-off" switches
[a] Endurance cycling requirements for compressor and motor protectors are specified in the appropriate compressor or motor standard. See Section 18.	

17.23 Unless specified elsewhere in this standard protective (safety) controls where the control functions are being relied upon to reduce the risk of fire, electric shock or personal injury during abnormal operation of the equipment shall additionally comply with Supplement SA or one of the appropriate standards in Table 17.4 using the specified functional safety test parameters/conditions.

Table 17.4
Functional safety standards and test conditions

Functional safety test parameters/severity levels etc.	Hardware only	Software only		Hardware and software	
	UL 991	UL 1998	H.11.12, UL 60730-1	UL 991, UL 1998	UL 60730-1 (+)
FMEA analysis	X	X	X	X	X
Equipment failure rate	X failures/10^6	–	–	–	–
Test accelerated multiplier	Intermittent use – 5763 Continuous use – 5763	–	–	–	–
Test accelerated factor	Table 25.2 based on ambient temperature	–	–	–	–
Voltage dips, variation and interruptions See SA12.1(f)	X	–	–	X	X
Harmonics and Interharmonics: Mains Signaling. See SA12.1(g)	X	–	–	X	X
Influence of voltage unbalance (3-phase product only)	–	–	–	–	X
Surge immunity (+ +)	X	–	–	X	X
Fast transient/burst	X	–	–	X	X
Ring wave	X	–	–	X	X
Electrostatic discharge	6 kV – contact	–	–	6 kV – contact	6 kV – contact
	8 kV – air	–	–	8 kV – air	8 kV – air
Electric and magnetic field	X	–	–	X	–
RF – conducted disturbances	–	–	–	X	
Radiated EMF immunity	10 V/m	–	–	10 V/m	X
Influence of supply frequency (+ + +)	–	–	–	X	X
Magnetic field immunity	–	–	–	X	X

Table 17.4 Continued on Next Page

Table 17.4 Continued

Functional safety test parameters/severity levels etc.	Hardware only	Software only		Hardware and software	
	UL 991	UL 1998	H.11.12, UL 60730-1	UL 991, UL 1998	UL 60730-1 (+)
Thermal cycling	Indoor 0 – 40°C	–	–	Indoor 0 – 40°C	Indoor 0 – 40°C
	Outdoor minus 35 – 40°C	–	–	Outdoor minus 35 – 40°C	Outdoor minus 35 – 40°C
Humidity	Indoor 50 percent	–	–	Indoor 50 percent	Indoor 50 percent
	Outdoor 98 percent	–	–	Outdoor 98 percent	Outdoor 98 percent
Class of software	–	Class 1	Class B/C	Class 1	Class B/C

NOTES

(+) the test values shall be based on the type of control function under consideration. Test parameters corresponding to test / severity level 2 shall be used for Class B control functions. Test parameters corresponding to test/severity level 3 shall be used for Class C control functions, unless otherwise noted.

(+ +) – Indoor Use is installation Class 3. Outdoor Use is Installation Class 4.

(+ + +) – If supply frequency is relied upon for correct operation of the control.

17.24 With regards to 17.23, the protective (safety) functions shall be as noted in Table 17.5, unless otherwise specified.

Exception: Endurance cycling requirements for compressor and motor protectors are specified in the appropriate compressor or motor standard. See Section 19.

Table 17.5
Protective functions

Protective function	Type of control function	Criteria of acceptance
Temperature limiting control (thermal cutout)	Class B	+
Door interlock	Class B	Shall reliably disconnect power to the hazard (for example, a door switch controlling an auger motor)
Motor OLP/overtemperature/ overheating protection (not running overload)	Class B	A control becoming permanently inoperative and disconnecting power meets the criteria for mitigating the risk
Pressure limiting device (Pressure Limiter)	Class B	Before endurance, maximum marked (rated) setting + 5 percent. After endurance, ± 5 percent of measured initial setting.

[+] Before endurance: ±10°F (±6°C) of its maximum marked set-point temperature up to a 300°F (149°C) rating, 4 percent of its maximum set-point Fahrenheit temperature up to 400°F (204°C), and 5 percent above 400°F; and After endurance; not vary from the as-received cutout temperature by more than 5 percent of the maximum set-point Fahrenheit temperature or more than 10°F, whichever is greater.

17.25 *Deleted.*

18 Motors And Motor Overload Protection

18.1 Motors shall comply with the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1. Hermetic Motor-Compressors shall comply with the requirements in the Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-Compressors, UL 60335-2-34.

18.2 Motors having openings in the enclosure or frame shall be arranged to prevent particles from falling out of the motor onto flammable material within or under the assembly.

18.3 The requirement in 18.2 will necessitate the use of a barrier of nonflammable material under an open-type motor unless:

a) The structural parts of the motor or of the ice cream maker, such as the bottom closure, provide the equivalent of such a barrier, or

b) The motor overload protective device provided with the motor is such that no burning insulation or molten material falls to the surface that supports the ice cream maker when the motor is energized under each of the following fault conditions applicable to the motor type:

1) Open main winding,

2) Open starting winding,

3) Starting switch short-circuited,

4) Capacitor shorted (permanent split capacitor type), or

c) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current) that will prevent the temperature of the motor windings from:

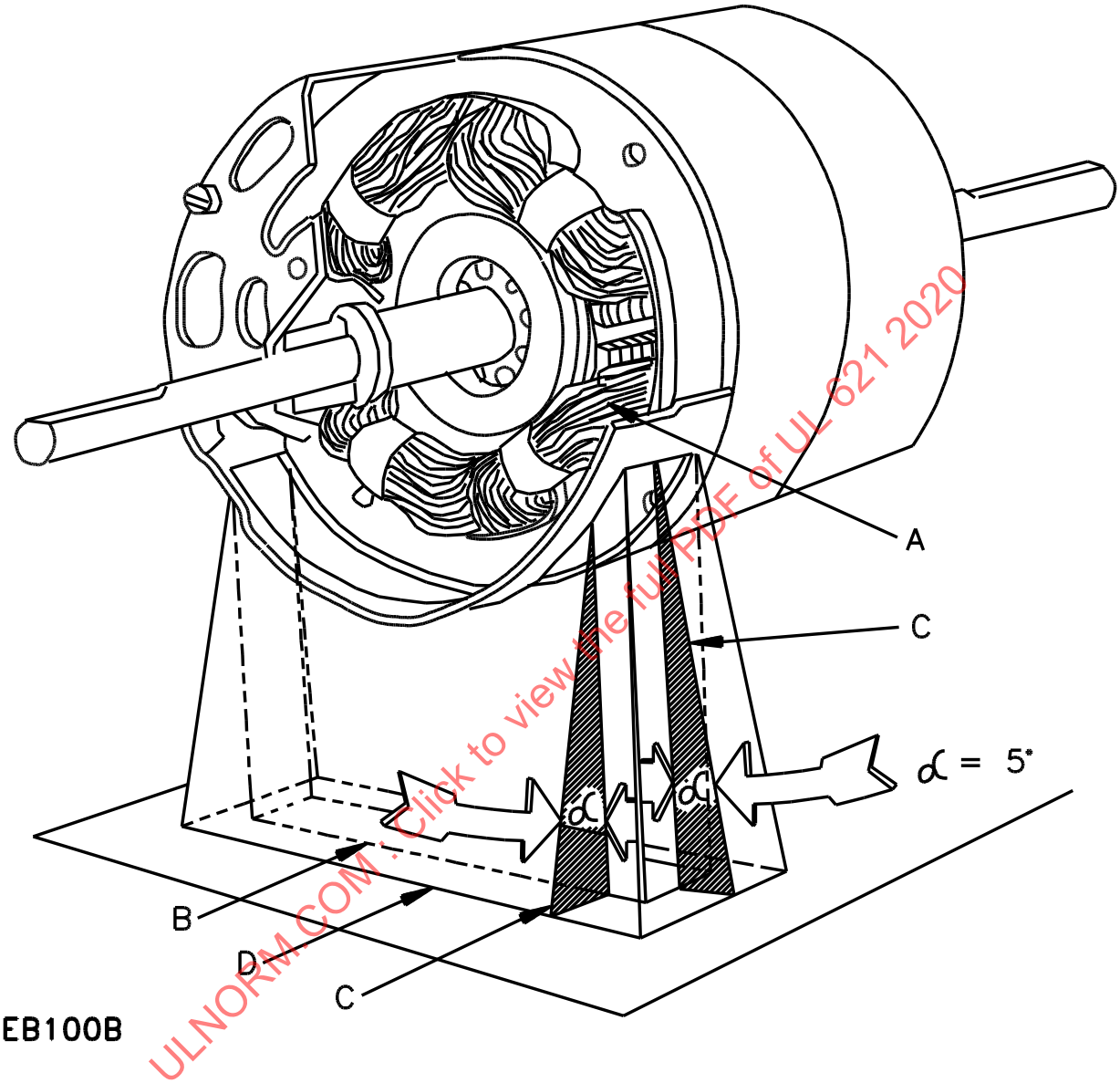
1) Exceeding 257° F (125° C) under the maximum load under which the motor will run without causing the protector to cycle, and

2) Exceeding 302°F (150°C) with the rotor of the motor locked.

18.4 The barrier mentioned in 18.3 shall be horizontal, shall be located as indicated in Figure 18.1, and shall have an area not less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier provided that such openings would not permit molten metal, burning insulation, or the like to fall onto flammable material.

Figure 18.1

Location and extent of barrier



A – Motor winding is to be shielded by barrier. This is to consist of the entire motor winding if it is not otherwise shielded, and is to consist of the unshielded portion of a motor winding which is partially shielded by the motor enclosure or equivalent.

B – Projection of outline of motor winding on horizontal plane.

C – Inclined line which traces out minimum area of the barrier. When moving, the line is to be always:

1) Tangent to the motor winding,

2) Five degrees from the vertical, and

3) So oriented that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is to be that inclined inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

19 Motors

19.1 General

19.1.1 Each motor shall be protected against overload by one of the means specified in 19.2 – 19.3.

19.1.2 Overcurrent protective devices and thermal protective devices for motors shall comply with applicable short-circuit current requirements for the class of protective device and shall, in addition, comply with the requirements of the Limited Short-Circuit Test, Section 55.

19.1.3 When a motor protective system is used, all components shall be provided as part of the equipment.

19.2 Protection of single-phase nonhermetic motors

19.2.1 All single-phase motors other than a hermetic refrigerant motor compressor shall be protected by one or more of the following:

a) A separate device responsive to motor current and rated or set to trip at not more than the percentage of the motor nameplate full-load current rating specified in Table 19.1. If the percentage protection specified in Column A of Table 19.1 does not correspond to the percentage value of an overload relay of a standard size, the device of the next higher size may be used. However, the overload device of the next higher size shall protect against currents exceeding the percentage values specified in Column B of Table 19.1.

b) A separate overload device which combines the functions of overload and overcurrent protection and is responsive to motor current rated or set at values not greater than the percentages of the motor nameplate full-load current rating as specified Table 19.1. Such a device shall be capable of fully protecting the circuit and motor both under overload and short circuit conditions.

c) A protective device integral with the motor that complies with the Standard for Overheating Protection for Motors, UL 2111 and the Standard for Motors with Inherent Overheating Protection. If such a device relies on software as part of the protection, the software shall comply with the Standard for Software in Programmable Components, UL 1998 or Annex H of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

d) A protective device integral with the motor that complies with the Standard for Thermally Protected Motors, UL 1004-3. A motor intended to move air only, by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor, is required to have locked-rotor protection only.

e) Impedance protection complying with the Standard for Overheating Protection of Motors, UL 2111 or the Standard for Impedance protected Motors, UL 1004-2.

f) Protective electronic circuits integral to the motor that comply with the Standard for Electronically Protected Motors, UL 1004-7.

g) Protective electronic circuits that comply with clause 19.2.2.

h) Other protection that is shown by test to be equivalent to the protection specified in (c) and (d). If a fuse is used as a motor protective device, the motor shall be protected by the largest size fuse that can be inserted into the fuseholder.

Table 19.1
Protective device activation level

	Maximum percentage full-load current rating protection	
	A	B
Motor with a marked service factor no less than 1.15	125	140
Motor with a marked temperature rise no more than 40°C	125	140
Any other motor	115	130

19.2.2 Except as indicated in 19.2.1 (c) and (f), electronically protected motor circuits shall comply with one of the following:

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

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, as well as the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9. If software is relied upon to perform a safety function, it shall be considered software Class B; or,

c) The Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1 for a power conversion controller incorporating overcurrent protection with the percentage protection set as indicated in Table 19.1.

Exception: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or casualty hazard during abnormal testing with the motor electronic circuit rendered ineffective.

