



UL 471

Underwriters Laboratories Inc. Standard for Safety

Commercial Refrigerators and Freezers



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UL Standard for Safety for Commercial Refrigerators and Freezers, UL 471

Ninth Edition, Dated January 27, 2006

Revisions: This Standard contains revisions through and including July 15, 2009.

Summary of Topics

These revisions to ANSI/UL 471 are being issued to add requirements for large-scale refrigeration equipment using R744 (CO₂) as refrigerant.

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated November 21, 2008.

The revisions dated July 15, 2009 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ulforeword.html>.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition, Classification, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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The Department of Defense (DoD) has adopted UL 471 on March 23, 1976. 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 <http://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover commercial refrigerators and freezers intended for connection to alternating-current circuits rated not greater than 600 volts.

1.2 These requirements apply to unitary and remote commercial refrigerators and freezers. For the purposes of this standard, commercial refrigerators and freezers include equipment, such as display cases, reach-in cabinets, meat cases, frozen food and merchandising cabinets, beverage coolers, beverage cooler-dispensers, food service carts, ice cream cabinets, soda fountain units, door panel assemblies and processing water coolers.

1.3 Self-contained commercial refrigerators and freezers covered by these requirements employ hermetic refrigerant motor-compressors and air- and water-cooled condensers.

1.4 These requirements do not apply to refrigeration systems such as those used in cold-storage rooms, walk-in coolers, and similar places, that are fabricated in the field.

1.5 Requirements for the installation of commercial refrigerators and freezers are included in the National Electrical Code, ANSI/NFPA 70, and the Safety Standard for Refrigeration Systems, ASHRAE 15.

2 General

2.1 Components

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

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

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

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

2.3 Terminology

2.3.1 The term “refrigerator” refers to all commercial refrigerators and freezers or any part thereof covered by this standard unless specifically noted otherwise.

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, such as a superstructure, intended for installation in or connection to a refrigerator for the purpose of modifying or supplementing the functions of the refrigerator. It may be factory installed or intended for installation by the user or service personnel.

3.3 BEVERAGE COOLERS AND BEVERAGE COOLER-DISPENSERS – Assemblies that have provision(s) for refrigerating beverages. The dispensing means may be located remote from the beverage cooler.

3.4 BUILT-IN REFRIGERATOR – A refrigerator intended to be mounted permanently in a wall or other vertical surface of a building or in a cabinet.

3.4.1 CASCADE SYSTEM – A refrigeration system that incorporates two or more independent vapor-compressor refrigeration cycles in series. This is done to acquire low temperatures that may not be readily achieved with a single refrigeration cycle.

3.4.1 added July 15, 2009

3.5 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 – 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 a primary battery, a standard Class 2 National Electrical Code, ANSI/NFPA 70 transformer, or a combination of a transformer and fixed impedance which, as a unit, complies with all performance requirements for a Class 2 National Electrical Code, ANSI/NFPA 70 transformer.

3.6 CONTROL, DEFROST CYCLE – A control that is intended to regulate a normal defrost cycle.

3.7 CONTROL, TEMPERATURE-LIMITING – A control that serves to prevent excessive temperature.

3.8 DESIGN PRESSURE – The maximum acceptable working pressure for which a refrigerator is designed.

3.9 ENCLOSURE – A part that by itself or in conjunction with barriers:

- a) Renders inaccessible all or any parts that may otherwise present a risk of electric shock,
- b) Reduces the risk of contact with parts that may cause injury to persons, or
- c) Prevents propagation of flame due to electrical disturbances occurring within.

A unit cabinet that serves as a 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.

3.10 FOOD SERVICE CART – Unitary refrigeration equipment equipped with wheels and intended to be moved from one place to another for delivery of food. It may include provisions for heating food or for maintaining heated food at the desired temperature.

3.11 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.

3.12 NONFUNCTIONAL PART – A part, such as a 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.

3.12.1 PRESSURE REGULATING RELIEF VALVE – Similar to a pressure relief valve except specifically intended for use with refrigeration systems utilizing carbon dioxide (R744) as the refrigerant in a secondary loop or cascade system. The pressure relief setting of this valve is always lower than the relief setting of a pressure relief valve. This valve may open and re-close many times during the life of the system.

3.12.1 added July 15, 2009

3.12.2 PRESSURE RELIEF DEVICE – A pressure actuated valve or rupture member designed to automatically relieve excessive pressure.

3.12.2 added July 15, 2009

3.12.3 PRESSURE RELIEF VALVE – A pressure actuated valve held closed by a spring or other means and designed to automatically relieve pressure in excess of its setting.

3.12.3 added July 15, 2009

3.13 PRESSURE VESSEL – Any refrigerant-containing receptacle of a refrigerating system other than evaporators [each separate section of which does not exceed 1/2 cubic feet (0.014 m³) of refrigerant containing volume], evaporator coils, compressors, condenser coils, controls, headers pumps, and piping.

3.14 PROCESSING WATER COOLER – A commercial product intended to provide cooled and/or tempered water to remotely located equipment.

3.15 REMOTE REFRIGERATORS – Refrigerators intended to be connected to a field-installed condensing unit located remote from the refrigerators. Such refrigerators are intended to be connected to the condensing unit in accordance with the Safety Standard for Refrigeration Systems, ASHRAE 15.

3.15.1 SECONDARY LOOP – A piping circuit containing a fluid circulating within the circuit. The fluid transfers heat from a remote type refrigerator to a colder heat exchanger located within the circuit. The circuit normally includes a circulating pump as well as other associated fittings. Such a circuit is considered to be equivalent to the low-side parts that are located in a refrigeration system.

3.15.1 added July 15, 2009

3.16 SECTIONAL REFRIGERATOR – Independent assemblies, usually having an evaporator, that may be coupled together during field installation. A sectional refrigerator may be self-contained.

3.17 SELF-CONTAINED REFRIGERATOR – Unitary equipment consisting of a completely factory assembled and factory tested refrigerating system in which all of the refrigerant-containing parts are permanently connected at the factory.

3.18 SODA FOUNTAIN UNIT – A refrigerator that is equipped for the storing and dispensing of frozen desserts or beverages, or similar items.

3.18.1 START-TO-DISCHARGE PRESSURE – The pressure at which a relief valve begins to discharge, typically the pressure where the first bubbles can be seen when a valve is immersed in water.

3.18.1 added July 15, 2009

3.19 SUPERSTRUCTURE – A separate electrical assembly such as a lighting assembly for permanent mounting on the top of a refrigerator cabinet. The superstructure may be factory installed or may be shipped separately for field installation on the refrigerator cabinet.

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

3.21 UNITARY REFRIGERATORS – Equipment consisting of a complete factory assembled and factory tested refrigerating system comprising one or more assemblies that may be shipped separately but are intended to be used together.

3.22 DISPLAY REFRIGERATOR OR FREEZER – An open or closed refrigerator or freezer intended to display foods, either frozen or non-frozen, in a controlled ambient location.

3.23 TYPE I DISPLAY REFRIGERATOR OR FREEZER – An open or closed display refrigerator or freezer intended for use in an indoor location where the environmental conditions are controlled and maintained such that the ambient temperature does not exceed 24°C (75°F).

3.24 TYPE II DISPLAY REFRIGERATOR OR FREEZER – An open or closed display refrigerator or freezer intended for use in an indoor location where the environmental conditions are controlled and maintained such that the ambient temperatures does not exceed 27°C (80°F).

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 similar parts, where corrosion of such unprotected parts would not affect compliance with the requirements of this standard.

