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.

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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.

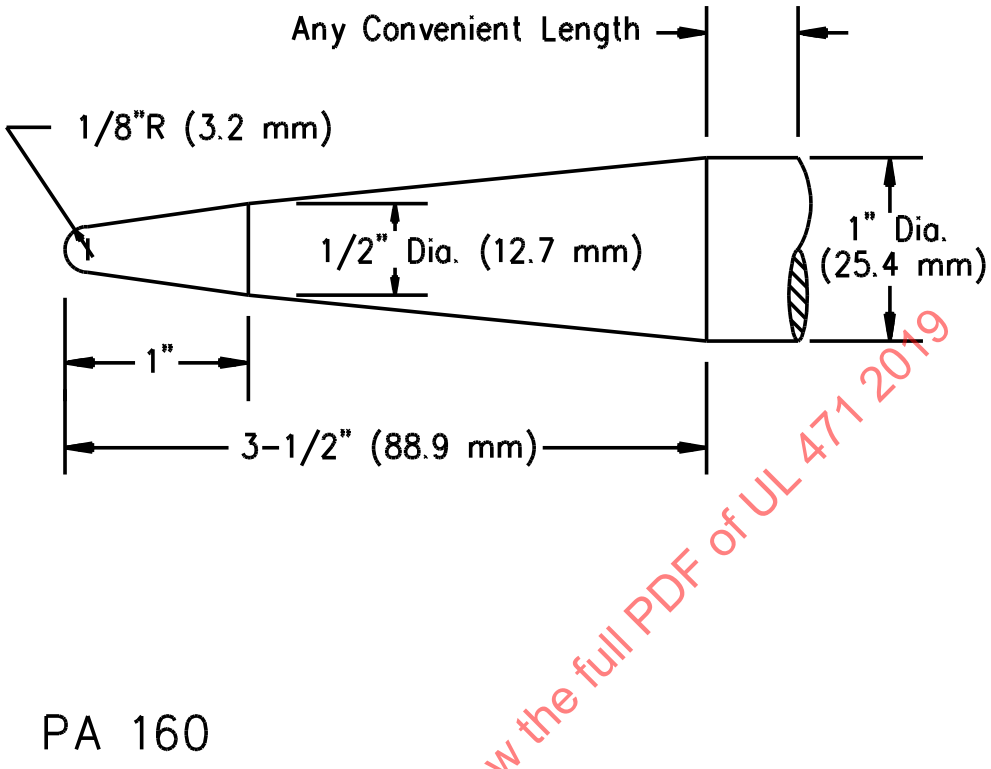
5.3.8 A fan blade or moving part employing a guard with openings having a minor dimension less than 1 inch (25.4 mm) shall be guarded such that the probe illustrated in Figure 5.1 cannot contact any part of the fan blade or moving part when inserted through openings in the guard with a force of 2.5 pounds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

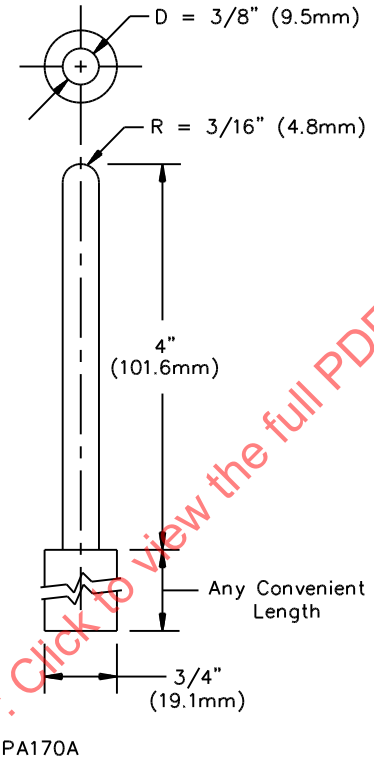
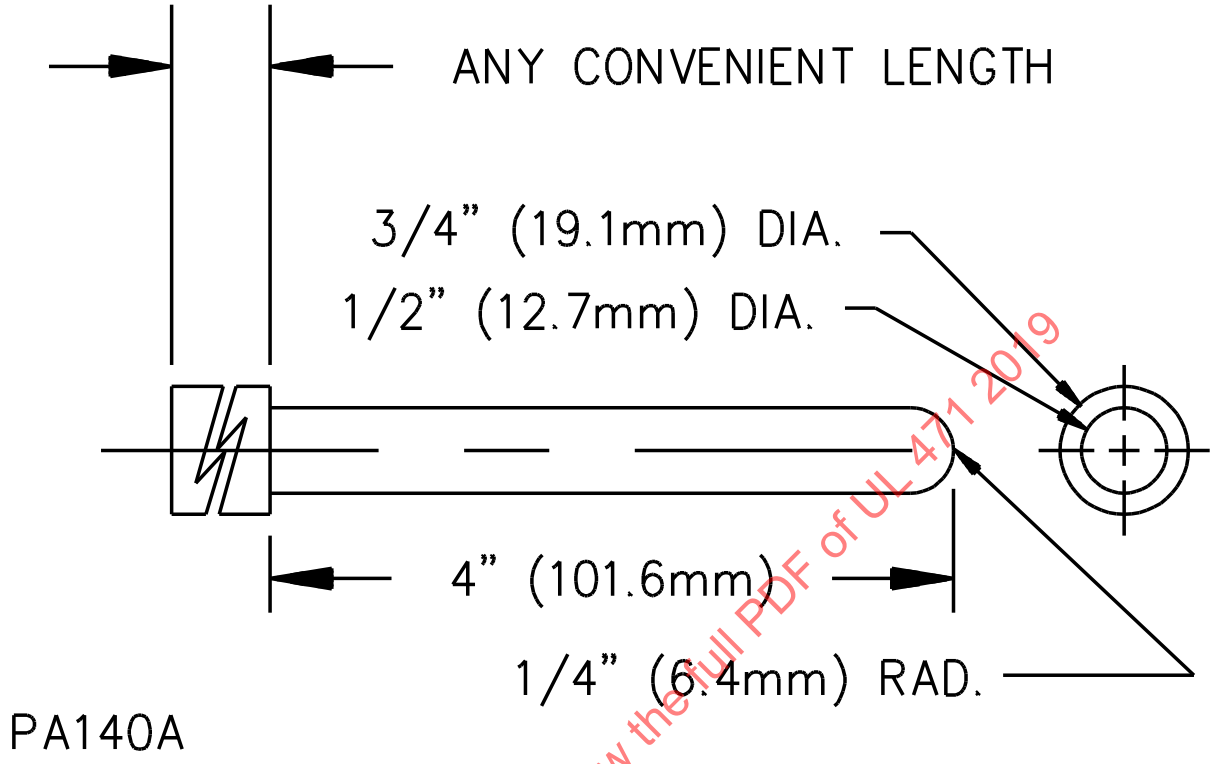
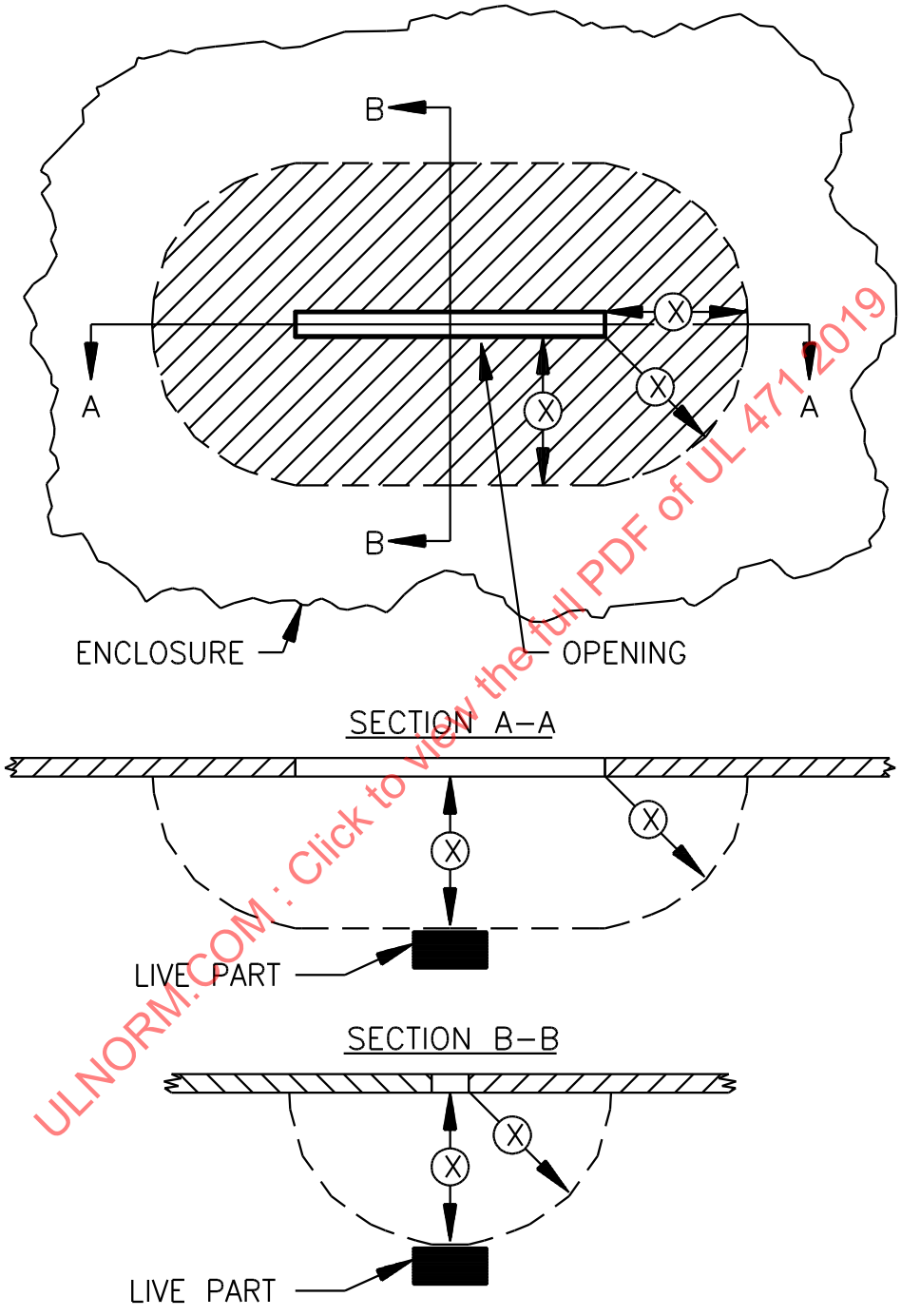


Figure 5.3
Probe



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



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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.

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 81.

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 17.3.

Exception No. 4: Transformers complying with the requirements in Section 28 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

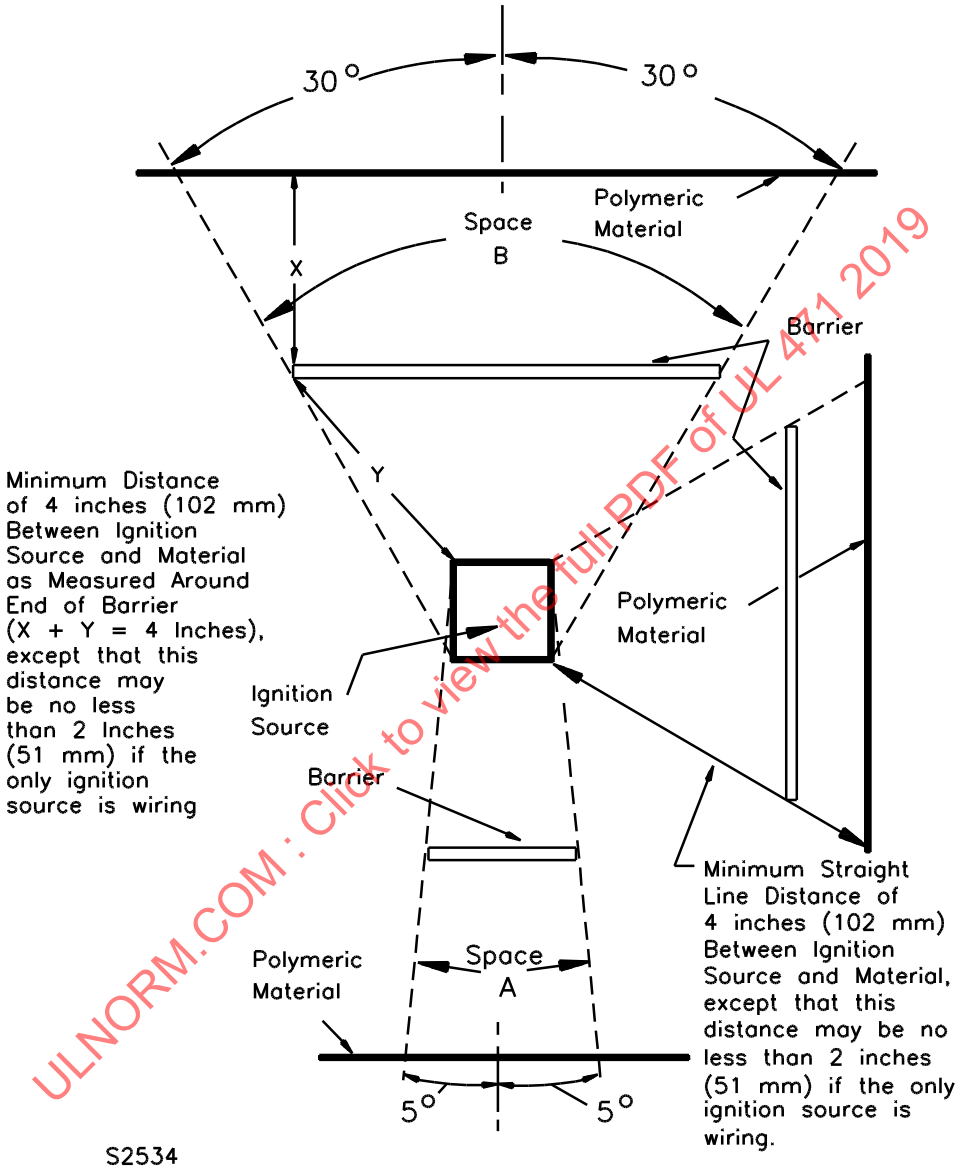
8.3.1 A nonmetallic enclosure isolating an ignition source(s) shall be evaluated in accordance with Group 1 of Table 82.1. A nonmetallic enclosure not isolating an ignition source shall be evaluated in accordance with Group 2.

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 82.1.

8.3.3 With respect to footnotes c, d, and h of Table 82.1 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



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 82.1 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 inch^2 (645.2 mm^2). For unsealed holes larger than 1 square inch (645.2 mm^2) the thermal insulation shall be rated HF-1

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 *deleted*

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 23.1 and 23.2.

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 88.25 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)

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

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 mm^2) or smaller conductor.

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

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 mm^2) or smaller wire and not less than 0.050 inch (1.27 mm) thick for a wire larger than 14 AWG. In either case, there shall be not less than two full threads in the metal.

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 mm^2), 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 56.

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 9.3.3 – 9.3.8; 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 A cordset or power supply cord shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817.

9.3.3 The marked rating of a cord-connected refrigerator, see 89.1, shall not exceed 80 percent of the rating of the attachment plug.

9.3.4 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 40.1, 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

Table 9.2 Continued on Next Page

Table 9.2 Continued

Nameplate rating			Attachment plug	
Volts	Phase	Amperes[a]	Rating	ANSI designation[b]
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 9.3.3.

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

9.3.5 A cord-connected refrigerator shall 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 44, or the Defrost Test, Section 47. The ampere input value shall include the loads for convenience outlets and the current drawn by accessories intended for use with the refrigerator. See 87.3.1 and 87.3.2.

9.3.6 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 18.4.2 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 67, 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.

9.3.7 A power supply cord for an outdoor use refrigerator shall be one of the types specified in 9.3.5 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.

9.3.8 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.

9.3.9 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 56. 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.

9.3.10 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.

9.3.11 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 9.3.5.

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 89.3(a) and 89.3(c) shall be provided.

h) The instructions shall contain information as indicated in 90.3.

9.3.12 With regard to 9.3.11, 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 89.3(b).

9.3.13 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 9.3.11 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.

Table 9.3
Internal terminal connections for bonding

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

9.4.5 On permanently connected refrigerators, a wire binding screw intended for the connection of an equipment grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. Except as indicated in 9.4.6, a pressure wire connector intended for connection of such a conductor shall be plainly identified such as by being marked "G," "GR," "GROUND," or "GROUNDING," or by a marking on a wiring diagram provided on the refrigerator. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the refrigerator and shall be located so that it is unlikely to be removed during service operations, such as replacing fuses, resetting manual-reset devices, or oiling motors.

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

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

10 Internal Wiring And Wiring Methods

10.1 General

10.1.1 Wiring shall have insulation for the potential involved and the temperatures to which it may be subjected. Compliance is to be determined on the basis of the temperatures measured during the applicable temperature tests specified in Sections 44 – 47.

Exception: If it can be determined that the wiring will not be exposed to heat from radiating sources or heated components, and if the ampacity of the conductors is in accordance with Table 10.1, the temperature tests on the wiring may be waived.

10.1.2 With reference to the Exception to 10.1.1, high-voltage circuit conductors supplying one motor shall have an ampacity not less than 125 percent of the motor full load current rating. Conductors supplying more than one motor shall have an ampacity not less than 125 percent of the full load current rating of the largest motor plus the full load current rating of any other motors supplied. Conductors supplying a motor load and other loads shall have an ampacity not less than 125 percent of the motor full load current rating plus the marked current ratings or measured inputs of the additional loads supplied. See also 10.5.1.

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

Table 10.1
Wiring materials ampacities

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

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

10.2 High voltage circuits

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

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

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

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

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

d) Wiring cannot be contacted through openings in the outer enclosure or cabinet by the probe illustrated in Figure 5.3; and

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

10.2.3 Cords or appliance wiring material of a type indicated in Table 10.2 need not be enclosed as indicated in 10.2.2 if the wiring is:

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

b) Cord type indicated in 9.3.5 or protected from physical damage by baffles, barriers, or the like so that the wiring cannot be contacted by a 1/2 inch (12.7 mm) diameter rod inserted vertically downward into the wiring compartment.

Table 10.2
Wiring

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

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

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

10.2.6 Resistance-type heater wire employed to prevent condensation is considered in compliance with 10.1.1 if the insulation is rated 80°C (176°F) or higher, the input is less than 2.5 watts per foot (8.3 W/m), and adjacent heater wires are maintained not less than 3/4 inch (19.1 mm) apart and in contact with a metal, phenolic, or other radiating panel. Heater wire that does not comply with the above ratings and installation is to be subjected to the Heating Test – Condensation Wiring, Section 45.

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

10.2.8 When wiring extends from the cabinet to a hinged door or to another part that provides access to the product storage area, or is subject to movement during service operations such as replenishing the product and routine cleaning, flexible conductors shall be employed. The wiring shall be routed or protected to reduce the risk of damage to the insulation. When the wiring is exposed to the user or attendant, the wiring shall be one of the S series of cord specified in Table 10.2 and shall be provided with strain relief so that stress will not be transmitted to terminals or splices. See Strain Relief Test, Section 56.

10.2.9 With reference to 10.2.8, wiring that is subject to movement is to be tested by cycling the moving part through the maximum travel permitted by the design unless it is evident that the wiring will not be damaged. The duration of the test is to be 100,000 cycles. Following this, the unit is to be subjected to the Dielectric Voltage-Withstand Test, Section 48, and the wiring is to be visually examined for damage to determine if individual strands have penetrated the insulation.

10.2.10 Wiring to a shelf assembly shall be provided with strain relief so that stress will not be transmitted to terminals or splices within the assembly. See Strain Relief Test, Section 56. The wiring shall be routed and supported to minimize exposure and the maximum free length between the last routing clamp and the connector shall not exceed 12 inches (305 mm). Such wiring shall be of the type indicated in Table 10.2.

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

10.3 Low voltage circuits

10.3.1 If grounding, short-circuiting, or damaging of low-voltage wiring may cause malfunctioning of a pressure-limiting device, motor overload protective device or other protective device that may result in a risk of fire, electric shock, or injury to persons, such wiring shall be enclosed as indicated in 10.2.2 or shall be Type SPT-2 or SP-2 cord or one of the types indicated in 10.2.3.

10.3.2 Low voltage non-safety circuit wiring requirements are not specified.

10.4 Wiring method

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

a) Sharp edges,

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

c) Moving parts, and

d) Parts that can be expected to vibrate, such as motors, motor compressors, refrigerant lines, and similar parts. Clamping means shall have smooth, rounded surfaces.

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

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

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

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

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

Exception: Water may enter an enclosure when:

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

b) The live parts are not wetted.

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

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

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

10.4.6 Splicing devices, such as pressure-type wire connectors, may be employed when they comply with the Standard for Wire Connectors, UL 486A-486B.

10.4.7 Quick-connecting assemblies shall:

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

b) Form a secure electrical connection, such as by detents in the mating parts, and shall be capable of carrying the current as determined during the Temperature and Pressure Test, Section 44. Securement of the connections may be determined by engagement/disengagement tests as specified in the Standard for Electrical Quick-Connect Terminals, UL 310.

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

10.4.9 Open-slot type connectors shall not be used unless they are constructed to prevent disconnection resulting from loosening of the clamping means. When required spacings are reduced below the minimum acceptable values by movement of the connector, the shanks of terminal connectors shall be protected by electrical insulation secured in position and not less than 0.028 inch (0.71 mm) thick, except as permitted by 30.10.

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

a) Smooth, rounded surfaces; or

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

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

10.4.11 A wiring enclosure formed between the cabinet shell, liner, molding, trim strips, or the like shall be constructed of metal or of nonmetallic material, see 7.1.8, and shall provide a smooth wireway with no sharp edges or sharp projecting screws that might damage the wire insulation. Wood framing may be employed in the cabinet-wireway enclosure, but other flammable thermal insulating material may not be in direct contact with the wiring unless it can be shown that a risk of fire is not introduced.

10.4.12 Wiring shall be separated from HB and HBF materials in accordance with Table 82.1 and Section 8.

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

10.5 Short circuit protection

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

a) Have an ampacity of not less than one-third the ampacity of the branch circuit conductors as determined in 9.2.8, or

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

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

d) Withstand the conditions of the Limited Short-Circuit Test, Section 66.

