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 November 14, 2024 includes the following changes in requirements:

– Addition of Requirements for Use of Flammable Refrigerants; 1.2, 3.8A, 3.8B, Table 17.5, 32.1, 32.2, 37.1.1, Supplement SB

– Revision to Update and Clarify the Scope; 1.1

– Maximum Operating Current and Maximum Rated Current Requirements; 3.2A, 3.2B, 3.5A, 3.5B, 11.1.2, 17.6, 17.7, 17.14, 17.15, 19.2.1, Table 19.1, 19.4.1 – 19.4.3, 50.3, 68.2, 68.7, 68.9 – 68.11A

Text that has been changed in any manner or impacted by ULSE'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 March 8, 2024 and August 16, 2024.

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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 November 14, 2024.

The most recent designation of ANSI/UL 621 as an American National Standard (ANSI) occurred on November 14, 2024. 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 ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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SUPPLEMENT SB – REQUIREMENTS FOR ICE CREAM MAKERS EMPLOYING A FLAMMABLE REFRIGERANT IN THE REFRIGERATING SYSTEM

INTRODUCTION

1 Scope

1.1 These requirements cover unitary ice cream makers intended for commercial (not household) use and designed for connection to alternating current circuits rated not more than 600 V. 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.

NOTE: Household ice cream makers, which could include those used in the following environments are covered by UL 60335-2-24:

a) Staff kitchen areas in shops, offices, and other working environments;

b) Use by clients in hotels, motels, bed/breakfast, and other residential environments; and

c) In catering and similar non-retail applications.

1.2 Ice cream makers covered by these requirements employ sealed (hermetic type) motor compressors and air-cooled or water-cooled condensers, and may also employ flammable refrigerant as specified in Supplement SB.

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.

3.2A ADJUSTABLE SPEED DRIVE – A combination of power converter, inverter, motor, and motor-mounted auxiliary devices such as encoders, tachometers, thermal switches and detectors, air blowers, heaters, and vibration sensors.

3.2B ADJUSTABLE SPEED DRIVE SYSTEM – An interconnected combination of equipment that provides a means of adjusting the speed of a mechanical load coupled to a motor. A drive system typically consists of an adjustable speed drive and auxiliary electrical apparatus.

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.

3.5A MAXIMUM OPERATING CURRENT (MOC) – The current resulting when an electric motor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor/adjustable speed drive or drive system is at a maximum.

3.5B MAXIMUM RATED CURRENT (MRC) – The current resulting when a hermetic refrigerant motor-compressor and adjustable speed drive or drive system are operated under any conditions such as maximum speed/maximum load, maximum speed/minimum load, minimum speed/minimum load, minimum speed/maximum load, including locked-rotor such that current to the motor-compressor/adjustable speed drive or drive system is at a maximum.

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).

3.8A REFRIGERATION SYSTEM – A combination of interconnected refrigerant containing parts, forming a closed circuit, in which refrigerant is circulated, for the purpose of extracting then rejecting heat.

3.8B REMOTE ICE CREAM MAKER – Ice cream maker intended to be connected to a field-installed condenser or condensing unit located remote from the ice cream freezing cylinder and dispenser. Such equipment is intended to be connected to the condenser or condensing unit in accordance with the Safety Standard for Refrigeration Systems, ASHRAE 15.