4.2 Exposed unimpregnated asbestos material shall not be used in air handling or food storage compartments. The unprotected edge of a gasket sandwiched between two parts is considered to be exposed.

4.3 When a superstructure may be employed as an optional accessory, the refrigerator is to be evaluated with and without the superstructure to determine compliance with the requirements of this standard.

4.4 A superstructure intended to be shipped separately for field installation shall comply with requirements for accessories as specified in 6.1 – 6.5.

4.5 Unless provided with other means of exit, door(s) intended for entrance of persons into the refrigerated compartment of a refrigerator shall be provided with a latch release mechanism that will open the door(s) from the inside by a force applied outwardly to the door or to a release actuator. If the latch is provided with a key lock, the latch release mechanism shall be constructed so that the lock can be opened from the interior. See Door Latch Release Test, Section 71.

4.6 Interior latch release actuators shall function with the refrigerator in its intended operating position and shall be operable from all spaces that are directly accessible when the door(s) is opened.

4.7 A latch release device shall not depend on an electrical source for operation.

4.8 A latch release device shall be constructed so that spillage of foods or beverages, cleaning or defrosting in accordance with the manufacturer's recommendations, or condensation will not affect compliance with the requirements of the Door Latch Release Test, Section 71.

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5 Assembly

5.1 General

5.1.1 If a unitary refrigerator 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 assembly incorporating a condensing unit of the pull-out type shall be constructed so that the condensing unit can be pulled out and reinserted without:

- a) Kinking or otherwise damaging the refrigerant tubing; and
- b) Pinching, abrading, or stressing electrical wires and cords.

5.1.3 A refrigerator shall be assembled so that removal and replacement of tanks and containers, replenishment of the product, and similar actions, will not result in damage to electrical components and wiring, or to refrigerant-containing components.

5.1.4 A refrigerator having provision for the storage of carbon dioxide cylinders or the like shall be provided with means for retaining the cylinders in position.

5.1.5 When a product employs food warming capabilities, that portion of the product shall comply with applicable requirements in the Standard for Commercial Electric Cooking Appliances, UL 197, including surface temperature limitations.

5.2 Pressurized product system

5.2.1 A gas pressure regulator or reducing valve shall either comply with 2.1.1 or be tested for the application.

5.2.2 A pressure-relief valve shall be installed in the pressurized product system of the refrigerator. There shall be no shutoff valve between the relief valve and any parts of the system under pressure. See 65.2.2.

Exception: A pressure relief valve is not required when:

- a) The system consists only of tubing or hose, or both, with or without dispensing valves,*
- b) The system complies with the strength requirement in 65.2.2, and*
- c) The refrigerator is marked in accordance with 83.4.5.*

5.3 Mechanical protection

5.3.1 Each horizontally-hinged door that provide access to the refrigerated storage compartments of chest-type units and that may cause injury to persons upon unintentional closing shall be:

- a) Counterweighted,
- b) Spring loaded, or
- c) Provided with an automatic latch to retain them in the open position. Action members, such as springs and latches that may cause injury to persons due to pinching or the like, shall be enclosed or guarded.

5.3.2 A slideout food storage component, such as a drawer or shelf, shall be restrained to prevent its being unintentionally pulled free of its supporting means. See Component Restraint Test, Section 69.

5.3.3 When installed in its intended manner (see Installation and Operating Instructions, Section 86), openings in the refrigerator shall be constructed or located to reduce the risk of injury to persons due to unintentional contact with moving parts, such as fan blades, blower wheels, gears, and belts; and surfaces that exceed the temperatures permitted by subitems 2 and 3 of item D of Table 41.1. The minor dimension of such openings shall not exceed 3 inches (76.2 mm). In evaluating openings, parts of the enclosure, such as covers, panels, and grilles are to be removed unless:

- a) Tools are required for their removal, or
- b) When exposed, a moving part is made inoperative through the use of interlocking devices. See 7.2.1.

Exception: Openings may be larger than 3 inches if the part is unlikely to be contacted because of the location of fixed components, including baffles, water and refrigerant tubing, drain tubes, and similar parts.

5.3.4 Parts such as covers, panels, or grilles that serve as guards may be removable without tools if a warning marking as described in 83.3.6 identifies the guarded moving or hot part, and

- a) The guard is located in an area not exposed to persons using or attending the refrigerator, or
- b) The guard is not less than 2 square feet (0.18 m²) in size, is retained in position by gravity, channels, or similar means, is unlikely to be removed by other than an attendant or service personnel, and is not removed for replenishing the product, or
- c) The guard is unlikely to be removed other than by an attendant or service personnel, is not removed for replenishing the product, and is secured by fasteners or a combination of fasteners and hinges, tabs, or the like. Disengagement of any one of the fasteners, hinges or tabs of a guard shall not result in exposure of moving or hot parts.

5.3.5 The fasteners reference in 5.3.4 (c) shall require manual operation, such as a push, pull, or turning action to disengage. Magnetic catches and friction-type fasteners such as clips are not acceptable. Mating parts of the fastening means shall be metal.

5.3.6 Components of a sectional refrigerator, such as end closures, are to be in place when judging compliance with 5.3.3 and 5.4.1, when they are:

- a) Required to make the section functional, and
- b) Secured by means requiring tools for removal.

5.3.7 The rotor of a motor, a pulley, a gear, a belt, a fan blade, or other moving parts that may cause injury to persons shall be guarded or enclosed so that the minor dimension of any opening does not exceed the values indicated in 5.3.8 or 5.3.9. Except as indicated in 5.3.4, each guard shall be secured by means requiring tools for removal unless functioning of the refrigerator requires the guard to be in place.

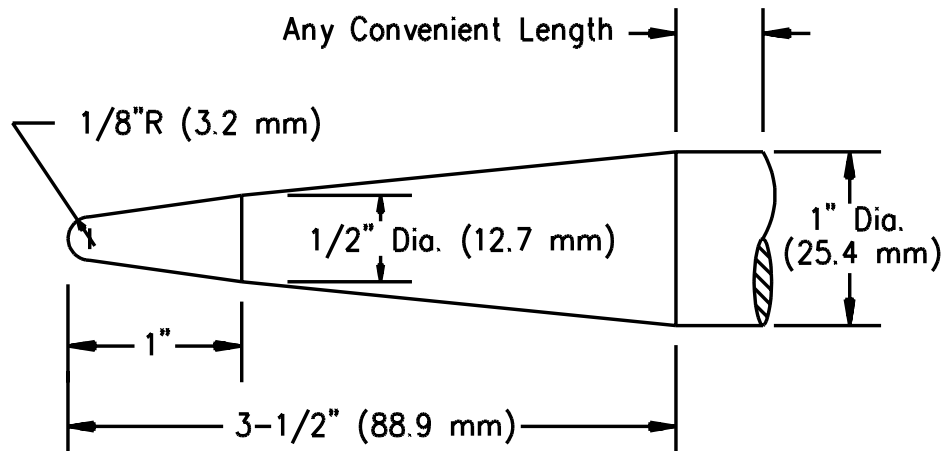
5.3.8 A fan blade employing a guard with openings having a minor dimension less than 1 inch (25.4 mm) shall be guarded such that the probe illustrated in Figure 5.1 cannot contact any part of the fan blade when inserted through openings in the guard with a force of 2.5 pounds (11.1 N).

Exception: The probe illustrated in Figure 5.1 may contact the trailing edge of a fan blade if the relationship between weight (w) in pounds, radius (r) in inches and speed (n) in revolutions per minute of the fan blade is such that K in the equation:

$$K = 6 \times 10^{-10} (w r^2 n^2)$$

is less than 100.