11 Secondary Circuits

11.1 General

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

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

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

b) The circuit complies with the requirements for one of the types of secondary circuits referenced in 11.2 and 11.3; and

c) The circuit is separated from other circuits as required in Section 12, Separation of Circuits.

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

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

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

Exception: A Class 2 circuit (see 11.2) and a Limited Voltage/Current Circuit (see 11.3) are not prohibited from being connected to the frame at more than one point.

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

11.2 Class 2 circuits

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

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

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

11.2.2 A Class 2 transformer that is not inherently limited shall be provided with a means to limit the available power in accordance with 11.3.3.

11.3 Limited voltage/current circuits

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

a) A fixed impedance;

b) A fuse;

c) A nonadjustable manual reset circuit protector; or

d) A regulating network.

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

11.3.3 When a secondary fuse or other such secondary circuit protective device is used to limit the available current in accordance with 11.3.1, it shall be rated in accordance with Table 11.1.

Table 11.1
Rating for fuse or circuit protective device

Maximum available voltage[a]	Amperes
0 – 20 ac (rms) or 0 – 20 dc	5.0
Over 20 – 30 ac (rms) or over 20 – 60 dc	100/V[b]

[a] Includes open circuit voltage.

[b] V is defined as the maximum available voltage, including open circuit voltage.

11.3.4 When a primary circuit protective device is used to limit the available current in accordance with 11.3.1, there are no restrictions on the current rating of the protective device as long as it limits the available secondary current in accordance with Table 11.1.

11.3.5 A fuse used in accordance with 11.3.3 and 11.3.4 shall be one of the following:

a) A non-interchangeable fuse;

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

c) Not subject to user servicing and marked as indicated in 11.3.6.

11.3.6 When a protective device is used as specified in 11.3.3 or 11.3.4, the device shall comply with the requirements of this Standard and shall be provided with an adjacent replacement marking in accordance with 87.3.9.

11.3.7 An impedance or regulating network used to limit the power in accordance with 11.3.1 shall limit the current under short-circuit conditions to not more than 8.0 amperes measured after 2 minutes.

11.3.8 When a fixed impedance (such as a component or grouping of components in the same circuit) or a regulating network (such as used in a switching type power supply) is provided to limit the voltage and/or the available current in accordance with 11.3.1, the fixed impedance or regulating network shall function to limit the voltage to the values given in 11.3.1 and limit the current to the value given in 11.3.7 under single fault conditions.

11.3.9 The impedance, the fuse, the protector, or the regulating network, and the wiring between it and the isolating transformer mentioned in 11.3.1 shall be judged as if it were a part of a high-voltage circuit.

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

12 Separation Of Circuits

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

Exception: Secondary-circuit wiring of an electric discharge lamp which requires higher voltage wiring based on the output voltage rating marked on the ballast (see 21.4) is not required to be segregated from wiring with lower voltage rated insulation when the lower voltage rated insulation is greater than the secondary voltage to ground marked on the ballast.

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

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

12.4 Field-installed conductors of a high-voltage circuit or a low-voltage circuit with National Electrical Code, ANSI/NFPA 70, Class 1 wiring shall be segregated or separated by barriers from:

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

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

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

12.5 Field-installed conductors of a low-voltage circuit with National Electrical Code, ANSI/NFPA 70, Class 2 wiring shall be segregated or separated by barriers from:

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

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

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

13 Bonding For Grounding

13.1 A refrigerator shall have provision for the grounding of all exposed or accessible noncurrent carrying metal parts that are likely to become energized and that may be contacted by the user or by service personnel during service operations likely to be performed when the refrigerator is energized.

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

Exception: The following metal parts are not required to be grounded:

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

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

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

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

13.3 Metal-to-metal hinge bearing members for a door or cover may be used as a means for bonding a door or cover for grounding when a multiple-bearing pin-type hinge(s) is employed.

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

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

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

13.5 The bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connection, welding, or soldering and brazing materials having a softening or melting point greater than 455°C (850°F). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or other nonmetallic material except as indicated in 13.7.

13.6 With reference to 13.5, a bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings. When the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

13.7 A connection that depends upon the clamping action exerted by rubber or other nonmetallic material is acceptable provided that it compiles with the requirements of the Current Overload Test, Section 64, and the Limited Short-Circuit Test, Section 66, under any normal degree of compression permitted by a variable clamping device and after exposure to the effects of oil, grease, moisture, and thermal degradation that may occur in service. Also, a clamping device is to be investigated to verify the likelihood of its being disassembled and reassembled in the intended fashion.

13.8 On a cord connected refrigerator, a bonding conductor or strap shall have a cross-sectional area no less than that of the grounding conductor of the supply cord except as permitted by 13.11 and 13.12.

13.9 On a permanently connected refrigerator, the size of a conductor employed to bond an electrical enclosure or motor frame shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. Except as indicated in 13.11, the size of the conductor or strap shall be in accordance with Table 13.1.

Table 13.1
Bonding wire conductor size

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

[a] Or equivalent cross-sectional area.

13.10 A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in 13.9, may be used when the minimum cross-sectional conducting area is equivalent to the wire sizes indicated in Table 13.1.

13.11 A smaller conductor may be used when the bonding conductor and connection comply with the provisions of the Current Overload Test, Section 64, and the Limited Short-Circuit Test, Section 66.

13.12 The size of a bonding conductor to a motor or other electrical component is not required to be larger than the size of the motor-circuit conductors or the conductors supplying the component. See 10.5.1.

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

13.14 When more than one size branch circuit overcurrent device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, when a motor is individually protected by a branch circuit overcurrent device smaller than other overcurrent devices used with the refrigerator, a bonding conductor for that motor is to be sized on the basis of the overcurrent device intended for ground-fault protection of the motor.

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

13.16 With reference to 13.15, the size of the bonding conductor used to bond the secondary conductor that is to be grounded shall be in accordance with 13.12. When one of the secondary circuit conductors is white or gray in color and located in a field wiring compartment, the white or gray conductor shall be the one that is grounded.

ELECTRICAL COMPONENTS

14 Current-Carrying Parts

14.1 Each current-carrying part shall be of silver, copper, a copper alloy, or other material inherently resistant to corrosion and acceptable for use as an electrical conductor.

Exception No. 1: Multimetallic thermal elements and heater elements of a thermal protector are not required to be inherently resistant to corrosion.

Exception No. 2: Aluminum may be used as a current-carrying part when treated to resist oxidation and corrosion.

14.2 Iron or steel shall not be used as a current-carrying part.

Exception: Iron or steel, when provided with a corrosion resistant coating, or stainless steel may be used for a current-carrying part when permitted in accordance with 4.9, or within a motor.

15 Insulating Material

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

15.2 Vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock.

15.3 Polymeric materials used for the sole support of uninsulated live parts shall comply with the requirements for materials used as direct support of live parts in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

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

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

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

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

16 Switches And Controllers

16.1 General

16.1.1 A cord connected refrigerator shall be provided with a manually operable switch that will shut off the complete refrigerator or will shut off any motor load exceeding the values shown in 16.2.3. Such switches shall have a marked "OFF" position (the international symbol "O" may be used), and, when the switch does not control the complete refrigerator, shall indicate which load it controls, such as compressor, fan motor, or similar load. The switch shall be accessible without the use of tools.

Exception No. 1: Laboratory refrigerators may be provided with a key-operated switch.

Exception No. 2: A switch is not required when the only supplied loads are receptacles.

16.1.2 A switch or other control device shall be rated for the load it controls as determined by the Temperature and Pressure Test, Section 44, and the Defrost Test, Section 47. See also 16.2.4 and 16.2.7.

16.1.3 The current rating ampacity of a switch that controls an inductive load (other than a motor), such as a transformer or an electric-discharge lamp ballast, shall be not less than twice the current of the controlled load and shall have a voltage rating not less than the potential of the circuit in which it is used.

Exception: An ac general-use snap switch may be used to control an inductive load that does not exceed the current rating of the switch at rated voltage.

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

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

16.1.6 The load controlled by a switch connected in an electric-discharge lighting system is to be determined by the marked rating of the ballast units and other equipment controlled by the switch.

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

16.1.8 A switch provided for the control of an electric-discharge lamp(s) shall be connected in the line side of the lamp controls.

16.1.9 Circuit breakers used as switches in 120 volt fluorescent lighting circuits shall be rated as indicated in 16.1.3 and shall be marked "SWD."

16.1.10 Opening of a switching device that interrupts the main power supply circuit to a heater of a permanently connected refrigerator shall disconnect all ungrounded conductors of the power supply circuit when the switching device or the pilot device that controls the switching device has a marked "ON" or "OFF" position.

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

16.1.12 Switching devices shall be housed within an enclosure that will protect coils and contacts against mechanical damage, dirt, and moisture. The enclosure of the switching device may be provided by:

a) Its method of mounting within the refrigerator enclosure,

b) By inherent construction of the component, or

c) By means of a separate enclosure.

16.1.13 A clock-operated switch used to terminate the operation of an electric defrost heaters(s) in a remote refrigerator shall be provided as an integral part of the refrigerator.

Exception: A clock-operated switch need not be provided if the refrigerator (1) is marked in accordance with 88.28, (2) complies with the Defrost Test, Section 47, without the switch, or (3) complies with the Abnormal Operation Test – Electric Heater, Section 59, without exceeding the temperature rises specified in the defrost test without the switch.

16.1.14 A defrost cycle control may control the defrost heater(s) directly or through other switching devices. The switching device(s) is not required to be provided with a remote refrigerator.

16.1.15 A switch provided as an interlock shall have an endurance rating of 100,000 cycles of operation at not less than the load it controls.

16.1.16 Where circuit breaker or switch handles are operated vertically, the "UP" position shall be the "ON" position.

16.1.17 A single-pole switching device shall not be connected to the identified grounded conductor. An automatic regulating control that does not have a marked OFF position is not required to be connected to the ungrounded conductor.

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

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

16.1.19 Switches shall comply with one of the following standards:

a) *Deleted*

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

c) The Standard for General Use Snap Switches, UL 20,

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

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

16.1.20 Clock-operated switches shall comply with one of the following standards:

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

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

16.1.21 Controls shall comply with one of the appropriate standards in Table 16.01 for its inherent safety under the specified parameters/conditions noted in Table 16.02.

Exception: An electronic operating control (e.g. a non-protective control), the failure of which would not increase the risk of electric shock, fire, or personal injury, are not required to meet the component control requirements of paragraph 16.1.21, but need only be subjected to the following applicable requirements of this end product standard.

a) Components (paragraphs 4.9, 4.10),

b) Quick-Connects (paragraphs 10.4.7 – 10.4.9),

c) Wiring (Section 10),

d) Secondary Circuits (Section 11),

e) Separation of Circuits (Section 12),

f) Current Carrying Parts (Section 14),

g) Insulating Material (Section 15),

h) Spacings (Sections 30 – 32),

i) Printed Wiring Boards (Section 27I),

j) Temperature Test (Section 44),

k) Dielectric Withstand Test (Section 48),

l) Component Failure Test (Section 83C).

Table 16.01
Controls – standards for inherent safety

Purpose of the control	Applicable standards
Temperature sensing control	UL 873/UL 244A; or
	UL 60730-1 and UL 60730-2-9
Pressure controls	UL 873/UL 244A; or
	UL 508; or
	UL 60730-1 and UL 60730-2-6
Motor and speed controls	UL 873; or
	UL 508; or
	UL 508C; or
	UL 244A; or
	UL 60730-1
Timers	UL 244A; or
	UL 60730-1 and UL 60730-2-7
Liquid level controls	UL 244A; or
	UL 873; or
	UL 508; or
	UL 60730-1 and UL 60730-2-16A; or
	UL 60730-1 and UL 60730-2-18A
Limit controls	UL 353

Table 16.02
Required parameters/conditions for controls

Features/conditions	Requirement
Electrical rating	The control shall meet or exceed the electrical ratings of the load it is controlling. Compliance shall be shown by measuring and recording the electrical parameters under all normal modes of operation of the equipment.
Maximum operating ambient, T_{max}	The maximum operating ambient of the control shall be equal to or exceed the manufacturer's specified value or the measured value during the temperature test, whichever is higher.
Number of cycles of manual action (reset)	Operating – 6000 cycles Protective (safety) – 6000 cycles; 1000 with current, 5000 without current
Number of cycles of automatic action	Operating (regulating) – 6000 cycles Protective (safety) – 100,000 cycles[a]
CTI of materials	175 < V < 400
Type of action	A control incorporating Class A control functions are considered to have type 1 action A control incorporating Class B or C control functions are considered to have type 2 action
Reset limits for thermal cut-outs	minus 35 °C
Pollution degree	See Table 32.1
Overvoltage category	See Table 32.2

Table 16.02 Continued on Next Page

Table 16.02 Continued

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

16.1.22 Unless specified elsewhere in this standard, protective (safety) controls where the control functions are being relied upon to reduce the risk of fire, electric shock or personal injury during abnormal operation of the equipment shall additionally comply with one of the appropriate standards in Table 16.03 using the specified functional safety test parameters/conditions.

Table 16.03
Functional safety standards and test conditions

Functional safety test parameters/severity levels etc.	Hardware only	Software only		Hardware and software	
	UL 991	UL 1998	H.11.12, UL 60730-1	UL 991, UL 1998	UL 60730-1 (+)
FMEA analysis	X	X	X	X	X
Equipment failure rate	X failures/10^6	–	–	–	–
Test accelerated multiplier	Intermittent use – 576.3 Continuous use – 5763	–	–	–	–
Test accelerated factor	Table 25.2 based on ambient temperature	–	–	–	–
Voltage dips, variation and interruptions	X	–	–	X	X
Influence of voltage unbalance (3-phase product only)	–	–	–	–	X
Surge immunity (+ +)	X	–	–	X	X
Fast transient/burst	X	–	–	X	X
Ring wave	X	–	–	X	X
Electrostatic discharge	6 kV – contact	–	–	6 kV – contact	6 kV – contact
	8 kV – air	–	–	8 kV – air	8 kV – air
Electric and magnetic field	X	–	–	X	–
RF – conducted disturbances	–	–	–	X	
Radiated EMF immunity	3 V/m	–	–	3 V/m	X
Influence of supply frequency (+ + +)	–	–	–	X	X
Magnetic field immunity	–	–	–	X	X
Thermal cycling	Indoor 0 – 40°C	–	–	Indoor 0 – 40°C	Indoor 0 – 40°C
	Outdoor minus 35 – 40°C	–	–	Outdoor minus 35 – 40°C	Outdoor minus 35 – 40°C

Table 16.03 Continued on Next Page

Table 16.03 Continued

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

NOTES

For a limit control evaluated to UL 353, use Supplement SA for software evaluations.

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

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

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

16.1.23 With regards to 16.1.22, the protective (safety) functions shall be as noted in Table 16.04, unless otherwise specified.

Table 16.04
Protective functions

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

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

16.1.24 *deleted*

16.2 Motor controllers

16.2.1 A motor controller(s) used for controlling the loads involved shall be provided for all refrigerators incorporating two or more motors, or a motor(s) and other load(s) intended for connection to the same power supply. See 16.2.3 and 16.2.5.

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

16.2.3 The attachment plug and receptacle may serve as the controller on a cord connected refrigerator when the marked ampere rating does not exceed the values shown in Table 16.1 for the voltage indicated.

Table 16.1
Ampere rating

Amperes	Voltage
7.2	115
4.0	208
3.6	230

16.2.4 On a cord-connected refrigerator, a manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of the motor-compressor's rated load current and the rated current for other controlled loads. See 17.4.

16.2.5 A controller is not required for any supply circuit of a permanently connected refrigerator where the circuit supplies two or more motors or a motor(s) and other load(s) when, in either case:

a) The marked maximum size of the supply circuit overcurrent protective device for that circuit does not exceed 20 amperes at 125 volts or less or 15 amperes at 600 volts or less, and

b) When the rating of any motor in the circuit does not exceed 1 horsepower [746 watts output] and 6 full load amperes.

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

16.2.7 On a permanently connected refrigerator, a manually operated switch with a marked off position that controls a hermetic refrigerant motor-compressor with or without other loads shall have a current rating that is at least 115 percent of the sum of the motor-compressor's rated load current or branch-circuit selection current, whichever is greater; and the rated current for other controlled loads, as shown on the refrigerator nameplate. See 17.4.

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

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

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

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

17 Motors

17.1 Motors shall comply with the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1. Hermetic Motor-Compressors shall comply with the requirements in

the Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-Compressors, UL 60335-2-34.

17.2 Motors having openings in the enclosure or frame shall be arranged to reduce the risk of particles falling out of the motor onto flammable material within or under the assembly. For built-in refrigerations, also see 7.1.12 – 7.1.14.

17.3 The requirement in 17.2 will necessitate the use of a barrier of nonflammable material under an open-type motor unless:

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

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

1) Open main winding,

2) Open starting winding,

3) Starting switch short-circuited,

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

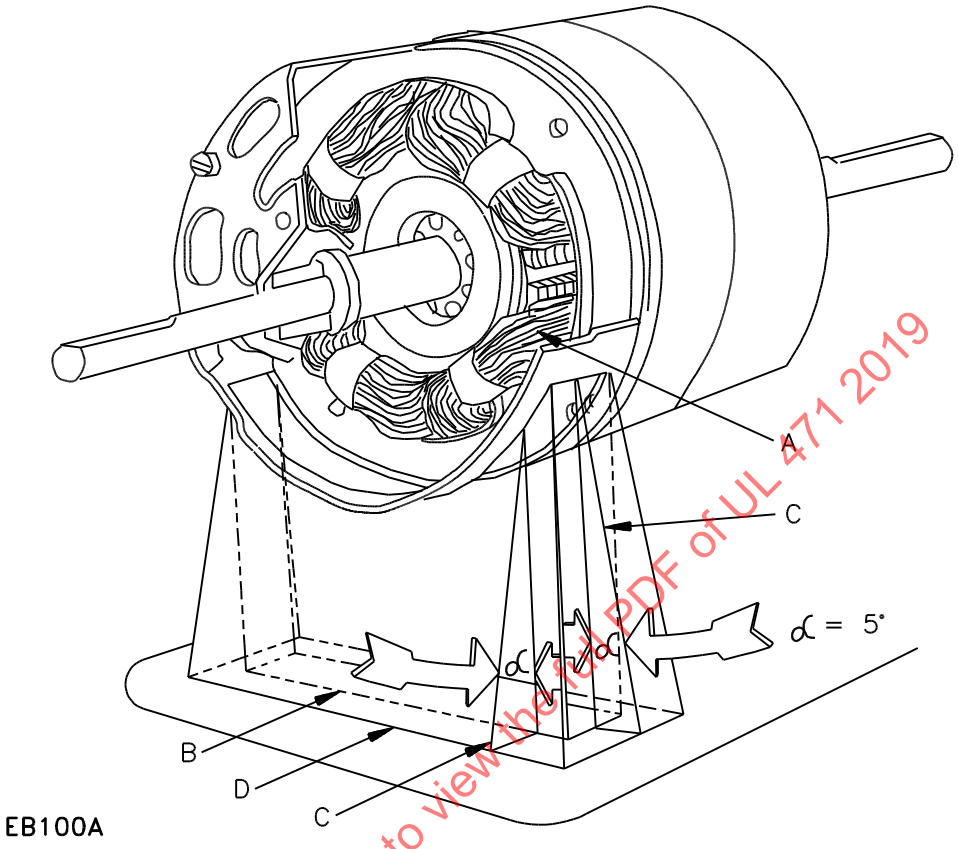
c) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current) that will prevent the temperature of the motor windings from exceeding:

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

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

17.4 The barrier mentioned in 17.3 shall be horizontal, shall be located as indicated in Figure 17.1, and shall have an area not less than that described in that illustration. Openings for drainage, ventilation, and similar functions, may be employed in the barrier when such openings do not permit molten metal, burning insulation, or similar material, to fall onto flammable material.

Figure 17.1
Location and extent of barrier



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

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

C – Inclined line which traces out minimum area of the barrier. When moving, the line is to be always (1) tangent to the motor winding, (2) five degrees from the vertical, and (3) so oriented that the area traced out on a horizontal plane is maximum.

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

18 Motor Protection

18.1 General

18.1.1 Each motor shall be protected against overload by one of the means specified in 18.2 – 18.3.

18.1.2 Overcurrent protective devices and thermal protective devices for motors shall comply with applicable short-circuit current requirements for the class of protective device and shall, in addition, comply with the requirements of the Limited Short-Circuit Test, Section 66.

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

18.1.4 When a fuse is used as a motor protective device, the motor shall be protected by the largest size fuse that can be inserted into the fuseholder.

18.2 Protection of single-phase nonhermetic motors

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

a) A separate device responsive to motor current and rated or set to trip at not more than the percentage of the motor nameplate full-load current rating specified in Table 18.1. If the percentage protection specified in Column A of Table 18.1 does not correspond to the percentage value of an overload relay of a standard size, the device of the next higher size may be used. However, the overload device of the next higher size shall protect against currents exceeding the percentage values specified in Column B of Table 18.1.

b) A separate overload device which combines the functions of overload and overcurrent protection and is responsive to motor current rated or set at values not greater than the percentages of the motor nameplate full-load current rating as specified Table 18.1. Such a device shall be capable of fully protecting the circuit and motor both under overload and short circuit conditions.

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

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

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

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

g) Protective electronic circuits that comply with 18.2.2.

h) Other protection that is shown by test to be equivalent to the protection specified in (c) and (d).

Table 18.1
Protective device activation level

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

18.2.2 Except as indicated in 18.2.1 (c) and (f), electronically protected motor circuits shall comply with one of the following:

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

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

c) The Standard for Power Conversion Equipment, UL 508C for a power conversion controller incorporating overcurrent protection with the percentage protection set as indicated in Table 18.1.

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

18.2.3 With reference to 18.2.2, the test parameters in Table 16.02, Table 16.03, and Table 16.04 shall be considered when judging the acceptability of a protective circuit.

Table 18.2
Acceptability criteria
Table deleted

18.3 Protection of three-phase motors

18.3.1 Three-phase motors shall be protected by:

a) Three properly rated overcurrent devices, each complying with 18.2; or

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

c) Electronic protection that complies with 18.2.2 and 18.2.3.