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

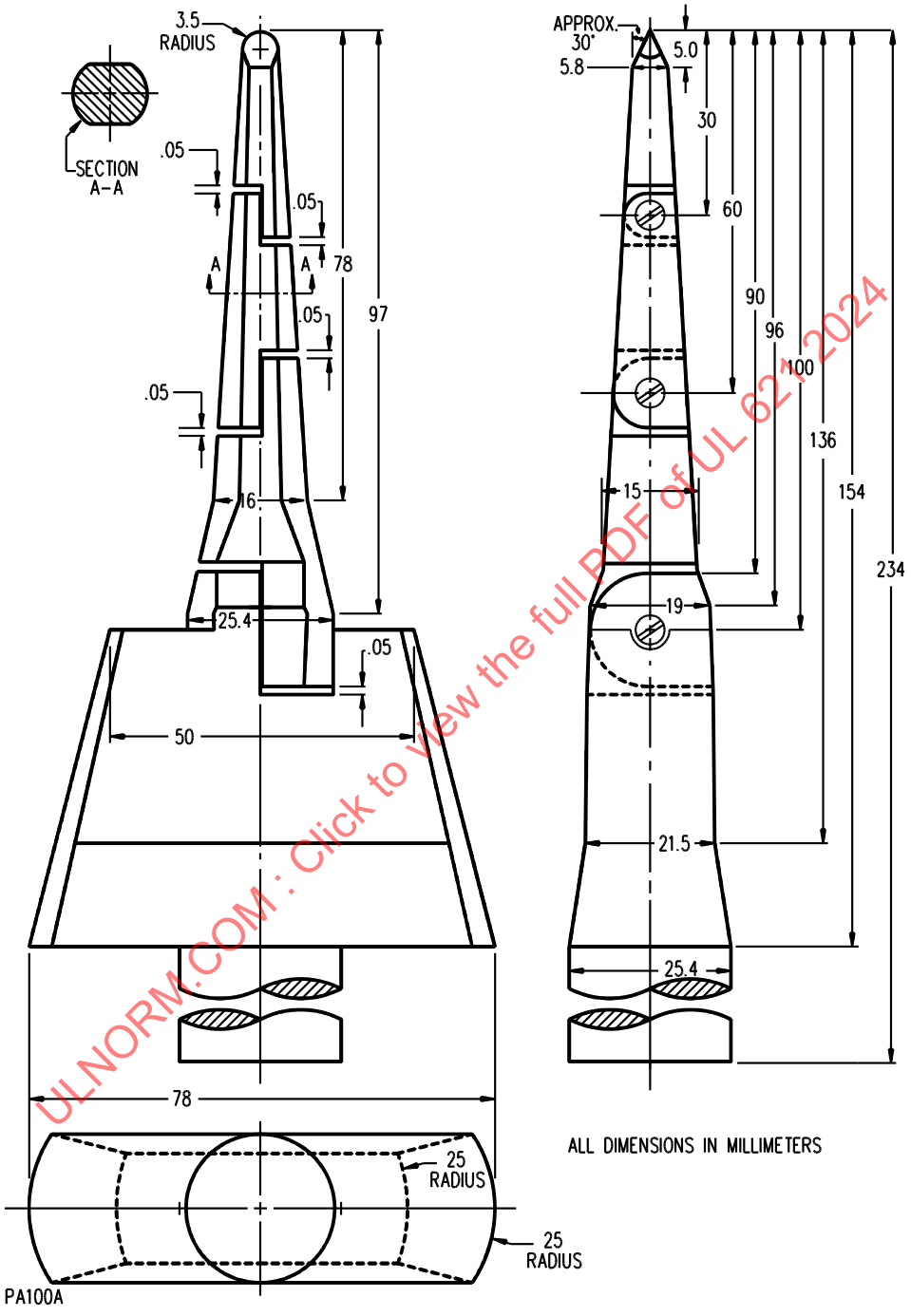


Table 6.1
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock or injury to persons