Figure 5.1
Probe for fan blades



PA 160

5.3.9 A fan blade employing a guard with openings having a minor dimension 1 inch (25.4 mm) or larger, and any other moving part shall be guarded such that the distance from an opening to the moving part is in accordance with Table 5.1. The minor dimension shall not, in any case, exceed 3 inches (76.2 mm). For an opening having a minor dimension intermediate between two of the values shown in the table, the distance from the opening to the moving part shall not be less than that found by appropriate interpolation between the corresponding values in the right column of the table. The minor dimension of the opening is determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 2.5 pounds (11.1 N).

Table 5.1
Clearance from openings

Minor dimension of opening ^{a,d}		Minimum distance from opening to moving part ^c	
inches	(mm)	inches	(mm)
1/4	(6.4)	3/8	(9.5)
3/8	(9.5)	1-1/4	(31.8)
1/2	(12.7)	2	(50.8)
3/4	(19.1)	3-5/8	(92.1)
1	(25.4)	5-1/4	(133.4)
1-1/2	(38.1)	8-3/8	(212.7)
2	(50.8)	11-5/8	(295.3)
Over 2 ^b	(Over 50.8)	30	(762.0)

^a Openings less than 1/4 inch (6.4 mm) are not to be considered.
^b But not more than 3 inches (76.2 mm). See 5.3.9.
^c Also applies to hot parts. See 5.3.11 and 5.3.12.
^d For fan blade guards that have openings with minor dimensions less than 1 inch (25.4 mm), see 5.3.8.

5.3.10 A moving part is not to be considered when determining compliance with 5.3.7 – 5.3.9 when:

- 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.

5.3.11 When tested according to Sections 41 – 44, surfaces having temperatures that exceed the temperature rise of items 2 and 3 of item D of Table 41.1 shall be guarded as specified in 5.3.7 – 5.3.10.

Exception: This requirement does not apply to compressors, condensers, or refrigerant tubing located inside the refrigerator enclosure (regardless of whether these components are accessible without requiring tools for removal of covers, panels, grilles, and similar parts) or to fittings for refrigerant tubing located outside of the refrigerator enclosure, such as those used for the interconnection of a condensing unit and a remote refrigerator.

5.3.12 When the temperature on the sheath of a heater element, as installed in the refrigerator exceeds the limits permitted by subitem 2 or 3 of item D of Table 41.1, whichever is appropriate, it shall be guarded in accordance with 5.3.7 – 5.3.10 to reduce the risk of injury to persons coming in contact with it.

Exception: The sheath of a defrost heater not guarded in accordance with 5.3.7 – 5.3.10 may exceed the temperature permitted by subitem 2 or 3 of item D of Table 41.1, when:

- a) The heater is in direct contact with the fins of the evaporator coil for the exposed length of the heater,
- b) The lowest part of the exposed heater is 7 feet (2.1 m) or more above floor level, and
- c) The refrigerator is marked in accordance with 84.25.

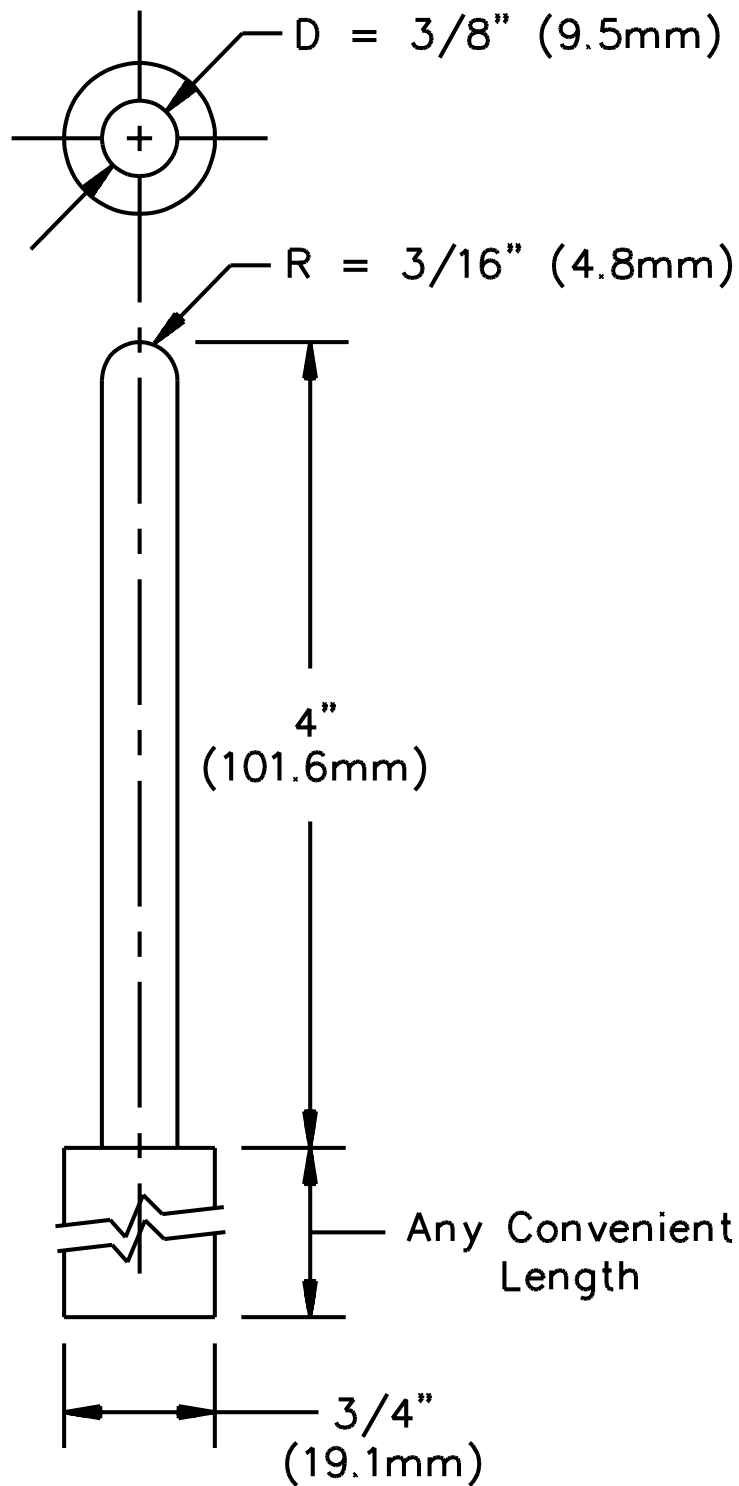
5.4 Electrical protection

5.4.1 Louvers and other openings in the enclosure shall be constructed and located to reduce the risk of unintentional contact with uninsulated live parts. Parts of the enclosure, such as covers, panels, or grilles are to be removed unless:

- a) Tools are required for their removal, or
- b) An interlock is provided. See 5.4.2 and 7.2.1.