19.2.3 With reference to 19.2.2, test parameters in Table 17.3, Table 17.4, and Table 17.5 shall be considered when judging the acceptability of a protective circuit.

19.3 Protection of three-phase motors

19.3.1 Three-phase motors shall be protected by:

a) Three properly rated overcurrent devices, each complying with 19.2; or

b) Other protective methods if the methods provide protection under primary single-phase failure conditions when supplied from wye-delta or delta-wye connected transformers. Units with such protective methods shall be marked to indicate that the motor is protected under primary single-phasing conditions.

c) Electronic protection that complies with 19.2.2 and 19.2.3.

19.4 Protection of hermetic refrigerant motor-compressors

19.4.1 Hermetic refrigerant motor-compressors shall be protected in accordance with one or more of the following:

a) The applicable requirements in the Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-Compressors, UL 60335-2-34; or

b) The Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1 for power a conversion controller incorporating overcurrent protection with the percentage protection set as indicated in Table 19.1; or

c) A separate overload relay that is responsive to motor compressor current and will trip at not more than 140 percent of the rated load current of the motor compressor; or

d) An overcurrent device, such as a fuse or a circuit breaker, responsive to motor current, and rated at no more than 125 percent of the motor-compressor rated-load current of the motor-compressor; or

e) Electronic protection that complies with 19.2.2 and 19.2.3.

19.4.2 Motor protection systems and thermal protection of a motor-compressor shall not permit a continuous current in excess of 156 percent of the motor-compressor rated load current (or 156 percent of the branch circuit selection current if the latter is marked).

Exception: A continuous current exceeding 156 percent is permitted when a unit is rated for single phase ac and marked with a single overall ampere rating that does not exceed:

a) 12A at 208-240 V and (if provided) the marked minimum circuit ampacity and maximum overcurrent protective device size does not exceed 15 A; or

b) 16A at 120 V and (if provided) the marked minimum circuit ampacity and maximum overcurrent protective device size does not exceed 20 A.

19.4.3 For a cord-connected ice cream maker, the rated load current of the motor-compressor is the current drawn by the motor-compressor during the Temperature and Pressure Test, Section 43.

20 Fuseholders

20.1 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, in conjunction with any of the associated Standards tabulated below, as applicable for the class of fuseholder:

a) Standard for Fuseholders – Part 4: Class CC, UL 4248-4; or

b) Standard for Fuseholders – Part 5: Class G, UL 4248-5; or

c) Standard for Fuseholders – Part 8: Class J, UL 4248-8; or

d) Standard for Fuseholders – Part 9: Class K, UL 4248-9; or

e) Standard for Fuseholders – Part 11: Class C (Edison Base) and Type S Plug Fuse, UL 4248-11; or

f) Standard for Fuseholders – Part 12: Class R, UL 4248-12; or

g) Standard for Fuseholders – Part 15: Class T, UL 4248-15.

20.1.1 A fuseholder shall be installed, or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. A separation of less than 4 inches (102 mm) from the insulating body of a fuse is considered to be adjacent. A barrier of vulcanized fiber or similar material employed as a guard for uninsulated high-voltage live parts shall be not less than 0.028 inch (0.71 mm) thick.

20.2 The screw shell of a plug fuseholder used in a high-voltage circuit shall be connected toward the load.

20.3 Plug fuseholders of the Edison-base type shall be provided with an adapter designed for Type S fuses.

20A Fuses, Circuit Breakers, and Supplementary Protectors

20A.1 Unless otherwise specified, fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, in conjunction with any of the associated standards tabulated below, as applicable for the class of fuse:

a) Standard for Low-Voltage Fuses – Part 4: Class CC, UL 248-4; or

b) Standard for Low-Voltage Fuses – Part 5: Class G, UL 248-5; or

c) Standard for Low-Voltage Fuses – Part 8: Class J, UL 248-8; or

d) Standard for Low-Voltage Fuses – Part 9: Class K, UL 248-9; or

e) Standard for Low-Voltage Fuses – Part 11: Class C (Edison Base) and Type S Plug Fuse, UL 248-10; or

f) Standard for Low-Voltage Fuses – Part 12: Class R, UL 248-11; or

g) Standard for Low-Voltage Fuses – Part 15: Class T, UL 248-12.

h) Standard for Low-Voltage Fuses – Part 15: Class T, UL 248-15.

20A.2 If a supplementary fuse is permitted in accordance with the requirements in this Standard, such a fuse shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, in conjunction with the Standard for Low-Voltage Fuses – Part 14: Supplemental Fuses, UL 248-14.

20A.3 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489. In addition, circuit breakers used in telecommunications circuitry shall comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A.

20A.4 Circuit breakers used to protect circuits having more than one ungrounded conductor and no grounded neutral shall be of the multipole common trip type arranged to open all ungrounded conductors. The use of external handle ties does not in itself constitute a common trip mechanism.

20A.5 Supplementary Protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

20A.6 A supplementary protector shall not be used in place of a circuit breaker or protective control.

21 Incandescent Lighting Systems

21.1 No part of a screw-shell type lampholder shall operate at a potential of more than 150 volts between conductors or to ground.

Exception: This requirement does not apply to a lampholder for a pilot light or indicating lamp requiring the use of tools for replacement.

21.2 A lampholder shall be constructed and installed so that uninsulated live parts, other than the screw-shell, will not be exposed to contact by persons removing or replacing lamps.

Exception: This requirement does not apply if, in order to remove or replace a lamp, it is necessary to dismantle the ice cream maker or to remove a cover plate or other part by means of tools.

22 Receptacles

22.1 Receptacles shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

22.1.1 Unless intended to be connected to a power supply separate from that supplying other loads, a receptacle intended for general use shall be rated 15 or 20 amperes, 125 or 250 volts. All general-use receptacles shall be of the grounding type.

22.2 Receptacles shall be located so that liquid due to overflow, splashing, leakage, cleaning, and defrosting will not enter the receptacle. This will require the face of the receptacle to be mounted not less than 60 degrees from the horizontal.

23 Receptacle And Lighting Circuit Overcurrent Protection

23.1 Overcurrent protection shall be provided for each receptacle or lighting circuit included in the ice cream maker by a circuit breaker(s) or fuse(s) that is intended for branch circuit use, as a part of the ice cream maker.

Exception No. 1: This requirement does not apply if the receptacle or lighting circuit is intended to be connected to a power supply separate from that supplying the ice cream maker, see 68.24.

Exception No. 2: This requirement does not apply if, in accordance with the National Electrical Code, NFPA 70, the ice cream maker can be connected to a branch circuit rated at not more than 20 amperes.

23.2 A 15-ampere protective device shall be provided when a single 15-ampere receptacle outlet is furnished. Two or more 15-ampere receptacles (two separate receptacles or a duplex receptacle) shall be protected by either a 15 or 20-ampere protective device. A 20-ampere receptacle or a combination 15 and 20-ampere receptacle shall be protected by a 20-ampere protective device.

24 Lampholders

24.1 Lampholders and indicating lamps with integral lamp / lampholder (e. g. neon pilot lamp) shall comply with the Standard for Lampholders, UL 496. Lampholders forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

25 Valves And Solenoids

25.1 Electrically operated valves shall comply with the:

a) Standard for Electrically Operated Valves, UL 429; or

b) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements, UL 60730-2-8 or

c) Paragraphs 25.1.1 – 25.4.

25.1.1 The coil of an electrically operated valve or solenoid shall not overheat when the ice cream maker is subjected to the Temperature and Pressure Test, Section 43.

25.2 There shall be no risk of fire or electrical shock if an electrically operated valve or solenoid fails to operate. See Burnout Tests – Components, Section 49.

25.3 If a valve must be cleaned periodically, the arrangement shall permit this operation to be performed without damage to the electrical parts of the valve or wiring.

25.4 The coil windings of an electrically operated valve or solenoid shall be impregnated, dipped, varnished, or equivalently treated to resist absorption of moisture.

26 Capacitors

26.0 Motor Capacitors shall comply with the Standard for Capacitors, UL 810 or shall comply with 26.1 – 26.3.

26.1.0 Capacitors shall comply with the Standard for Capacitors, UL 810 or shall comply with 26.1 – 26.4.

26.1 A motor starting or running capacitor shall be housed within an enclosure or container that will protect the plates against mechanical damage and that will reduce the risk of the emission of flame or molten material resulting from capacitor failure. The container shall be of metal that provides strength and protection not less than that of uncoated steel having a thickness of 0.020 inch (0.51 mm) (No. 24 MSG).

Exception: If the capacitor is mounted within the enclosure of the equipment or within an enclosure that houses other parts of the equipment, the individual container of a capacitor may be of sheet metal having a thickness less than that required, or material other than metal.

26.2 If the container of an electrolytic capacitor is metal, the container shall be considered as a live part and shall be provided with moisture-resistant electrical insulation to isolate it from dead metal parts and to reduce the risk of contact during servicing operations. The insulating material shall be not less than 1/32 inch (0.8 mm) thick except as indicated in 29.8.

26.3 A capacitor employing a liquid dielectric medium more combustible than askarel shall be protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements of this standard, including faulted overcurrent conditions based on the circuit in which it is used. See Short-Circuit Test, Section 55.

Exception: If the available fault current is limited by other components in the circuit, such as a motor start winding, the capacitor may be tested using a fault current less than the test current specified in Table 55.1 but not less than the current established by dividing the circuit voltage by the impedance of the other component(s).

26.4 Capacitors intended for connection directly across the line shall comply with the requirements of the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

26.5 In reference to 26.4, if a capacitor complies with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, it shall have specifications as follows:

a) Operating voltage – Not less than 110 percent of the rated voltage of the appliance.

b) For capacitors connected across the line (phase-to-phase) – Subclass X1 (≤ 4.0 kV) or X2 (≤ 2.5 kV) for impulse voltage (based on minimum Overvoltage Category of II).

c) For capacitors connected from line to ground – Subclass Y1 or Y2 for any appliance having a rated voltage not exceeding 500 volts; or as an alternate, subclass Y4 if the appliance has a rated voltage not exceeding 150 volts.

d) Upper category temperature – Based on the maximum capacitor surface temperature measured during the Temperature Test in Section 43, but not less than 185ºF (85ºC).

e) Lower category temperature – Based on the minimum surface temperature for which the capacitor has been designed to operate when installed within the appliance as intended, but not greater than 14ºF (minus 10ºC).

f) Duration of the damp-heat steady-state test – Not less than 21 days.

g) Passive flammability category B or C. As an alternate, a polymeric capacitor case shall have a V-0 flame rating as described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

26A Outlet Boxes, Electrical Cable, Conduit and Tubing

26A.1 Outlet boxes shall comply with the Standard for Metallic Outlet Boxes, UL 514A or the Standard for Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers, UL 514C. Fittings shall comply with the Standard for Conduit, Tubing, and Cable Fittings, UL 514B. Cover plates shall comply with the Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

26A.2 Aluminum or steel armored cable shall comply with the Standard for Armored Cable, UL 4. Nonmetallic sheathed cables shall comply with the Standard for Nonmetallic Sheathed Cables, UL 719.

26A.3 Flexible metal conduit shall comply with the Standard for Flexible Metal Conduit, UL 1. Rigid steel conduit shall comply with the Standard for Electrical Rigid Metal Conduit – Steel, UL 6.

26A.4 Electrical steel tubing shall comply with the Standard for Electrical Metallic Tubing – Steel, UL 797.

26B Electromagnetic Interference Filters

26B.1 Electromagnetic interference filters shall comply with the Standard for Electromagnetic Interference Filters, UL 1283.

26C Relays and Contactors

26C.1 Electromagnetic relays and contactors shall comply with:

a) The Standard for Industrial Control Equipment, UL 508; or

b) The Standard for Low-Voltage Switchgear and Controlgear, – Part 1: General Rules, UL 60947-1, and the Standard for Low-Voltage Switchgear and Controlgear, – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters, UL 60947-4-1.

26D Optical Isolators and Semiconductor Devices

26D.1 An optical isolator shall comply with the Standard for Optical Isolators, UL 1577 if it is relied upon to provide isolation between:

a) Primary and secondary circuits;

b) Extra-low-voltage safety circuits; or

c) Other high-voltage circuits.

26D.2 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557.

26E Terminal Blocks

26E.1 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of Section 10.3 (Terminals and leads), Section 15 (Current-carrying parts), Section 16 (Insulating material), and Sections 29, 30, and 31 (spacings) of this end product standard.

26F Printed-Wiring Boards

26F.1 A printed-wiring board shall comply with the Standard for Printed-Wiring Boards, UL 796, and shall have a flammability level of at least V-1 when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: This requirement does not apply to a printed-wiring board that contains only Class 2 non-safety circuits.