18.4 Protection of hermetic refrigerant motor-compressors or Stirling engines

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

a) The applicable requirements in UL 60335-2-34; or

b) The Standard for Power Conversion Equipment, UL 508C for a power conversion controller incorporating overcurrent protection with the percentage protection set as indicated in Table 18.1; or

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

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

e) Electronic protection that complies with 18.2.2 and 18.2.3.

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

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

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

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

18.4.3 For a cord-connected refrigerator, the rated load current of the motor-compressor or Stirling engine is the current drawn by the motor-compressor or Stirling engine during the Temperature and Pressure Test, Section 44.

19 Electric Heaters

19.1 Heater elements

19.1.1 A defrost heater shall be an encased assembly constructed of materials that will not be damaged by the temperature to which they will be subjected in the refrigerator.

19.1.2 Metal tubing forming a heater element enclosure shall be constructed of corrosion resistant material or shall be plated, dipped, or coated to resist external corrosion and shall be acceptable for the temperatures to which it is subjected. See 19.1.4.

19.1.3 A heater element, installed in the complete refrigerator, shall be protected against mechanical damage. The heater is considered to be protected when it:

a) Employs a copper or steel sheath that is at least 0.016 inch (0.41 mm) thick, or

b) Cannot be contacted by the probe illustrated in Figure 5.1 when inserted with a force of 5 pounds (22.2 N).

19.1.4 Uncoated copper tubing is acceptable for temperatures of 200° C (392° F) and lower; metallic coated copper tubing is acceptable for temperatures below the melting temperature of the coating. Uncoated or oxide-coated steel tubing is not acceptable as a heater sheath. Plated steel tubing may be employed when the coating is corrosion resistant and will withstand the temperatures to which it may be subjected. Aluminum tubing may be employed when the alloy withstands the Abnormal Operation Test –

Electric Heater, Section 59, without melting or other malfunction. Stainless steel tubing of the austenitic grades, such as ASTM Type 304, is acceptable for heater sheaths.

19.1.5 Insulating materials, such as washers and bushings, that are integral parts of a heating element shall be of a moisture-resistant material that will not be damaged by the temperatures to which they will be subjected in the refrigerator.

19.1.6 Insulating material employed in a heating element shall be used as the sole support of live parts. Materials, such as magnesium oxide, may be used in conjunction with other insulating materials when located and protected so that mechanical damage is prevented and when not subjected to the absorption of moisture. When determining acceptability of an insulating material, consideration is to be given to its mechanical strength, dielectric strength, insulation resistance (see 65.1.1 – 65.1.3), heat resistant qualities, the degree to which it is enclosed or protected, and any other features involved that can result in a risk of fire and unintended contact in conjunction with conditions of service. All of these factors are to be considered with respect to thermal aging.

19.1.7 Each heater case or terminal seal of rubber, neoprene, or thermoplastic materials shall comply with the Accelerated Aging Test – Electric Heaters, Section 76.

19.1.8 Electric heaters exposed to moisture within the refrigerator shall be sealed to prevent entrance of moisture. See Insulation Resistance Test, Section 65. Molded seal caps, vulcanized to the heater leads and heater sheath, shall have a wall thickness equivalent to that required for the heater leads.

19.1.9 The requirements of Section 19.1 do not apply to insulated resistance-type heater wire that complies with the applicable requirements of Section 10.

19.2 Heater control

19.2.1 When malfunction could result in a risk of fire or electric shock, an electric heater shall be provided with a thermal protective device or a replaceable thermal cutoff in all ungrounded conductors. See Abnormal Operation Test – Electric Heater, Section 59. Thermal cutoffs shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

19.2.2 A temperature-limiting control that is required to reduce the risk of fire in the refrigerator (see Abnormal Operation Test – Electric Heater, Section 59) shall be an integral part of the refrigerator and shall:

a) Control each heater directly, or

b) Control each heater indirectly through a switching device that is also an integral part of the refrigerator. The switching device shall comply with the endurance test requirements for temperature-limiting controls (see 57.1.1 (b) or (c)).

19.2.3 A thermal cutoff shall be secured in place and located so that it will be accessible for replacement without damaging other connections or internal wiring. See 19.2.4 and 19.2.5.

19.2.4 Replacement of a thermal cutoff shall not necessitate:

a) Removal of the heater from its installation, or

Exception: This requirement does not preclude the withdrawal of a removable heating element(s) to permit replacement of a thermal cutoff.

b) Disconnection of the field-wiring system.

19.2.5 Wiring connected to a thermal cutoff shall be secured so that replacement of the thermal cutoff will not result in displacement or disturbance of internal wiring other than leads to either the cutoff or to a heating element assembly on which the cutoff is mounted.

20 Fuseholders And Circuit Breakers

20.1 Fuseholders

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

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

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

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

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

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

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

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

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

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

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

20.2 Circuit breakers

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

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

20A Fuses and Supplementary Protectors

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

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

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

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

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

e) The Standard for Low-Voltage Fuses – Part 10: Class L Fuses, UL 248-10,

f) The Standard for Low-Voltage Fuses – Part 11: Plug Fuses, UL 248-11,

g) The Standard for Low-Voltage Fuses – Part 12: Class R Fuses, UL 248-12,

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

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

20A.3 Supplementary Protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

20A.4 A supplementary protector shall not be used in place of a circuit breaker or protective control.

21 Electric-Discharge Lighting Systems

21.1 Equipment for use with electric-discharge lighting systems in a refrigerator shall be limited to an open circuit potential of 1000 volts rms or less.

21.2 Each component, such as ballasts, starters, capacitors, and lampholders of an electric-discharge lighting system shall be located in the refrigerator cabinet or superstructure.

21.3 An electric-discharge lampholder shall have a voltage rating not less than the output voltage rating marked on the ballast used, except that if the ballast is also marked with a lower secondary voltage to ground, the rating of the lampholder may be less than the output voltage marked on the ballast, but not less than the marked secondary voltage to ground.

21.4 The voltage rating of the secondary-circuit wiring of an electric-discharge lamp shall be not less than the output voltage rating marked on the ballast or ballasts to which it is connected, but not less than 300 volts in any case.

21.5 Lead wires provided as part of a lampholder are determined to have voltage ratings not exceeding the voltage rating of the lampholder, unless a higher voltage rating is printed on the surface of the lead wires.

21.6 A refrigerator employing electric-discharge lamps shall be provided with a ballast designed to operate lamps of the size for which the cabinet is designed and shall be wired in accordance with the diagram or instructions on the ballast.

21.7 No uninsulated live part of an electric-discharge lighting system that involves a potential of more than 300 volts shall be accessible:

a) When the lamps are in place or removed, or

b) While a lamp is in the process of being inserted or removed.

Exception: This requirement does not apply to an electric lampholder having recessed inaccessible contacts.

21.8 Compliance with 21.7 will require that it not be possible to insert one end of a bi-pin lamp such that one pin makes electrical contact and the other adjacent pin is accessible, and:

a) The use of lampholders constructed and wired so that when a lamp is removed, the potential in that lamp circuit is less than 300 volts, or

b) That the primary circuit is open during the relamping operation and all live parts are inaccessible when a lamp is removed.

21.9 When bi-pin lampholders (e. g., G5 or G13 ANSI type lampholders) are used with electronic fluorescent ballasts the ballasts shall be marked “Type CC”.

Exception: A ballast need not be marked “Type CC” when the lampholder is a circuit-interrupting type; when the lampholder employs a means to hold the lamp in place, such as by incorporating a spring-loading feature or other equivalent feature that restricts lamp movement after lamp installation; or when the lampholder additionally complies with IEC 60400, International Standard for Lampholders for Tubular Fluorescent Lamps and Starterholders.

21.10 Lighting ballasts shall comply with the:

a) Standard for Fluorescent-Lamp Ballasts, UL 935; or

a) Standard for High-Intensity Discharge Lamp Ballasts, UL 1029.

Exception No. 1: Ballasts forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Ballasts for other light sources shall comply with the appropriate UL standard(s).

22 Lighted and Associated Components

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

22.2 Lighting ballasts shall comply with the Standard for Fluorescent-Lamp Ballasts, UL 935, or the Standard for High-Intensity Discharge Lamp Ballasts, UL 1209. Ballasts forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

Exception: Ballasts for other light sources shall comply with the appropriate standard (s) and need not comply with UL 935 or UL 1029.

22.3 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use In Lighting Products, UL 8750. LED light sources forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

Exception: Individual LED light sources mounted on printed wiring boards and intended for indicating purposes need not comply with UL 8750.

23 Incandescent Lighting Systems

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

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

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

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

23.3 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

Exception: Lampholders forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

24 Guarding Of Lamps

24.1 A lamp employed in a refrigerator shall be installed or guarded so that it is not likely to be unintentionally broken by material being placed in or removed from the refrigerator.

24.2 The surface of a lamp shall not be contacted when a rod, 3 inches (76 mm) long, 3/4 inch (19.1 mm) diameter, with hemispherical ends, is supported vertically and inserted into the refrigerator at any elevation, not higher than the level permitted by projecting guarding members, such as cornices. The rod then is to be moved horizontally in any direction that results in maximum exposure of the lamp. In addition, the rod is to be moved vertically downward to any position that may permit contact with a lamp. When lamp guards are employed, see 24.3 and 24.4.

24.3 A guard, such as a lens or shield, shall not be supported by the lamp unless the guard, when subjected to an impact as described in 24.4, is capable of retaining any broken glass.

24.4 When a guard is required, it shall not become damaged to the extent that the lamp is no longer protected in accordance with 24.1 when the guard is subjected to an impact of 0.75 foot-pound (1.0 J). The impact energy is to be imposed by a 2 inch (50.8 mm) diameter, 1.18 pound-mass (0.53 kg) steel ball, either falling vertically or swinging as a pendulum. The lamp guard is to be mounted in its intended position, either in the refrigerator or on a section of the refrigerator, and struck within 1 inch (25 mm) of its center. Three samples are to be used for this test. Each sample is to be subjected to a single impact. If the manufacturer so elects, fewer samples may be used if the sample can withstand repeated impacts.

24.5 When a nonmetallic lamp guard is used within a freezer compartment, Three samples are to be (1) cooled to a temperature of minus 18 ±1.4 °C (0 ±2.5 °F) and maintained at this temperature for 3 hours and impacted according to 24.4 while still cold; See footnote i of Table 82.1.

25 Receptacles

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

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

25.2 Each special purpose receptacle, such as used in supplying lighting systems, shall be of the grounding type.

25.3 A 125 volt, single-phase, 15 or 20 ampere receptacle intended for general use shall have ground-fault circuit-interrupter (GFCI) protection for personnel. The GFCI shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

Exception: Receptacles on remote display refrigerators need not be GFCI protected type if the refrigerator is marked as indicated in paragraph 88.31.

25.4 Receptacles rated more than 125 volt, single-phase, 15 or 20 amperes shall be located so that liquid due to overflow, splashing, leakage, cleaning, and defrost will not enter the receptacle. This will require the face of the receptacle to be mounted not less than 60 degrees from the horizontal.

Exception: A receptacle used in a circuit provided with a ground fault circuit interrupter may be mounted less than 60 degrees from the horizontal.

26 Receptacle And Lighting Circuits Overcurrent Protection

26.1 Overcurrent protection shall be provided as part of the refrigerator for each receptacle or lighting circuit included in the refrigerator.

Exception No. 1: Overcurrent protection is not required when the receptacle or lighting circuit is intended to be connected to a power supply separate from that supplying the refrigerator. See 88.26.

Exception No. 2: Overcurrent protection is not required when the refrigerator:

a) Can be connected to a branch circuit rated at not more than 20 amperes in accordance with the National Electrical Code, ANSI/NFPA 70, and

b) Is not marked as specified in 87.3.2.

26.2 The overcurrent protection specified in 26.1 shall be provided by a circuit breaker(s) or fuse(s) acceptable for branch circuit use. A 15 ampere protective device shall be provided if a single 15 ampere receptacle outlet is furnished. Two or more 15 ampere receptacles (two separate receptacles or a duplex receptacle) shall be protected by either a 15 or 20 ampere protective device. A 20 ampere receptacle or a combination 15 and 20 ampere receptacle shall be protected by a 20 ampere protective device.

Exception: A receptacle circuit may be protected by an overcurrent protective device rated less than indicated above when the rating equals the receptacle load which is marked on the refrigerator. See 87.3.2. When the refrigerator is intended for connection to a branch circuit rated at not more than 20 amperes, the overcurrent protective device provided for the receptacle circuit may be of the supplementary type.

27 Capacitors

27.1 Capacitors shall comply with the Standard for Capacitors, UL 810 or shall comply with 27.1.1 – 27.4.

27.1.1 A motor starting or running capacitor shall be housed within an enclosure or container that will protect the plates against mechanical damage and that will reduce the risk of emission of flame or molten material resulting from capacitor failure. The container shall be of metal providing the strength and protection not less than that of uncoated steel not less than 0.020 inch (0.51 mm) thick.

Exception: When the capacitor is mounted within the enclosure of the refrigerator or within an enclosure that houses other parts of the refrigerator, the individual container of a capacitor may be of:

a) Sheet metal having a thickness less than that specified, or

b) Material other than metal.

27.2 When exposed to the effects of weathering, ferrous metal capacitor enclosures shall be protected against corrosion in accordance with 7.3.1. See also 7.1.23.

27.3 When the container of an electrolytic capacitor is metal, the container shall be considered as a live part and shall be provided with moisture-resistant electrical insulation to isolate it from dead metal parts and to prevent contact during servicing operations. The insulating material shall be at least 1/32 inch (0.8 mm) thick except as indicated in 30.9.

27.4 A capacitor employing a liquid dielectric medium more combustible than askarel shall be protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements of this standard, including faulted overcurrent conditions based on the circuit in which it is used. See Limited Short-Circuit Test, Section 66.

Exception: When the available fault current is limited by other components in the circuit, such as motor start winding, the capacitor may be tested using a fault current less than the test current specified in Table 66.1 but not less than the current established by dividing the circuit voltage by the impedance of the other component(s).

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

27.6 In reference to 27.5, if a capacitor complies with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, it shall have specifications as follows:

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

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

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

d) Upper category temperature – Based on the maximum capacitor surface temperature measured during the Temperature Test in Section 44, but not less than 185°F (85°C).

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

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

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

27A Valves and Solenoids

27A.1 Electrically operated valves shall comply with:

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

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

c) Paragraphs 27A.2 – 27A.5.

27A.2 The coil of an electrically operated valve or solenoid shall not overheat when the refrigerator is subjected to the Temperature and Pressure Test, Section 44; or Defrost Test, Section 47.

27A.3 There shall be no risk of fire or electrical shock if an electrically operated valve or solenoid fails to operate. See Burnout Tests – Electromagnetic Components, Section 60.

27A.4 If a valve must be cleaned periodically, the arrangement shall permit this operation to be performed without damage to the electrical parts of the valve or wiring.

27A.5 The coil windings of an electrically operated valve or solenoid shall be impregnated, dipped, varnished, or equivalently treated to resist absorption of moisture.

27B Outlet Boxes, Electrical Cable, Conduit and Tubing

27B.1 Outlet boxes shall comply with the Standard for Metallic Outlet Boxes, UL 514A or the Standard for Nonmetallic Outlet Boxes, Flush Device Boxes, and Covers, UL 514C. Fittings shall comply with for the Standard for Conduit, Tubing, and Cable Fittings, UL 514B. Cover plates shall comply with the Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

27B.2 Aluminum or steel armored cable shall comply with the Standard for Armored Cable, UL 4. Nonmetallic sheathed cables shall comply with the Standard for Nonmetallic Sheathed Cables, UL 719.

27B.3 Flexible metal conduit shall comply with the Standard for Flexible Metal Conduit, UL 1. Rigid steel conduit shall comply with the Standard for Rigid Metal Conduit – Steel, UL 6.

27B.4 Electrical steel tubing shall comply with the Standard for Electrical Metallic Tubing – Steel, UL 797.

27C Electromagnetic Interference Filters

27C.1 Electromagnetic interference filters shall comply with the Standard for Electromagnetic Interference Filters, UL 1283.

27D Relays and Contactors

27D.1 Electromagnetic relays and contactors shall comply with:

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

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

27E Wireways, Auxiliary Gutters and Associated Fittings

27E.1 Wireways, Auxiliary Gutters and Associated Fittings shall comply with the Standard for Wireways, Auxiliary Gutters and Associated Fittings, UL 870.

27F Batteries and Battery Chargers

27F.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642. A lithium ion multiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

27F.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the applicable construction and performance requirements of this end product standard.

27F.3 Rechargeable nickel metal-hydride (Ni-MH) battery cells and packs shall comply with construction and performance requirements of this end product standard, or the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

27F.4 A Class 2 battery charger shall comply with one of the following:

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

b) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, with an output marked “Class 2”, or that complies with the limited power source (LPS) requirements and is marked “LPS”.

27F.5 A non-Class 2 battery charger shall comply with one of the following:

a) Standard for Power Units Other Than Class 2, UL 1012; or

b) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

27G Optical Isolators and Semiconductor Devices

27G.1 An optical isolator shall comply with the Standard for Optical Isolators, UL 1577 if it is relied upon to provide isolation between:

a) Primary and secondary circuits;

b) Extra-low-voltage safety circuits; or

c) Other high-voltage circuits.

27G.2 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557.

27H Terminal Blocks

27H.1 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of paragraphs 9.2.9 – 9.2.16, 10.4.7 – 10.4.9, Section 14 (Current-Carrying Parts), Section 15 (Insulating Material), and Sections 30 – 32 (Spacings) of this end product standard.

27I Printed-Wiring Boards

27I.1 A printed-wiring board shall comply with the Standard for Printed-Wiring Boards, UL 796, and shall have a flammability level of at least V-1 when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

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

28 Transformer Protection

28.1 General

28.1.1 A transformer (including an autotransformer), other than one as described in 28.3.4 is considered to be a high-voltage transformer and shall:

a) Be provided with thermal overload protection in accordance with the requirements in 28.2.1,

b) Be protected by an overcurrent device in accordance with the requirements in 28.3.1, or

c) Comply with the Burnout Test – High-Voltage Transformers, Section 61.

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

28.1.2 Transformers complying with the Standard for Low Voltage Transformers: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers: General Purpose Transformers, UL 5085-2, are considered to fulfill the requirements of 28.1.1.

28.2 High-voltage transformers – thermal protection

28.2.1 When a high-voltage transformer is provided with a thermal overload protective device, the device shall be arranged to interrupt primary current and shall limit temperatures of the transformer windings, under overload conditions, to that permitted for the class of insulation employed in the windings. See Overload Test – High-Voltage Transformers, Section 62.

Exception: When the thermal overload protective device provided is a nonrenewable thermal cutoff, a burnout test is to be conducted in place of the overload test. See Burnout Test – High-Voltage Transformers, Section 61.

28.2.2 A thermal cutoff shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691. A manual or automatic resetting thermal protector shall have an endurance rating of not less than 6000 cycles and shall comply with the Standard for Temperature-Indicating and

-Regulating Equipment, UL 873, or the Standard for Limit Controls, UL 353 pertaining to the calibration of temperature limiting controls.

Exception: A type-2 action thermal cut-out, as specified in the Standard for Automatic Electrical Controls – Part 1; General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, is considered to comply with the requirements of UL 873.

28.3 High-voltage transformers – overcurrent protection

28.3.1 When a high-voltage transformer is protected by an overcurrent device, such protection shall comply with the requirements specified in 28.3.2, 28.3.3, and 28.4.1 – 28.4.3.

28.3.2 Except as noted in 28.3.3, a high-voltage transformer shall be protected by an overcurrent device(s) located in the primary circuit and rated or set as indicated in Table 28.1. See 28.4.1.

Exception: When the rated primary current of the transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device may be used. Standard ratings of protective devices are specified in Section 240-6 of the National Electrical Code, ANSI/NFPA 70.

Table 28.1
Rating of overcurrent devices

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

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

28.3.3 When the circuit supplying a transformer other than an autotransformer is provided with overcurrent protection rated or set at not more than 250 percent of the rated primary current of the transformer, additional overcurrent protection is not required in the primary circuit provided the secondary circuit is protected at not more than 125 percent of the rated secondary current of the transformer. See 28.4.2.

Exception No. 1: When the rated secondary current of the transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device may be used in the secondary circuit. Standard ratings of protective devices are specified in Section 240-6 of the National Electrical Code, ANSI/NFPA 70.

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

28.3.4 A transformer that directly supplies a National Electrical Code, ANSI/NFPA 70, Class 2 circuit (see 3.6) shall, in accordance with one of the Standards referenced in 11.2.1 either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer).

28.4 Overcurrent protective device

28.4.1 Overcurrent protection in the primary circuit of a transformer, as described in 28.3.2, need not be provided as part of the refrigerator when, based on the marked rating or ratings of the refrigerator, the rating of the branch circuit overcurrent protective device or devices does not exceed the values specified in 28.3.2.

28.4.2 Overcurrent protection in the secondary circuit of a transformer, as required by 28.3.3, shall be provided as part of the refrigerator.

28.4.3 A required transformer overcurrent protective device(s) provided as part of the refrigerator shall be provided for all ungrounded conductors; be sized in accordance with requirements in 28.3.2 and 28.3.3, as applicable; and have a voltage rating not less than the circuit in which it is used. The device(s) shall be:

a) A circuit breaker acceptable for branch circuit protection or

b) A fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 87.3.9.

Exception: When a transformer supply is tapped from a circuit supplying other loads in the refrigerator, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 66.1. If the supplementary type device used is a fuse, the refrigerator shall be marked in accordance with the requirements in the Exception to 87.3.9.

29 High-Voltage Control Circuit Conductor Overcurrent Protection

29.1 General

29.1.1 For the purpose of these requirements, a “control circuit” is one that carries electric signals directing the performance of a controller which, in turn, governs power delivered to a motor or other load in the refrigerator. A control circuit does not carry main power current. When a control-circuit is supplied through a transformer provided as part of the refrigerator, see Transformer Protection, Section 28, for additional requirements.

