UL 471

STANDARD FOR SAFETY

Commercial Refrigerators and Freezers

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

Tenth Edition, Dated November 24, 2010

Summary of Topics

This revision of ANSI/UL 471 dated September 12, 2019 includes requirements for beverage product system pressure and miscellaneous editorial corrections.

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 21, 2019.

No Text on This Page

NOVEMBER 24, 2010
(Title Page Reprinted: September 12, 2019)

ANSI/UL 471-2019

UL 471

Standard for Commercial Refrigerators and Freezers

The First through Third editions were titled Standard for Commercial Refrigerators.

First Edition – October, 1957
Second Edition – June, 1962
Third Edition – May, 1973
Fourth Edition – September, 1975
Fifth Edition – May, 1978
Sixth Edition – January, 1985
Seventh Edition – July, 1992
Eighth Edition – November, 1995
Ninth Edition – January, 2006

Tenth Edition

November 24, 2010

This ANSI/UL Standard for Safety consists of the Tenth Edition including revisions through September 12, 2019.

The most recent designation of ANSI/UL 471 as an American National Standard (ANSI) occurred on September 12, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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 https://csds.ul.com.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

ELECTRICAL SYSTEM

ELECTRICAL COMPONENTS

SPACINGS

REFRIGERATION SYSTEM

PERFORMANCE

MANUFACTURING AND PRODUCTION TESTS

MARKING

INSTRUCTIONS

SUPPLEMENT SA – COMMERCIAL REFRIGERATORS AND FREEZERS FOR MARINE USE

INTRODUCTION

CONSTRUCTION

PERFORMANCE

MARKING

SUPPLEMENT SB – REQUIREMENTS FOR REFRIGERATORS AND FREEZERS EMPLOYING A FLAMMABLE REFRIGERANT IN THE REFRIGERATING SYSTEM

SUPPLEMENT SC – UL 60335-1 BASED REQUIREMENTS FOR THE EVALUATION OF ELECTRONIC CIRCUITS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

APPENDIX A

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.

1.1.1 These requirements also cover commercial refrigerators and freezers intended for installation within motor fuel dispensing facilities as defined by the Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A.

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, laboratory refrigerators and freezers, and processing liquid coolers.

1.3 Self-contained commercial refrigerators and freezers covered by these requirements employ hermetic or semi-hermetic refrigerant motor-compressors and air- and water-cooled condensers or are of the thermoelectric type.

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 *Deleted*

2.1.2 *Deleted*

2.1.3 *Deleted*

2.1.4 *Deleted*

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

3.5 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.

3.5.1 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.

3.6 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.

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

3.8 *delete*

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

3.10 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.

3.10.1 FLASH GAS BYPASS VALVE – Enables gas from the flash gas tank to be removed for compression within carbon dioxide (R-744) transcritical systems.

3.10.2 FLASH GAS TANK – Provided to separate the vapor and supply liquid to evaporators for expansion in carbon dioxide (R-744) transcritical systems. Once cooled in the gas cooler, refrigerant is throttled to the subcritical region and enters this device.

3.11 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.

3.12 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.

3.12.1 MOTOR FUEL DISPENSING FACILITY – That portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into containers, including all equipment used in connection therewith. The area surrounding a fuel dispenser in an outdoor motor fuel dispensing facility extending up to 18 in. (450 mm) above grade level and 20 ft (6 m) horizontally in all directions from the dispenser enclosure is considered to be a location where flammable or combustible gas and/or liquids may be present in combustible concentrations as noted in the Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A.

3.12.2 GAS COOLER – A heat exchanger designed to remove heat from a carbon dioxide (R-744) transcritical system.

3.12.3 INTERMEDIATE PRESSURE STAGE – This applies to carbon dioxide (R-744) transcritical systems, lays between the high side and low side pressure stages and is regulated by a flash gas bypass valve. This stage may include a flash gas tank and gas cooler.

3.13 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.

3.14 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.

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

3.16 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.

3.17 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 m^3) of refrigerant containing volume], evaporator coils, compressors, condenser coils, controls, headers pumps, and piping.

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

3.19 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.

3.19.1 REMOTE TRANSCRITICAL REFRIGERATOR – A remote refrigerator or freezer intended for use in a transcritical refrigeration system. As the remote refrigerator is on the low pressure side, the refrigerant is not necessarily in the transcritical range.

3.20 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.

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

3.22 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.

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

3.24 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.