27 Transformer Protection

27.1 High-voltage transformers

27.1.1 General

27.1.1.1 A transformer (including an autotransformer), other than one as described in 27.1.3.4 is considered to be a high-voltage transformer and shall:

a) Be provided with thermal overload protection in accordance with the requirements in 27.1.2.1,

b) Be protected by an overcurrent device in accordance with the requirements in 27.1.2.2, or

c) Comply with the Burnout Test – High-Voltage Transformers, Section 49.

Exception: A transformer rated less than 50 volt-amperes that supplies only a motor control circuit and is located in the same enclosure as the motor controller need not comply with this requirement.

27.1.1.2 Transformers complying with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2, are considered to fulfill the requirements of 27.1.1.1.

27.1.2 Thermal protection

27.1.2.1 If a high-voltage transformer is provided with a thermal overload protective device, the device shall be arranged to interrupt primary current and shall limit temperatures of the transformer windings,

under overload conditions, to that permitted for the class of insulation employed in the windings. See Overload Test – High-Voltage Transformers, Section 51.

Exception: If the thermal overload protective device provided is a nonrenewable thermal cutoff, a burnout test is to be conducted in place of the overload test. See Burnout Test – High-Voltage Transformers, Section 50.

27.1.2.2 A thermal cutoff shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691. A manual or automatic resetting thermal protector shall have an endurance rating of not less than 6000 cycles and shall comply with the requirements for a type-2 action thermal cut-out, as specified in the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

27.1.3 Overcurrent protection

27.1.3.1 If a high-voltage transformer is protected by an overcurrent device, such protection shall comply with the requirements specified in 27.1.3.2, 27.1.3.3, and 27.2.1 – 27.2.3.

27.1.3.2 Except as noted in 27.1.3.3, a high-voltage transformer shall be protected by an overcurrent device(s) located in the primary circuit and rated or set as indicated in Table 27.1. See 27.2.1.

Exception: If the rated primary current of the transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device may be used. Standard ratings of protective devices are specified in Section 240.6 of the National Electrical Code, NFPA 70.

Table 27.1
Rating of overcurrent devices

Rated primary current, amperes		Maximum rating of overcurrent device, percent of transformer primary current rating
Transformer other than an autotransformer	Autotransformer	
Less than 2	–	300[a]
2 or more, less than 9	Less than 9	167
9 or more	9 or more	125

[a] May be increased to 500 percent if transformer supplies a motor control circuit.

27.1.3.3 If the circuit supplying a transformer other than an autotransformer is provided with overcurrent protection rated or set at not more than 250 percent of the rated primary current of the transformer, additional overcurrent protection is not required in the primary circuit provided the secondary circuit is protected at not more than 125 percent of the rated secondary current of the transformer. See 27.2.2.

Exception No. 1: If the rated secondary current of the transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device may be used in the secondary circuit. Standard ratings of protective devices are specified in Section 240.6 of the National Electrical Code, NFPA 70.

Exception No. 2: If the rated secondary current of the transformer is less than 9 amperes, the overcurrent device(s) in the secondary circuit may be rated or set at not more than 167 percent of the rated secondary current.

27.1.3.4 A transformer that directly supplies a National Electrical Code, NFPA 70, Class 2 circuit (see 3.3) shall, in accordance with one of the Standards referenced in 12.2.1, either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer).

27.2 Overcurrent protective devices

27.2.1 Overcurrent protection in the primary circuit of a transformer, as described in 27.1.3.2, need not be provided as part of the ice cream maker if, based on the marked rating or ratings of the ice cream maker, the rating of the branch circuit overcurrent protective device or devices does not exceed the values specified in 27.1.3.2.

27.2.2 Overcurrent protection in the secondary circuit of a transformer, as required by 27.1.3.3, shall be provided as part of the ice cream maker.

27.2.3 A required transformer overcurrent protective device(s) provided as part of the ice cream maker shall:

a) Be provided for all ungrounded conductors,

b) Be sized in accordance with requirements in 27.1.3.2 and 27.1.3.3, as applicable, and

c) Have a voltage rating not less than the circuit in which it is used.

The device(s) shall be:

a) A circuit breaker acceptable for branch circuit protection, or

b) A fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 67.19.

Exception: If a transformer supply is tapped from a circuit supplying other loads in the ice cream maker, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 55.1. If the supplementary type device used is a fuse, the ice cream maker shall be marked in accordance with the requirements in the Exception to 67.19.

28 High-Voltage Control Circuit Conductor Overcurrent Protection

28.1 General

28.1.1 For the purpose of these requirements, a “control circuit” is one that carries electric signals directing the performance of a controller which, in turn, governs power delivered to a motor or other load in the ice cream maker. A control circuit does not carry main power current. If a control-circuit is supplied through a transformer provided as part of the ice cream maker, see Transformer Protection, Section 27, for additional requirements.

28.2 Direct-connected, high-voltage control circuits

28.2.1 For the purpose of these requirements, a “direct-connected high-voltage control circuit” is one that is supplied from a branch circuit separate from a branch circuit that supplies other loads within the ice cream maker. It is not tapped from the load side of the overcurrent device or devices of any controlled circuit within the ice cream maker. See 68.23.

28.3 Tapped high-voltage control circuits

28.3.1 For the purpose of these requirements, a “tapped, high-voltage control circuit” is one that is tapped within the ice cream maker from the load side of the overcurrent device or devices for the controlled load.

28.3.2 A tapped, high-voltage control circuit conductor shall be provided with overcurrent protection. The rating of the overcurrent protective device or devices shall not exceed the applicable value specified in Table 28.1.

Exception No. 1: An 18, 16, and 14 AWG (0.82, 1.3, and 2.1 mm^2) conductor that does not exceed 4 feet (1.2 m) in length between points of opposite polarity may be protected by a fuse or circuit breaker rated 60 amperes or less.

Exception No. 2: An overcurrent protective device of a higher rating may be used if the conductors withstand short-circuiting when tested as specified in the Limited Short-Circuit Test, Section 55.

Exception No. 3: A lead 12 inches (305 mm) or less in length need not be provided with overcurrent protection.

Exception No. 4: A control-circuit conductor, supplied from the secondary of a single-phase transformer that is connected so that only a 2-wire (single voltage) secondary is used, may be protected by an overcurrent device(s) located on the primary side of the transformer provided:

a) This protection is in accordance with requirements specified in Transformer Protection, Section 27, and

b) The rating of the device does not exceed the applicable value specified in Table 28.1 multiplied by the ratio of secondary-to-primary rated transformer voltage.

Exception No. 5: A control circuit conductor that is tapped from the main power circuit at a point outside of the control equipment enclosure shall be protected as specified in Column A of Table 430.72(b) of the National Electrical Code, NFPA 70.

Table 28.1
Overcurrent protective device rating for control circuit conductors

Tapped control-circuit conductor size, AWG	Maximum rating of overcurrent protective device, amperes			
	Conductors contained in control equipment enclosure		Conductors extending beyond control equipment enclosure	
	Copper	Aluminum[a]	Copper	Aluminum[a]
18	25	–	7	–
16	40	–	10	–
14	100	–	45	–
12	120	100	60	45
10	160	140	90	75
Larger than 10	b	b	c	c

[a] Includes copper-clad aluminum.

[b] 400 percent of value specified for 60°C conductors in Table 310.17 of National Electrical Code, NFPA 70.

[c] 300 percent of value specified for 60°C conductors in Table 310.16 of National Electrical Code, NFPA 70.

28.4 Overcurrent protective devices

28.4.1 Overcurrent protection for a tapped high-voltage control circuit conductor, as required by 28.3.2, shall be provided as part of the ice cream maker.

Exception: The overcurrent device(s) need not be provided as part of the ice cream maker if, based on the marked rating(s) of the ice cream maker, the rating of the branch circuit overcurrent protective device(s) does not exceed the values specified in Table 28.1.

28.4.2 A control circuit overcurrent protective device(s) shall:

a) Be provided for all ungrounded conductors,

b) Be sized in accordance with requirements in 28.3.2, and

c) Have a voltage rating not less than the circuit in which it is used.

The device(s) shall be:

a) A circuit breaker acceptable for branch circuit protection, or

b) A fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 67.19.

Exception: If the control-circuit is tapped from a circuit supplying other loads in the ice cream maker, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 55.1. If the supplementary type device used is a fuse, the ice cream maker shall be marked in accordance with the exception to 67.19.

SPACINGS

29 High-Voltage Circuits

29.1 The following electrical spacing requirements apply to high-voltage circuits, as defined in 3.3(a).

29.2 Unless specifically noted otherwise, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall be not less than the values indicated in Table 29.1.

29.3 The “Through air” and “Over surface” spacings specified in Table 29.1 and Table 29.2 at an individual component part are to be based on the total volt-ampere consumption of the load or loads that the component controls. For example, the spacings at a component that controls only the compressor motor are based on the volt-amperes of the compressor motor. Spacings at a component that controls loads in addition to the compressor motor are to be based on the sum of the volt-amperes of the loads so controlled. Spacings at a component that independently controls separate loads are to be based on the volt-amperes of the largest load. The volt-ampere values for the loads referred to above are to be determined by the marked rating of the loads. For loads that are not required to have a marked rating, the measured input is to be used in determining the volt-ampere values.

29.4 The spacings indicated in Table 29.2 are applicable only to electrical components mounted in totally enclosed nonrefrigerated and/or nonair handling compartments which are free of moisture, including that caused by condensation. At wiring terminals and for circuits over 250 volts or over 2000 volt-amperes, spacings in Table 29.1 apply.

Table 29.1
Minimum spacings

Ratings		Inches (mm)					
Volt-amperes	Volts	Through air[c]		Over surface[c]		To enclosure[b]	
2000 or less	300 or less	1/8[a]	(3.2)	1/4	(6.4)	1/4	(6.4)
2000 or less	301 – 600	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)
More than 2000	150 or less	1/8[a]	(3.2)	1/4	(6.4)	1/2	(12.7)
	151 – 300	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
	301 – 600	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)

[a] The spacings between wiring terminals of opposite polarity, or between a wiring terminal and ground shall be not less than 1/4 inch (6.4 mm), except that if short-circuiting or grounding of such terminals will not result from projecting strands of wire, spacing need not be greater than that given in the above table. Wiring terminals are those connected in the field and not factory wired.

[b] Includes fittings for conduit or metal-clad cable.

[c] At points other than field-wiring terminals, the spacings for heater elements only may be as indicated below provided the elements are not subject to moisture, such as may result from condensation on cooled surfaces:

1/16 inch (1.6 mm) through air and over surface for heaters rated 0 – 300 volts

1/4 inch (6.4 mm) through air and over surface for heaters rated 301 – 600 volts

Table 29.2
Spacings in non-refrigerated and/or non-air handling compartments

Ratings		Minimum spacing in inches (mm)					
Volt-amperes	Volts	Through air		Over surface		To enclosure[a]	
0 – 2000	0 – 125	1/16	(1.6 mm)	1/16	(1.6 mm)	1/4	(6.4 mm)
	125 – 250	3/32	(2.4 mm)	3/32	(2.4 mm)	1/4	(6.4 mm)

Note – See 29.4.

[a] Includes fittings for conduit or metal-clad cable.

29.5 All uninsulated live parts connected to different circuits shall be spaced from one another as though they were parts of opposite polarity in accordance with the requirements indicated above and shall be based on the highest voltage involved.

29.6 With reference to 29.2 and 29.3, the “To enclosure” spacings given in Table 29.1 are not to be applied to an individual enclosure of a component part within an outer enclosure or cabinet.

29.7 The above spacing requirements are not to apply to the inherent spacings of a component part of the ice cream maker, such as a hermetic motor-compressor, motor, snap switch, controller, attachment-plug cap, and the like, for which spacing requirements are given in a standard for the component. However, the electrical clearance resulting from the assembly of the components into the complete product, including clearance to dead metal or enclosures, shall be those indicated.

29.8 If higher than rated potential is developed in a motor circuit through the use of capacitors, the rated voltage of the system shall be employed in applying the spacings indicated in this section.

Exception: If the developed steady-state potential as determined in the Temperature and Pressure Test, Section 43, exceeds 500 volts, the developed potential is to be used in determining the spacings for the parts affected.

29.9 An insulating lining or barrier of fiber or similar material, employed where spacings would otherwise be less than the required values, shall be no less than 0.028 inch (0.7 mm) thick and shall be so located or of such material that it will not be deteriorated by arcing.

Exception No. 1: Fiber not less than 0.013 inch (0.3 mm) thick may be used in conjunction with an air spacing of no less than 50 percent of the spacing required for air alone.

Exception No. 2: Thinner material may be used if it has equivalent insulating, mechanical, and flame-resistance properties when compared with materials in thicknesses specified above.