29.2 Direct-connected high-voltage control circuit

29.2.1 For the purpose of these requirements, a “direct-connected high-voltage control circuit” is one that is supplied from a branch circuit separate from a branch circuit that supplies other loads within the refrigerator. It is not tapped from the load side of the overcurrent device or devices of any controlled circuit within the refrigerator. See 88.29.

29.3 Tapped high-voltage control circuit

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

29.3.2 A tapped high-voltage control circuit conductor shall be provided with overcurrent protection. The rating of the overcurrent protective device or devices shall not exceed the applicable value specified in Table 29.1.

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

Exception No. 2: An overcurrent protective device of a higher rating may be used if the conductors withstand short-circuiting when tested as specified in the Limited Short-Circuit Test, Section 66.

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

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

a) This protection is in accordance with requirements specified in Transformer Protection, Section 28, and

b) The rating of the device does not exceed the applicable value specified in Table 29.1 multiplied by the ratio of secondary-to-primary rated transformer voltage.

Exception No. 5: A control circuit conductor that is tapped from the main power circuit at a point outside of the control equipment enclosure shall be protected as specified in Column A of Table 430-72(b) of the National Electrical Code, ANSI/NFPA 70.

Table 29.1
Overcurrent protective device rating for control circuit conductors

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

[a] Includes copper-clad aluminum.

[b] 400 percent of value specified for 60°C conductors in Table 310-17 of National Electrical Code, ANSI/NFPA 70.

[c] 300 percent of value specified for 60°C conductors in Table 310-16 of National Electrical Code, ANSI/NFPA 70.

29.3.3 Overcurrent protection for a tapped high-voltage control circuit conductor, as required by 29.3.2 shall be provided as part of the refrigerator.

Exception: The overcurrent device(s) is not required to be provided as part of the refrigerator when, based on the marked rating(s) of the refrigerator, the rating of the branch circuit overcurrent protective device(s) does not exceed the values specified in Table 29.1.

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

a) Be provided for all ungrounded conductors,

b) Be sized in accordance with requirements in 29.3.2 and

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

29.3.5 The device(s) mentioned in 29.3.4 shall be:

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

b) A fuse acceptable for branch circuit protection, such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or Type S plug fuse. See 87.3.9.

Exception: When the control-circuit is tapped from a circuit supplying other loads in the refrigerator, a device used for overcurrent protection may be of the supplementary type provided it has a short-circuit rating acceptable for the circuit in which it is used. See Table 66.1. When the supplementary type device used is a fuse, the refrigerator shall be marked in accordance with the Exception to 87.3.9.

SPACINGS

30 High-Voltage Circuits

30.1 The spacing requirements in 30.2 – 30.10 apply to high-voltage circuits, defined in 3.6(a).

30.2 Unless specifically noted otherwise, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and a dead metal part shall be not less than the values indicated in Table 30.1.

Table 30.1
Electrical spacings in refrigerated and/or air-handling compartments

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

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

1/16 inch (1.6 mm) Through Air and Over Surface for heaters rated 0 – 300 volts.

1/4 inch (6.4 mm) Through Air and Over Surface for heaters rated 301 – 600 volts.

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

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

30.3 The “Through Air” and “Over Surface” spacings specified in Table 30.1 and Table 30.2 at an individual component part are to be based on the total volt-ampere consumption of the load or loads that the component controls. For example, the spacings at a component that controls only the compressor motor are based on the volt-amperes of the compressor motor. Spacings at a component that controls loads in addition to the compressor motor are to be based on the sum of the volt-amperes of the loads so controlled. Spacings at a component that independently controls separate loads are to be based on the volt-amperes of the largest load controlled. The volt-ampere values for loads are to be determined by the marked rating of the loads. For loads that are not required to have a marked rating, the measured input is to be used in determining the volt-ampere values.

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

30.5 With reference to 30.2 and 30.3, the "To Enclosure" spacings specified in Table 30.1 do not apply to an individual enclosure of a component part within an outer enclosure or cabinet.

30.6 The spacings indicated in Table 30.2 are applicable only to electrical components mounted in totally enclosed nonrefrigerated and/or nonair handling compartments which are free of moisture, including that caused by condensation. At wiring terminals and for circuits over 250 volts or over 2000 volt-amperes, spacings in Table 30.1 apply.

Table 30.2
Spacings in non-refrigerated and non-air handling compartments

Ratings		Minimum spacing in inches (mm)					
Volt-amperes	Volts	Through air		Over surface		To enclosure[a]	
0 – 2000	0 – 125	1/16	(1.6 mm)	1/16	(1.6 mm)	1/4	(6.4 mm)
	126 – 250	3/32	(2.4 mm)	3/32	(2.4 mm)	1/4	(6.4 mm)

Note – See 30.6.

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

30.7 The spacings specified in 30.6 do not apply to the inherent spacings of a component part of the refrigerator, such as a snap switch, controller, attachment plug, and similar part, for which spacing requirements are given in a standard for the component. However, the electrical clearance resulting from the assembly of the components into the complete product, including clearance to dead metal or enclosures, shall be those indicated.

30.8 When higher than rated potential is developed in a motor circuit through the use of capacitors, the rated voltage of the system is to be employed in judging the required spacings.

Exception: When the developed steady-state potential as determined in the temperature and pressure test exceeds 500 volts, the developed potential is to be used in determining the spacings for the parts affected.

30.9 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a dead metal part or enclosure shall be not less than 1/2 inch (12.7 mm) when the potential is 600 volts or less and not less than 3/4 inch (19.1 mm) if the potential is 601 – 1000 volts.

30.10 An insulating lining or barrier of fiber or similar material, employed where spacings would otherwise be less than the required values, shall be not less than 0.028 inch (0.7 mm) thick and shall be located or of such material so that it will not be deteriorated by arcing.

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

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

31 Low-Voltage Circuits

31.1 The following spacing requirements apply to low-voltage circuits, as defined in 3.6(b).

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

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

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

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

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

31.4 The spacings in low-voltage circuits that do not contain devices such as indicated in 31.3 are not specified.

32 Alternate Spacings – Clearances and Creepage Distances

32.1 As an alternative to the specified spacing requirements of Sections 30 and 31, the spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, are applicable. The spacing requirements in UL 840 shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal enclosure. In determining the pollution degree and overvoltage category, the environmental conditions to which the appliance is subjected in the end-use application shall be applied and those characteristics given in 32.2 and 32.3 modified accordingly.

32.2 When applying specific requirements in UL 840, the degrees of pollution shall be as indicated in Table 32.1.

Table 32.1
Degrees of pollution

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

32.3 When applying specific requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, the spacing requirements in UL 840, shall be based on the overvoltage categories as indicated in Table 32.2.

Table 32.2
Overvoltage categories

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

REFRIGERATION SYSTEM

33 Refrigerants

33.1 *Deleted*

33.1 General

33.1.1 Except as specified in 33.1.2, the refrigerant employed in the system shall exhibit:

a) Flammability characteristics evaluated in accordance with the Standard for Refrigerants, UL 2182 or be evaluated as described in 33.1.4; and

b) A Lower Toxicity (Safety Group A) classification in accordance with the Designation and Safety Classification of Refrigerants, ASHRAE 34.

Exception: The use of ammonia (R717, Class B) is acceptable.

33.1.2 A refrigerant blend not complying with 33.1.1 shall consist of component refrigerants each individually complying with 33.1.1 and be evaluated as described in 33.1.4. The refrigerant blend shall be considered to have:

a) A toxicity classification that is the most toxic of any of the individual components within the blend; and

b) A flammability classification that is the most flammable of any of the individual components within the blend.

33.1.3 In reference to 33.1.2, a refrigerant blend containing one component exhibiting A1 toxicity/flammability classification, another exhibiting A3 toxicity/flammability classification and another with B2 toxicity/flammability classification, shall be considered a B3 refrigerant. Other refrigerant blends shall be considered in like manner.

33.1.4 A compositional analysis of the refrigerant shall be conducted:

a) If the flammabililty characteristics required in accordance with 33.1.1(a) have not been evaluated in accordance with UL 2182, to confirm composition consistent with refrigerants specified in Designation and Safety Classification of Refrigerants, ASHRAE 34:

b) For a refrigerant blend as specified in 33.1.2 to confirm compositions consistent with a blend of individual refrigerants specified in Designation and Safety Classification of Refrigerants, ASHRAE 34.

33.2 Testing

33.2.1 General

33.2.1.1 These tests are applicable to refrigerants required to be subjected to a compositional analysis in accordance with 33.1.4.

33.2.1.2 The composition (nominal for blends) of the refrigerant shall be determined by analytical testing (e.g. infrared spectroscopy and gas chromatography).

33.2.2 Qualitative infrared analysis

33.2.2.1 An infrared analysis shall be performed with a Fourier Transform Infrared (FTIR) spectrometer. The infrared spectra obtained shall consist of a minimum wavenumber range of 4000 – 400 reciprocal centimeters.

33.2.2.2 A representative gas sample of the refrigerant shall be captured in a sealed cell and infrared spectra of the refrigerant shall be obtained.

33.2.2.3 The results shall be recorded as a plot of the percent transmittance of the infrared radiation through the specimen versus the reciprocal wavelength (cm-1) or "wavenumber" of the radiation. Percent transmittance shall be expressed on the ordinate and wavenumber on the abscissa.

33.2.3 Gas chromatography analysis

33.2.3.1 A gas chromatography analysis shall be performed with a gas chromatograph using thermal conductivity, flame ionization or equivalent detection.

33.2.3.2 A representative aliquot of the liquid is transferred to an evacuated container and allowed to vaporize. A known volume of the vaporized sample is injected into a gas chromatograph that has been calibrated for the sample component(s). A chromatogram of the refrigerant shall be obtained. The results shall be recorded as a plot of time, measured from the start of the analysis on the abscissa, versus the detector response of the individual fractions of the refrigerant on the ordinate.

33.2.3.3 The qualitative/quantitative composition of the sample is to be derived from the retention times and detector responses of the sample using the standard calibration curves of the refrigerant component (s).

34 Pump-Down Capacity

34.1 The section of a refrigerator intended to receive the refrigerant charge during a pump-down shall have the capacity to receive the charge without the liquid occupying more than 90 percent of the volume of the section when the temperature of the refrigerant is 32°C (90°F).

35 Refrigerant Tubing And Fittings

35.1 The wall thickness of copper, steel , or aluminum tubing used to connect refrigerant-containing components shall be not less than indicated in Table 35.1.

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

Table 35.1
Minimum wall thickness for copper and steel tubing

Outside Diameter		Copper				Steel		Aluminum	
		Protected within refrigerator		Unprotected					
Inch	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)
3/16	(4.76)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.035	(0.89)
1/4	(6.4)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.035	(0.89)
5/16	(7.9)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.035	(0.89)
3/8	(9.5)	0.0245	(0.622)	0.0265	(0.673)	0.025	(0.64)	0.035	(0.89)
1/2	(12.7)	0.0245	(0.622)	0.0285	(0.724)	0.025	(0.64)	0.035	(0.89)
5/8	(15.88)	0.0315	(0.799)	0.0315	(0.799)	0.032	(0.813)	0.0488	(1.24)
3/4	(19.05)	0.0315	(0.799)	0.0385	(0.978)	0.032	(0.813)	0.0488	(1.24)
7/8	(22.23)	0.0410	(1.041)	0.0410	(1.041)	0.046	(1.168)	0.0650	(1.65)
1	(25.40)	0.0460	(1.168)	0.0460	(1.168)	–	–	0.0720	(1.83)
1-1/8	(28.58)	0.0460	(1.168)	0.0460	(1.168)	0.046	(1.168)	–	–
1-1/4	(31.75)	0.0505	(1.283)	0.0505	(1.283)	0.046	(1.168)	–	–
1-3/8	(34.93)	0.0505	(1.283)	0.0505	(1.283)	–	–	–	–
1-1/2	(38.10)	0.0555	(1.410)	0.0555	(1.410)	0.062	(1.575)	–	–
1-5/8	(41.28)	0.0555	(1.410)	0.0555	(1.410)	–	–	–	–
2-1/8	(53.98)	0.0640	(1.626)	0.0640	(1.626)	–	–	–	–
2-5/8	(66.68)	0.0740	(1.880)	0.0740	(1.880)	–	–	–	–

NOTE – Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimum wall thickness.

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

35.3 Tubing forming part of components such as evaporators or condensers, where protection is afforded by inherent construction, shall be judged according to Strength Test – Pressure Containing Components, Section 68.

35.4 Special alloys or constructions used in refrigerant-containing components, including tubing with a wall thickness less than indicated in 35.1 are acceptable, subject to an investigation that considers resistance to mechanical abuse, strength against internal pressure, resistance to corrosion, protection against refrigerant contamination, and compliance with requirements of safety codes such as the Safety Standard for Refrigeration Systems, ASHRAE 15, as compared to tubing of the minimum wall thicknesses indicated in Table 35.1.

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

36 Refrigerant-Containing Parts

36.1 Parts of a refrigerator subjected to refrigerant pressure shall:

a) Comply with the Strength Tests – Pressure Containing Components, Section 68; or

b) Comply with the Fatigue Test Analysis, Section 69; or

c) Employ overpressure protection as indicated in 36.1.1 and withstand the pressures indicated in 68.1.1.1 for high-side parts and 68.1.4(f) for low-side parts if the refrigerator is provided with a self-contained or unitary transcritical carbon dioxide (R-744) refrigeration system.

36.1.1 In reference to 36.1(c), the high pressure side of the self-contained or unitary transcritical carbon dioxide (R-744) refrigeration system shall be provided with a pressure relief device or pressure limiting device set to function no higher than the high-side design pressure in accordance with 87.2.8.1.

36.1.2 When carbon dioxide (R744) is used as the refrigerant in a secondary loop, cascade, or remote transcritical system, the refrigerator shall comply with 38.1.7, 68.1.4 exception number 5, 87.2.3, 87.2.8, 87.3.11, and 90.4.

36.2 In addition to the requirement of 36.1, parts of a refrigerator subjected to refrigerant pressure shall be constructed of corrosion resistant material such as copper or stainless steel; or plated, dipped, coated, or equivalently treated to resist external corrosion.

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

36.4 Pressure vessels bearing the ASME Code "U" symbol complying with 36.3 are considered acceptable without tests.

36.5 Pressure vessels bearing the ASME Code "UM" symbol are to be tested to determine compliance with the Strength Tests – Pressure Containing Components, Section 68. The manufacturer shall submit evidence compliance of these vessels with ASME Boiler and Pressure Vessel Code, Section VIII.

37 Pressure-Limiting Device

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

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

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

38 Pressure Relief

38.1 General

38.1.1 Each refrigerator shall be constructed so that pressure due to fire, or other abnormal conditions, will be relieved. Pressure-relief devices, fusible plugs, or soldered or brazed tubing joints may be employed for this purpose.

38.1.2 With reference to 38.1.3 and 38.1.4, a component such as a drier, filter, filter-drier, oil separator, or strainer is not considered to be a pressure vessel unless identified as an ASME pressure vessel. See 3.17.

38.1.3 A refrigerator with a pressure vessel over 3 inches (76 mm) inside diameter, but not exceeding 3 cubic feet (0.08 m^3) internal gross volume, which may contain liquid refrigerant shall be protected by a pressure-relief device or fusible plug.

38.1.4 A refrigerator with a pressure vessel having an internal gross volume exceeding 3 cubic feet (0.08 m^3) but less than 10 cubic feet (0.28 m^3) which may contain liquid refrigerant shall be protected by a pressure-relief device.

38.1.5 There shall be no stop valve between the pressure-relief means and the parts or section of the system that are required to be protected.

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

38.1.7 Refrigerators intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or remote transcritical system and that may contain a pressure vessel within the R744 loop or system shall be provided with the following:

a) A pressure relief valve set to open as indicated in 38.2.2, and

b) A pressure regulating relief valve set to operate at no higher than 90 percent of the marked setting of the pressure relief valve. Such a valve shall:

1) Be factory set and sealed to prevent changing the relief setting;

2) Be mounted to minimize the likelihood of removal and plugging the opening (e.g., use of a threaded fitting other than the NPT type);

3) Comply with the Regulating Relief Valve Endurance Test, Section 71; and

4) Have a discharge capacity not less than 20 percent of the marked discharge capacity of a required pressure relief valve.

Exception No. 1: Remote refrigerators that may contain a pressure vessel within the R744 loop or system are not required to be provided with the pressure relief or the pressure regulating relief valve if the instructions provide the information indicated in 90.4(c) and the equipment is marked according to 87.3.11 (b).

Exception No. 2: Equipment intended to utilize carbon dioxide (R744) in a remote transcritical system is not required to be provided with a pressure regulating relief valve.

38.2 Relief valves

38.2.1 Pressure-relief and pressure regulating-relief valves shall comply with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII. Valves of 1/2 inch iron pipe size and larger shall bear the authorized code “UV” symbol together with the set pressure and capacity. Valves of less than 1/2 inch iron pipe size shall be similarly marked, except that where the size does not permit a nameplate, the code symbol may be omitted and the set pressure and capacity may be stamped on the valve or on a metal plate attached to it. Manufacturers of valves that do not bear the code symbol shall provide evidence of certification of the valve and its pressure and capacity rating by appropriate code authorities.

38.2.2 Pressure-relief valves shall be set to start to function at a pressure not to exceed the design pressure of the parts of the system protected.

38.2.3 The marked discharge capacity of a pressure regulating-relief valve shall be not less than the minimum required discharge capacity as computed from 38.3.1.

38.3 Fusible plugs or rupture members

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

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

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

38A Thermoelectric System

38A.1 A thermoelectric cooling appliance shall comply with requirements in this standard except for those requirements specifically applying to vapor-compression refrigeration systems.

38A.2 In addition to the temperature test in the cooling mode, when a thermoelectric appliance can also be operated in a heating mode, it shall comply with the Temperature Test, Section 44, when operated in the heating mode, except the ambient temperature shall be 77 ±5 ºF (25 ±3ºC).

38A.3 A thermoelectric cooling appliance in which the thermoelectric circuit is powered by a low voltage Class 2 or Limited Power Source supply shall not result in a risk of fire as specified in accordance with 83D.1.1, if no fan is provided or 83D.1.2 if provided with fan(s).

38A.4 A thermoelectric cooling appliance in which the thermoelectric circuit is powered by other than a low voltage Class 2 or Limited Power Source supply shall not result in a risk of fire or electric shock in accordance with 83D.1.1 (if no fan is provided), 83D.1.2 (if provided with fan(s)), and 83D.1.3.

Exception: When the thermoelectric module complies with 83D.5, the tests of 83D.1.1, and 83D.1.3 are not required.

38A.5 In reference to 38A.3 and 38A.4, a thermoelectric cooling appliance that uses a fan motor, other than one that is protected in accordance with Section 18.2, to cool the semiconductor thermoelectric module shall not develop temperatures exceeding 302°F (150°C) on the fan motor winding (open type) or on the fan motor enclosure (enclosed type) when tested in accordance with 83D.3.1. This requirement also applies to fan motors supplied by a low voltage Class 2 or Limited Power Source circuit.

38A.6 In reference to the polymeric material requirements, a semiconductor thermoelectric module powered by other than a low voltage Class 2 or Limited Power Source circuit shall be considered an ignition source.

PERFORMANCE

39 Instrumentation

39.1 Temperature measurements

39.1.1 Temperatures are to be measured by thermocouples, except that the change-in-resistance method may be used to measure the temperature of motor windings or of coils. See 44.4. The

thermocouples are to consist of 24 – 30 AWG (0.21 – 0.05 mm^2) wires. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire shall conform to the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

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

39.1.2.1 Except as specified in 39.1.2.2, during any test in which temperatures are measured, temperatures shall be monitored until maximum temperatures are attained. Thermal equilibrium is to be considered to exist when three successive readings indicate the same or decreasing temperatures. Readings shall be taken at the end of not less than three consecutive periods, the duration of each period being not less than 5 minutes.

39.1.2.2 In reference to 39.1.2.1, if temperatures on the component being monitored cycle between higher and lower temperatures due to the component cycling as part of the test (for example a load cycling on and off due to operation of a protective device), equilibrium is to be considered obtained when three successive peak temperatures indicate the same or decreasing temperatures.

39.1.2.3 In reference to 39.1.2.1 and 39.1.2.2, the recorded temperature shall be the highest of the three readings.

39.1.3 When thermocouples are used in the determination of temperatures in connection with the heating of electrical equipment, it is recommended that thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of indicating instrument are to be used whenever reference temperature measurements by means of thermocouples are required.

39.1.4 When the temperature of a copper motor winding or coil is to be determined by the change-in-resistance method the following formula shall be used:

$$T = \frac{R}{r}(234.5 + t) - 234.5$$

in which:

T = the temperature to be determined in degrees C.

t = the known temperature in degrees C.

R = the resistance in ohms at the temperature to be determined.

r = the resistance in ohms at the known temperature.

39.1.5 When it is required to de-energize the winding before measuring R, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to give the value of R at shutdown.

39.2 Pressure measurements

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

39.2.2 Opening of the gauge line valves are not to cause a significant change in the electrical input of the system. High-side gauges and lines may be heated above the saturation temperature corresponding to the expected pressure or may be precharged with a liquid refrigerant of the same type as used in the system to reduce the effect of opening the gauge line valves.

39.2.3 The instrumentation and test procedures specified in Sections 38, 44, 47, 49, and 50 may be modified for the investigation of a remote refrigerator, as such a unit does not include a complete refrigeration system.

40 Test Voltage

40.1 Unless otherwise specified, a refrigerator is to be tested at 60 hertz voltages maintained at the refrigerator's supply connections in accordance with Table 40.1.

Exception: A refrigerator rated at other than 60 hertz frequency is to be tested at its rated voltage(s) and frequency(s).

Table 40.1
Test voltages

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

[a] These test voltages are nominal for the Condenser or Heat Rejection Fan Motor Failure Test, Section 49, and Condenser or Heat Rejection Water Failure Test, Section 50.

41 Leakage Current Test – Cord Connected Refrigerators

41.1 A cord-connected refrigerator shall comply with the leakage current requirements in the Standard for Leakage Current for Appliances, UL 101 with the leakage current being no more than 0.75 MIU.

Exception No. 1: The following appliances shall have a leakage current not exceeding 3.5 MIU:

a) Refrigerators with a plug rated 30 A or higher.

b) Refrigerators with a special configuration plug, such as an ANSI type L5-15 twist-lock plug.