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

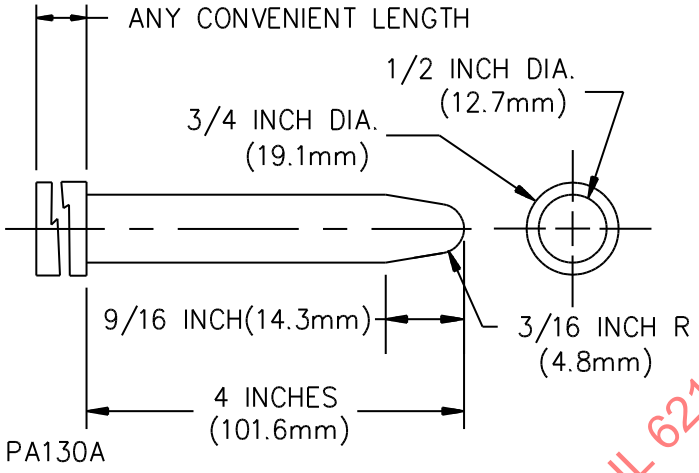


Figure 6.3

Probe for film-coated wire

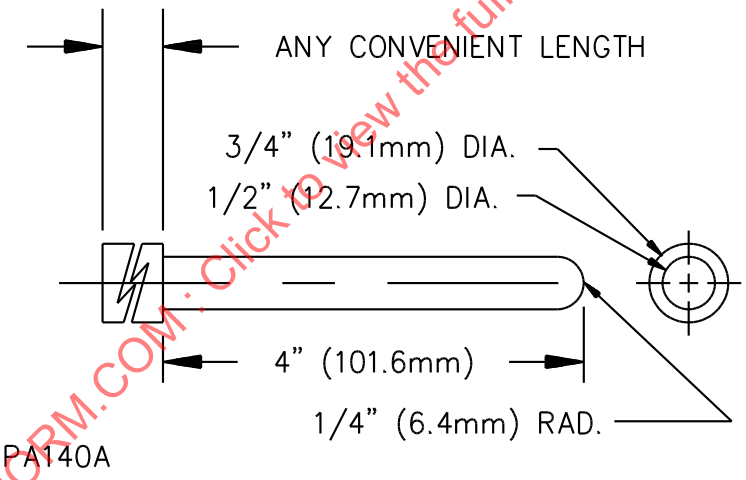
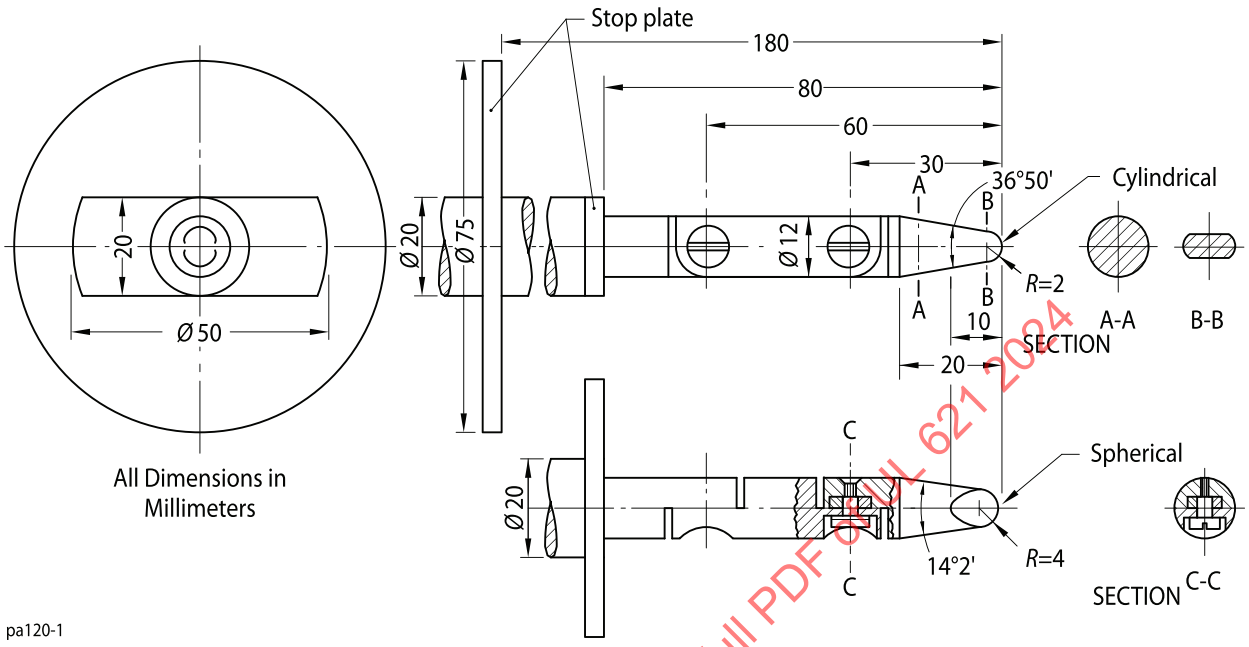


Figure 6.4

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 nor 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)
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.