29.10 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a dead metal part or enclosure shall not be less than 1/2 inch (21.7 mm) if the potential is 600 volts or less and not less than 3/4 inch (19.1 mm) if the potential is 601 – 1000 volts.

30 Low-Voltage Circuits

30.1 The following electrical spacing requirements apply to low-voltage circuits, as defined in 3.3(b).

30.2 A circuit derived from a source of supply classified as a high-voltage circuit, having resistance connected in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

30.3 The spacings for low-voltage electrical components that are installed in a circuit that includes a pressure-limiting device, motor overload protective device, or other protective device, where a short or grounded circuit may result in a risk of fire, electric shock, or injury to persons shall comply with (a) - (c):

a) The spacing between an uninsulated live part and the wall of a metal enclosure, including fittings for the connection of conduit or metal-clad cable, shall be not less than 1/8 inch (3.2 mm). See 29.5.

b) The spacing between wiring terminals regardless of polarity and between the wiring terminal and a dead metal part, including the enclosure and fittings for the connection of conduit, that may be grounded when the device is installed, shall be not less than 1/4 inch (6.4 mm).

c) The spacing between uninsulated live parts regardless of polarity and between an uninsulated live part and a dead metal part, other than the enclosure, that may be grounded when the device is installed, shall be not less than 1/32 inch (0.8 mm) provided that the construction of the parts is such that spacings will be maintained.

30.4 The spacings in low-voltage circuits that do not contain devices such as indicated in 30.3 are not specified.

31 Alternate Spacings – Clearances and Creepage Distances

31.1 As an alternative to the specified spacing requirements of Sections 25 and 26, Spacings, the spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, are applicable. The spacing requirements in UL 840 shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal enclosure. In determining the pollution degree and overvoltage category, the environmental conditions to which the appliance is subjected in the end-use application shall be applied and those characteristics given in 31.2 and 31.3 modified accordingly.

31.2 When applying specific requirements in UL 840, the degrees of pollution shall be as indicated in Table 31.1.

Table 31.1
Degrees of pollution

Equipment	Pollution degree
Hermetically sealed or encapsulated equipment or printed wiring boards with protective coating.[a]	1
Equipment for ordinary locations and indoor use, such as residential controls, commercial controls for use in a clean environment, nonsafety controls for installation on or in appliances.	2
All safety or limit controls, equipment for outdoor use, and equipment influenced by surrounding environment, such as controls within the refrigerated compartment and within the machine compartment.	3
[a] Tested in accordance with the protective coating test in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.	

31.3 When applying specific requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, the spacing requirements in UL 840, shall be based on the overvoltage categories as indicated in Table 31.2.

Table 31.2
Overvoltage categories

Equipment	Overvoltage category
Intended for fixed wiring connection	III
Portable and stationary cord-connected	II
Low voltage circuits on the secondary side of a transformer[a]	I
[a] Applicable to low-voltage circuits if a short circuit between the parts involved does not result in operation of the controlled equipment that increases the risk of fire or electric shock.	

REFRIGERATION SYSTEM

32 Refrigerant

32.1 The kind of refrigerant employed in the system shall comply with the Standard for Refrigerants, UL 2182.

33 Pumpdown Capacity

33.1 The section of an ice cream maker designed to receive the refrigerant charge during a pumpdown shall have the capacity to receive the charge without the liquid occupying more than 90 percent of the volume of the section when the temperature of the refrigerant is 90°F (32.2°C).

34 Refrigerant Tubing And Fittings

34.1 The wall thickness of copper or steel tubing used to connect refrigerant-containing components shall be not less than indicated in Table 34.1.

Exception: Copper or steel capillary tubing that is protected against mechanical damage by the cabinet or assembly shall have a wall thickness not less than 0.020 inch (0.51 mm).

34.2 Tubing shall be constructed of corrosion-resistant material, such as copper, or shall be plated, dipped, coated, or equivalently treated to resist external corrosion. Aluminum may be used where the material is not subject to galvanic corrosion.

34.3 Tubing forming part of components, such as evaporators or condensers, where protection is afforded by inherent construction, shall be judged according to the requirements of the Strength Tests – Pressure Containing Components, Section 57.

34.4 Special alloys or constructions used in refrigerant-containing components, including tubing with a wall thickness less than indicated in 34.1, may be acceptable. Among the factors taken into consideration when judging the acceptability are its:

a) Resistance to mechanical abuse,

b) Strength against internal pressure,

c) Resistance to corrosion,

d) Protection against refrigerant contamination, and

e) Conformity with requirements of safety codes, such as the Safety Standard for Refrigeration Systems, ASHRAE 15, as compared to tubing of the minimum wall thicknesses indicated in Table 34.1.

Table 34.1
Minimum wall thickness[a] for copper, steel, and aluminum tubing

Outside diameter,		Copper				Steel		Aluminum	
		Protected within ice cream maker,		Unprotected,					
Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
1/4	(6.4)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
5/16	(7.9)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
3/8	(9.5)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
1/2	(12.7)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.0350	(0.89)
5/8	(15.9)	0.0315	(0.800)	0.0315	(0.800)	0.032	(0.81)	0.0350	(0.89)
3/4	(19.1)	0.0315	(0.800)	0.0385	(0.978)	0.032	(0.81)	0.0488	(1.24)
7/8	(22.2)	0.0410	(1.041)	0.0410	(1.041)	0.046	(1.17)	0.0488	(1.24)
1	(25.4)	0.0460	(1.168)	0.0460	(1.168)	–	–	0.0650	(1.65)
1-1/8	(28.6)	0.0460	(1.168)	0.0460	(1.168)	0.046	(1.17)	0.0720	(1.65)
1-1/4	(31.8)	0.0505	(1.283)	0.0505	(1.283)	0.046	(1.17)	–	–
1-3/8	(34.9)	0.0505	(1.283)	0.0505	(1.283)	–	–	–	–
1-1/2	(38.1)	0.0555	(1.410)	0.0555	(1.410)	0.062	(1.57)	–	–
1-5/8	(41.3)	0.0555	(1.410)	0.0555	(1.410)	–	–	–	–
2-1/8	(54.0)	0.0640	(1.626)	0.0640	(1.626)	–	–	–	–
2-5/8	(66.7)	0.0740	(1.880)	0.0740	(1.880)	–	–	–	–

[a] Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimum wall thickness.

34.5 Tubing connections shall be made by means of flare-type fittings with steel or forged brass nuts, by soldering or brazing, or by equivalent means. Flare-type fittings shall comply with the applicable requirements in the Standard for Refrigeration Tube Fittings – General Specifications, SAE J513.

35 Refrigerant-Containing Parts

35.1 Parts of an ice cream maker subjected to refrigerant pressure shall withstand, without failure, the pressure indicated in the Strength Tests – Pressure Containing Components, Section 57.

35.2 Parts of an ice cream maker subjected to refrigerant pressure shall be:

a) Constructed of corrosion resistant material, such as copper or stainless steel, or

b) Plated, dipped, coated, or equivalently treated to resist external corrosion.

35.3 Pressure vessels, as referred to in this standard, are any refrigerant-containing parts other than compressors, controls, evaporators [each separate section of which does not exceed 1/2 cubic foot (0.01 m^3) of refrigerant-containing volume], evaporator and condenser coils, headers, pipe, and pipe fittings.

35.4 Pressure vessels over 6 inches (152 mm) inside diameter shall be designed, tested, and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, for a working pressure in compliance with the applicable performance requirements of this standard.

35.5 Pressure vessels bearing the ASME Code "U" symbol complying with 35.4 are considered acceptable without tests.

35.6 Pressure vessels bearing the ASME Code "UM" symbol are to be tested to determine compliance with the Strength Tests – Pressure Containing Components, Section 57. The manufacturer shall submit evidence of compliance of these vessels with ASME Boiler and Pressure Vessel Code, Section VIII.

36 Pressure-Limiting Devices

36.1 A pressure-limiting device designed to automatically stop the operation of the compressor shall be installed on all ice cream makers with a system containing more than 22 pounds (10 kg) of refrigerant.

36.2 The adjustable cutout pressure setting of a pressure-limiting device shall not exceed one-third of the ultimate strength of high-side refrigerant-containing parts, provided this setting does not exceed 90 percent of the setting of the pressure-relief device.

36.3 There shall be no stop valves between the pressure-limiting device and the compressor.

37 Pressure Relief

37.1 General

37.1.1 An ice cream maker shall be constructed so that pressure due to fire, or other abnormal conditions, will be relieved. Pressure-relief devices, fusible plugs, soldered joints, or special terminals may be employed for this purpose. See 37.3.1.

37.1.2 A pressure-relief device is a pressure-actuated valve or rupture member designed to relieve excessive pressures automatically.

37.1.3 An ice cream maker with a pressure vessel over 3 inches (76.2 mm) inside diameter, but not exceeding 3 cubic feet (0.08 m^3) internal gross volume, shall be protected by a pressure-relief device or fusible plug.

37.1.4 An ice cream maker with a pressure vessel exceeding 3 cubic feet (0.08 m^3), but less than 10 cubic feet (0.28 m^3) internal gross volume, shall be protected by a pressure-relief device.

37.1.5 There shall be no stop valve between the pressure-relief means and the parts or section of the system protected.

37.1.6 All pressure-relief devices shall be connected as close as practicable or directly to the pressure vessel or parts of the system protected. Pressure-relief devices shall be connected above the liquid refrigerant level, installed so that they are accessible for inspection and repair, and arranged so that they cannot readily be rendered inoperative.

37.1.7 Fusible plugs in the high-side of the refrigeration system may be located above or below the liquid refrigerant level. Fusible plugs in the low-side of the refrigeration system shall be located above the liquid refrigerant level.

37.2 Relief valves

37.2.1 Pressure-relief valves shall comply with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII. Valves of 1/2 inch [0.840 inches (21.3 mm) outside diameter] iron pipe size (ips) and larger shall bear the authorized Code "UV" symbol together with the set pressure and capacity. Valves of less than 1/2 inch ips shall be similarly marked, except that where the size does not permit a nameplate, the code symbol may be omitted and the set pressure and capacity may be stamped on the valve or on a metal plate attached to it. Manufacturers of valves that do not bear the code symbol shall provide evidence of certification of the valve and its pressure and capacity rating by proper code authorities.

37.2.2 Pressure-relief valves shall be sealed at a start-to-discharge pressure not exceeding:

a) The marked working pressure of the pressure vessel protected or

b) One-fifth of the ultimate strength of pressure vessels that do not have a marked working pressure.

37.2.3 The marked discharge capacity shall be not less than the minimum required discharge capacity. See 37.3.1.

37.3 Fusible plugs or rupture members

37.3.1 Calculation of the minimum required discharge capacity and the rated discharge capacity of a rupture member or fusible plug shall be in accordance with the Safety Standard for Refrigeration Systems, ASHRAE 15.

37.3.2 Fusible plugs and rupture members shall comply with the requirements in the Standard for Refrigerant-Containing Components and Accessories, Nonelectrical, UL 207, as applicable to such devices.

37.3.3 Rupture members shall have a nominal rated rupture pressure not exceeding the design pressure of the parts of the system protected.

PERFORMANCE

38 Instrumentation

38.1 Temperature measurements

38.1.1 Temperatures are to be measured by thermocouples, except that the change-in-resistance method may be used to measure the temperature of motor windings or of coils. See 43.4. The thermocouples are to consist of 24 – 30 AWG (0.21 – 0.05 mm^2) wires. The thermocouples and related instruments are to be accurate and calibrated. The thermocouple wire is to comply with the requirements listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

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

38.1.3 If the thermocouples are used in the determination of temperatures in connection with the heating of electrical equipment, thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of indicating instrument are to be used whenever referee temperature measurements by means of thermocouples are necessary.

38.1.4 Except as specified in 38.1.5, during any test in which temperatures are measured, temperatures shall be monitored until maximum temperatures are attained. Thermal equilibrium is to be considered to exist when three successive readings indicate the same or decreasing temperatures. Readings shall be taken at the end of not less than three consecutive periods, the duration of each period being not less than 5 minutes.

38.1.5 In reference to 38.1.4, if temperatures on the component being monitored cycle between higher and lower temperatures due to the component cycling as part of the test (for example a load cycling on and off due to operation of a protective device), equilibrium is to be considered obtained when three successive peak temperatures indicate the same or decreasing temperatures.

38.1.6 In reference to 38.1.4 and 38.1.5, the recorded temperature shall be the highest of the three readings.

38.2 Pressure measurements

38.2.1 Pressure gauges are to be attached in such a manner as to prevent leakage. Special fittings for direct connection to the system or minimum lengths of 1/8-inch (3.2-mm) outside diameter commercial capillary tubing may be employed for gauge connections. The volume of the pressure-measuring gauge and lines is to be held to a minimum. All joints in the gauge system are to be tested for leakage.