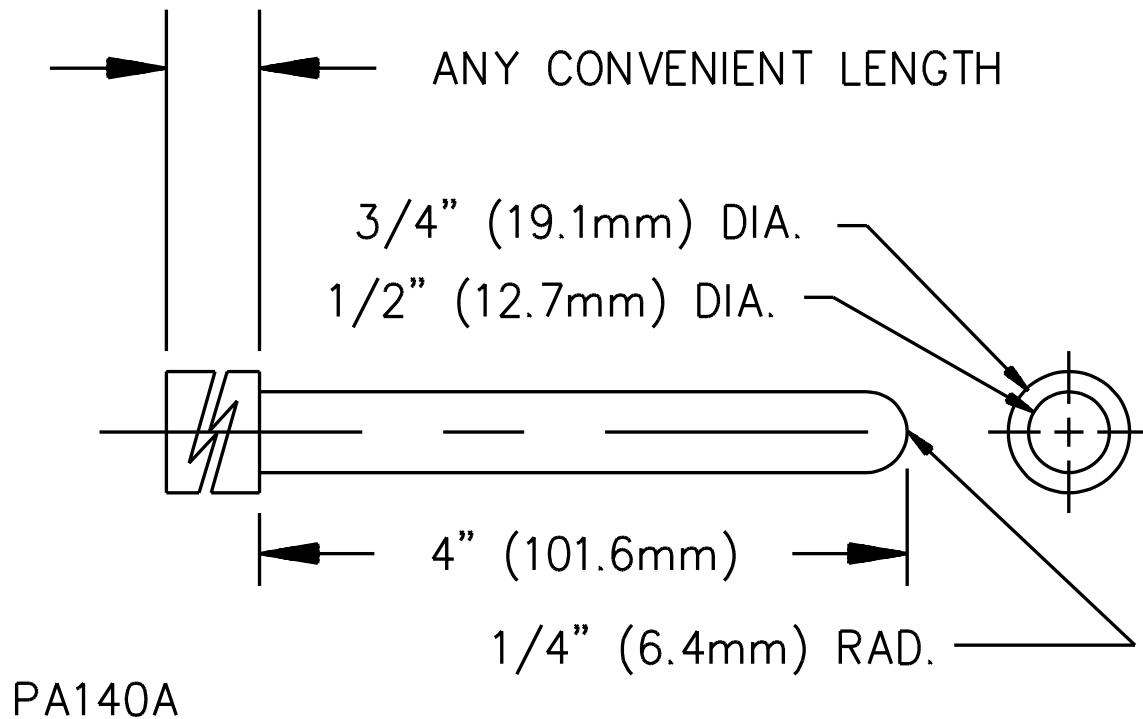
5.4.2 If an opening in the enclosure will not permit the entrance of a 3/4 inch (19.1 mm) diameter rod:

- a) The probe illustrated in Figure 5.2 shall not touch any uninsulated live parts, and
- b) The probe illustrated in Figure 5.3 shall not touch any film-coated insulated wire when the probe is inserted through the opening. The probe shall not pass through grilles, screens, louvers, or similar parts, when a force of 5 pounds (22.3 N) is applied.

Figure 5.2
Probe

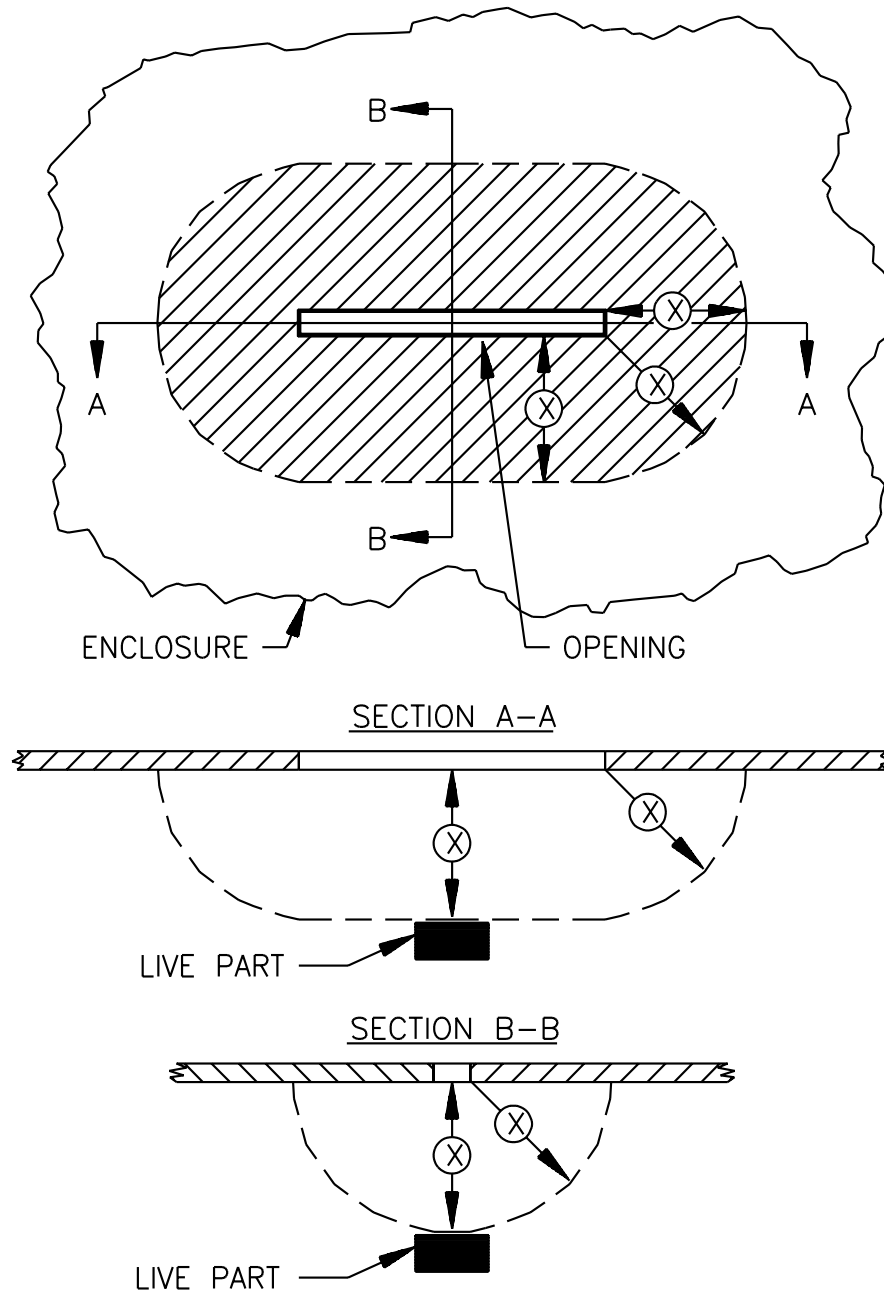
PA170A

Figure 5.3
Probe



5.4.3 When an opening in the enclosure permits the entrance of a 3/4 inch (19.1 mm) diameter rod, the conditions described in Figure 5.4 are to be used to determine compliance with the requirements. The minor dimension of the opening shall not exceed 1 inch (25 mm) in any case.

Figure 5.4
Opening in enclosure



EC100A

The opening is acceptable when, within the enclosure, there is no uninsulated live part or film-coated insulated wire (1) less than X inches (mm) from the perimeter of the opening, as well as (2) within the volume generated by projecting the perimeter X inches (mm) normal to its plane. X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 4 inches (102 mm).

5.4.4 In addition to the requirements of 5.4.2 and 5.4.3, uninsulated live parts located inside the enclosure that are likely to be contacted by a person performing operations, such as refilling, relamping, replacing fuses, resetting manual-reset devices, oiling motors, or other such service operations shall be located, guarded or enclosed to prevent unintentional contact, unless tools are required to expose the live part. See 83.3.6.

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

5.4.6 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.

5.4.7 A condensate pan shall be constructed and located so that overflow due to a blocked drain will not wet live parts or film-coated insulated wire. A waste outlet having a clear opening of not less than 3/4 inch (19.1 mm) diameter and located at the lowest level to which water may drain is not considered subject to blockage.