Exception: The instructions provided with such refrigerators shall include the statement shown in clause 90.5.

Exception No. 2: A cord-connected refrigerator may produce a leakage current greater than 0.75 MIU under the following conditions:

a) The refrigerator shall, upon loss of grounding, reliably disconnect the sources that cause leakage current from the equipment to be greater than 0.75 MIU.

b) The leakage current shall not exceed 3.5 MIU with the equipment grounding conductor open and with any loss of ground disconnect capability disabled.

41.2 For the purpose of this test, commercial refrigerators are to be considered stationary appliances.

41.3 The test is to be conducted at the ambient conditions specified in 41.4.

41.4 The sample is to be conditioned in an ambient temperature of 21 – 27°C (70 – 80°F) and minimum 50 percent relative humidity for not less than 8 hours.

42 Input Test

42.1 The measured ampere input to a cord connected refrigerator shall not exceed the total rating marked on the refrigerator nameplate by more than 10 percent when tested as described in the Temperature and Pressure Test, Section 44, and the Defrost Test, Section 47.

42.2 The measured input to a permanently connected refrigerator shall not exceed the individual rating of each load or group of loads or the total rating as marked on the nameplate by more than 10 percent when tested as described in the Temperature and Pressure Test, Section 44, and the Defrost Test, Section 47.

42.3 With reference to the requirements of 42.1 and 42.2, the measured ampere input is to be the value obtained 1/2 hour after continuous operation under cooling conditions and is to be the maximum value measured during defrost or other heating operation. For a beverage cooler as described in 44.14, the input is to include the dispensing operation if this results in a higher current. The power input of all accessories is to be considered when establishing the minimum marked rating of the refrigerator.

42.4 With reference to 42.3, the measured ampere input is to be increased for accessible 15 and 20 ampere convenience outlets connected to the same circuit as the refrigerator, as follows:

a) By 80 percent of the receptacle rating when a single receptacle is employed.

b) By 100 percent of the receptacle rating when more than one receptacle is employed.

c) By 100 percent of the load(s) marked on or adjacent to the receptacle(s) when the refrigerator is marked as indicated in 87.3.2 and is provided with overcurrent protection as specified in the Exception to 26.2.

42.5 With reference to 42.1 and 42.2, the measured ampere input is not to include a periodic (once or twice an hour) short-time (less than 5 minutes) load that is greater than the load measured on any one branch circuit. However, when such a load exceeds 125 percent of the marked nameplate rating, it shall be included in the marked rating of the refrigerator.

42.6 The load described in 42.5 shall not exceed the rating of the attachment plug on a cord-connected unit or the minimum circuit ampacity marked on a permanently connected unit.

43 Starting Test

43.1 A refrigerator shall start, operate, and defrost as intended without rupturing a line fuse of the size required by the refrigerator.

Exception: For a permanently connected refrigerator protected by a fuse sized in accordance with 66.1.4, no starting test is required.

43.2 The refrigerator, with four fuses connected in series, is to be operated under the conditions described in the Temperature and Pressure Test, Section 44, and when provided with a defrost system, operated under the conditions described in the Defrost Test, Section 47. See 43.7.

43.3 For a cord connected refrigerator, the fuse rating is to be determined by the rating of the attachment plug. For a permanently connected refrigerator protected by a fuse size in accordance with Exception No. 1 to 66.1.4, the fuse rating is to be as marked on the nameplate.

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

43.5 If it is determined that time-delay fuses are required for starting, the refrigerator shall be marked in accordance with 88.14 or 89.2, whichever is appropriate.

43.6 If an automatic-reset thermal protective device interrupts the current flow one or more times during the test, the refrigerator shall restart and run after each interruption and shall comply with the fusing requirements of 43.4 and 43.5.

43.7 A defrost system that employs only electric heaters is not required to be so tested.

43.8 When 15 or 20 ampere general purpose receptacles are provided and intended to be connected to the same circuit as the refrigerator, the starting test is to be conducted with an additional resistive load connected to the refrigerator. The resistive load is to be sized as follows:

a) The load is to be equal to 80 percent of the rating of the receptacle when a single receptacle is employed.

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

c) The load is to be equal to 100 percent of the load(s) marked on or adjacent to the receptacle(s) the refrigerator is marked as indicated in 87.3.2 and is provided with overcurrent protection as specified in the Exception to 26.2.

44 Temperature and Pressure Test

44.1 The temperature rises measured on the electric components and surfaces of a refrigerator shall not exceed those specified in Table 44.1.

Table 44.1
Maximum temperature rises

Device or material	°C	(°F)
A. Motors		
1. Class A insulation systems on coil windings of alternating-current motors having a frame diameter of 7 inches (178 mm) or less (not including hermetic motor-compressors)[a]		
a. In open motors –		
Thermocouple or resistance method	75	(135)
b. In totally enclosed motors –		
Thermocouple or resistance method	80	(144)
2. Class A insulation systems on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm) (not including hermetic motor-compressors)[b]		
a. In open motors –		
Thermocouple method	65	(117)
Resistance method	75	(135)
b. In totally enclosed motors –		
Thermocouple method	70	(126)
Resistance method	80	(144)
3. Class B insulation systems on coil windings of alternating-current motors having a frame diameter of 7 inches (178 mm) or less (not including hermetic motor-compressors)		
a. In open motors –		
Thermocouple or resistance method	95	(171)
b. In totally enclosed motors –		
Thermocouple or resistance method	100	(180)
4. Class B insulation systems on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm) (not including hermetic motor-compressors)		
a. In open motors –		
Thermocouple method	85	(153)
Resistance method	95	(171)
b. In totally enclosed motors –		
Thermocouple method	90	(162)
Resistance method	100	(180)
B. Components		
1. Capacitors		
Electrolytic type[c]	40	(72)
Other types[d]	65	(117)
2. Field wiring[e]	35	(63)
3. Fuses		
a. Class CC, G, J, L, and T		
Tube	100	(180)
Ferrule or blade	85	(153)
b. Other classes[g]	65	(117)

Table 44.1 Continued on Next Page

Table 44.1 Continued

Device or material	°C	(°F)
4. Hermetic motor-compressor or Stirling engine enclosure[f]	150	(302)
5. Relay, solenoid, and other coils (except motor coil windings) with:[b]		
a. Class 105 insulated wiring –		
Thermocouple method	65	(117)
Resistance method	85	(153)
b. Class 130 insulation –		
Thermocouple method	85	(153)
Resistance method	105	(189)
6. Solid contacts	65	(117)
7. Transformer enclosures – with		
a. Class 2 transformers	60	(108)
b. Power Transformers	65	(117)
8. Wood or other flammable material	65	(117)
C. Insulated Conductors		
1. Flexible cords and wires with rubber, thermoplastic, or neoprene insulation unless recognized as having special heat-resistant properties as follows:		
°C (°F)		
60 (140)	35	(63)
75 (167)	50	(90)
80 (176)	55	(99)
90 (194)	65	(117)
105 (221)	80	(144)
D. Surfaces:[h]		
1. Surfaces of refrigerators at points of zero clearance to test enclosure	65	(117)
2. Surfaces of refrigerator contacted by persons in operating it (control knobs, pushbuttons, levers, and similar surfaces)		
Metal	35	(63)
Nonmetallic	60	(108)
3. Surfaces of refrigerator subjected to casual contact by persons (enclosure, grille, and similar surfaces)		
Metal	45	(81)
Nonmetallic[h]	65	(117)
4. Surfaces of test enclosure where clearance to flammable material is specified	65	(117)
E. Electric Insulation – General		
1. Fiber used as electrical insulation or cord bushings	65	(117)
2. Phenolic composition used as electric insulation or as parts where deterioration will result in a risk of electric shock or fire	125	(225)
3. Thermoplastic material	Rise based on temperature limits of material	

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

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

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

Table 44.1 Continued on Next Page

Table 44.1 Continued

Device or material	°C	(°F)
[d] A capacitor that operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating.		
[e] A temperature rise of no more than 50°C (90°F) is acceptable in the terminal box or wiring compartment of a refrigerator that requires supply conductors with an ampacity of more than 100 amperes when the refrigerator is clearly marked with the following statement or its equivalent: "For supply connections, use ___ AWG or larger wires acceptable for at least 75°C (167°F)." See 9.2.8.		
[f] Maximum – not rise.		
[g] Includes both casing and ferrule or blade.		
[h] See 5.3.11 and 5.3.12.		

44.2 The maximum pressure developed in a refrigeration system, including equalization pressures after compressor or Stirling engine shutdown, shall be used as a basis for the Strength Test – Pressure Containing Components, Section 68.

44.3 Motor-compressors or Stirling engines shall operate continuously under the conditions of this test with any protective device in the circuit.

Exception: An automatic reset protective device may cycle during the first 8 hours of the test. A manual reset protective device shall not trip during the test.

44.4 The refrigerator is to be fitted with pressure gauges on the high- and low-sides for a compressor system or on the motor enclosure when a Stirling system is used. Thermocouples are to be secured to electrical components, such as the compressor or Stirling motor enclosure, fan-motor windings, starting-relay coil, capacitors, and wiring insulation, and to surfaces as indicated in item D of Table 44.1. The temperature of motor windings or of coils may be measured by the change-in-resistance method, but the primary method of temperature measurement is to be the thermocouple method. The electrical input is to be measured with a voltmeter and an ammeter. The temperature controller is to be short-circuited during this test.

44.5 The refrigerator is to be installed in accordance with the manufacturer's instructions, see 90.1 and 90.2, and operated under the conditions specified in 44.7 – 44.14, as applicable. The test potential is to be as indicated in Table 40.1.

44.6 When the wiring to a general purpose receptacle does not comply with the requirements of 10.1.1, a resistive load is to be connected to the receptacle circuit during the test and the temperature of the wiring insulation measured. The resistive load is to be sized as described 43.8 (a), (b), or (c).

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

44.8 For cooling operation and simultaneous cooling/heating operation, the air-cooled refrigerator is to be placed within a room maintained at 40°C (104°F) with doors or lids open until the assembly reaches room temperature. For heating operation only, the appliance is to be placed in a room maintained at 25°C (77°F). See 44.12 and 44.13.

Exception No. 1: Equipment that does not incorporate a complete refrigeration system, such as a remote refrigerator, may be tested in an ambient temperature of 25°C (77°F).

Exception No. 2: A refrigerator or freezer for use as a Type I Display Refrigerator or Freezer may be tested in an ambient temperature of 24°C (75°F).

Exception No. 3: A refrigerator or freezer for use as a Type II Display Refrigerator or Freezer may be tested in an ambient temperature of 27°C (80°F).

Exception No. 4: The need for additional testing on a Thermoelectric or Peltier device capable of operating in heating mode shall be determined based on a room ambient maintained at 25° C (77° F). Usually, such testing is not required for a device in a Class 2 or Limited Voltage / Current circuit.

Exception No. 5: Refrigerated buffet units and refrigerated food preparation units may be tested in an ambient temperature of 30°C (86°F).

Exception No. 6: A laboratory refrigerator or freezer may be tested in an ambient temperature of 27 °C (80.6 °F).

44.9 Lights, other electrical loads, or both, that may operate concurrently with the condensing unit are to be energized during the test. The assembly is to be started and operated with doors or lids closed until temperatures and pressures have stabilized. The potential is to be maintained as indicated in Table 40.1. The electrical input, the temperature of electrical components and surfaces, and high- and low-side pressures are to be recorded at intervals during the test.

44.10 The appliance is to be operated in all normal modes of operation, except that insulated resistance-type heater wiring, ballasts, and defrost heaters are to be tested as indicated in Sections 45 – 47.

44.11 For the test of a refrigerator of the water-cooled type, the condenser or heat rejection cooling water flow is to be maintained at 27°C (80°F) inlet and 38°C (100°F) outlet temperatures. When the outlet water cannot attain a temperature of 38° C (100° F) because of product construction considerations, the refrigerator is to be tested at 27°C (80°F) inlet water and 35 psig (241 kPa) nominal pressure.

44.12 For the test of a wet-type beverage cooler, the tank is to be filled to the marked height with water at 40°C (104°F). The refrigerator then is to be tested in accordance with 44.9.

44.13 For the test of a batch-type beverage dispenser, the ingredient charge is to be prepared and the container filled in accordance with the manufacturer's instructions. When water is to be added to the ingredients, the temperature of the water is to be 27° C (80° F). The refrigerator then is to be tested in accordance with 44.9 under “no-draw” conditions.

44.14 For the test of a beverage cooler or beverage cooler-dispenser that employs make-up water, the ingredient charge is to be prepared and the containers filled in accordance with the manufacturer's instructions. The temperature of the make-up water is to be maintained at 27° C (80° F). The refrigerator then is to be tested in accordance with 44.9 under “no-draw” conditions for the period of time recommended by the manufacturer. At the end of this time the test is to be continued at the draw rate recommended by the manufacturer until temperatures and pressures have stabilized.

44.15 For the test of a processing water cooler, the inlet and outlet temperatures or the make-up water shall be as specified by the manufacturer.

44.16 The refrigerator shall comply with the Dielectric-Voltage Withstand Test, Section 48, following this test.

45 Heating Test – Condensation Wiring

45.1 This test is conducted only on cabinets supplied with insulated resistance-type heater wire or similar condensation wiring that does not comply with 10.2.6.

45.2 The temperature measured on the insulation of the heater wire shall not exceed its temperature limit.

45.3 The heater wire, installed in the cabinet or in the section enclosing the wire, is to be connected to a power supply maintained as indicated in 40.1 until constant temperatures are attained, as determined by thermocouples on the insulation. The test is to be conducted at 25°C (77°F) ambient temperature with the refrigerator in the OFF position.

45.4 The condensation wiring system is to comply with the Dielectric-Voltage Withstand test, Section 48, following this test.

46 Heating Test – Ballasts And Wiring

46.1 Ballasts are to be tested in accordance with the 46.2 – 46.7 when they are:

a) Installed so that thermal insulation may cause overheating;

b) Subject to external heat; or

c) Mounted at more than one level within a common compartment.

46.2 The temperature on the coil of an open-type ballast and on the enclosure of an enclosed reactor-type ballast or other control device employed in an electric-discharge lamp system shall be not higher than 90°C (194°F); the temperature on the enclosure of an automatic starter shall be not higher than 80°C (176°F); and the temperature attained on insulated conductors and splices shall not exceed the limits indicated in Table 44.1 under the test conditions described in 46.3 – 46.7.

46.3 The test is to be conducted only on cabinets with electric-discharge lamp systems that are not exempt by the provisions of 46.6.

46.4 The test is to be conducted with the ballasts installed in a complete cabinet with light loads connected or in a simulated cabinet section with the ballasts loaded in accordance with the ballasts rating. The refrigeration system is to be shut off when the test is conducted in the complete cabinet, unless the ballasts are located where they are exposed to heat from components of the refrigeration system.

46.5 The ballast and load are to be connected to a supply circuit maintained at the voltage specified on the control equipment. The test ambient is to be 25°C (77°F). Thermocouples are to be attached to open coils, ballast enclosures, and wiring. The test is to be continued until components reach constant temperatures.

46.6 Except as indicated in 46.1, the heating test may be waived for ballasts on refrigerators that:

a) Employ not more than one lighting control unit;

b) Employ two 2-lamp 20 watt control units mounted side-by-side, provided that the spacing between the sides of the control units is not less than 3/4 inch (19.1 mm);

c) Employ four or more single-lamp 20 watt control units mounted in pairs, provided that the spacing between the sides of the control units in each pair is not less than 2 inches (50.8 mm) and the spacing between the ends of adjacent pairs is not less than 4 inches (102 mm); or

d) Employ control units other than described in (b) and (c), provided that the spacing between any two control units is not less than 1 inch (25.4 mm) when arranged end-to-end and not less than 4 inches when arranged otherwise.

46.7 The ballasts and wiring are to comply with the Dielectric-Voltage Withstand Test, Section 48, following this test.

47 Defrost Test

47.1 While operating in the defrost mode, temperature rises of electrical components, wiring, enclosure surfaces, and the like, of a refrigerator shall not exceed the values specified in Table 44.1. A hot-gas defrost system of a self-contained refrigerator shall not rupture or develop leaks during the test. After defrost operation, the refrigerator shall have an insulation resistance of at least 50,000 ohms. After the test, the refrigerator shall comply with the requirements of the Dielectric Voltage-Withstand Test, Section 48.

Exception: Determination of insulation resistance following the defrost cycle may be omitted when:

a) 47.4 is omitted, or

b) It is evident from visual examination of the refrigerator that moisture or water resulting from the defrost operation cannot contact uninuslated live parts.

47.2 The test voltage is to be as specified in Table 40.1. The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 68.

47.3 A remote refrigerator is to be connected to a condensing unit of the size recommended by the manufacturer.

Exception: Connection to a condensing unit is not required if frost build-up is not necessary as permitted by the Exception to 47.4(b).

47.4 The defrost test sequence is to be as follows:

a) The refrigerator is to be mounted or positioned in accordance with the manufacturer's instructions (see 90.1).

b) The refrigerator is to be operated in a room maintained at a temperature of 21 – 27° C (70 – 80° F) dry-bulb and 50 percent relative humidity until frost has built up sufficiently to block the evaporator. Blockage of the evaporator is considered to have occurred when (1) the average cabinet temperature starts to increase or (2) the refrigeration system low-side pressure starts to decrease. Other equally reliable methods of detecting evaporator coil blockage may be used. Adjustments may be made to the refrigerator to reduce the length of the frost build-up period. The following are examples of two methods which may be used although other methods may serve the same purpose: (1) a door(s) that provides access to the refrigerated compartment may be opened or (2) the evaporator fan motor(s) may be disconnected from the electrical supply.

Exception: When agreeable to all concerned, (b) may be omitted when there are no uninsulated live parts located beneath (1) any portion of the evaporator including tubing, hairpin turns, return bends, fins, end plates and inlet and outlet tubes, (2) refrigerant suction lines, and (3) an expansion valve.

c) Following (b), the refrigerator is to be returned to its intended defrost mode; that is, any open doors are to be closed, electrical components that normally operate during the defrost cycle are

placed back in the circuit, and the like. The defrost cycle is to be initiated and allowed to continue until the cycle is terminated by its automatic control. In addition to electrical input, temperatures and pressures are to be recorded as specified in 47.1 and 47.2.

Exception: If (b) is omitted, temperature rises are to be determined in the following manner for temperature-terminated defrost systems. The cut-in/cut-out temperature differential of the defrost cycle control is to be determined. The control is then shunted out of the circuit and a thermocouple placed at the location where the control senses the temperature. The defrost heaters are energized and allowed to operate until the temperature rise at the control sensing location is equal to the temperature differential previously determined. The temperatures recorded at the time the differential is reached are to be reduced by 23°C (42°F) and the resulting values are to be used to determine compliance with 47.1.

d) Following (c), the insulation resistance of the refrigerator is to be determined.

47.5 With reference to 47.4(c), if the defrost cycle is time-terminated, the refrigerator is to be operated for the maximum adjustable length of time permitted by an integral control arrangement. When a refrigerator with a time-terminated defrost cycle control arrangement is marked to specify a maximum defrost time, the length of the defrost cycle is to be as marked but not less than the minimum increment permitted by the control. Temperatures recorded after the elapsed time are to be used in determining compliance with the requirements of 47.1.

Exception: For a remote refrigerator:

a) When the time-terminated defrost cycle control is not an integral part of the refrigerator, the refrigerator is to be operated in the defrost mode for a period equal to 125 percent of the time specified on the refrigerator (see 88.28) but not less than 15 minutes.

b) When the defrost cycle control is not an integral part of the refrigerator and the marking specified in 88.28 is not provided, the defrost test is terminated when stabilized temperatures are reached on electrical components, wiring and enclosure surfaces.

48 Dielectric-Voltage Withstand Test

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

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

Exception No. 2: When the steady-state voltage developed in a motor circuit through the use of capacitors exceeds 500 volts, as measured during the temperature and pressure test, the test potential for the parts affected is to be 1000 volts plus twice the developed capacitor voltage.

48.2 A refrigerator employing a low-voltage circuit shall withstand, without breakdown, a test potential applied for 1 minute between low-voltage live parts and dead metal parts. The test potential is to be 500 volts at any frequency between 40 and 70 hertz. When components specified in 31.3 are employed in the low-voltage circuit, the dielectric voltage withstand test is also to be conducted between live parts of opposite polarity.

48.3 With reference to 48.2, the test between low-voltage parts of opposite polarity is to be conducted on magnet coil windings after breaking the inner coil lead where it enters the layer. This opposite polarity test

may be waived on the complete assembly provided that the components have been separately subjected to this test.

48.4 A 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with 48.1 – 48.3. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at that value for 1 minute.

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

48.5 When the charging current through a capacitor or capacitor-type filter connected across the line, or from line to earth ground, is large enough so the required alternating-current test potential is unable to be maintained, the capacitors and capacitor-type filters may be tested as described in 48.6.

48.6 The capacitors and capacitor-type filter mentioned in 48.5 are to be subjected to a direct-current test potential of 1414 volts for equipment rated 250 volts or less or 1414 volts plus 2.828 times the rated circuit voltage for equipment rated at more than 250 volts. The direct-current test potential is to be maintained for 1 minute without breakdown.

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

49 Condenser or Heat Rejection Fan Motor Failure Test

49.1 A refrigerator with a compressor system shall not leak refrigerant nor develop pressures or temperatures in excess of those indicated in (a) and (b), if the condenser fan motor locks or fails to start.

a) The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 68. An assembly employing a pressure-limiting device complying with 37.2 is considered to comply with the high-side pressure requirement.

b) The maximum temperature of the compressor enclosure or the fan motor winding (open type) or of the fan motor enclosure (enclosed type) shall not exceed 150° C (302° F). Compressors and condenser fan motors equipped with thermal protective devices as specified in Motors and Motor Overload Protection, Section 17, are considered to comply with this requirement.

49.1.1 With regards to 49.1 (b), the maximum temperature of an impedance protected motor winding shall be allowed to be greater than 150° C if the maximum temperature of the motor winding does not exceed:

a) 175° C for a motor with a Class B insulation system;

b) 200° C for a motor with a Class F insulation system; or

c) 225° C for a motor with a Class H insulation system.