38.2.2 Opening of the gauge line valves shall not cause a significant change in the electrical input of the system that would prevent the equipment from performing in its intended manner. High-side gauges and lines may be heated above the saturation temperature corresponding to the expected pressure or may be precharged with a liquid refrigerant of the same type as used in the system to minimize the effect of opening the gauge line valves.

39 Test Voltage

39.1 Unless otherwise specified, ice cream makers are to be tested at 60-hertz voltages maintained at the ice cream maker supply connections in accordance with Table 39.1.

Exception: Ice cream makers rated at other than 60 hertz frequencies are to be tested at their rated voltages and frequencies.

Table 39.1
Test voltages

Name plate voltage rating	Normal test voltage[a]
110 to 120	120
200 to 208	208
220 to 240	240
254 to 277	277
440 to 480	480
550 to 600	600
Other	Rated

[a] These test voltages are nominal for the condenser fan motor failure test, Section 45, and condenser water failure test, Section 46.

40 Leakage Current Test – Cord-Connected Ice Cream Makers

40.1 The leakage current of a cord-connected ice cream maker shall be not more than 0.75 milliamperes when tested in accordance with 40.2 – 40.8.

Exception: A cord-connected ice cream maker may produce a leakage current greater than 0.75 mA under the following conditions:

a) The ice cream maker shall have a reliable disconnect circuit that, upon loss of grounding, disconnects the sources that produce a leakage current greater than 0.75 mA.

b) The leakage current shall not exceed 3.5 mA with the grounding conductor open and with the ground integrity disconnect circuit disabled.

Note: leakage current measurement on equipment investigated under this exception should be made with the appropriate meter and circuitry specified in the Standard for Leakage Current for Appliances, UL 101.

40.2 Leakage current refers to all currents, including capacitively-coupled currents, that may be conveyed between exposed conductive surfaces of an ice cream maker and ground or other exposed surfaces of the ice cream maker.

40.3 All exposed conductive surfaces are to be tested for leakage currents. Leakage currents are to be measured between the grounded supply conductor and:

a) Each exposed surface individually, and

b) All exposed surfaces collectively if the surfaces are simultaneously accessible. Leakage currents also are to be measured between simultaneously accessible surfaces.

Parts are considered to be exposed surfaces unless guarded by an enclosure providing protection in accordance with 6.1 – 6.14. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time.

Exception: These measurements do not apply to terminals operating at an open circuit voltage not exceeding 42.4 volts peak (30 volts rms if the wave form is sinusoidal).

40.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 3.9 by 7.8 inches (100 by 200 mm) in contact with the surface. If the surface is less than 3.9 by 7.8 inches, 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 ice cream maker.

40.5 The measurement circuit for leakage current is to be as shown in Figure 40.1. The measurement instrument is defined in (a) – (c). The meter actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all of 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 the impedance of a 1500-ohm resistor shunted by a 0.15-microfarad capacitor to 1500 ohms. At an indication of 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

40.6 A sample of the ice cream maker is to be prepared and conditioned for leakage current measurement as specified in (a) – (d):

a) The sample is to be representative of the wiring methods, routing, components, component location, installation, and the like, of the production ice cream maker.

b) The grounding conductor is to be open at the attachment plug and the test ice cream maker isolated from ground.

c) The sample is to be conditioned in an ambient temperature of 70 – 80°F (21.1 – 26.7°C) and minimum 50 percent relative humidity for not less than 8 hours.

d) Unless the measuring circuit is being used to measure leakage current from one part of the ice cream maker to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

40.7 The test is to be conducted at the ambient conditions specified by 40.6 (c) and with the supply voltage adjusted to the test voltage as specified in 39.1.

40.8 With reference to the measuring circuit in Figure 40.1, the leakage current test sequence shall be as described in (a) – (d). During any of the following tests, if the compressor stalls during positioning of switch S2, the sequence is to be conducted in its entirety in one polarity. The polarity is then to be reversed and the test repeated.

a) With switch S1 open, the ice cream maker is to be connected to the measuring circuit. The leakage current is to be measured using both positions of switch S2. All manually-operated switching devices are to be operated in their intended manner, and leakage currents are to be measured using both positions of switch S2.

b) With the ice cream maker switching devices in their intended operating position, switch S1 is to be closed to energize the ice cream maker. Within a period of 5 seconds, the leakage current is to

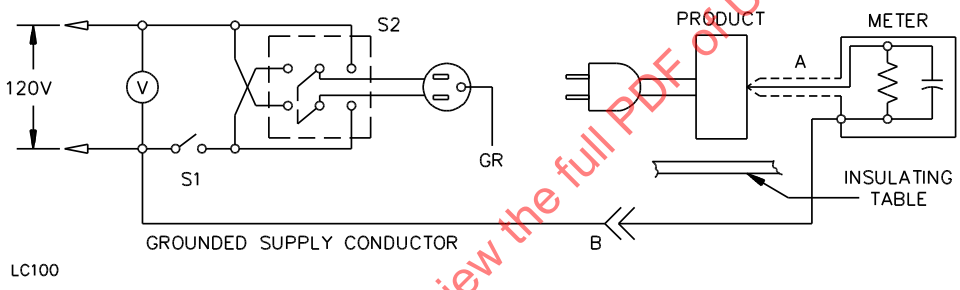
be measured using both positions of switch S2. All manual switching devices are to be operated in their intended manner, and leakage currents are to be measured using both positions of switch S2.

c) The ice cream maker switching devices are to be returned to their intended operating positions and the ice cream maker allowed to run until thermal equilibrium is obtained. Leakage current is to be monitored continuously. For this test, thermal equilibrium is defined as that condition where leakage current is found to be constant or decreasing in value. Both positions of switch S2 are to be used in determining this measurement. Thermal equilibrium may involve cycling caused by an automatic control in the cooling and defrost cycles. This cycling shall be observed in both positions of switch S2.

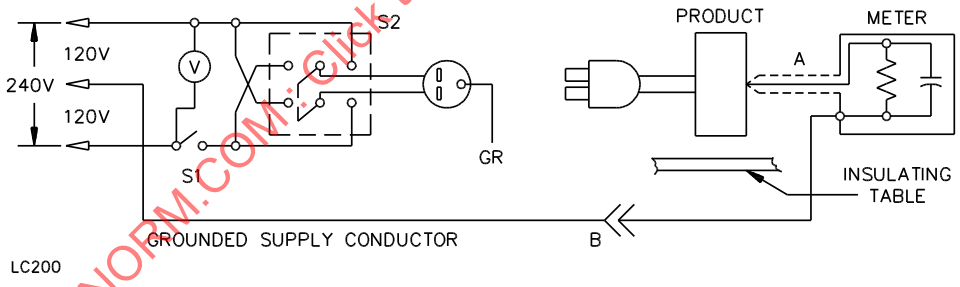
d) Immediately following 40.8(c), any single-pole switch or thermostat on the ice cream maker is to be opened, and the leakage current monitored until constant or decreasing values of leakage current are recorded. Readings are to be taken in both positions of switch S2.

Figure 40.1

Leakage current measurement circuits



Product intended for connection to a 120 volt power supply.



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

A – Probe with shielded lead – Under some circumstances where higher frequency components are present, shielding of measuring instrument and its leads may be necessary

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

41 Input Test

41.1 The measured ampere input, see 41.3, to a cord-connected ice cream maker shall not exceed the total rating marked on the ice cream maker nameplate by more than 10 percent when tested as described in the Temperature and Pressure Test, Section 43.

41.2 The measured ampere input, see 41.3, to a permanently connected ice cream maker shall not exceed the individual rating of each load or group of loads or the total rating as marked on the nameplate by more than 10 percent when tested as described in the Temperature and Pressure Test, Section 43.

41.3 The measured ampere input is to be the value obtained under stabilized conditions and is to include the dispensing operation if this results in a higher current.

41.4 With reference to 41.2, the measured ampere input is to be increased for 15- and 20-ampere accessible convenience outlets by:

a) Eighty percent of the receptacle rating, if the ice cream maker incorporates only one 15- or 20-ampere receptacle.

b) One hundred percent of the receptacle rating, if the ice cream maker incorporates more than one 15- or 20-ampere receptacle.

42 Starting Test

42.1 An ice cream maker shall start, and operate, as intended without rupturing a line fuse of the size required by the ice cream maker.

42.2 The ice cream maker, with four fuses connected in series, is to be operated under the conditions described in the Temperature and Pressure Test, Section 43.

42.3 For a cord-connected ice cream maker, the fuse rating is determined by the rating of the attachment plug. For a permanently connected ice cream maker protected by a fuse sized in accordance with 55.2.1, the fuse rating is to be as marked on the nameplate. For a permanently connected ice cream maker protected by a fuse sized in accordance with 55.1.6, no starting test is required.

42.4 If no fuse opens, the fuse size is acceptable for starting the ice cream maker. If one fuse opens, the test is to be repeated using the three remaining fuses. If none of these three opens, the results are acceptable. If one of the three opens, the results are not acceptable and the test is to be repeated using four time-delay fuses of the same rating as the original fuse.

42.5 If it is determined that time-delay fuses are required for starting, the ice cream maker shall be marked in accordance with 68.15 or 69.2, whichever is appropriate.

42.6 If an automatic-reset thermal protective device interrupts the current flow one or more times during the test, the ice cream maker shall restart and run after each interruption and shall comply with the fusing requirements of 42.4 and 42.5.

42.7 If 15- or 20-ampere general purpose receptacles are provided and are intended to be connected to the same circuit as the ice cream maker, the starting test is to be conducted with an additional noninductive load connected to the unit of the size specified in (a) or (b):

a) Eighty percent of the receptacle rating if the ice cream maker incorporates only one 15- or 20-ampere receptacle.

b) One hundred percent of the receptacle rating if the ice cream maker incorporates more than one 15- or 20-ampere receptacle.

43 Temperature And Pressure Test

43.1 The temperature rises measured on the components of an ice cream maker shall not exceed those specified in Table 43.1.

Table 43.1
Maximum temperature rises

Device or material	Degrees, C	Degrees, F
A. Motors		
1. Class A insulation systems on coil windings of alternating-current motors 7 inches (178 mm) or less in diameter (not including hermetic motor-compressors)[a]		
a. In open motors – Thermocouple or resistance method	75	135
b. In totally enclosed motors – Thermocouple or resistance method	80	144
2. Class A insulation systems on coil windings of alternating-current motors more than 7 inches (178 mm) in diameter (not including hermetic motor-compressors)[b]		
a. In open motors –		
Thermocouple method	65	117
Resistance method	75	135
b. In totally enclosed motors –		
Thermocouple method	70	126
Resistance method	80	144
3. Class B insulation systems on coil windings of alternating-current motors 7 inches (178 mm) or less in diameter (not including hermetic motor-compressors)		
a. In open motors – Thermocouple or resistance method	95	171
b. In totally enclosed motors – Thermocouple or resistance method	100	180
4. Class B insulation systems on coil windings of alternating-current motors more than 7 inches (178 mm) in diameter (not including hermetic motor-compressors)		
a. In open motors –		
Thermocouple method	85	153
Resistance method	95	171
b. In totally enclosed motors –		

Table 43.1 Continued on Next Page

Table 43.1 Continued

Device or material	Degrees, C	Degrees, F
Thermocouple method	90	162
Resistance method	100	180
B. Components		
1. Capacitors		
Electrolytic type[c]	40	72
other types[d]	65	117
2. Field wiring	35	63
3. Hermetic motor compressor enclosures[e]	150	302
4. Relay, solenoid, and, other coils (except motor coil windings) with:[b]		
a. Class 105 insulated winding –		
Thermocouple method	65	117
Resistance method	85	153
b. Class 130 insulation –		
Thermocouple method	85	153
Resistance method	105	189
5. Transformer enclosures – with		
a. Class 2 transformers	60	108
b. Power transformers	65	117
6. Other Components and Materials		
a. Fiber used as electrical insulation or cord bushings	65	117
b. Phenolic composition used as electrical insulation or as parts where deterioration will result in a risk of electric shock or fire	125	225
c. Solid contacts	65	117
d. Thermoplastic material. Rise based on temperature limits of material	–	–
e. Wood or other combustibles	65	117
C. Conductors		
1. Flexible cords and wires with rubber, thermoplastic, or neoprene insulation unless recognized as having special heat-resistant properties as follows:		
Degrees C / Degrees F		
50 / 140	35	63
75 / 167	50	90
80 / 176	55	99
90 / 194	65	117
105 / 221	80	144
D. General		
1. Surfaces at points of zero clearance to test enclosure	65	117
2. Surfaces normally contacted by the user in operating the unit (control knobs, pushbuttons, levers, and the like)		
Metal	35	63
Nonmetallic	60	108
3. Surfaces subjected to casual contact by user (enclosure, grille, and the like)		
Metal	45	81
Nonmetallic	65	117

Table 43.1 Continued on Next Page

Table 43.1 Continued

Device or material	Degrees, C	Degrees, F
4. Surfaces of test enclosure where clearance to combustible material is specified	65	117

[a] Thermocouple applied directly to the integral insulation of the coil conductor.