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

3.26 THERMOELECTRIC REFRIGERATOR – A refrigerator in which the air is cooled using the Peltier Effect such that a direct current supply source is applied to a semiconductor thermoelectric module creating a temperature gradient which transfers heat from one surface to another.

3.26.1 TRANSCRITICAL REFRIGERATION SYSTEM – Refrigeration system where the pressure in the high pressure side is above the pressure where the vapor and liquid states of the refrigerant can coexist in thermodynamic equilibrium.

3.26.2 STIRLING REFRIGERATION SYSTEM – A hermetic refrigeration system based on the Stirling gas cycle in which the refrigerant is at all times in the gas or vapor phase. The Stirling refrigeration system may include a thermosiphon containing a different refrigerant in a saturation condition.

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

3.28 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.

3.29 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.

3.30 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).

3.31 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).

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

3.33 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. An example would be a pressure limiting control (pressure cut-out) or a temperature limiting control (thermal cut-out).

3.34 LABORATORY REFRIGERATOR OR FREEZER – A refrigerator or freezer for use in a building, space, room or group of rooms intended for medical storage or to serve activities involving procedures for investigation, diagnosis, or treatment.

3.35 LIMITED CHARGE SYSTEM – A system in which, with the compressor idle, the design pressure will not be exceeded when the refrigerant charge has completely evaporated.

3.36 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.

3.37 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.

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 functions which are not intended to be relied upon for the safety of the application. Examples are: room thermostats, temperature control.

3A.6 CLASS B CONTROL FUNCTION – Control functions which are intended to prevent an unsafe state of the appliance. Failure of the control function will not lead directly to a hazardous situation. Examples

are: temperature limiting control (thermal cut-out), pressure limiting control (pressure cut-out). This equates to Software Class 1 in UL 1998.

3A.7 CLASS C CONTROL FUNCTION – Control functions which are intended to prevent special hazards such as explosion or whose failure could directly cause a hazard in the appliance. Examples are: burner control systems, 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 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 or freezer; including a door panel assembly door, shall be able to be opened from the inside by a force applied outwardly to the door or to a release actuator. Doors shall comply with the Door Opening Test of Section 75.2. In addition, doors with an interior latch release device shall comply with the Door Latch Release Test of Section 75.1.

4.5.1 If the door is provided with a key lock, it shall be constructed such that the lock can be opened from the interior without using a key or tool.

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 75.1.

4.9 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.

4.10 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 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 4.9 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 68.2.2.

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 68.2.2, and

c) The refrigerator is marked in accordance with 87.3.10.

5.2.3 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.

5.2.4 A pressurized beverage product system shall comply with the tests in 68.2.

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 73.

5.3.3 When installed in its intended manner (see Installation and Operating Instructions, Section 90), 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 44.1. 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 87.3.6 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 m^2) 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.

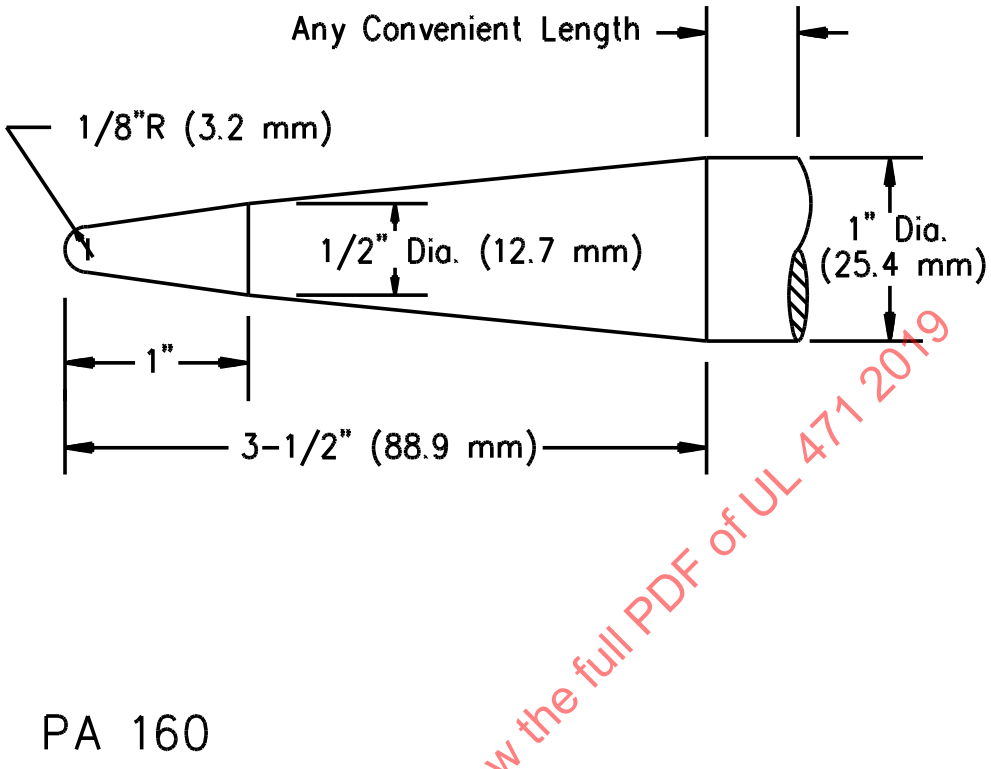
5.3.8 A fan blade or moving part employing a guard with openings having a minor dimension less than 1 inch (25.4 mm) shall be guarded such that the probe illustrated in Figure 5.1 cannot contact any part of the fan blade or moving part when inserted through openings in the guard with a force of 2.5 pounds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