49.1.2 A refrigerator with a Stirling system shall not develop pressure or temperature in excess of those indicated in (a) or (b), if the cooling fan motor locks or fails to start.

a) The maximum pressure is to be recorded as a reference value for requirements of the Strength Tests – Pressure Containing Components, Section 68.

b) The maximum temperature of the Stirling engine enclosure or the fan motor winding (open type) or the fan motor enclosure (enclosed type) shall not exceed 150°C (302°F). Stirling engines and cooling fan motors equipped with thermal protective devices as specified in Motors and Motor Overload Protection, Section 17, are considered to comply with this requirement.

49.2 In the case of a compressor system, a sample of the assembly is to be fitted with pressure gauges on the high- and low-pressure sides of the refrigeration system and provided with thermocouples on the compressor enclosure and condenser fan motor winding (open type) or condenser fan motor enclosure (enclosed type). The sample is to be installed in accordance with 44.7. The low-side pressure is to be recorded both while the compressor is operating and after shutdown. When the refrigerator is provided with means to relieve discharge pressure into the low side of the system, the low-side pressure is to be recorded:

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

b) After shutdown of the compressor.

49.2.1 In the case of a Stirling system, a sample of the assembly is to be fitted with a pressure gauge to measure the charge pressure and provided with thermocouples on the engine heat rejection side and fan motor winding (open type) or fan motor enclosure (enclosed type). The sample is to be installed in accordance with 44.7. The pressure is to be recorded both while the engine is running and after shutdown.

49.3 The ambient air temperature is to be 25 ±5°C (77 ±9°F). The test potential is to be maintained as indicated in Table 40.1. When two or more condenser or heat rejection fan motors are employed for removing heat, the test is to be conducted with one motor locked.

49.4 The controls are to be set for maximum cooling and the refrigerator is to be operated with the condenser or heat rejection fan motor locked until stabilized temperatures and pressures are reached. The compressor or Stirling refrigeration system motor overload device the fan motor overload device, or both, may operate during this test.

50 Condenser or Heat Rejection Water Failure Test

50.1 During failure of the cooling water supply, a water-cooled refrigerator with a compressor system shall not leak refrigerant nor develop pressures or temperatures in excess of those indicated in (a) and (b), nor shall electrical parts be damaged.

a) The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 68.

b) The maximum temperature of the compressor enclosure shall not exceed 150°C (302°F). When the compressor is equipped with a thermal protective device(s) as specified in Motors and Motor Overload Protection, Section 17, this temperature measurement may be waived.

50.1.1 During the failure of the cooling water supply, a water-cooled refrigerator with a Stirling system shall not develop pressure or temperature in excess of those indicated in (a) or (b), nor shall electrical parts be damaged.

a) The maximum pressure is to be recorded as a reference value for requirements of the Strength Tests – Pressure Containing Components, Section 68.

b) The maximum temperature of the Stirling engine enclosure shall not exceed 150°C (302°F). When the Stirling engine is equipped with thermal protective device(s) as specified in Motors and Motor Overload Protection, Section 17, this temperature measurement may be waived.

50.2 In the case of a compressor system, a sample of the assembly is to be fitted with pressure gauges on the high- and low-pressure sides of the refrigeration system and provided with thermocouples on the compressor enclosure. The low-side pressure is to be recorded as specified in 49.2. The refrigerator is to be operated with the condensing water shut off and also with the condensing water restricted until maximum stabilized temperatures are attained or until representative maximum temperatures are attained under cycling load. If the refrigerator cycles on a motor-overload protective device, the test is to continue until the maximum pressure is obtained. The room ambient is to be 25°C (77°F). The potential is to be maintained as indicated in Table 40.1.

50.2.1 In the case of a Stirling system, a sample of the assembly is to be fitted with a pressure gauge to measure the charge pressure and thermocouples on the engine heat rejection side. The pressure is to be recorded as specified in 49.2.1. The refrigerator is to be operated with the cooling water shut off and also with the cooling water restricted until maximum stabilized temperatures are attained or until representative maximum temperatures are attained under cycling load. If the refrigerator cycles on a motor-overload protective device, the test is to continue until the maximum pressure is obtained. The room ambient is to be 25°C (77°F). The potential is to be maintained as indicated in Table 40.1.

50.3 When a pressure-limiting device is provided, the test need not be conducted to determine compliance with 50.1. The maximum cutout pressure to which the pressure-limiting device may be readily adjusted by the adjusting means provided shall be employed in determining compliance with 50.1. See 68.1.1.

51 Evaporator Fan Motor Failure Test

51.1 This test is to be conducted only when the evaporator fan motor(s) is intended to operate during the defrost period.

51.2 An electric defrost heater shall not ignite flammable material or cause the emission of flames, burning particles, or molten metal if the evaporator fan motor locks or fails to start.

51.3 The test arrangement is to be as described in the Abnormal Operation Test – Electric Defrost Heaters, Section 59, except that the defrost shutoff control is to be operable as in the Defrost Test, Section 47, and the evaporator fan motor is to be locked. The potential is to be maintained as indicated in 40.1.

51.4 When more than one evaporator fan motor is employed, the test is to be conducted by blocking the fan motor that would result in the most severe condition.

51.5 The test is to continue until the defrost control opens the circuit.

52 Overflow Test

52.1 With reference to 5.4.7, if condensate water may accumulate or overflow due to blocked waste outlet, the water shall not wet live parts or the windings of motors or coils.

52.2 The refrigerator is to be positioned as intended in operation and the evaporator condensate drain pan is to be filled until overflowing occurs.

52.3 Compliance with 52.1 can be determined by visual examination, dielectric-voltage withstand, or insulation resistance, except that motor windings shall have an insulation resistance of not less than 50,000 ohms and shall comply with the Dielectric-Voltage Withstand Test, Section 48.

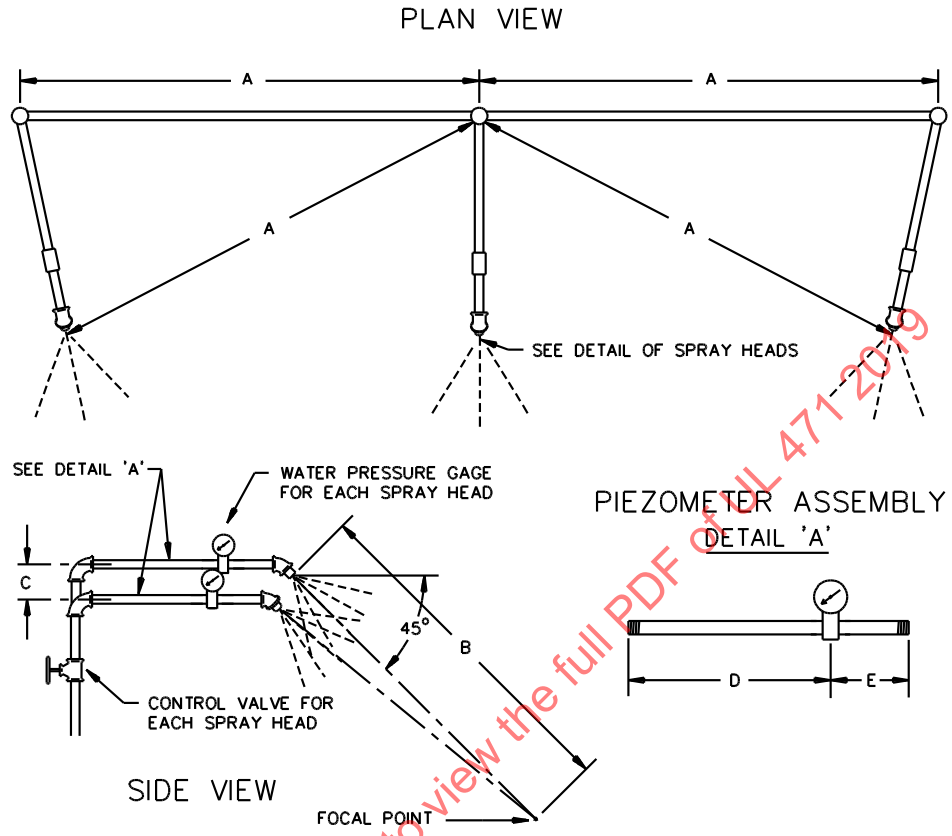
53 Rain Test

53.1 A refrigerator exposed to weather is to be subjected to a rain exposure without creating a risk of electric shock due to current leakage or insulation breakdown. Following the rain test exposure, the refrigerator shall have an insulation resistance of not less than 50,000 ohms measured between current-carrying parts and noncurrent-carrying parts, and shall withstand the Dielectric-Voltage Withstand Test, Section 48.

53.2 The refrigerator is to be installed in accordance with the manufacturer's instructions and subjected to the rain exposure under conditions most likely to cause entrance of water into or onto the electrical components. The duration of exposure is to be 1 hour.

53.3 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as shown in Figure 53.1. Spray heads are to be constructed in accordance with the details shown in Figure 53.2. The water pressure for all tests is to be maintained at 5 psig (34 kPa) at each spray head. The distance between the center nozzle and the refrigerator is to be approximately 5 feet (1.5 m). The refrigerator is to be brought into the focal area of the three spray heads in such a position and under such conditions that the greatest quantity of water will enter it. The spray is to be directed at an angle of 45 degrees to the vertical toward the louvers or other openings closest to current-carrying parts. The refrigerator is to be operated so that electrical components are energized.

Figure 53.1
Rain-test spray-head piping



Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

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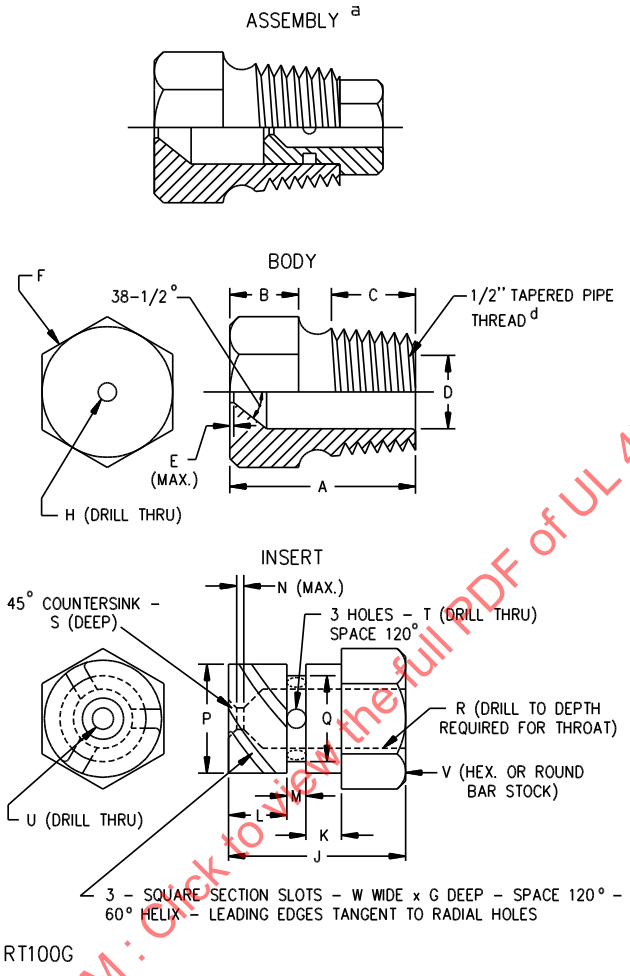
53.4 At the conclusion of the test there shall be no evidence of the entrance of water into enclosures above the lowest uninsulated electrical part or wetting of uninsulated electrical parts, except as follows:

a) Motor windings may be judged on the basis of the insulation resistance (see 53.1) and by the Dielectric-Voltage Withstand Test, Section 48, when the motors are within the outer enclosure and are shielded from openings in the top of the outer enclosure.

b) Water may enter an enclosure above the lowest uninsulated electrical part when the point of entrance is not in proximity to uninsulated electrical parts and uninsulated electrical parts are not wetted during the rain exposure.

Figure 53.2
Rain-test spray head



item	inch	(mm)	item	inch	(mm)
A	1-7/32	(31.0)	N	1/32	(0.80)
B	7/16	(11.0)	P	.575	(14.61)
C	9/16	(14.0)		.576	(14.53)
D	.578	(14.68)	Q	.453	(11.51)
	.580	(14.73)		.454	(11.53)
E	1/64	(0.40)	R	1/4	(6.35)
F	c	c	S	1/32	(0.80)
G	.06	(1.52)	T	(No. 35)[b]	(2.80)
H	(No. 9)[b]	(5.0)	U	(No. 40)[b]	(2.50)
J	23/32	(18.3)	V	5/8	(16.0)
K	5/32	(3.97)	W	0.06	(1.52)
L	1/4	(6.35)			
M	3/32	(2.38)			

[a] Nylon Rain-Test Spray Heads are available from Underwriters Laboratories.

[b] ASME B94.11, Twist Drills.

[c] Optional – To serve as a wrench grip.

[d] ASME B1.20.1, Pipe Threads, General Purpose (Inch).

54 Stability Test

54.1 A refrigerator shall be stable when tested in accordance with 54.2 – 54.5. A refrigerator having a supporting base such that both the width and depth dimensions are greater than the height is considered to comply with the requirement.

54.2 A refrigerator is to be supported by the legs, leveling screws, or casters provided in its base. Other means of support, such as plumbing connections or conduit connections are not to be relied on during the test, except that a door support that complies with the requirements of 54.3 may be used for the test described in (b). The refrigerator shall not overturn under the conditions specified in (a) and (b):

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

1) For refrigerators not exceeding 4 feet (1.2 m) in cabinet length, or not exceeding 200 pounds (97 kg) in weight, or both, a force equal to one-fourth the weight of the refrigerator, but not exceeding 50 pounds (223 N), is to be applied horizontally at the vertical centerline of any side of the refrigerator at the highest points, not to exceed 5 feet (1.5 m) above floor level, with all doors closed.

2) For refrigerators exceeding 4 feet (1.2 m) in cabinet length and weighing more than 200 pounds, the force is to be 50 pounds plus an additional 1 pound-force (4.4 N) for each inch (25.4 mm) of cabinet length greater than 4 feet.

b) An empty refrigerator weighing 50 pounds or more with accessories installed, is to be placed on a horizontal surface. When leveling screws are provided, they are to be adjusted equally to raise the refrigerator 1 inch above floor level. When swivel type casters are provided, they are to be oriented so that the tendency to overturn is maximum.

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

2) For other hinged doors, a force equal to one-fourth the weight of the refrigerator, but not exceeding 35 pounds (156 N), is to be applied vertically downward at the edge of the door farthest from the hinges with the door opened at an angle of 90 degrees to the cabinet. For refrigerators with three or more doors, every other door is to be opened and the force is to be applied to the one door that would result in the maximum tendency of the refrigerator to overturn. When it is provided with tiers of doors, only every other door in one tier is to be opened.

54.3 When required for compliance of 54.2(b), a leg, brace, or similar support provided in the refrigerator door shall be fixed in position or shall operate automatically to position itself when the door is opened, and shall be constructed so that its intended function cannot be readily defeated. See 87.3.8.

54.4 The manufacturer's instructions are to be used to install the refrigerator for tests to determine compliance with 54.3. All adjustments of door support means are to be made in accordance with the directions included with the refrigerator. After the initial installation procedure is completed, no further adjustments are to be made.

54.5 When the manufacturer provides hardware for securement of the unit, the unit is to be installed in accordance with the manufacturer's instructions and tested with the hardware in place.

55 Static Load Test

55.1 A refrigerator intended to be suspended from a wall or ceiling shall withstand the test described in 55.2 without collapse of the mounting means and severance of its securement to the mounting means.

55.2 The refrigerator is to be installed using its mounting hardware in accordance with the manufacturer's instructions. A load equal to the sum of the following, acting vertically downward, is to be applied uniformly to the refrigerator:

a) A load equal to three times the weight of the refrigerator, but not exceeding 400 pounds-mass (181.6 kg), plus

b) A load equal to the weight of all shelves simultaneously loaded in accordance with 72.3.

56 Strain Relief Test

56.1 The strain relief means provided on a power supply cord, including that for an externally-mounted accessory, and wiring exposed to the refrigerator user or attendant, shall withstand a direct pull of 35 pounds (156 N) applied to the cord or wiring without such movement of the cord or wiring as to indicate that stress would be transmitted to internal connections and wiring.

56.2 The strain relief means provided on leads intended for connection of field-installed supply conductors and power supply conductors of internally-mounted accessories shall withstand a direct pull of 20 pounds (89 N) applied to the conductors without such movement of the cord or wiring as to indicate that stress would be transmitted to internal connections and wiring.

56.3 A 35 or 20 pound (15.9 or 9.1 kg) weight is to be suspended on the cord or wiring and supported by the refrigerator so that the strain relief will be stressed from any angle permitted by the construction of the refrigerator. The load is to be applied for 1 minute.

57 Heater Control Tests

57.1 Endurance test

57.1.1 A control for an electric heater shall withstand an endurance test when the control makes and breaks the load that it controls for the number of cycles indicated in (a) – (c):

a) For an automatic-reset cycle control that operates during each defrost cycle, 30,000 cycles of operation under load. When the control also serves to limit temperatures, see (b).

b) For an automatic-reset temperature-limiting control, 100,000 cycles of operation under load if short-circuiting results in a risk of fire or electric shock, see 58.2 and 58.3. The test need not be conducted when short-circuiting of the control does not result in a risk of fire or electric shock. See Abnormal Operation Test – Electric Heater, Section 58.

c) For a manual-reset temperature-limiting control, 1000 cycles of operation under load plus an additional 5000 cycles under no load. The test need not be conducted if short-circuiting of the control does not result in a risk of fire or electric shock. See Abnormal Operation Test – Electric Heater, Section 58.

57.1.2 The test is to be conducted with the device connected either to the heater element load or to an equivalent noninductive load. The frame of the device is to be connected through a 3-ampere fuse to ground or to the grounded conductor of the supply circuit.

57.2 Calibration test

57.2.1 Defrost cycle controls (57.1.1 (a)) and temperature-limiting controls (57.1.1 (b) and (c)) shall comply with the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, or the Standard for Limit Controls, UL 353 pertaining to the calibration of temperature-limiting controls.

Exception: A type-2 action temperature or thermal cut-out, as specified in the Standard for Automatic Electrical Controls – Part 1; General Requirements, UL 60730-1 and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, is considered to comply with the requirements of UL 873. See 57.1.1.

58 Condensate Water Evaporator Test

58.1 A condensate water evaporator assembly installed in a location subject to accumulation of dirt or dust shall not exceed a temperature of 150°C (302°F) when tested as described in 58.2.

58.2 In this test, the water evaporator assembly is to be operated with the water receptacle dry. A float-operated control is to be shunted out of the circuit. A protective device that does not have an endurance rating of 100,000 cycles for an automatic-reset device or 6000 cycles for a manual-reset device in compliance with the requirements of the Heater Control Tests, see 57.1.1, is to be shunted out of the circuit. The test is to terminate when the temperatures of components and materials, such as the water evaporator assembly, conductor insulation, electrical insulation, and thermal insulation have stabilized. When a manual-reset control is used, temperatures are to be measured at the time the control opens the circuit.

58.3 The assembly shall comply with the Dielectric-Voltage Withstand Test, Section 48, following this test.

59 Abnormal Operation Test – Electric Heater

59.1 Operation of a heater shall not result in a risk of fire or electric shock.

59.2 A risk of fire is considered to exist when there is emission of flame or molten metal from the refrigerator, or glowing or flaming of flammable material.

59.3 A risk of electric shock is considered to exist if the insulation resistance of the refrigerator is less than 50,000 ohms.

59.4 Opening of a sheath-type heater element is acceptable when it does not result in the risk of fire and electric shock. If the heater element opens, three samples are to be tested to determine that the heater is designed to function in this manner.

59.5 The ambient air temperature is to be 25° C (77° F). The heater is to be energized at the voltage specified in Table 40.1. A liquid heater shall be operated dry. An air heater shall be operated with the fan motor blocked.

59.6 When an automatic-reset temperature-limiting control (See Section 57) is employed, the control is to be allowed to cycle until representative maximum temperatures of components and materials, such as conductor insulation, electrical insulation, thermal insulation, and flammable materials near the heater element are attained. When a manual-reset temperature-limiting control is employed, the test is to terminate when the device opens the heater circuit. All other controls are to be shunted out of the circuit.

Exception: This test is not required when the temperature-limiting control is calibrated to open the circuit at a temperature of 25°C (77°F) or less.

59.7 When a replaceable thermal cutoff is employed, the test is to be conducted five times using a different sample of the thermal cutoff for each test. The thermal cutoff shall open the circuit as intended without causing the short-circuiting of live parts and without causing live parts to become grounded to the enclosure. During the test the enclosure is to be connected to ground through a 3-ampere fuse, and any thermally operated control devices in the heater circuit, other than the thermal cutoff, are to be shunted out of the circuit. The 3-ampere fuse shall not open during the test.

60 Burnout Tests – Electromagnetic Components

60.1 An electromagnet operator (solenoid) shall be subjected to a burnout test to determine if the refrigerator presents a risk of fire or electric shock.

Exception No. 1: This requirement does not apply to an electrically operated valve, magnetic motor controller, or a similar component incorporating an electromagnet and complying with the applicable requirements for the component.

Exception No. 2: The determination of a risk of electric shock may be waived for electromagnet operators in low-voltage circuits.

60.2 A risk of fire is considered to exist if there is any emission of flame or molten metal from the refrigerator or a glowing or flaming of flammable material. Opening of the supply circuit fuse is acceptable when a risk of fire does not exist.

60.3 A risk of electric shock is considered to exist when the insulation resistance of the refrigerator is less than 50,000 ohms.

60.4 The tests are to be conducted with the component installed as intended in the refrigerator. The refrigerator is to be connected to a supply circuit maintained as indicated in 40.1. Each ungrounded conductor in the supply circuit is to be provided with a fuse of the maximum rating that may be used. For cord connected refrigerators, the supply circuit fuses are to correspond with the rating of the attachment plug, except that 20 amperes is to be the minimum fuse size for refrigerators rated 150 volts or less. The test is to be conducted with the component:

a) Continuously energized until the ultimate result is determined if this condition could exist due to malfunction of a single switch or controller, and

b) Blocked in the position assumed when it is de-energized and then energized continuously until the ultimate result is determined.