[b] Thermocouple applied as in (1) or applied to conventional coil wrap.

[c] For an electrolytic capacitor which is physically integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure may be not more than 65°C (117°F).

[d] A capacitor that operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating.

[e] Maximum – not rise.

43.2 The maximum pressure developed in an ice cream maker, tested as described in 43.3 – 43.13, shall be used in applying strength test requirements, see Section 57.

43.3 The assembly is to "pulldown" under the following test conditions. Pulldown will be effected when the assembly runs continuously at approximately constant electrical input and low-side pressure. An automatic-reset protective device may cycle at the start of the initial cycle. A manual-reset protective device shall not trip during the starting or operating period.

43.4 The ice cream maker is to be fitted with pressure gauges on the high- and low-sides. Thermocouples are to be secured to electrical components, such as the compressor-motor enclosure, fan-motor windings, starting-relay coil, capacitors, and wiring insulation. The temperature of motor windings or of coils may be measured by the change-in-resistance method, but the primary method of temperature measurement is to be the thermocouple method. The electrical input is measured with a voltmeter and an ammeter. The temperature controller is to be adjusted to the lowest adjustable setting.

43.5 The ice cream maker is to be installed in accordance with the manufacturer's instructions and operated under the conditions specified in 43.9 – 43.12, as applicable. The test potential is to be as indicated in Table 39.1.

43.6 The ice cream maker is to be placed in an enclosure simulating conditions of intended use. The enclosure is to consist of a bottom, back, two sides, and top constructed of 3/8 inch (9.5 mm) thick plywood with the inside surfaces painted flat black and with all joints sealed. The enclosure top is not necessary if the ice cream maker is intended to be filled from the top. The enclosure is to be brought into close contact with the ice cream maker unless indicated otherwise in the manufacturer's instructions.

43.7 With reference to 43.6, a remote condenser is to be placed in an enclosure simulating conditions of intended use. The enclosure is to consist of a bottom, back and two sides of 3/8 inch (9.5 mm) thick plywood with the inside surfaces painted flat black and with all joints sealed. The enclosure is to be brought into close contact with the remote condenser unless indicated otherwise in the manufacturer's instructions.

43.8 If the wiring to a general purpose receptacle does not comply with Table 11.1, a resistive load is to be connected to the receptacle circuit during the test and the temperature of the wiring insulation measured. The resistive load shall be as specified in (a) or (b):

a) If a single receptacle is employed, the load shall be equal to 80 percent of the rating of the receptacle.

b) If more than one receptacle is employed on the same circuit, the load shall be equal to 100 percent of the rating of the largest receptacle.

43.9 An ice cream maker employing an air-cooled condenser is to be placed within a room maintained at 104°F (40°C) until the assembly reaches room temperature. The ice cream mix used in the test is to be maintained at the highest temperature recommended by the manufacturer. The unit is to be charged with the mix and placed in operation in accordance with the manufacturer's instructions. The product is to be withdrawn either continuously or in batches at the maximum rate recommended by the manufacturer. The unit is to be kept filled with mix by recharging as required during the test.

43.10 Electrical loads that may operate concurrently with the condensing unit are to be energized during the test. The assembly is to be operated until temperatures and pressures have stabilized. The potential is to be maintained as indicated in Table 39.1. The electrical input, the temperature of electrical components, and high- and low-side pressures are to be recorded at intervals during the test.

43.11 For the test of an ice cream maker of the water-cooled type, the condenser water flow is to be maintained at 80°F (26.7°C) inlet and 100°F (37.8°C) outlet temperatures. If 100°F (37.8°C) outlet water cannot be attained due to design, the ice cream maker is to be tested at 80°F (26.7°C) inlet water and 35 psig (241 kPa) nominal pressure.

43.12 Upon completion of the tests described in 43.9 – 43.11, the ice cream maker is to continue to operate with no product withdrawal until stabilized temperatures are obtained. The unit may cycle on the temperature controller.

43.13 The ice cream maker shall comply with the Dielectric Voltage-Withstand Test, Section 44, following the test.

44 Dielectric Voltage-Withstand Test

44.1 A complete ice cream maker and all electrical components shall withstand, without breakdown, a test potential of 1000 volts plus twice rated voltage applied for 1 minute, between high-voltage live parts and dead metal parts and between live parts of high- and low-voltage circuits. The test potential shall be at any frequency between 40 and 70 hertz.

Exception No. 1: The test potential for motors rated at not more than 1/2 horsepower (373 W output) shall be 1000 volts.

Exception No. 2: If the steady-state voltage developed in a motor circuit through the use of capacitor exceeds 500 V, as measured during the temperature and pressure test, the test potential for the parts affect shall be 1000 V plus twice the developed capacitor voltage.

44.2 An ice cream maker employing a low-voltage circuit shall withstand, without breakdown, a test potential of 500 volts applied for 1 minute between low-voltage live parts and dead metal parts. The test potential shall be at any frequency between 40 and 70 hertz. If components specified in 30.3 are employed in the low-voltage circuit, the dielectric voltage withstand test shall also be conducted between live parts of opposite polarity.

44.3 With reference to 44.2, the test between low-voltage parts of opposite polarity is to be conducted on magnet coil windings of the transformer after breaking the inner coil lead where it enters the layer. This opposite polarity test may be waived on the complete assembly provided that the components have been separately subjected to this test.

44.4 A 500-volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with the previous paragraph. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at that value for 1 minute.

Exception: The requirement of a 500-volt-ampere or larger transformer can be waived if the high potential testing equipment maintains the specified high potential voltage at the equipment during the duration of the test.

44.5 If the charging current through a capacitor or capacitor-type filter connected across the line, or from line to earth ground, is large enough to make it impossible to maintain the required alternating-current test potential, the capacitors and capacitor-type filters may be tested as described in 44.6.

44.6 The capacitors and capacitor-type filters mentioned in 44.5 are to be subjected to a direct-current test potential of 1414 volts for equipment rated 250 volts or less or 1414 volts plus 2.828 times the rated circuit voltage for equipment rated at more than 250 volts. The direct-current test potential is to be maintained for 1 minute without breakdown.

44.7 Components providing a DC path in parallel with the insulation to be tested, such as discharge resistors for filter capacitors and voltage limiting devices (transient voltage suppressors), may be disconnected during the test.

45 Condenser Fan Motor Failure Test

45.1 An ice cream maker shall not leak refrigerant nor develop pressures or temperatures in excess of those indicated in (a) and (b), if the condenser fan motor locks or fails to start.

a) The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 57. An assembly employing a pressure-limiting device complying with 36.2 is considered to comply with the high-side pressure requirement.

b) The maximum temperature of the compressor enclosure, of the fan motor winding (open type), or of the fan motor enclosure (enclosed type) shall not exceed 302°F (150°C). Compressors and condenser fan motors equipped with thermal protective devices as specified in 19.4.1 (a) and 19.2.1 (c), (d), or (h) are considered to comply with this requirement.

45.2 A sample of the assembly is to be fitted with a pressure gauge on the high-pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure and condenser fan motor winding (open type) or condenser fan motor enclosure (enclosed type). When evaluating low-side components for compliance with the strength requirements of 57.1.4, a pressure-gauge is to be fitted on the low-side of the system. The low-side pressure is to be recorded while the compressor is operating and after shutdown. If the ice cream maker is provided with means to relieve discharge pressure into the low-side of the system, the low-side pressure is to be recorded:

a) While the compressor is operating, the pressure relief means is open and the low-side pressure is increasing, and

b) After shutdown of the compressor.

The controls are to be set for maximum cooling and the ice cream maker is to be operated with the condenser fan motor locked until stabilized temperatures and pressures are reached. The compressor motor overload device, the fan motor overload device, or both, may operate during this test. The ambient air temperature is to be 77°F ±9° (25°C ±9°). The test potential is to be maintained as indicated in Table 39.1. If two or more condenser fan motors are employed, the test is to be conducted with one motor locked.

46 Condenser Water Failure Test

46.1 A water-cooled ice cream maker shall not leak refrigerant nor develop pressures or temperatures in excess of those indicated in 46.1 (a) and (b), during water failure. The test shall not damage electrical parts.

a) The maximum high- and low-side pressures are to be recorded as reference values for requirements of Strength Tests – Pressure Containing Components, Section 57.

b) The maximum temperature of the compressor enclosure shall not exceed 302° F (150° C). Compressors equipped with a thermal protective device(s) as specified in 19.4.2 are considered to comply with this requirement.

46.2 A sample of the assembly is to be fitted with a pressure gauge on the high-pressure side of the refrigeration system and provided with thermocouples on the compressor enclosure. When evaluating low-side components for compliance with the strength requirements of 57.1.4, a pressure gauge is to be fitted on the low side of the system. The low-side pressure is to be recorded as specified in 45.2. The ice cream maker is to be operated with the condensing water shut off and also with the condensing water restricted until maximum stabilized temperatures are reached or until representative maximum temperatures are attained under cycling load. If the ice cream maker cycles on a motor-overload protective device, the test is to continue until the maximum pressure during the protective device operation is obtained. The room ambient temperature is to be 77°F ±9° (25°C ±9°). The test potential is to be maintained as indicated in Table 39.1.

46.3 If a pressure-limiting device is provided, the test need not be conducted to determine compliance with 46.1. The maximum cutout pressure to which the pressure-limiting device may be readily adjusted by the adjusting means provided shall be employed in determining compliance with 46.1. See 57.1.1.

47 Overflow Test

47.1 With reference to 5.3.4, a drippage or drain pan in which liquids may accumulate or overflow due to a blocked waste outlet shall not allow the liquids to wet live parts or the windings of motors or coils.

47.2 The ice cream maker is to be positioned as intended in operation and the drain pan is to be filled until overflowing occurs.

47.3 Compliance with 47.1 can be determined by visual examination, or by comparison of dielectric voltage withstand or insulation resistance measurements taken before and after overflow, except that motor windings are to have an insulation resistance of not less than 50,000 ohms and are to comply with the Dielectric Voltage-Withstand Test, Section 44.

48 Stability Test

48.1 An ice cream maker shall be stable when tested in accordance with 48.2 and 48.3.

48.2 A freestanding ice cream maker is to be supported by the legs, leveling screws, or casters provided in its base. Other means of support, such as wall brackets, plumbing connections, or conduit connections, shall not be relied on for the purpose of the test. The ice cream maker shall not overturn under the conditions specified in 48.2 (a) and (b):

a) An empty ice cream maker, with service doors, covers, and panels closed, is to be placed on a plane surface inclined at an angle of 10 degrees with the horizontal. Accessories intended for use with the ice cream maker are to be installed. Swivel-type casters, if any, are to be oriented so that the tendency to overturn is maximum, or

b) An empty ice cream maker weighing 50 pounds-mass (22.7 kg) or more with accessories installed, is to be placed on a horizontal surface. If leveling screws are provided, they are to be adjusted equally to raise the machine to its maximum height but not to more than 1 inch (25.4 mm) above floor level. If swivel-type casters are provided, they are to be oriented so that the tendency to overturn is maximum. A force equal to one-fourth the weight of the ice cream maker, but not exceeding 50 pounds-force (223 N), is to be applied horizontally at the vertical centerline of any side of the ice cream maker at the highest point, not to exceed 5 feet (1.5 m), above floor level.

1) For a drawer or horizontally-hinged door that swings downward and that provides access to the product storage compartment, a force equal to one-fourth the weight of the ice cream maker, but not exceeding 50 pounds-force (223 N), is to be applied vertically downward at the center of the outermost edge of the drawer or door with the drawer or door opened to its maximum.

2) For other hinged doors, a force equal to one-fourth the weight of the ice cream maker, but not exceeding 35 pounds-force (156 N), is to be applied vertically downward at the edge of the door farthest from the hinges with the door opened at an angle of 90 degrees to the cabinet.

48.3 Unique mounting or support systems for ice cream makers that would require securing to a wall, floor, or other support surface shall be separately evaluated to determine their reliability, ease of operation, and likelihood of continued use.

49 Burnout Tests – Components

49.1 There shall be no manifestation of fire or potential for electrical shock when an ice cream maker is operated under conditions, that may occur in service, as described in 49.2 – 49.7.

49.2 A potential for fire is considered to exist if there is:

a) Any emission of flame or molten metal from the ice cream maker, or

b) A glowing of flaming of flammable material.