5.4.8 An overflow spout, drain hole, cutout, or the like, in the condensate pan is acceptable when dripping of water on electrical parts is not likely to occur. An overflow test, see 49.1 and 49.2, is to be conducted when it is not evident that the refrigerator complies with the requirements of 5.4.7.

5.4.9 A switch, lampholder, an attachment-plug receptacle, or similar component shall be secured in position and shall be prevented from turning. See 5.4.10.

Exception No. 1: A switch need not be prevented from rotating 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 shall be 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 when rotation cannot reduce electrical spacings below the minimum acceptable values. See Spacings, Sections 28 and 29.

5.4.10 The means for preventing rotation mentioned in 5.4.9 shall consist of more than friction between surfaces. A toothed lock washer that provides both spring take up and an interference lock is acceptable as means for preventing a small stem-mounted switch or other device having a single-hole mounting from rotating.

5.4.11 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 when such motion results in a reduction of electrical spacings below the minimum acceptable values. See Spacings, Sections 28 and 29. 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 5.4.10 is acceptable.

5.4.12 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated live parts. See 62.2.1.

6 Accessories

6.1 A refrigerator having provisions for the use of electrical accessories to be attached in the field shall be constructed so that the use of these accessories will not introduce a risk of fire, electric shock, or injury to persons. See 83.4.1 and 83.4.2.

6.2 The refrigerator shall comply with all requirements of this standard with or without the accessory installed.

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

6.4 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.

6.5 Accessories intended for connection to a source of field power supply independent of that of the equipment shall comply with the requirements:

- a) Specified in Section 9.3 when intended to be a cord-connected accessory.
- b) Specified in Section 9.2 when intended to be a permanently connected accessory. A permanently connected accessory shall not be used with supply cord connected equipment.

6.6 When an accessory is powered from a source of supply separate from that supplying the equipment, disconnection of any one supply shall automatically cause de-energization of all circuits within the equipment and accessory.

Exception: Automatic de-energization may be omitted when the equipment and accessory are marked in accordance with 83.4.5.

6.7 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:

- a) Electrical enclosures, or
- b) Other areas where such operations may result in damage to electrical or refrigeration components and wiring within the enclosure.

6.8 Strain-relief means shall be provided for the wiring in the accessory when there is a possibility of transmitting stress to the terminal connections during installation. See Strain Relief Test, Section 53.

6.9 Each terminal and wiring intended to be field connected shall be identified on the:

- a) Accessory,
- b) Refrigerator when connections are to be made between the accessory and the refrigerator, and
- c) Wiring diagram(s).

6.10 The mounting location of the accessory shall be indicated on the refrigerator.

Exception: When the mounting location is fixed due to the function of the accessory and arrangement of the refrigerator, and instructions are provided specifying the installation and location for the accessory, the mounting location of the accessory need not be indicated on the refrigerator.

6.11 As part of the investigation, accessories are to be trial-installed to determine that:

- a) Their installation is feasible,
- b) The instructions are detailed and correct, and
- c) The use of the accessories does not introduce a risk of fire, electric shock, and injury to persons.

7 Enclosures

7.1 General

7.1.1 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 increasing the risk of fire or injury to persons due to 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.

7.1.2 Among the factors that are to be taken into consideration when judging the acceptability of an enclosure are mechanical strength, resistance to impact, moisture-absorptive properties, flame resistance, resistance to distortion at temperatures to which the material may be subjected under conditions of use, and resistance to corrosion. For a nonmetallic enclosure or part of an enclosure, all of these factors, including the effect of exposure to weathering if for outdoor use, are to be considered with respect to aging.

7.1.3 A nonmetallic outer enclosure or part of an outer enclosure shall have a flame spread index (FSI) of not more than 200 when tested in accordance with the Standard for Tests for Surface Burning Characteristics of Building Materials, UL 723.

Exception No. 1: When the total unbroken surface area is 25 square feet (2.32 m²) or less, a material having a FSI of not more than 200 when tested in accordance with the radiant panel method in the Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162 is acceptable.

Exception No. 2: When the total unbroken surface area is 10 square feet (0.93 m²) or less, a material having a flammability rating of HB, V-0, V-1, V-2, or 5V in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, is acceptable.

7.1.4 The requirement in 7.1.3 also applies to a refrigerator that is intended for end-to-end installation with other refrigerators that may result in a continuous unbroken section of nonmetallic material over 25 square feet (2.32 m²) in area.

7.1.5 For the purpose of the requirement in 7.1.3 and 7.1.4, the surface area is considered to be broken when there is an air gap at least 12 inches (305 mm) wide or a metallic material at least 12 inches wide between sections of nonmetallic material.

7.1.6 With reference to 7.1.3, the interior liner of an open type refrigerator is not considered part of the outer enclosure.

7.1.7 Additional flammability tests may be needed on nonmetallic outer enclosure materials when internal wiring is not enclosed by means such as conduit, electrical metallic tubing, metal raceways or control boxes. See Internal Wiring and Wiring Methods, Section 10.

7.1.8 The enclosure(s) of a refrigerator shall reduce the risk of mechanical damage to wiring, electrical components, and refrigerant tubing.

7.1.9 The enclosure shall reduce the risk of emission of molten metal, burning insulation, flaming particles, or similar materials, through openings onto flammable material, including the surface over which the refrigerator is mounted.

7.1.10 Electrical components, such as controls, solenoids, starting relays, and switches, shall be individually enclosed except terminals unless it can be determined that failure of a component will not result in a risk of fire. See Burnout Tests – Components, Section 57.

7.1.11 Electrical parts, see 7.1.10, within the outer cabinet are not required to be individually enclosed when 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 it can be shown that failure of the component would not result in a risk of fire,
- b) There are no openings in the bottom of the compartment in which the part is located that would permit dropping of molten metal, and similar materials, on flammable material, and
- c) The part is not in proximity to flammable material other than electrical insulation.

7.1.12 A built-in refrigerator shall be constructed and assembled to reduce the risk of fire due to the emission of molten metal, burning insulation, flaming particles, or similar materials, into the wall space or floor area enclosing the refrigerator.

7.1.13 The requirement of 7.1.12 necessitates the use of totally enclosed fan motors and complete enclosures for controls, starting relays, capacitors, and other electrical components, including wiring, unless these parts are installed in an overall enclosure.

7.1.14 An overall enclosure that has no ventilating openings that will permit the entrance of a 3/8 inch (9.5 mm) diameter rod, except in the front of the refrigerator, has all ventilating openings located or provided with a barrier, baffle, or louver to reduce the risk of expelling molten metal, burning insulation, or similar materials, and has a noncombustible solid bottom without openings may be employed in lieu of the individual enclosures referred to in 7.1.13.

7.1.15 Glass panels used for the enclosure of electrical parts or subject to contact during intended use or maintenance of the refrigerator, or both, shall have acceptable strength (see 70.1 – 70.4) and shall be supported or secured in place.

7.1.16 A sheet metal enclosure is to be judged for acceptability with respect to its size, shape, metal thickness, and use in a particular application. Sheet steel for use as an electrical enclosure shall be not less than 0.026 inch (0.66 mm) thick when uncoated or 0.029 inch (0.74 mm) when galvanized, and nonferrous sheet metal shall be not less than 0.036 inch (0.91 mm), except for relatively small areas or for surfaces which are curved or otherwise reinforced.