61 Burnout Test – High-Voltage Transformers

61.1 There shall be no emission of flame or molten metal from the refrigerator enclosure when a high-voltage transformer is operated under the conditions described in 61.2 and 61.3.

Exception: This test does not apply to a high-voltage transformer that is provided with thermal overload protection of other than the nonrenewable thermal cutoff type (see 28.2.1) or that is protected by an overcurrent device(s) in accordance with the requirements in 28.3.1.

61.2 Three samples of the transformer are to be operated continuously at the normal test voltage indicated in Table 40.1 and rated frequency with the enclosure grounded. The test ambient temperature is to be 25° C (77° F) and operation is to be continued until constant temperature is indicated by a

thermocouple on the enclosure or until burnout occurs. The circuit on which the transformer is tested is to be protected by fuses rated not less than that required for the refrigerator.

61.3 The load connected to the output terminals is to be the highest of the values specified in (a) – (c) and is to be readjusted to the specified value after 2 minutes of operation, when required, with no further readjustment during the test.

a) A resistance load to provide a current equal to three times the full rated transformer secondary current; or

b) When the transformer supplies a motor with or without additional loads, a resistance load to provide a current equal to the motor locked-rotor current plus any additional loads; or

c) When the transformer supplies an inductive load (other than a motor), such as the coils of relays, solenoids, and the like, a resistance load to provide a current equal to the sum of such loads with the armature of the largest blocked open.

Exception: The test may be conducted with the output terminals short-circuited if this results in less than three times rated secondary current.

62 Overload Test – High-Voltage Transformers

62.1 This test applies to a high-voltage transformer provided with thermal protection of other than the nonrenewable thermal cutoff type. See 28.2.1.

62.2 Temperatures of a thermally protected high-voltage transformer, measured on the surface of the windings, shall not exceed the insulation temperature rating when the transformer is tested as indicated in 62.3 and 62.4. Insulation temperature rating is defined as the rating for the class of insulation; such as, 105°C for Class 105 insulation, 130°C for Class 130 insulation, and similar ratings. The transformer shall comply with the Dielectric Voltage-Withstand Test, Section 48, following the test specified in 62.3 and 62.4.

62.3 A variable resistance load is to be connected to the output terminals and the transformer operated continuously at the normal test voltage indicated in Table 40.1. When the protective device controls a switching device that, in turn, interrupts primary current to the transformer, the switching device is to be in the circuit. The test ambient temperature is to be 25°C (77°F). The resistance load is to be adjusted so that the transformer winding is brought to a stabilized temperature of 10°C (18°F) below its insulation rating. The load is then to be gradually increased until operation of the protector occurs.

62.4 Three samples of the transformer-protector combination are to be tested. Average temperatures of the three samples shall not exceed the winding insulation rating and the temperature of any one sample shall not exceed the insulation rating by more than 5°C (9°F).

63 Overvoltage And Undervoltage Tests

63.1 An electromagnet, such as employed on a relay or solenoid in a low-voltage circuit, shall withstand 10 percent above rated voltage without damage and shall operate at that voltage and also at 15 percent below rated voltage. When the component is supplied by the secondary winding of a low-voltage transformer provided as part of the unit, the voltage adjustments are to be made in the primary of the transformer based on the Normal Test Voltages specified in Table 40.1.

Exception: When failure of a low-voltage component to operate at 15 percent below rated voltage does not result in a risk of fire, electric shock, or injury to persons, the undervoltage test may be waived.

63.2 When a relay or other control is used in combination with a motor controller to prevent automatic recycling of the motor due to the operation of a protective device, the components involved shall comply with the requirements of 63.1 under any condition that might result from operation of the protective device and de-energization of the circuit.

63.3 Relays and solenoids are to be connected to a supply source maintained at the overvoltage condition until the coils of the relays and solenoids attain constant temperature. The potential then is to be reduced to the rated voltage and each relay and solenoid shall operate as intended at this voltage. A relay or solenoid that will not be subject to continuous operation is to be energized at the overvoltage condition at the rated voltage for the maximum time permitted by its duty cycle or until constant temperature is attained, whichever occurs first.

64 Current Overload Test

64.1 When required by 13.7 or 13.11, bonding conductors and connections shall not open, when carrying a current equal to twice the rating of the branch circuit overcurrent-protective device for the interval indicated in Table 64.1.

Table 64.1
Current overload test

Rating of overcurrent protection device, amperes	Minimum duration of current flow, minutes
30 or less	2
31 – 60	4
61 – 100	6
101 – 200	8

65 Insulation Resistance Test

65.1 Heaters

65.1.1 The insulation resistance of encapsulated heaters and sheath-type heaters that are exposed to moisture in a refrigerator shall be not less than 50,000 ohms when tested as described in 65.1.2 and 65.1.3 and the heater shall comply with the Dielectric Voltage-Withstand Test, Section 48, following exposure.

65.1.2 When an encapsulated heater or heater terminal seal is intended to be immersed in water as it is used in the refrigerator, the test is to be conducted by cycling two samples of the heater for 30 days, submerged in water. The water is to be maintained at a temperature of 94 – 100°C (194 – 212°F). The heater is to be energized at its rated voltage and cycled at a rate of 1-1/2 minutes on and 13-1/2 minutes off.

65.1.3 When an encapsulated heater or heater terminal seal is exposed to moisture but is not subject to more than occasional contact with water in the refrigerator, the test is to be conducted by cycling two samples of the heater assembly or terminal seal in an atmosphere of not less than 98 percent relative humidity at any convenient temperature above 0°C (32°F). The heater is to be energized at its rated voltage and operated for 1000 cycles at a rate of 1-1/2 minutes on 13-1/2 minutes off.

65.2 Thermal and acoustical insulating material

65.2.1 A refrigerator employing insulating material subject to the deteriorating conditions of moisture shall have an insulation resistance of not less than 50,000 ohms between live parts and interconnected

dead metal parts after exposure for 24 hours to air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (90 ±4°F).

66 Limited Short-Circuit Test

66.1 General

66.1.1 The components specified in (a) – (c) shall comply with the requirements of 66.2.1 – 66.4.1, as applicable, following short circuiting while protected by a branch-circuit overcurrent device of the size required by the refrigerator:

a) Motor overload protective devices connected in the motor circuit.

b) Motor circuit conductors and connections as required by 10.2.9.

c) Bonding conductors and connections as required by 13.7 and 13.11.

66.1.2 For a cord-connected unit, the branch-circuit protection specified in 66.1.1 is to be provided by a fuse having a rating not less than the rating of the attachment plug.

Exception: The minimum fuse size for a cord-connected refrigerator is to be 20 amperes rated 125 volts or less.

66.1.3 For a permanently-connected unit, the branch-circuit protection specified in 66.1.1 is to be provided by either:

a) A device that is recognized for branch-circuit protection and located in the unit, or

b) A branch-circuit protective device of the type and maximum rating specified on the refrigerator nameplate.

66.1.4 A permanently-connected refrigerator having more than one motor wired for connection to one supply line shall withstand short-circuiting while protected by a branch-circuit overcurrent device rated as indicated in 88.11.

Exception No. 1: The branch-circuit overcurrent device may have a lower rating, but not less than 15 amperes, provided that the refrigerator will start and operate without opening a fuse having this lower rating. See Starting Test, Section 43.

Exception No. 2: When the unit incorporates a branch-circuit overcurrent device as described in 66.1.3(a), the test is to be conducted with that device.

66.1.5 With regard to branch-circuit overcurrent protective devices and for the purpose of these tests, fuses of the same rating are considered to be interchangeable. Fuses and circuit breakers are not considered to be interchangeable. Circuit breakers are not considered to be interchangeable with each other.

66.1.6 The component is to be connected in a test circuit having a capacity based on the full-load current and voltage rating of the refrigerator. See Table 66.1. When the full-load current falls between two values in the table, the larger value is to be used in determining the circuit capacity. If the refrigerator nameplate shows individual loads, the full-load current is to be the total of all individual loads that may occur simultaneously. If more than one simultaneous load condition is possible, the condition resulting in the maximum total current is to be used as a basis for determining the capacity of the test circuit. The voltage for the test circuit is to be an alternating current supply, and the circuit capacity is to be measured without

the component in the circuit. The power factor of the test circuit is to be 0.9 – 1.0 unless a lower power factor is agreeable to those concerned.

Table 66.1
Short-circuit test currents

Full-load amperes				
Single phase				Circuit capacity amperes
115 V	208 V	230 – 240 V	277 V	
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.0	6.65 or less	1000
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 40.0	–	3500
Over 80.0	Over 44.0	Over 40.0	Over 6.65	5000
3 Phase				Circuit capacity amperes
208 V	220 – 240 V	440 – 480 V	550 – 600 V	
2.12 or less	2.0 or less	–	–	200
2.13 – 3.7	2.1 – 3.5	1.3 or less	1.4 or less	1000
3.8 – 9.5	3.6 – 9.0	–	–	2000
9.6 – 23.3	9.1 – 22.0	–	–	3500
Over 23.3	Over 22.0	Over 1.8	Over 1.4	5000

66.1.7 Three samples of each component or conductor under test are to be subjected to each test condition and a new protective device is to be used for each test. Consideration is to be given to both short-circuit and ground-fault conditions.

66.2 Motor overload protective device

66.2.1 There shall be no ignition of cheesecloth surrounding the enclosure of a motor protective device when samples are subjected to this test.

66.2.2 When a thermally protected motor or a separately enclosed motor overload protective device is within an outer cabinet, and if the assembly is constructed so that flame and molten metal will be confined within the cabinet and there is no flammable material except electrical insulation within the cabinet, the short-circuit test may be waived.

66.3 Bonding conductors and connections

66.3.1 Bonding conductors and connections shall not open when samples are subjected to this test.

66.4 Motor circuit conductors and connections

66.4.1 Motor circuit conductors and connections shall not be damaged when samples are subjected to this test.

67 Protective Devices – Maximum Continuous Current Test

67.1 To determine when a thermal protector or when a protective system complies with the requirement specified in 18.4.2, the refrigerator is to be tested as specified in 67.2, unless the motor-compressor has been separately tested as described in 67.4.

67.2 The refrigerator is to be connected to a circuit of rated voltage and operated under the conditions described in Table 67.1 for at least 1 hour or until stable conditions have been reached, whichever is longer. Stable operation is considered to be obtained when two consecutive readings, 15 minutes apart, of the temperature on top of the motor-compressor shell do not change more than 1.7°C (3°F). The voltage then is to be reduced in steps of 2 percent of rated voltage (to the nearest integral volt). Operation is to be allowed to become stable after each reduction in voltage before the next reduction is made, and readings of current input to the motor-compressor are to be noted after stable operation is obtained subsequent to each voltage reduction. If the refrigerator will operate at 90 percent of rated voltage without tripping the motor protective device, the first step in voltage reduction may be to 90 percent of rated voltage followed by alternate stabilization periods and 2 percent steps in voltage reduction as outlined above. This procedure is to be continued until the protective device opens the circuit. The motor-compressor current input at the lowest voltage step during which continuous operation occurs (the lowest voltage preceding the voltage at which the protective device opens the circuit) is to be used as the basis for judging compliance with the requirements in 17.1, 17.3(b) and 17.3(d).

Exception: Initial operation of the refrigerator may be at such a voltage that the current input is 156 percent of the rated current. The voltage then is to be reduced by 2 percent of rated voltage (to the nearest integral volt) to establish that the protective device opens.

Table 67.1
Test conditions for calibration of thermal protectors and protective systems in refrigerators

Location	Temperature °C	Temperature (°F)
Air temperature surrounding unit	40	(104)
For water-cooled unit		
Water temperature entering condenser	26.7	(80)
Water temperature leaving condenser	37.8[a]	(100)
For air-cooled unit		
Air temperature entering condenser	40	(104)

[a] Where this condition cannot be attained due to the design of the unit, the unit is to be tested at 80°F inlet condenser water temperature and 35 psig (2.41 kPa) nominal pressure.

67.3 The voltage reductions mentioned in 67.2 may be applied to the motor-compressor only, with the other components in the refrigerator operated at rated (or higher) voltage. For dual-voltage rated units, the rated voltage referred to in 67.2 is to be the higher of the two ratings.

67.4 The motor-compressor and its protective system, as employed in the refrigerator, may be separately tested as described in 67.2 under the conditions described in Table 67.2. This separate test may be used as a basis for judging compliance with the requirements in 17.1, 17.3(b) and 17.3(d).

Table 67.2
Test conditions for calibration of thermal protectors and protective systems separately from refrigerator

Location	°C	(°F)	°C	(°F)	°C	(°F)
Back Pressure Category	**Medium**		**Low**		**Extra Low**	
Return Gas						
Saturated vapor temperature	0	(32)	minus 12	(10)	minus 29	(minus 20)
Superheat	27	(81)	39	(102)	56	(133)
Discharge gas						
Saturated vapor temperature	60	(140)	55	(131)	55	(131)
Ambient Air						
Temperature	50	(122)	43	(110)	43	(110)
Velocity	400 fpm[a] (2.03m/s)		400 fpm[a] (2.03m/s)		400 fpm[a] (2.03m/s)	

[a] The velocity specified is the horizontal air velocity in the test chamber without the compressor installed. The actual velocity across the compressor may be different from this value, depending on the shape of the compressor and its effect on the air-flow pattern. A higher velocity may be employed if the results of the test with the higher air velocity indicate compliance with 18.4.2.

68 Strength Tests – Pressure Containing Components

68.1 Refrigeration system

68.1.1 Except as specified in 68.1.1.1 or for Stirling systems as in 68.1.1.2, high-side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Five times the marked high-side design pressure. See 87.2.7.

b) Five times the maximum pressure developed in the Temperature and Pressure Test, Section 44, and the Defrost Test, Section 47.

c) Five times the start-to-discharge pressure of a pressure relief valve or five times the set-pressure of a rupture member.

d) For a unit containing more than 22 pounds-mass (10 kg) of refrigerant, three times the maximum adjustable setting of the pressure-limiting device.

e) For a unit equipped with a fusible plug, 2-1/2 times the vapor pressure of the refrigerant at the relief temperature of the fusible plug or 2-1/2 times the critical pressure of the refrigerant, whichever is smaller.

f) For an air-cooled unit, three times the maximum high-side pressure developed in the Condenser Fan Motor Failure Test, Section 49.

g) For water-cooled units, five times the pressure developed in the Condenser Water Failure Test, Section 50.

h) For laboratory refrigerators and freezers with a limited charge system, one and one-half times the system pressure measured at 60°C (140°F) during the static pressure test, Section 83A. For all other refrigerators and freezers, one and one-half times the vapor pressure of the refrigerant at 60°C (140°F).

Exception: Alternatively, the fatigue tests of Section 69 may be conducted to determine component strength.

68.1.1.1 For refrigerant containing parts intended to comply with 36.1 (c), high-side and intermediate stage parts of a refrigerator with a transcritical carbon dioxide (R-744) refrigeration system and not complying with 68.1.1 shall be subjected to the higher of the pressures specified below:

a) Three times the maximum pressure measured in the Temperature and Pressure Test, Section 44;

b) Three times the minimum design pressure marked on the refrigerator nameplate;

c) For refrigerators equipped with a pressure relief valve, three times the start-to-discharge pressure of the relief valve;

d) For refrigerators equipped with a rupture member, three times the set pressure of the rupture member;

e) For refrigerators equipped with a high-side pressure-limiting device, three times the maximum cutout pressure that can be permitted by adjustment of the pressure-limiting device; or

f) 6,100 psig (42 MPa).

68.1.1.2 For refrigerant containing parts of a refrigerator with a Stirling engine cooling system, the thermosiphon (if equipped) shall be comply with Section 36 and 68.1.1.3 and the engine shall be subjected to the higher of the pressures specified below.

a) Three times the maximum pressure measured in the Temperature and Pressure Test, Section 44;

b) Three times the design pressure marked on the refrigerator nameplate;

c) For refrigerators equipped with a rupture member, three times the set pressure of the rupture member.

68.1.1.3 Thermosiphons shall have an ultimate strength not less than one and one-half times the vapor pressure of the refrigerant at 60°C (140°F). If the thermosiphon is supercritical at 60°C (140°F), the vapor pressure will be considered to be the thermosiphon refrigerant pressure at this temperature.

68.1.2 Pressure vessels bearing the ASME Code “U” symbol and having a working pressure not less than required by 68.1.1 or 68.1.4, as applicable, are acceptable without test.

68.1.3 A refrigerant-containing component of a compressor system having a marked working pressure shall have an ultimate strength equal to five times the marked working pressure.

68.1.4 Low-side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Three times the marked low-side design pressure. See 87.2.7;

b) Three times the maximum low-side pressure developed in the Temperature and Pressure Test, Section 44, including equalization pressure developed after compressor shutdown;

c) For an air-cooled unit, three times the maximum low-side pressure developed in the Condenser Fan Motor Failure Test, Section 49, including discharge pressure relieved to the low-side and equalization pressure developed after compressor shut-down;

d) For a water-cooled unit, three times the maximum low-side pressure developed in the Condenser Water Failure Test, Section 50, including discharge pressure relieved to the low-side and equalization pressure developed after compressor shut-down; or

e) One and one-half times the vapor pressure of the refrigerant at 60°C (140°F).

f) A pressure of 4150 psig (28.6 MPa) for refrigerators with a self-contained or unitary transcritical refrigeration system employing carbon dioxide as the refrigerant.

Exception No. 1: Low-side pressure vessels shall have an ultimate strength of not less than five times the highest of the following: low-side design pressure; maximum pressure developed during the Temperature and Pressure Test, Section 44; maximum pressure developed during the Defrost Test, Section 47; start-to-discharge pressure of a pressure-relief valve; or the set-pressure of a rupture member.

Exception No. 2: Low-side pressure vessels protected by a fusible plug shall have an ultimate strength not less than 2-1/2 times the vapor pressure of the refrigerant at the relief temperature of the fusible plug or 2-1/2 times the critical pressure of the refrigerant, whichever is smaller.

Exception No. 3: In a self-contained refrigerator, low-side parts exposed to hot-gas defrost pressure shall have an ultimate strength of not less than five times the maximum pressure developed in the low-side during the Defrost Test, Section 47.

Exception No. 4: In a remote refrigerator, low-side parts exposed to hot-gas defrost pressure shall have an ultimate strength of not less than three times the marked low-side design pressure.

Exception No. 5: For refrigerators intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or remote transcritical system, the low-side parts shall have an ultimate strength of not less than three times the start-to-discharge value of the pressure relief valve. Carbon dioxide (R744) used as a secondary coolant is considered to be at low-side pressure.

68.1.5 With reference to 68.1.1(h) and 68.1.4(e) vapor pressures of R134a, R500, and R502 at 60°C (140°F) are 229, 248, and 362 psig (1579, 1710, and 2496 kPa), respectively.

68.1.6 With reference to the requirements of 68.1.1 thru 68.1.4, sections of the refrigeration system constructed of continuous tubing or of lengths of tubing connected by soldered, brazed, or welded joints are considered as complying with these requirements, provided the tubing employed in the assembly complies with the requirements of 35.1.

68.1.7 Two samples of each refrigerant-containing part are to be tested. The test medium is to be any nonhazardous liquid, such as water. The test samples are to be filled with the test medium to exclude air and are to be connected in a hydraulic pump system. The pressure is to be raised gradually until the required pressure is reached. This pressure is to be maintained for 1 minute during which time the samples shall not burst or leak. Leakage is to be determined visually; for example, by examination of the sample for release of the test medium or as evidenced by a decreasing hydrostatic gauge pressure.

Exception No. 1: When gaskets are employed in components of refrigeration systems intended only for use with refrigerants classified as A1 or A1/A1 in accordance with the Standard for the Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34, leakage at gaskets is permitted provided that

such leakage occurs at a pressure greater than 40 percent of the required pressure. The component shall not rupture at the required strength test pressure even though leakage occurs at the gaskets or seals.

Exception No. 2: For Stirling engine systems, using refrigerants classified as A1 or A1/A1 in accordance with the Standard for the Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34 in amounts less than 100 g (3.53 oz), leakage is permitted provided that the test pressure can be maintained for 1 minute. The component shall not rupture at the required strength test pressure even though leakage has been detected.

68.1.8 Pressure-actuated refrigeration controllers rated for the application are exempt from strength test requirements for pressure containing components.

68.2 Beverage product system

68.2.1 Parts of a product system pressurized by a pump or compressed gas, including carbonation systems, provided with a refrigerator shall comply with the requirements of 68.2.2 or 68.2.3.

68.2.2 Except as specified in 68.2.5, parts of a product system pressurized by gas shall withstand a pressure equal to five times the start-to-discharge pressure of the relief valve. Systems consisting only of tubing or hose, with or without dispensing valves, and not incorporating a pressure relief valve (see 5.2.2) shall withstand a pressure of five times the maximum allowable pressure marked on the equipment. However, systems pressurized by gas which do not contain a relief valve shall withstand a test pressure of not less than 650 psig (4.5 MPa).

68.2.3 Except as specified in 68.2.5, parts that are pressurized by a pump shall withstand a pressure equal to five times the maximum pressure that the pump can develop. Systems which contain a relief valve with a start-to-discharge pressure less than the maximum pressure the pump can develop shall only be required to withstand a pressure equal to five times the start-to-discharge pressure of the relief valve, except as specified in 68.2.5.

68.2.4 The requirements of 68.2.3 apply to water and product pump housings, containers, interconnecting lines, and fittings that form part of a closed pressurized system. The parts are to be tested as described in 68.1.8. Parts that are not pressurized are exempt from this requirement.

68.2.5 Leakage at valves, tubing, and connections is acceptable when tests on three samples demonstrate that:

a) Leakage occurs at a pressure greater than 40 percent of the pressure required by 68.2.2 or 68.2.3 and

b) Liquid from such leakage does not impinge on uninsulated live parts.