Opening of the supply circuit fuse is acceptable if a potential for fire does not exist.

49.3 A potential for electrical shock is considered to exist if the insulation resistance of the ice cream maker is less than 50,000 ohms.

49.4 A burnout test is to be conducted on components, such as an intermittent-duty relay, solenoid, electrically-operated valve or others, if the design of the ice cream maker indicates the potential for a fire or an electrical shock. The tests are to be conducted with the component installed as intended in the ice cream maker. The ice cream maker is to be connected to a supply circuit maintained as indicated in Table 39.1. Each ungrounded conductor in the supply circuit is to be provided with a fuse of the maximum rating that may be used. For cord-connected ice cream makers, the supply circuit fuses are to correspond in size to the rating of the attachment plug except that 20 amperes is to be the minimum size used for ice cream makers rated 150 volts or less.

49.5 If a single component malfunction may result in an intermittent-duty relay or solenoid being continuously energized, the test is to be conducted with the relay or solenoid continuously energized until the ultimate result is determined.

49.6 If a relay, solenoid, or electrically operated valve becomes blocked in the de-energized position, the relay, solenoid, or valve is to be blocked in its de-energized position and then energized continuously until the ultimate result is determined.

49.7 If, in a liquid-level system, malfunction of a relay may overload a transformer or other part of the system, the liquid-level system is to be energized with the relay armature blocked until the ultimate result is determined.

50 Burnout Test – High-Voltage Transformers

50.1 There shall be no emission of flame or molten metal from the ice cream maker enclosure when a high-voltage transformer is operated under the conditions described in 50.2 and 50.3.

Exception: This test does not apply to a high-voltage transformer that is provided with thermal overload protection of other than the nonrenewable thermal cutoff type (see 27.1.2.1) or that is protected by an overcurrent device(s) in accordance with the requirements in 27.1.3.1.

50.2 Three samples of the transformer are to be operated continuously at the normal test voltage indicated in Table 39.1 and rated frequency with the enclosure grounded. The test ambient temperature is to be approximately 77°F (25°C) and operation is to be continued until constant temperature is indicated by a thermocouple on the enclosure or until burnout occurs. The circuit on which the transformer is tested is to be protected by fuses rated not less than that required for the ice cream maker.

50.3 The load connected to the output terminals is to be the highest of the values specified in (a) – (c) and is to be readjusted to the specified value after 2 minutes of operation, if necessary, with no further readjustment during the test.

a) A resistance load to provide a current equal to three times the full rated transformer secondary current, or

b) If the transformer supplies a motor with or without additional loads, a resistance load to provide a current equal to the motor locked-rotor current plus any additional loads, or

c) If the transformer supplies an inductive load (other than a motor), such as the coils of relays, solenoids, and the like, a resistance load to provide a current equal to the sum of such loads with the armature of the largest blocked open.

Exception: The test may be conducted with the output terminals short-circuited if this results in less than three times rated secondary current.

51 Overload Test – High-Voltage Transformers

51.1 This test applies to a high-voltage transformer provided with thermal protection of other than the nonrenewable thermal cutoff type. See 27.1.2.1.

51.2 Temperatures of a thermally protected high-voltage transformer, measured on the surface of the windings, shall not exceed the insulation temperature rating when the transformer is tested as indicated in 51.3 and 51.4. Insulation temperature rating is defined as the rating for the class of insulation; such as, 105°C for Class 105 insulation, 130°C for Class 130 insulation, and the like.

51.3 A variable resistance load is to be connected to the output terminals and the transformer operated continuously at the normal test voltage indicated in Table 39.1. If the protective device controls a switching device that, in turn, interrupts primary current to the transformer, the switching device is to be in the circuit. The test ambient temperature is to be approximately 77°F (25°C). The resistance load is to be adjusted so that the transformer winding is brought to a stabilized temperature of approximately 18°F (10°C) below its insulation rating. The load is then to be gradually increased until operation of the protector occurs.

51.4 Three samples of the transformer-protector combination are to be tested. Average temperatures of the three samples shall not exceed the winding insulation rating and the temperature of any one sample shall not exceed the insulation rating by more than 9°F (5°C).

51.5 The transformer shall comply with the Dielectric Voltage-Withstand Test, Section 44, following the test specified in 51.3 and 51.4.

52 Overvoltage And Undervoltage Tests

52.1 An electromagnet, as employed on a relay or solenoid, shall not be damaged and shall operate as intended when tested as specified in 52.4. The test voltages are to be as indicated in Table 52.1.

Table 52.1
Test voltages

Rated voltage	Overvoltage	Undervoltage
110 – 120	132	102
208	229	177
220 – 240	264	204
440 – 480	528	408
550 – 600	660	510
Other	110 percent rated	85 percent rated

52.2 A relay or solenoid that has been separately investigated for the voltage and operating conditions involved, including ambient temperature conditions, is not required to be tested in the ice cream maker to determine if it complies with the requirement in 52.1.

52.3 If a relay or other control is used in combination with a compressor controller to prevent automatic recycling of the compressor due to the operation of a protective device, the components involved shall comply with the requirements of 52.1 under any condition that might result from operation of the protective device and de-energizing of the circuit.

52.4 Relays and solenoids are to be connected to a supply source maintained at the overvoltage condition until the coils of the relays and solenoids attain constant temperature. The potential then is to be reduced to the rated voltage specified in 39.1, and each relay and solenoid shall operate at this voltage. The potential is to be maintained at this voltage until the coils attain constant temperatures. The potential then is to be reduced to the undervoltage condition, and each relay and solenoid shall operate at this voltage. If relays and solenoids are energized through a transformer, the voltage adjustments described are to be made at the transformer primary. A relay or solenoid that will not be subject to continuous operation is to be energized at the overvoltage condition and at the rated voltage for the maximum time permitted by its duty cycle or until constant temperature is reached, whichever occurs first.

53 Current Overload Test – Bonding Conductors and Connections

53.1 Bonding conductors and connections shall not open, when carrying current equal to twice the rating of the branch circuit overcurrent-protective device for the interval indicated in Table 53.1.

Table 53.1
Current overload test

Rating of overcurrent protection device, amperes	Minimum duration of current flow, minutes
30 or less	2
31 – 60	4
61 – 100	6
101 – 200	8

54 Insulation Resistance Test

54.1 An ice cream maker employing insulating material that can be affected adversely by moisture under conditions of use shall have an insulation resistance of not less than 50,000 ohms between live parts and interconnected dead metal parts after exposure for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 89.6 ±3.6°F (32 ±2°C).

55 Limited Short-Circuit Test

55.1 General

55.1.1 The components specified in 55.1.1 (a) – (c) shall withstand short-circuiting when protected by a branch-circuit overcurrent device of the size required by the ice cream maker:

a) Motor overload protective devices connected in the motor circuit.

b) Motor circuit conductors and connections as required by 11.5.1.

c) Bonding conductors and connections as required by 14.8 and 14.12.

55.1.2 For a cord-connected unit, the protection specified in 55.1.1 is to be provided by a fuse having a rating not less than the rating of the attachment plug.

Exception: The minimum fuse size for cord-connected ice cream makers rated 125 volts or less is 20 amperes.

55.1.3 For a permanently-connected unit, the protection specified in 55.1.1 is to be provided by either:

a) A device that is recognized for branch-circuit protection and located in the unit or

b) A branch-circuit protective device of the type and maximum rating specified on the ice cream maker nameplate.

55.1.4 A permanently-connected ice cream maker having more than one motor wired for connection to one supply line shall withstand short-circuiting when protected by a branch-circuit overcurrent device rated at 225 percent of the rated-load current of the largest hermetic motor of the group plus an amount equal to the sum of any additional loads supplied. If a hermetic motor is not supplied, the branch-circuit overcurrent protective device is to be rated 400 percent of the full-load current of the largest motor of the group plus an amount equal to the sum of any additional loads supplied.

Exception No. 1: The test may be conducted with a branch-circuit overcurrent device having a lower rating than calculated above, but not less than 15 amperes, provided that the ice cream maker will start and operate without opening a fuse having this lower rating. See Starting Test, Section 42.

Exception No. 2: If the unit incorporates a branch-circuit overcurrent device as described in 55.1.3(a), the test is to be conducted with that device.

55.1.5 With regard to branch-circuit overcurrent protective devices and for the purpose of these tests, fuses of the same rating are considered to be interchangeable. Fuses and circuit breakers are not considered to be interchangeable.

55.1.6 The component is to be connected in a test circuit having a capacity based on the rated-load current and voltage rating of the ice cream maker. See Table 55.1. When the rated-load current is between two values in the table, the larger value is to be used in determining the circuit capacity. If the ice cream maker nameplate shows individual loads, the rated-load current is to be the total of all individual loads that may occur simultaneously. If more than one simultaneous load condition is possible, the condition resulting in the maximum total current is to be used as a basis for determining the capacity of the test circuit. The voltage for the test circuit is to be an alternating current supply, and the circuit capacity is to be measured without the component in the circuit. The power factor of the test circuit is to be 0.9 – 1.0 unless a lower power factor is agreeable to those concerned.

Table 55.1
Short-circuit test currents

Full-load amperes				Circuit capacity, amperes
Single phase				
115 V	208 V	230 – 240 V	277 V	
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.0	6.65 or less	1000
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 40.0	–	3500
Over 80.0	Over 44.0	Over 40.0	Over 6.65	5000
Three phase				
208 V	220 – 240 V	440 – 480 V	550 – 600 V	Circuit capacity, amperes
2.12 or less	2.0 or less	–	–	200
2.13 – 3.7	2.1 – 3.5	1.3 or less	1.4 or less	1000
3.8 – 9.5	3.6 – 9.0	–	–	2000
9.6 – 23.3	9.1 – 22.0	–	–	3500
Over 23.3	Over 22.0	Over 1.8	Over 1.4	5000

55.1.7 Three samples of each component or conductor under test are to be subjected to each test condition and a new protective device is to be used for each test. Consideration is to be given to both short-circuit and ground-fault conditions.

55.2 Motor overload protective devices

55.2.1 There shall be no ignition of cheesecloth surrounding the enclosure of a motor protective device when samples are subjected to the test.

55.2.2 If a thermally protected motor or a separately enclosed motor overload protective device is within an outer cabinet, and if the assembly is constructed so that flame and molten metal will be confined within the cabinet and there is no flammable material except electrical insulation within the cabinet, the short-circuit test may be waived.

55.3 Bonding conductors and connections

55.3.1 Bonding conductors and connections shall not open when samples are subjected to the conditions of this test.

55.4 Motor circuit conductors and connections

55.4.1 Motor circuit conductors and connections shall not be damaged when samples are subjected to the conditions of this test.

56 Compressor Protective Device Tests

56.1 To determine if a thermal protector complies with the requirement specified in 19.4.2 or if a protective system complies with the requirement specified in 19.4.2 of that clause, the ice cream maker is to be tested in accordance with 56.2, unless the motor-compressor has been separately tested as described in 56.3.

56.2 The ice cream maker is to be connected to a circuit of rated voltage and operated under the conditions described in Table 56.1 for at least 1 hour or until stable conditions have been reached, whichever is longer. The voltage applied to the ice cream maker then is to be reduced to 90 percent of its rated voltage (if it will operate at that voltage) and operated until stable conditions exist. The voltage applied to the ice cream maker then is to be reduced in steps of 2 percent of rated voltage (to the nearest integral volt). Operation is to be allowed to become stable after each reduction in voltage before the next reduction is made, and readings of current input to the motor-compressor are to be noted after stable operation is obtained subsequent to each voltage reduction. This procedure is to be continued until the protective device opens the circuit. If the motor-compressor protective device trips at 90 percent of rated voltage, the voltage applied to the ice cream maker is to be increased to the rated voltage and the unit operated until stable operation is obtained. The voltage then is to be reduced in the 2 percent steps described above until the protective device opens. The motor-compressor current input at the lowest voltage step during which continuous operation occurs (the lowest voltage preceding the voltage at which the protective device opens the circuit) is to be used as a basis for judging compliance with the requirements in 19.4.1 and 19.4.2.

Exception: Initial operation of the ice cream maker may be at such voltage that the current input is 156 percent of the rated current. The voltage then is to be reduced by 2 percent of rated voltage (to the nearest integral volt) to establish that the protective device opens at 156 percent of rated current or less. The voltage may be reduced to the motor-compressor only, with the other components in the ice cream maker maintained at rated voltage or higher if the results of the test under these conditions indicate compliance with 19.4.2. The rated voltage referred to is the highest of the rated voltages for dual-voltage-rated units. Stable operation is considered to be obtained when two consecutive readings, 15 minutes apart, of the temperature on top of the motor-compressor shell do not change more than 1°F (0.6°C).