7.1.17 Sheet metal to which a wiring system is to be connected in the field shall be:

- a) Not less than 0.032 inch (0.81 mm) thick when uncoated steel,
- b) Not less than 0.034 inch (0.86 mm) thick when galvanized steel, and
- c) Not less than 0.045 inch (1.14 mm) thick when nonferrous.

7.1.18 When threads for the connection of conduit are tapped 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 shall permit a conduit bushing to be attached. When threads for the connection of conduit are not tapped through a hole in an enclosure wall, conduit hub, or similar part, there shall be no 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.

7.1.19 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 7.1.21.

7.1.20 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.

7.1.21 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 reduce spacings between uninsulated live parts and the bushing to less than those required.

7.1.22 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 7.1 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 7.1
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)

7.1.23 Steel enclosures shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting. See 7.3.1 – 7.3.5.

7.2 Doors and covers

7.2.1 A door, cover, or panel may be provided with an interlock in accordance with 5.3.3 or 5.4.1. A required interlocking mechanism shall be one that:

- a) Must be engaged in the closed position of the cover before parts are energized and
- b) Secures the cover in the closed position when engaged.

7.2.2 A hinged or pivoted panel or cover shall be positioned or arranged so that when it is in an open position falling or swinging due to gravity or vibration will not 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.

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

7.2.4 A required protective device shall not be accessible from outside the enclosure without 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, provided that the clearance between the control member and the edge of the opening in the outer enclosure is not more than 1/8 inch (3.2 mm) for any setting or position of the control member.

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

Exception: A hinged cover is not required when 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) Extractor-type fuses with their own enclosure; or*
- d) Fuses in low-voltage circuits.*

7.2.6 A cover required to be hinged shall not depend solely upon screws or other similar means to hold them closed, but shall be provided with a latch or the equivalent.

7.2.7 With reference to the requirements of 7.2.6, a spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that holds the cover closed and requires some effort on the user's part to open is acceptable. When provided as the sole means for securing the cover an interlocking mechanism as described in 7.2.1 is also acceptable.

7.2.8 A door or cover giving direct access to a fuse 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 by not less than 1/2 inch (12.7 mm). A construction, such as a fuse enclosure, located within an outer enclosure, or a flange and rabbet combination that provides the equivalent protection is acceptable.

7.2.9 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 mm) from each end of each strip and at points between these end fastenings, not more than 6 inches (152 mm) apart.

7.3 Enclosures exposed to weather

7.3.1 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion by the means specified in Table 7.2 or by other metallic or nonmetallic coatings that provide equivalent protection.

Exception: These requirements do not apply to a metal part, such as a decorative grille, that is not required for conformance with this standard.

Table 7.2
Corrosion protection means

Type of cabinet and enclosure	Thickness 0.053 inch (1.35 mm) and heavier as specified by paragraph	Thickness less than 0.053 inch (1.35 mm) as specified by paragraph
Outer cabinets which protect motors, wiring or enclosed current-carrying parts	7.3.2	7.3.3
Inside enclosures which protect current-carrying parts other than motors	7.3.2	7.3.3
Outer cabinets which are the sole enclosure of current-carrying parts	7.3.3	7.3.3

7.3.2 To comply with the requirements of 7.3.1, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G60 or A60 in Table 1 of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in the ASTM Specification. The weight of zinc coating may be determined by any recognized method; however, in case of question, the weight of coating shall be established in accordance with the Test Method of the Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M. An A60 (alloyed) coating shall also comply with 7.3.4.
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be established by the Metallic-Coating Thickness Test, Section 75. An annealed coating shall also comply with 7.3.4.
- c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. Unless acceptability of the paint can be determined by consideration of its composition, corrosion tests are required.

7.3.3 To comply with 7.3.1, one of the following coatings shall be used:

- a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G90 in Table 1 of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirements in that ASTM Specification. The weight of zinc coating may be determined by any recognized method;

however, in case of question, the weight of coating shall be established in accordance with the Test Method of the Standard Test Method For Weight [Mass] Of Coating On Iron And Steel Articles With Zinc Or Zinc-Alloy Coatings, ASTM A90/A90M.

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.0155 mm) on each surface with a minimum thickness of 0.00054 inch (0.0137 mm). The thickness of the coating shall be established by the Metallic-Coating Thickness Test, Section 73. An annealed coating shall also comply with 7.3.4.

c) A cadmium coating of not less than 0.001 inch (0.025 mm) thick on both surfaces (only in areas where there is no likelihood of food contact.) The thickness of coating shall be established in accordance with the Metallic-Coating Thickness Test, Section 75.

d) A zinc coating conforming with 7.3.2 (a) or (b) with one coat of outdoor paint as specified in 7.3.2 (c).

e) A cadmium coating of not less than 0.00075 inch (0.0191 mm) thick on both surfaces with one coat of outdoor paint on both surfaces or not less than 0.0005 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces (only in areas where there is no likelihood of food contact.) The thickness of the cadmium coating shall be established in accordance with the Metallic-Coating Thickness Test, Section 75, and the paint shall be as specified in 7.3.2 (c).

7.3.4 An annealed zinc coating that is bent or similarly formed after annealing shall be painted in the bent or formed area if the bending or forming process has damaged the zinc coating, as evidenced by flaking or cracking of the zinc coating at the outside radius of the bent or formed section visible at 25 power magnification.

7.3.5 With reference to the requirements of 7.3.4, simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes shall comply with 7.3.4.

7.3.6 With reference to the requirements of 7.3.1, other finishes, including paints, special metallic finishes, and combinations of the two, are acceptable when comparative tests with galvanized sheet steel without annealing, wiping, or other surface treatment complying with 7.3.2 (a) or 7.3.3 (a), as applicable, indicate that they provide equivalent protection. Among the factors to be taken into consideration when judging the acceptability of such coating systems are exposure to salt spray, to moist carbon dioxide-sulphur dioxide-air mixtures, to moist hydrogen sulphide-air mixtures, and to ultraviolet light and water.

7.3.7 Nonferrous enclosures may be employed without special corrosion protection. See 7.1.2.

7.3.8 Gaskets required to seal electrical enclosures against the entrance of rain and condensate shall be held in place by mechanical fasteners or adhesives, except as indicated in 7.3.9, and shall comply with the requirements of 74.1 – 74.4. Sealing compounds required to seal electrical enclosures shall comply with the requirements of 74.5. Adhesives required to secure gaskets shall comply with the requirements of 74.6. Gaskets shall be neoprene, rubber, or thermoplastic. Other materials may be used when they have equivalent properties.

7.3.9 Gaskets that are prevented from displacement either by their location or placement of other components in the enclosure when the cover is removed and that would be reengaged in the intended manner when the cover is replaced are not required to be held by mechanical fasteners or adhesives. Consideration shall be given to the intended mounting of the gasket in the application.

8 Nonmetallic Materials

8.1 General

8.1.1 The requirements in 8.1.2 – 8.3.7 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 78.1 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 (0.903 m²).

8.1.2 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 Material – Use in Electrical Equipment Evaluations, UL 746C.

8.1.3 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 8.2.1 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.

8.1.4 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 8.3.1 and 8.3.3 if they comply with the Burnout Test – Impedance Protected Motors, Section 77.

Exception No. 3: Thermally protected motors having openings in their enclosures need not be separated as indicated in 8.3.1 and 8.3.2 if they comply with the requirements in 17.13.

Exception No. 4: Transformers complying with the requirements in Section 26 need not be separated.

8.1.5 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.

8.2 Classification

8.2.1 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.