$$K = 6 \times 10^{-7}(w\, r^2\, n^2)$$

is less than 100.

Figure 5.1
Probe for fan blades



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)

Table 5.1 Continued on Next Page

Table 5.1 Continued

Minor dimension of opening[a,d]		Minimum distance from opening to moving part[c]	
inches	(mm)	inches	(mm)
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.

c) The moving part is part of a mixer or blender assembly that complies with the protection against injuries to persons section of the Standard for Motor Operated Commercial Food Preparing Machines, UL 763.

5.3.11 When tested according to Sections 44 – 47, surfaces having temperatures that exceed the temperature rise of items 2 and 3 of item D of Table 44.1 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 44.1, 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 44.1, 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 88.25.

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

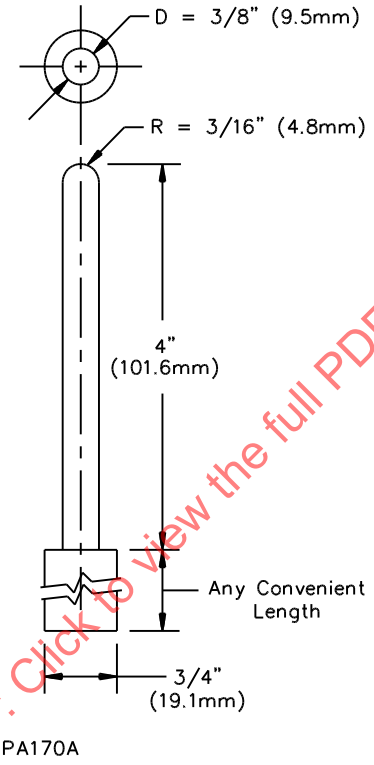
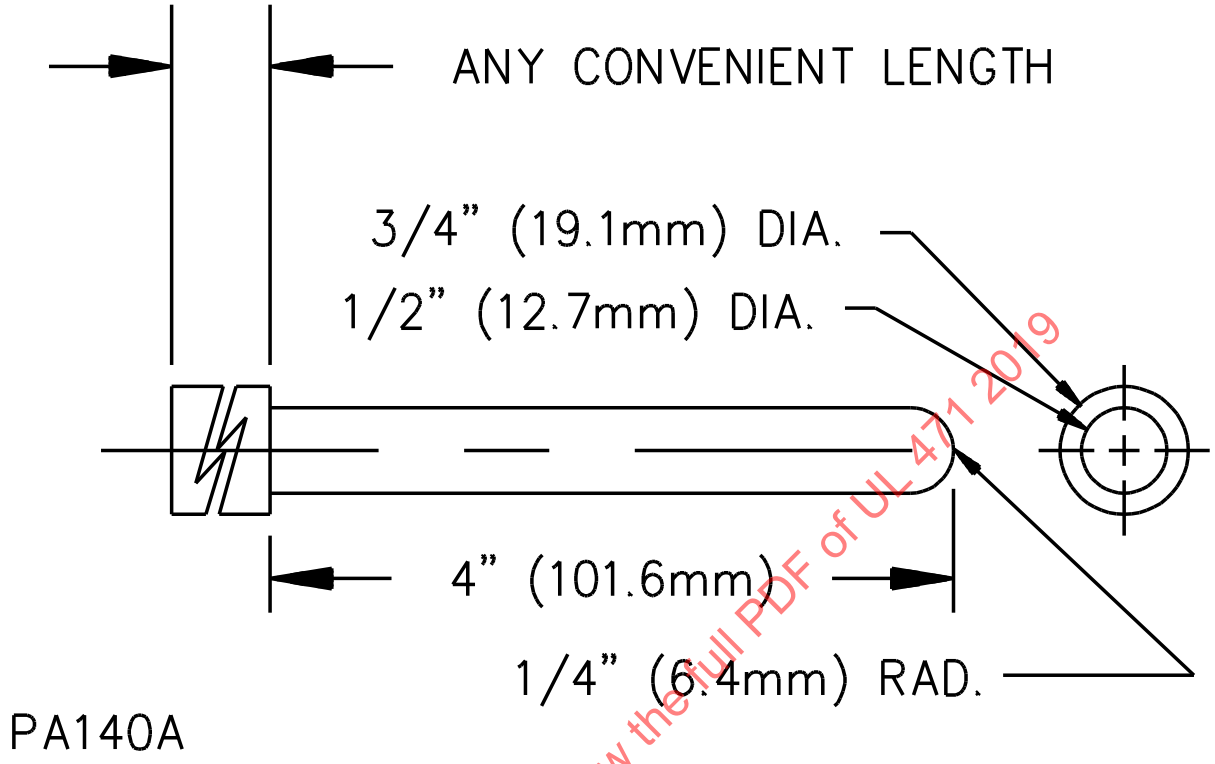
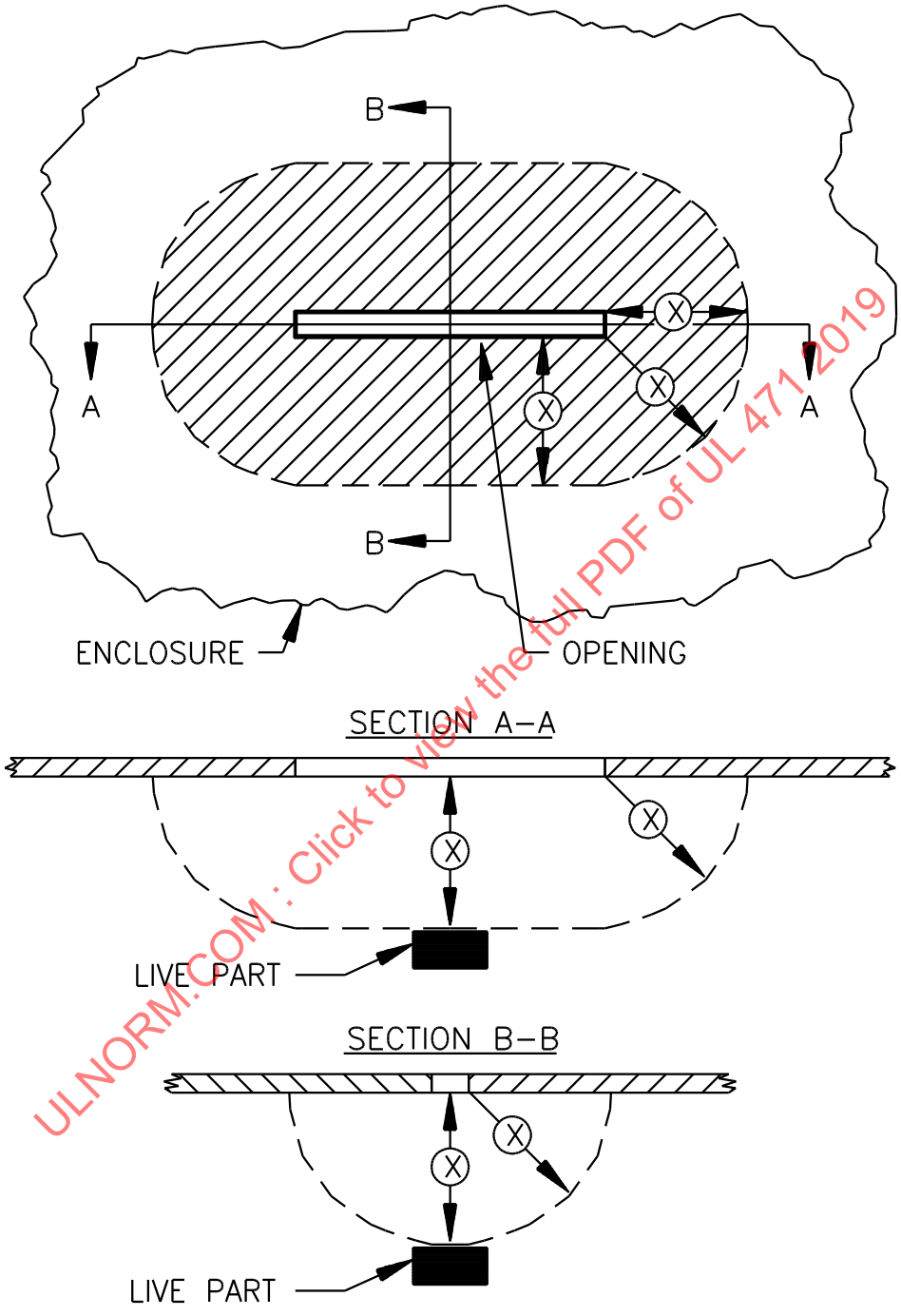