Table 56.1
Test conditions for calibration of thermal protectors and protective systems in ice cream makers

Location	Degrees
Air temperature surrounding unit	104°F (40°C)[a]
For water-cooled unit	
Water temperature entering condenser	80°F (26.7°C)
Water temperature leaving condenser	100°F (37.8°C)[b]

Table 56.1 Continued on Next Page

Table 56.1 Continued

Location	Degrees
For air-cooled unit	
Air temperature entering condenser	104°F (40°C)
[a] For convenience and if agreeable to all concerned, the test ambient air temperature for water-cooled units may be 77°F (25°C) to permit testing under the same conditions as the temperature and pressure test, Section 43.	
[b] Where this condition cannot be attained due to the design of the unit, it is to be tested at 80°F (26.7°C) inlet condenser water temperature and 35 pounds per square inch gauge (0.22 MPa) nominal pressure.	

56.3 The motor-compressor, with its protective system as employed in the ice cream maker, may be separately tested as described in 56.1 under the conditions described in Table 56.2. This separate test may be used as a basis for judging compliance with the requirements in 19.4.1 and 19.4.2.

Table 56.2
Test conditions for calibration of thermal protectors and protective systems separately from ice cream maker

Location	Degrees
Return gas	
Saturated vapor temperature	10°F (minus 12.2°C)
Superheat	70°F (38.9°C)
Discharge gas	
Saturated vapor temperature	131°F (54.6°C)
Ambient air	
Temperature	115°F (46.5°C)
Velocity	400 FPM[a] (2.1 m/s)
[a] The velocity specified is the horizontal air velocity in the test chamber without the compressor installed. The actual velocity across the compressor may be different from this value, depending on the shape of the compressor and its effect on the air-flow pattern. A higher velocity may be employed if the results of the test with the higher air velocity indicate compliance with b(2) or d(2) of 19.4.2.	

57 Strength Tests – Pressure Containing Components

57.1 Refrigeration system

57.1.1 High-side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Five times the marked high-side design pressure. See 67.9.

b) Five times the maximum pressure developed in the Temperature and Pressure Test, Section 43.

c) Five times the start-to-discharge pressure of a pressure relief valve or five times the set-pressure of a rupture member.

d) For a unit containing more than 22 pounds-mass (10 kg) of refrigerant, three times the maximum adjustable setting of the pressure-limiting device.

e) For a unit equipped with a fusible plug, 2-1/2 times the vapor pressure of the refrigerant at the relief temperature of the fusible plug or 2-1/2 times the critical pressure of the refrigerant, whichever is smaller.

f) For an air-cooled unit, three times the maximum high-side pressure developed in the Condenser Fan Motor Failure Test, Section 45.

g) For water-cooled units, five times the pressure developed in the Condenser Water Failure Test, Section 46.

h) One and one-half times the vapor pressure of the refrigerant at 140°F (60°C).

57.1.2 Pressure vessels bearing the ASME Code "U" symbol and having a working pressure not less than required by 57.1.1 or 57.1.4, as applicable, are acceptable without test.

57.1.3 A refrigerant-containing component having a marked working pressure shall have an ultimate strength equal to five times the marked pressure.

57.1.4 Low-side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Three times the marked low-side design pressure. See 67.9.

b) Three times the maximum low-side pressure developed in the Temperature and Pressure Test, Section 43, including equalization pressure developed after compressor shutdown.

c) For an air-cooled unit, three times the maximum low-side pressure developed in the Condenser Fan Motor Failure Test, Section 45, including discharge pressure relieved to the low-side and equalization pressure developed after compressor shut-down.

d) For a water-cooled unit, three times the maximum low-side pressure developed in the Condenser Water Failure Test, Section 46, including discharge pressure relieved to the low-side and equalization pressure developed after compressor shut-down.

e) One and one-half times the vapor pressure of the refrigerant at 140°F (60°C).

Exception No. 1: Low-side pressure vessels shall have an ultimate strength of not less than five times the highest of the following:

a) Low-side design pressure,

b) Maximum pressure developed during the Temperature and Pressure Test, Section 43,

c) Start-to-discharge pressure of a pressure-relief valve, or

d) The set-pressure of a rupture member.

Exception No. 2: Low-side pressure vessels protected by a fusible plug shall have an ultimate strength not less than 2-1/2 times the vapor pressure of the refrigerant at the relief temperature of the fusible plug or 2-1/2 times the critical pressure of the refrigerant, whichever is smaller.

57.1.5 With reference to 57.1.1(h) and 57.1.4(e) vapor pressures of R134a, R500, and R502 at 140°F (60°C) are 229, 248, and 362 psig (1579, 1710, and 2496 kPa), respectively.

57.1.6 With reference to the requirements of 57.1.1 and 57.1.4, sections of the refrigeration system constructed of continuous tubing or of lengths of tubing connected by soldered, brazed, or welded joints are considered as complying with these requirements, provided the tubing employed in the assembly complies with the requirements of 34.1.

57.1.7 Two samples of each refrigerant-containing component are to be tested to determine compliance with these requirements. The test medium is to be any nonhazardous liquid, such as water. The test samples are to be filled with the test medium to exclude air and are to be connected in a hydraulic pump system. The pressure is to be raised gradually until the required pressure is reached. This pressure is to be maintained for 1 minute during which time the samples shall not burst or leak. Leakage is to be determined visually, for example, by examination of the sample for release of the test medium or as evidenced by a decreasing gauge pressure.

Exception: Where gaskets are employed in components of ice cream makers containing Refrigerant 22, 134a, 500, or 502, leakage at gaskets is to be acceptable provided that such leakage occurs at a pressure greater than 40 percent of the required pressure. The component shall withstand the required strength test pressure even though leakage occurs at the gaskets or seals.

57.1.8 Pressure-actuated refrigeration controllers rated for the application are exempt from the requirements of this section.

57.1.9 Parts of a product system pressurized by gas shall withstand, without failure, a pressure equal to five times the start-to-discharge pressure of the relief device. Systems consisting only of tubing or hose, or both, with or without dispensing valves, and that do not incorporate a pressure relief valve, see 5.2.3, shall withstand a pressure of five times the maximum allowable pressure marked on the equipment, except that the test pressure shall be not less than 650 psig (4.48 MPa).

57.1.10 A part that is pressurized by a pump shall withstand, without failure, a pressure equal to five times the maximum pressure that the pump can develop.

57.1.11 With reference to 57.1.10, water and product pump housings, containers, interconnecting lines, and fittings that form part of a closed pressurized system are to comply with the requirement. The parts are to be tested as described in 57.1.7. Parts that are not pressurized are exempt from this requirement.

58 Start-To-Discharge Test

58.1 Pressure-relief devices used in the pressurized product system shall be subjected to a test to determine the pressure at which the device will open and start to discharge.

Exception: Pressure-relief devices that are part of components and that have been subjected to this test are exempt from this requirement.

58.2 Three samples of the device are to be tested. Each sample is to be connected to a gas source, such as air, carbon dioxide, or nitrogen, but oxygen or any flammable gas is not to be used. The sample is to be immersed in water, and the pressure is to be gradually increased until the device starts to discharge as evidenced by the occurrence of bubbles in the water. The average of three readings for each of three representative samples is to be used to determine the start-to-discharge pressure.

59 Component Restraint Test

59.1 A slideout product storage component, such as a drawer or shelf, shall be restrained to prevent its being unintentionally pulled free of its supporting means.

59.2 The restraint specified in 59.1 is acceptable if it will prevent the product storage component from being pulled clear of the ice cream maker with the application of a statically applied load equal to 30 pounds (13.6 kg). The force is to be applied horizontally by hanging a weight from a cord running over a pulley and attached to the center of the leading edge of the component.

60 Fastener Strength Test

60.1 This test applies to nonmetallic materials, as determined in footnotes (e), and (f) of Table 62.1, secured by:

a) Ultrasonic, solvent, or heat welds;

b) Nonmetallic screws and nuts; and

c) Metal screws threaded into nonmetallic materials.

60.2 The tightening torque and pull-off strength of such fasteners shall be not less than 50 percent of the as-received value.

60.3 Three sets of samples, each set consisting of three specimens, is to be conditioned as indicated in Table 60.1 and Table 60.2.

Table 60.1
Test specifications

Sample Set	No. of Samples	Test Specifications
1	3	As-received (no conditioning).
2	3	Oven aging – 300 hours at the service temperature plus 10°C (18°F) but not less than 70°C (158°F). Service temperature is considered to be the temperature measured during the Temperature and Pressure Test, Section 43.
3	3	Heat cycling – 40 cycles of alternate heating and cooling at the temperatures specified in Table 60.2. Each cycle is to consist of 4 hours at the upper temperature followed by 4 hours at the lower temperature.

Table 60.2
Temperature cycling parameters

Location	Upper Temperature	Lower Temperature
Nonrefrigerated Areas	Service temperature plus 10°C (18°F) but not less than 70°C (158°F)	25°C (77°F)
Refrigerated Area	32°C (90°F)	0°C (32°F)
Low Temperature Area	32°C (90°F)	minus 17.8°C (0°F)

61 Burnout Test – Impedance Protected Motors

61.1 This test is to be conducted on impedance protected motors when such motors are not enclosed in metal or in 5V material and are located adjacent to other than 5V materials. One sample is to be tested as described in 61.2.

61.2 Each motor to be equipped with a thermocouple for measurement of the winding temperature. The rotor is to be locked. The motor is to be mounted as intended in use, completely wrapped in dry absorbent surgical cotton, and connected to a variable voltage source. The motor is then to be energized at rated voltage and operated until the winding temperature stabilizes. The voltage is then to be progressively increased in 5 volt increments, allowing the winding temperature to stabilize after each increase in voltage. Operation is to continue until burnout occurs.

61.3 There shall be no ignition of cotton surrounding the motor.

61.4 As an alternate to testing the individual motor as described in 61.2, the test is to be conducted on the complete unit. The test arrangement and the test method is to be as described in 61.2 except that the motor is not to be wrapped in cotton. There shall be no ignition of flammable materials.

62 Tests on Nonmetallic Materials

62.1 Nonmetallic materials are to be evaluated as indicated in Table 62.1.

Table 62.1
Tests on nonmetallic materials

Test Group	Applicable Test Number
Group 1 A part serving as an ultimate enclosure for ignition sources.	1[a], 2[b], 3[c], or 4[d], 6, 7[e, f], 8[g], 9, 10, 11, 12
Group 2 An enclosure not serving as an ultimate enclosure for ignition sources.	Minimum 4, 6, 7[e, f], 8[g], 9, 10, 11, 12
Group 3 A functional part.	3[h], 4[d], 6, 7[e, f], 8[g], 9, 10, 11
Group 4 A nonfunctional part.	3[h], 4[d], 5[d]
NOTES 1. 5 inch end product flame test [i]. 2. 5V rated material. 3. V-0, V-1, V-2, HF-1, HF-2 rated materials 3/4 inch End Product Flame Test or 12 mm End Product Flame Test [i]. 4. HB or HBF rated material or a material with a flame spread rating of 25 or less and a smoke developed rating of 50 or less. 5. HBF, HF-1, HF-2 rated materials. 6. Mold Stress-Relief Test [i]. 7. Fastener Strength Test, Section 60. 8. Adhesive Test [i]. 9. Volume Resistivity Test [i] – Applies only if electrical spacings between uninsulated live parts and the material are less than specified in line-voltage circuits, and extra-low voltage (Class 2) circuits, or if the part is used as indirect support of an uninsulated live part. 10. High Current Arc Ignition Test [i] – Applies only if the material is used to enclose uninsulated live parts or to provide indirect support of uninsulated live parts. This test need not be conducted if the uninsulated live parts are located a minimum of 1/32 inch (0.79 mm) from the enclosure or functional part. 11. Hot Wire Ignition Test [i] – Applies only if the material is within 1/2 inch (12.7 mm) of electrically-heated wires or resistors. 12. Impact Tests [i] – 5 ft-lb (6.8 J) impact for enclosures containing uninsulated live parts, 1.5 ft-lb (2.0 J) impact for enclosures containing moving and hot parts. If an enclosure of uninsulated live parts is protected because of it's location within the confines of the refrigerator, it shall withstand an impact of 1.5 ft-lb (2.0 J).	
[a] An enclosure provided with a barrier interposed between the material and an ignition source will be tested with the barrier in place. [b] A material with a V-2 minimum rating is able to be used to enclose an ignition source if the ignition source is only energized as a result of a continuous action by an attending operator. [c] These materials are able to be used if ignition sources are separated or isolated in accordance with 9.3.3 and 9.3.4. When the ignition source is line voltage wiring, the wiring need not be separated or isolated from enclosures formed from a material with a minimum V-2 rating.	

Table 62.1 Continued on Next Page