8.3 Application

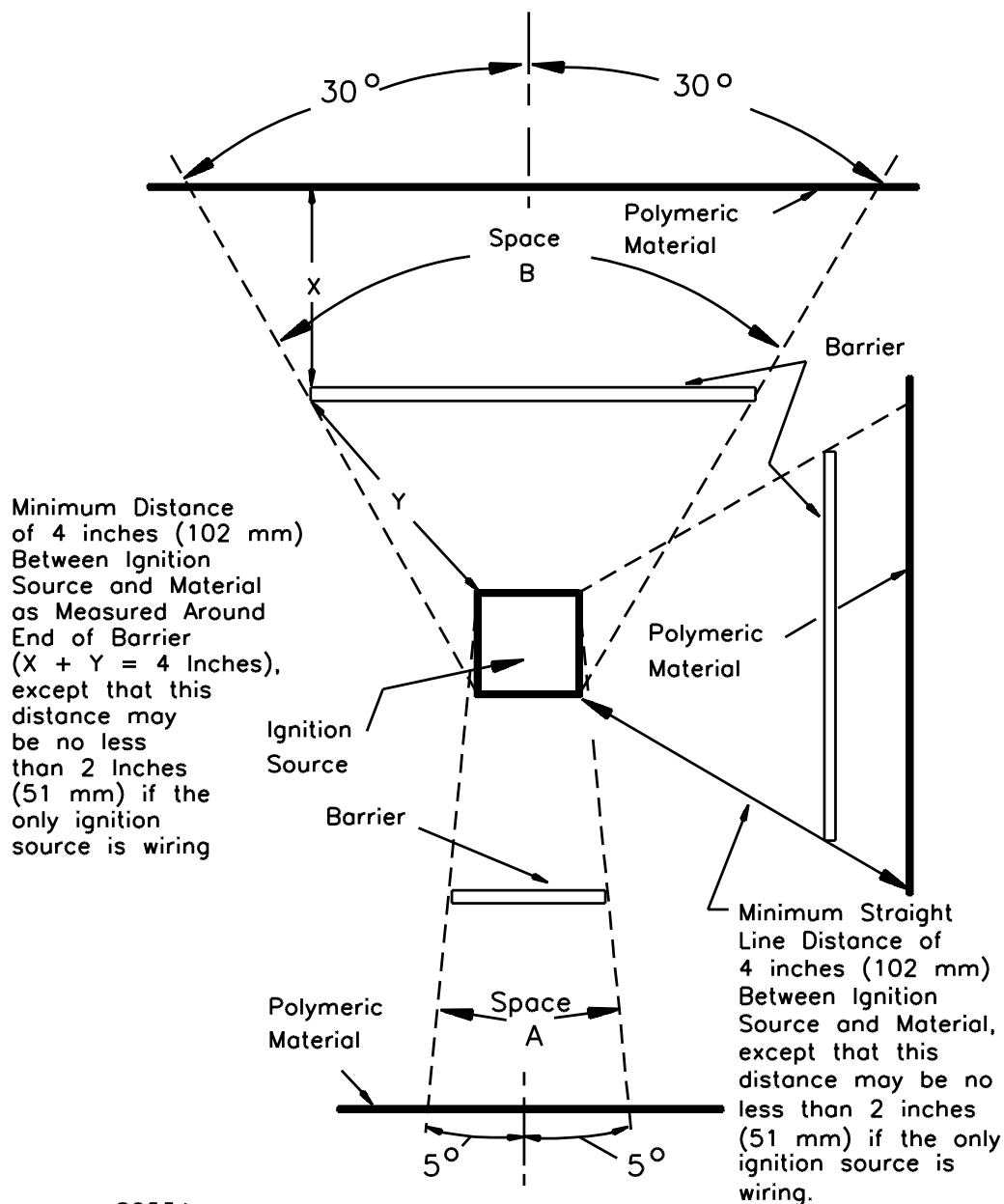
8.3.1 A nonmetallic enclosure isolating an ignition source(s) shall be evaluated in accordance with Group 1 of Table 78.1. A nonmetallic enclosure not isolating an ignition source shall be evaluated in accordance with Group 2.

8.3.2 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 78.1.

8.3.3 With respect to footnotes c, d, and h of Table 78.1 a nonmetallic material located below the ignition source and within Space A of Figure 8.1 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 8.1 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 8.3.5.

Figure 8.1
Separation of ignition sources from nonmetallic materials



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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.

8.3.4 With respect to footnotes c, d, and h of Table 78.1 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 8.3.5.

8.3.5 When required by 8.3.3 or 8.3.4, 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.

8.3.6 Thermal insulation located between an outer metal cabinet or metal door and inner liner of a refrigerator need not be tested for flammability when:

- a) All entrance and exit holes for wiring, foaming, and the like, located within this volume are sealed with caps, permagum, foil tape, or the like, and

Exception: Holes in the outer metal enclosure need not be sealed when there are not more than two, when wiring is not routed through the hole, and when The total area is no more than 1 inch²(645.2 mm²).

- b) Either the securement of the outer cabinet surfaces is inherent in the construction or the maximum spacing between screws, spot welds, or other securement means on the outer metal enclosure does not exceed 6 inches (152.4 mm).

8.3.7 A printed wiring board for high-voltage circuits shall have a flammability level of at least V-1 when tested in accordance with the method outlined in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. For unsealed holes larger than 1 square inch (645.2 mm²) the thermal insulation shall be rated HF-1.

ELECTRICAL SYSTEM

9 Field Supply Connections

9.1 General

9.1.1 When a refrigerator is intended to be connected to the conductor identified as the grounded conductor of a power supply circuit, a lampholder with a screwshell base shall be wired so that the screw shell will be connected to that conductor. See 21.1 and 21.2.

9.2 Permanently connected refrigerators

9.2.1 Refrigerators of the following types shall have provision for permanent connection to the power supply:

- a) Refrigerators rated in excess of 250 volts.
- b) Refrigerators having a rated-load current exceeding 40 amperes, 250 volts. The largest sum of concurrent rated loads shown on the nameplate is to be used to determine the rating.
- c) Remote refrigerators, sectional refrigerators, and unitary refrigerators other than of the self-contained type.

Exception: For remote refrigerators that consist of a remote dispensing unit (that is intended to be moved for sanitation) along with the associated condensing unit, the remote dispensing unit is not prohibited from being cord connected. The marking specified in 84.28 is required for dispensers that are electrically connected to the condensing unit.

- d) A built-in refrigerator.

9.2.2 As used in 9.2.3 – 9.2.20, 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 refrigerator is installed.

9.2.3 A refrigerator shall have provision for connection of one of the wiring systems that is in accordance with the National Electrical Code, ANSI/NFPA 70.

Exception: Leads provided for power-supply connection of a door panel assembly are not prohibited from being brought out through factory-attached flexible conduit 3 – 6 feet (0.91 – 1.83 m) long. An outlet box or conduit fitting shall be provided at the free end of the conduit.

9.2.4 A knockout intended for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 9.1.

Table 9.1
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)	1	(33.4)	1	(33.4)	1-1/4	(42.3)
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)	1-1/4	(48.3)	2	(60.3)	2	(60.3)

Table 9.1 Continued on Next Page

Table 9.1 Continued

Wire size		Number of wires				
AWG	(mm ²)	2	3	4	5	6
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. When more than six conductors are involved or when all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.						

9.2.5 Space shall be provided in the field-wiring compartment or outlet box for installation of conductors of the number and size required by 9.2.8. The space provided shall permit the required number and size of at least 6-inch (150-mm) lengths of Type TW or THW wire brought into the wiring compartment. When required, a trial installation is to be made.