Figure 5.3
Probe



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 87.3.6.

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 52.1 and 52.2, 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 30 and 31.

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 30 and 31. 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 65.2.1.

5.5 Refrigerators and freezers intended for installation within a motor fuel dispensing facility

5.5.1 Refrigerators and freezers intended for installation within a motor fuel dispensing facility shall comply with one of the following:

a) All electrical components, including wiring and electrical connections, shall be located a minimum of 18 in. (450 mm) above grade level when the unit is installed as intended; or

b) The unit shall be intended to be permanently mounted such that the entire unit is located a minimum of 18 in. (450 mm) above grade level.

5.5.2 The unit shall be provided with a complete metal base complying with the thickness requirements in paragraph 7.1.16. There shall be no openings in the base.

5.5.3 When the unit is constructed in accordance with 5.5.1(a), the complete metal base specified in 5.5.2 shall be located a minimum of 18 inch (450 mm) above grade level and underneath all electrical components when the appliance is installed as intended.

5.5.4 With regards to 5.5.1(b), when a minimum 18 inch (450 mm) stand is provided to raise the unit the bottom of the unit or the top of the base shall serve as the barrier and shall comply with all the barrier requirements.

5.5.5 When a minimum 18 inch (450 mm) stand is provided, the stand shall have provisions for being securely fastened to the unit, and the combination of the unit and stand shall comply with the Stability Test, Section 54.

5.5.6 When the unit is intended for permanent connection to the source of electrical supply, the location of the electrical connections shall be a minimum of 18 inches (450 mm) above grade.

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 87.4.1 and 87.4.2.

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 87.4.5.

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 56.

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 having in any single unbroken section, a projected surface area greater than 0.93 m^2 (10 ft^2) shall have a maximum flame-spread rating of 200 as determined by the requirements in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723. The radiant-panel test in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, may be used optionally to determine the flame spread characteristics of materials that are 0.93 m^2 (10 ft^2) – 2.32 m^2 (25 ft^2).

Exception: Thin fabrics and films such as awnings and night shades may instead comply with Test Method 1 or 2 of Standard Methods of Fire Tests for Propagation of Textiles and Films, NFPA 701.

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 m^2) 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 Nonmetallic Materials, Section 8.

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 – Electromagnetic Components, Section 60.

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 74.1 – 74.4) 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 of uninsulated live parts 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 and the second column of Table 7.2, 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 79, or by the Measurement of Coating Thickness by X-Ray Spectrometry, ASTM B568.. 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 and the third column of Table 7.2, 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 79, or by the Measurement of Coating Thickness by X-Ray Spectrometry, ASTM B568. 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 79.

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 79, 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 Copper, bronze, brass containing not less than 80 percent copper, or stainless steel may be used without additional protection against corrosion. Sheet, extruded, or cast aluminum, die-cast zinc, and other metals shall be of a grade or alloy known to be resistant to atmospheric corrosion, or shall be subjected to the appropriate tests, or shall be additionally protected against corrosion.

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 78.1 – 78.4. Sealing compounds required to seal electrical enclosures shall comply with the requirements of 78.5. Adhesives required to secure gaskets shall comply with the requirements of 78.6. Gaskets shall be neoprene, rubber, or thermoplastic. Other materials may be used when they have equivalent properties. Gaskets and Seals that comply with the Standard for Gaskets and Seals, UL 157, are considered to comply with Section 78.

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.

7.3.10 Metal shall be used in combinations that are galvanically compatible.

8 Nonmetallic Materials

8.1 General

8.1.1 The requirements in 8.1.2 – 8.3.6 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 82.1 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 (0.0924 m^2).

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.