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

9.2.6 A terminal box or compartment in which power supply connections are to be made shall be located so that these connections may be inspected after the refrigerator is installed. The connections shall 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.

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

9.2.8 The refrigerator shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity of not less than that indicated in 84.13. It is to be assumed that branch circuit conductors rated 60°C (140°F) will be used when the required circuit ampacity is 100 amperes or less and that conductors rated 75°C (167°F) will be used when the required ampacity is more than 100 amperes.

9.2.9 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 two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; by a connecting strap or clip fitted into an adjacent part; or by some equivalent method.

9.2.10 For 8 AWG (8.4 mm²) and larger conductors, pressure wire connectors shall be used. For 10 AWG (5.3 mm²) 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.

9.2.11 A wire binding screw at a field-wiring terminal shall not be 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 mm²) or smaller conductor.

9.2.12 According to the National Electrical Code, ANSI/NFPA 70, 14 AWG (2.1 mm²) 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.

9.2.13 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 mm²) 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.

9.2.14 A terminal plate formed from stock of the 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 when 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.

9.2.15 Upturned lugs or a cupped washer shall retain a conductor of the size mentioned in 9.2.8, but no smaller than 14 AWG (2.1 mm²), under the head of the screw or the washer.

9.2.16 A wire binding screw shall thread into metal.

9.2.17 A field-wiring terminal intended for the connection of a grounded conductor shall be of a metal, 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.

9.2.18 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 when it is evident that the use of a longer lead might result in a risk of fire or electric shock.

9.2.19 Leads intended for connection to field-installed conductors 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 53.

9.2.20 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.

9.2.21 When a refrigerator for end-to-end installation employs a wireway, such as a cartrail, that is intended to enclose supply conductors for more than one refrigerator, the wireway shall comply with the applicable requirements specified in the Standard for Wireways, Auxiliary Gutters, and Associated Fittings, UL 870.

9.3 Cord-connected refrigerators

9.3.1 A refrigerator intended for cord connection to the power supply shall be provided with:

- a) A flexible cord of a type, length, and ampacity and an attachment plug of a type and rating complying with the requirements of 9.3.2 – 9.3.7; or
- b) An appliance inlet for connection of a detachable power supply and either a detachable power supply cord or instructions for selection of a suitable detachable power supply cord.

9.3.2 The marked rating of a cord-connected refrigerator, see 85.1, shall not exceed 80 percent of the rating of the attachment plug.

9.3.3 A cord-connected refrigerator shall employ a grounding-type attachment plug that complies with the Standard for Wiring Devices-Dimensional Requirements, ANSI/NEMA WD6. See Table 9.2 for typical plugs used.

Exception: Refrigerators rated 250 volts or less and intended for connection to circuits rated other than 60 hertz, or other than the voltages specified in the first column of Table 37.1, or both, may employ a grounding-type attachment plug acceptable for the circuit involved.

Table 9.2
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	6 – 30P
200 – 240	1	40.0	50 amperes, 250 volts	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	14 – 30P
110 – 120/200 – 240	1	40.0	50 amperes, 125/250 volts	14 – 50P
200 – 240	3	12.0	15 amperes, 250 volts	15 – 15P
200 – 240	3	16.0	20 amperes, 250 volts	15 – 20P
200 – 240	3	24.0	30 amperes, 250 volts	15 – 30P
200 – 240	3	40.0	50 amperes, 250 volts	15 – 50P

^a The ampere rating is the maximum permitted to be marked on the refrigerator nameplate for the attachment plug indicated. See 9.3.2.

^b Standard for Wiring Devices – Dimensional Requirements, ANSI/NEMA WD6.

9.3.4 A cord-connected refrigerator may employ Type S, SE, SO, SOO, ST, STO, STOO, SJ, SJE, SJO, SJOO, SJT, SJTO, or SJTOO power supply cord rated for use at a voltage not less than the rated voltage of the refrigerator. The ampacity of the cord as given in the National Electrical Code, ANSI/NFPA 70, shall

be not less than that required by the ampere input measured in the Temperature and Pressure Test, Section 41, or the Defrost Test, Section 44. The ampere input value shall include the loads for convenience outlets and the current drawn by accessories intended for use with the refrigerator. See 83.3.1 and 83.3.2.

9.3.5 The ampacity of a power supply cord on a refrigerator intended for connection to a branch circuit which exceeds the limitations specified in the Exception to 17.5 shall be not less than 80 percent of the maximum continuous current of the motor-compressor determined in accordance with Protective Devices – Maximum Continuous Current Test, Section 64, plus the sum of all other loads, including accessories, which may operate concurrently.

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

9.3.6 A power supply cord for an outdoor use refrigerator shall be one of the types specified in 9.3.4 and recognized for outdoor use. Such cords are identified by the letters “W” or “W-A” following the cord type designation marked on the jacket. A cord that is marked “Outdoor” in addition to the letters “W” or “W-A” shall be used only on refrigerators that have been found acceptable for outdoor use.

9.3.7 The length of a power supply cord shall be not less than 6 feet (1.8 m) nor more than 10 feet (3.0 m). The length is to be measured between the attachment plug and:

- a) Any point at which the cord exits the refrigerator cabinet, or
- b) The last strain relief, whichever is shorter.

9.3.8 The power supply cord shall be provided with strain relief means so that a stress on the cord is not transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 53. A metallic strain relief shall not contact uninsulated live parts or reduce spacings within the enclosure when the cord is moved inward. The cord shall not be subject to damage by moving parts when it can be moved inward.

9.3.9 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 prevent damage to the cord insulation.

9.3.10 Cord connected equipment may be provided with more than one power supply cord when all of the following conditions are met:

- a) The equipment consists of two separate units joined together, two of the same unit in a single structure, or a unit with separately supplied convenience receptacles.
- b) Not more than two cords are provided.
- c) Each cord is of the type, size and rating required or permitted for the type of product and the load supplied to each unit. See 9.3.4.
- d) Each attachment plug cap is sized based on the load supplied to each unit.
- e) Both cords shall carry the system ground.
- f) When both cords provide power to the same control box or electrical panel, the equipment shall be provided with a mechanical or electrical interlock system that results in all ungrounded conductors of the supply being disconnected in the event that either cord is disconnected.

g) The marking specified in 85.3 (a) and 85.3 (c) shall be provided.

h) The instructions shall contain information as indicated in 86.3.

9.3.11 With regard to 9.3.10, where the combined rated current input to both supply cords exceeds 80 percent of the branch circuit to which the equipment will be connected, the unit or cord with the highest rated current input shall be marked adjacent to the supply cord in accordance with 85.3 (b).

9.3.12 The remote dispensing head of a beverage cooler/dispenser may be cord and plug connected . See the Exception to 9.2.1 (d). The requirement of 9.3.10 shall also apply when the beverage cooler dispenser is also cord connected.

9.4 Grounding

9.4.1 A refrigerator shall have provision for grounding as follows:

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

b) For a cord-connected refrigerator, there shall be an equipment grounding conductor in the power supply cord terminating in an identified grounding terminal as specified in 9.4.2.

9.4.2 On a cord connected refrigerator, 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 refrigerator by a positive means, see 13.5, 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.

9.4.3 On a permanently connected refrigerator, a terminal intended solely for connection of an equipment grounding conductor shall be capable of securing a conductor of the size required by the National Electrical Code, ANSI/NFPA 70.

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

Exception: An internal connection for bonding internal parts of 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, when:

a) The connector is not likely to be displaced; and

b) The component is limited to use on a circuit having a branch circuit protective device rated as shown in Table 9.3.