68.2.6 A pressurized system may be used for operating valves or other controls that dispense a product. Parts of such a system need not comply with the strength test requirements when they comply with all the conditions specified in (a) – (f):

a) The maximum pressure in the system is limited to 50 psig by a nonadjustable regulating device or the maximum setting of an adjustable regulating device. The regulating device shall be an integral part of the refrigerator.

b) The system is intended to be pressurized by nitrogen, carbon dioxide, air, or similar gas.

c) The system is constructed to prevent the continual release of gas in the event of leakage, rupture or disconnection of the part.

d) The pressurized part is formed of a flexible material such as polymeric tubing.

e) The part is protected within an enclosure to reduce the risk of injury to persons in the event of rupture or disconnection of the part.

f) Liquid or vapor from leakage of the part does not impinge on uninsulated live parts.

69 Fatigue Test Analysis

69.1 General

69.1.1 These tests shall be applicable to those parts or the complete system that contains refrigerant and that are required to comply with the strength requirements specified in the Exception to 68.1.1.

69.2 Initial test

69.2.1 With reference to 69.6.1, when cycled for 250,000 cycles, two samples of the part or complete system shall have sufficient strength to withstand the pressure strength test requirements specified in the Strength Test, Section 68. The test pressure shall be the higher of:

a) Three times the maximum normal working pressure, see 44.2; or

b) Three times the maximum abnormal pressure developed (or setting of the pressure limiting device), see 49.1 and 50.1; or

c) Three times the minimum design pressure specified in Table 87.1.

d) For refrigerators intended to utilize carbon dioxide (R744) in a secondary loop or cascade system, three times the start-to-discharge value of the pressure relief valve.

69.2.1.1 With reference to 69.6.1, when cycled for 500,000 cycles, Two samples of the part or complete system shall have sufficient strength to withstand the pressure strength test requirements specified in the Strength Test, Section 68. The test pressure shall be the higher of:

a) Two times the maximum normal working pressure, see 44.2; or

b) Two times the maximum abnormal pressure developed (or setting of the pressure limiting device), see 49.1 and 50.1; or

c) Two times the minimum design pressure specified in Table 87.1.

d) For refrigerators intended to utilize carbon dioxide (R744) in a secondary loop or cascade system, two times the start-to-discharge value of the pressure relief valve.

69.2.2 The samples shall not burst or leak, except as indicated in the Exception to 68.1.7.

69.3 Material specifications

69.3.1 Materials used in the pressure containment system and subjected to this test shall be identified by reference to an industry standard material specification, such as ASTM, SAE, AISI, and the like, as specified by the manufacturer. Joining methods shall be specified by materials, the manufacturer's process specifications, or the equivalent.

69.4 Cycling test specifications

69.4.1 Three samples of each refrigerant-containing part shall be tested as described in 69.5. The cyclic pressure values are to be as specified in 69.6.2 and the number of cycles are to be as specified in 69.6.1. At the manufacturer's option, three samples of the complete system shall be used for the test.

69.4.2 The samples shall be considered to comply if they comply with 69.5.3 at the completion of the test and if they do not rupture, burst, or leak.

69.5 Test method

69.5.1 The test samples shall be filled with inert fluid, and shall be connected to a pressure driving source. The pressure shall be raised and lowered between the upper and lower cyclic values at a rate specified by the manufacturer. The full specified pressure excursion shall occur during each cycle. The shape of the pressure cycle shall be such that the upper and lower pressure values shall be maintained for at least 0.1 seconds. For safety purposes, it is suggested that the inert fluid described in 69.5.1 shall be a hydraulic fluid. The fluid shall completely fill the part, displacing all of the air.

69.5.2 Material such as steel, copper, and aluminum have fatigue properties that are practically independent of temperature at the continuous operating temperatures normally encountered under the operating temperature conditions and internal system temperatures of the unit. If the continuous operating temperature is less than or equal to 121°C (250°F) for copper or aluminum or 204°C (400°F) for steel, the test temperature of the component part or assembly shall be at least 20° C (68° F). If the continuous operating temperature of the component exceeds 121°C (250°F) for copper or aluminum or 204°C (400°F) for steel, the test temperature of the parts or assemblies that are at these temperatures, and subjected to the pressure, shall be at least 149° C (300° F) for copper or aluminum and 260° C (500° F) for steel. For other materials or higher temperatures, the effects of temperature on the material fatigue characteristics shall be evaluated.

69.5.3 Following the specified number of test cycles, the test pressure shall be increased to the highest amount specified in (a) or (b) below. After the pressure is raised, the test value shall be maintained for 1 min without rupture, burst, or leak.

a) Two times the minimum upper pressure values specified in 69.7.1; or

b) One and one-half times the marked or accepted pressure rating required in 87.1.2(e).

69.6 Test parameters

69.6.1 The number of cycles shall be 250,000. if the initial pressure test was conducted in accordance with 69.2.1 (3X pressure). The number of cycles shall be 500,000 if the initial pressure test was conducted in accordance with 69.2.1.1 (2X pressure). The test pressure of the first cycle of the test shall be determined by 69.6.2. The test pressure for the remainder of the test shall be determined by 69.7.1.

69.6.2 Except as indicated in 69.6.3, the pressure for the first cycle shall be the pressure identified in 69.2.1 prior to multiplying by three or 69.2.1.1 prior to multiplying by two.

69.6.3 For high-side or intermediate stage parts of a transcritical refrigeration system, the upper pressure of the high-side parts during the first cycle shall be the higher of: the marked design pressure in accordance with 87.2.8.1 for high-side parts or 87.2.8.2 for intermediate stage parts; the maximum abnormal pressure developed during the condenser fan motor failure test, Section 49; or the condenser water failure test, Section 50.

69.7 Cycle test pressure specification

69.7.1 Except as indicated in 69.7.2, the pressure for the remainder of the test cycles shall be as follows:

a) Except as indicated in c) components subject to high side pressures, the upper pressure value shall not be less than the saturated vapor pressure of the refrigerant at 49°C (120°F), and the lower pressure value shall not be greater than the saturated vapor pressure of the refrigerant at 4.4°C (40°F);

b) Except as indicated in c) components subjected to only low side pressures, the upper pressure value shall be not less than the saturated vapor pressure of the refrigerant at 27°C (80°F), and the lower pressure value shall be between 0 psig and the greater of 5 psig or the saturated vapor pressure of the refrigerant at minus 12° C (10° F). When the saturated vapor pressure of the refrigerant at minus 12 °C (10 °F) is a negative value, then the lower pressure value may be any convenient value between 0 psig (0 kPa) and 5 psig (34.5 kPa). For zeotropic mixtures, the average of the dew point pressure value and the bubble point pressure value at the specified temperature is used as the saturated vapor pressure value;

c) For components used in refrigerators intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or remote transcritical system, the upper pressure value shall not be less than the start-to-discharge value of the pressure regulating relief valve. The lower pressure shall be not more than 100 psig; and

d) For high-side or intermediate stage parts of a transcritical refrigeration system, the upper pressure for the remaining cycles shall be not less than 95 percent of the higher of the values specified in 69.6.3. The lower pressure for all cycles shall not be greater than the saturated vapor pressure of the refrigerant at 40 °F (4.4 °C). For R744, this value is 553 psig (3.8 MPa).

69.7.2 For high-side or intermediate stage parts of a transcritical refrigeration system, the lower pressure for all cycles shall not be greater than the saturated vapor pressure of the refrigerant at 40 °F (4.4 °C). For R744, this value is 553 psig (3.8 MPa).

70 Start-To-Discharge Test

70.1 A pressure-relief device used in the carbonation system shall relieve at a pressure not exceeding its rated start-to-discharge pressure.

70.2 Three samples of the device are to be tested. Each sample is to be connected to a gas source, such as air, carbon dioxide, or nitrogen, but oxygen or any flammable gas is not to be used. The sample is to be immersed in water, and the pressure is to be gradually increased until the device starts to discharge as evidenced by the occurrence of bubbles in the water. The highest value obtained in tests of the three samples is to be used to determine compliance with 70.1.

71 Regulating Relief Valve Endurance Test

71.1 This test applies to pressure regulating relief valves which may be used on refrigerators using carbon dioxide (R744) in a secondary loop or in a cascade system.

71.2 The test shall be conducted in accordance with 70.2 except that the average of the initial three start-to-discharge pressure values is to be used as a reference. The average start-to-discharge pressure for the three samples shall not exceed the marked setting of the regulating relief valve. Each individual sample shall have a start-to-discharge pressure within ± 7 percent of the marked setting of the regulating relief valve.

71.3 The same three test samples shall then be cycled 300 times between the start-to-discharge pressure and any lower pressure such that no air is discharged through the test samples.

71.4 At the conclusion of the test, the start-to-discharge pressure obtained on the final cycle for each of the three test samples shall be averaged and compared to the initial referenced value. The final averaged value shall be within ±7 percent of the initial averaged reference value and each individual sample valve shall have a start-to-discharge pressure within ±10 percent of the marked setting of the regulating relief valve.

72 Shelf Strength Test

72.1 A food storage component shall remain in position and comply with 72.3 after being subjected to three impacts as indicated in (a) and (b). In addition, the impacts shall not result in exposure of live parts, damage to electrical components or wiring, or reduction of electrical spacings.

a) The release from a height of 4 inches (102 mm) of a bag containing lead shot, whose weight is equal to one-half the weight of the test load specified in 72.3, but not exceeding the weight of ten of the cylinders described in 72.3. The height of the drop is to be a measured to the bottom of the bag.

b) When the maximum loading height of the component is less than 10 inches (254 mm), the bag of lead shot is to be released from a height equal to the maximum loading height minus 6 inches (152 mm).

Exception: This requirement does not apply to food storage components in chest-type refrigerators.

72.2 The lead shot is to be trade size No. 9 to 6, or 0.08 to 0.11 inch (0.2 to 0.3 mm) diameter. The bag is to be spherical and is to impact the food storage component at the center.

72.3 A food storage component shall remain in position and retain a test load applied for 1 hour as specified in (a) – (c):

a) The maximum number of solid steel cylinders, each weighing 2.2 pounds (1 kg) and having a diameter of 3.15 inches (80.0 mm), that can be placed in a single tier, with their axes vertical, on the food storage component without any cylinder overhanging the front edge of the component.

b) When the maximum loading height of a shelf does not exceed 5.9 inches (150 mm), the solid steel cylinders are to be 3.15 inches (80.0 mm) in diameter are to weigh 1.1 pounds (0.5 kg) each, or

c) When more than one food storage component is supported by a bracket (for example, plaster arrangement), the bracket shall remain in position when all support components are simultaneously loaded as indicated in (a) or (b), as applicable. Adjustable food-storage components shall be equally spaced during this test.

Exception: This requirement does not apply to food storage components in chest-type refrigerators.

72.4 Other loading means may be used in lieu of cylinders, provided the load is equivalent to that calculated on the basis of 72.3.

72.5 The tests in 72.1 and 72.3 are to be conducted with any arrangement or removal of food storage component and, where the food storage component or its structural support parts are constructed of polymeric materials, the tests in 72.1 and 72.3 are to be conducted at the temperature specified in (a) or (b):

a) 15.6 to 32.2°C (60 to 90°F) for components in the fresh-food storage area.

b) Minus 17.8 ±1.4°C (0 ±2.5°F) for components in the frozen-food storage area. In this case, the components are to be maintained at the test temperature for a period of not less than 24 hours prior to testing.

73 Component Restraint Test

73.1 A slideout food storage component (drawer, shelf, or similar component) shall be restrained to prevent its being unintentionally pulled free of its supporting means.

Exception: The types of components specified in (a) – (d) need not be restrained:

a) A pan, tray, or similar container that rests freely on a shelf or on the storage compartment bottom;

b) A component that does not exceed 10 pounds (4.5 kg) in weight when loaded as indicated in 72.3;

c) A shelf or container located so that the bottom of the shelf or container is not more than 20 inches (508 mm) above the floor, with levelers adjusted to raise the refrigerator to its maximum elevation above the floor, but not to more than 1 inch (25.4 mm); and

d) A condensate tray not intended for food storage.

73.2 The restraint specified in 73.1 is acceptable if it will prevent the food storage component from being pulled clear of the refrigerator with the application of a statically applied load equal to the weight of the component loaded in accordance with 72.3, but not more than 30 pounds (13.6 kg). The component is to be loaded in accordance with 72.3 and is to be in its restrained position. The force is to be applied horizontally by hanging a weight from a cord running over a pulley and attached to the center of the load edge of the component.

74 Glass Strength Test

74.1 Except as indicated in 74.4 and 74.5, glass subject to contact during use and routine maintenance of the refrigerator shall be no less than 0.115 inch (2.92 mm) thick, and shall comply with the requirements of 74.2, when applicable, and 74.3.

74.2 Exterior glass having an exposed minor dimension exceeding 12 inches (305 mm) and an area greater than 144 square inches (929 cm^2) shall:

a) Be of a nonshattering or tempered type that when broken complies with the Safety Performance Specifications and Methods of Test for Safety Glazing Materials Used In Buildings, ANSI Z97.1, or

b) Withstand without cracking or breaking to the extent that pieces are released or dropped from their intended position, a 2-1/2 foot-pound (3.4 J) impact from a 2 inch (50.8 mm) diameter, 1.18 pound (0.54 kg) steel ball. The impact is to occur within 1 inch (25.4 mm) of the center of the glass area.

74.3 Exterior glass having an exposed minor dimension greater than 3 inches (76 mm) shall withstand for a period of 1 minute, a gradually applied force of 50 pounds (223 N). The force is to be evenly distributed and applied through a 3 inch (76 mm) diameter resilient disc located in the center of the glass area. There shall be no evidence of the failure of the glass or supporting means. When the entire section of glass is located 6 feet (1.8 m) or more above floor level, this test is not applicable.

Exception: The applied force is to be 35 pounds (156 N) when the entire section of glass is located more than 42 inches (1.1 m) above floor level and is in a plane that is 45 degrees or less with the vertical plane.

74.4 Among the factors that are to be taken into consideration when judging the acceptability of glass panels heated by electrically conductive surfaces or other means are: electrical input, temperature rise, operation at overvoltage condition, ability to withstand dielectric potential, reliability of vapor seal, resistance to moisture, stability of conductive coating, aging of terminal assemblies, resistance to impact, and resistance to thermal shock.

74.5 Glass components, other than lamps, used inside refrigerators shall:

a) Have smooth edges if the edges are exposed to contact during routine use, including cleaning. Edges exposed when the glass component is in its intended storage position shall be fire polished, heat-toughened or tempered, or covered by permanently attached smooth framing.

b) Withstand without breakage, a 1.6 foot-pound (2.2 J) impact from a 2 inch (50.8 mm) diameter, 1.18 pound-mass (0.54 kg) steel ball, specified in (1) – (3):

1) The impact energy is to be imposed on the sample by the steel ball, either falling vertically or by swinging as a pendulum. The sample component is to be struck within 1 inch (25.4 mm) of its center.

2) The test may be conducted on a panel of flat glass of the type employed in the refrigerator when it is determined that the results of the test on the separate panel are representative of the component as employed in the refrigerator.

3) Three samples of each component are to be tested, and a separate sample is to be used for each test.

75 Door Latch Release and Door Opening Test

75.1 *Deleted*

75.2 *Deleted*

75.3 *Deleted*

75.4 *Deleted*

75.1 Door Latch Release Test

75.1.1 An interior latch release device of a walk-in refrigerator, freezer, or door panel assembly door (see 4.5) shall release with a force of 15 pounds (66.7 N) or less, applied at the rate of 3 to 4 pounds (13.4 to 17.8 N) per second. This test is to be conducted before and after the test specified in 75.1.3.

75.1.2 When the force required to release the door latch is intended to be applied to an interior bar, lever, or similar actuator, the force is to be applied to this actuator.

75.1.3 Components of a latch release mechanism that permit the refrigerator door to open as a result of a force applied to an actuator shall not break, crack, or permanently deform from the application of 50 successive 20 pounds (88.9 N) pushing operations followed by 50 successive 20 pound pulling operations (when either or both are applicable, depending on the component construction).

75.2 Door Opening Test

75.2.1 The door of a walk-in refrigerator, freezer, or door panel assembly (see 4.5) shall open when a force of 50 pounds (220 N) is applied.

75.2.2 The force is to be applied at a rate of 3 – 4 lbs (13.4 – 17.8 N) per second until the door opens.

75.2.3 When a door latch release mechanism is employed, the force is to be applied to the door within 12 inches (30 cm) of the interior latch release mechanism. The door opening test is conducted after the Door Latch Release Test of 75.1.

75.2.4 When a door latch release mechanism is not employed, the release force measurements are to be made by means of a force gauge at each of three points on the inside of the door or door liner edge on the side opposite the hinges. One point is to be near the top of the door, one point near the bottom of the door, and one point midway between these two points. The force measurements may be made at points on the outer door surface corresponding to the three internal points.

75.2.5 When the test in 75.2.1 is applied to a door with an adjustable spring closing or counterbalancing mechanism, the mechanism is to be adjusted to the position requiring maximum opening force.

76 Accelerated Aging Test – Electric Heaters

76.1 Rubber, neoprene, or thermoplastic compounds used as a heater casing or for heater terminal seals shall withstand accelerated aging without deteriorating to a degree that will affect its use. Aging conditions, as specified in Table 76.1 are based on the maximum temperature rise, measured in an ambient from 25 to 40°C (77 to 104°F) on the device during the Temperature and Pressure Test, Section 44, Defrost Test, Section 47, or both.

Table 76.1
Accelerated aging test criteria

Measured temperature rise		Test program	
°C	(°F)	Rubber or Neoprene	Thermoplastic
35	(63)	Air oven aging for 70 hours at 100 ±2°C (212 ±3.6°F)	7 days in an air circulated oven at 100°C (212°F)
50	(90)	Air oven aging for 168 hours at 100 ±2°C	10 days in an air circulated oven at 100°C (212°F)
55	(99)	7 days in an air circulated oven at 113°C (235.4°F)	
65	(117)	10 days in an air circulated oven at 121°C (249.8°F)	7 days at 121°C (249.8°F) or 60 days at 97°C (206.6°F) in an air circulated oven
80	(144)	7 days in an air circulated oven at 136°C (276.8°F)	
100	(180)	60 days in an air circulated oven at 136°C (276.8°F)	
125	(225)	60 days in an air circulated oven at 158°C (316.4°F)	
175	(315)	60 days in an air circulated oven at 210°C (410°F)	

77 Reliability Test – Heater Terminations

77.1 Electric heaters employing either integrally molded leads or molded terminal assemblies shall withstand, without displacement of insulation or separation of the connection between the lead and heater, a test load of 20 pounds (9.1 kg) applied for 1 minute. The load is to be applied to the leads or terminals in the direction at which they exit the heater case or molded connection.

78 Accelerated Aging Tests

78.1 Gaskets and sealing compounds of neoprene or rubber required for use with electrical enclosures as determined during the Rain Test, Section 53, shall have physical properties before and after 70 hours of air oven aging at 100 ±2°C (212 ±3.6°F) as indicated in Table 78.1.

Exception: These requirements do not apply to foamed materials.

Table 78.1
Physical properties of gaskets and sealing compounds

	Before test	After test
Recovery – Maximum set when 1 inch (25.4 mm) gage marks are stretched to 2-1/2 inches (63.5 mm) and held for 2 minutes and measured 2 minutes after release	1/4 inch (6.4 mm)	
Elongation – Minimum increase in distance between 1 inch (25.4 mm) gage marks at break.	250 percent (1 to 3-1/2 inches) (25.4 to 88.9 mm)	65 percent of original
Tensile Strength – Minimum force at breaking point.	850 psig (5.9 MPa)	75 percent of original

78.2 Foamed neoprene or rubber compounds shall not harden or otherwise deteriorate to a degree that will affect their sealing properties after being subjected to 70-hour air oven test at 100 ±2°C (212 ±3.6°F).

78.3 A thermoplastic material shall not deform, melt, or otherwise deteriorate to a degree that will affect its sealing properties following exposure to air at a temperature of 87°C(190°F) for a period of 7 days.

78.4 With reference to 78.3, polyvinyl chloride gasket material shall have an ultimate tensile strength of not less than 1200 psig (8.3 MPa) and an ultimate elongation of not less than 250 percent prior to the exposure to the elevated air temperature. The minimum tensile strength shall be not less than 90 percent and the elongation not less than 75 percent of the original values following the exposure to the elevated air temperature.

78.5 Sealing compounds are to be applied to the surface they are intended to seal. A representative sample of the surface with the sealing compound applied is to be subjected to a test involving exposure to air at 87° C (190° F) for a period of 7 days. The sealing compound shall not melt, become brittle, or otherwise deteriorate to a degree that will affect its sealing properties as determined by comparing an aged sample to an unaged sample.

78.6 When gaskets are secured by adhesives, samples of the gasket adhesive and mounting surface are to be exposed to 87°C (190°F) air oven for 7 days; and immersion in distilled water for 3 days. The force required to peel the gasket from its mounting surface after exposure shall be not less than 50 percent of the value determined on “as-received” samples and in no case less than 2 pounds per inch (350 N/m) of gasket width.

79 Metallic Coating Thickness Test

79.1 The solution to be used for this test is to be made from distilled water containing 200 grams per liter of chemically pure chromic acid, CrO_3 and 50 grams per liter of chemically pure concentrated sulfuric acid, H_2SO_4. The latter is equivalent to 27 milliliters per liter of chemically pure concentrated sulfuric acid, specific gravity 1.84 containing 96 percent of H_2SO_4.

79.2 The test solution is to be contained in a glass vessel, such as a separatory funnel, with the outlet equipped with a stopcock and a capillary tube of 0.025 inch (0.64 mm) inside bore and 5.5 inches (140 mm) long. The lower end of the capillary tube is to be tapered to form a tip; each drop from which is to be 0.05 milliliter. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position adjusted so that the rate of dropping is 100 ±5 drops per minute when the stopcock is open. An additional stopcock may be used in place of the glass tube to control the rate of dropping.

79.3 The sample and the test solution are to be kept in the test room long enough to acquire the temperature of the room, which is to be noted and recorded. The test is to be conducted at a room temperature of 21.1 to 32.2°C (70 to 90°F).

79.4 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of an acceptable solvent. Samples then are to be thoroughly rinsed in water and dried with clean cheesecloth. Care should be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

79.5 The sample to be tested is to be supported 0.7 – 1 inch (17.8 – 25.4 mm) below the orifice so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested is to be inclined 45 degrees from horizontal.

79.6 After cleaning, the sample to be tested is to be placed under the orifice. The stopcock is to be opened and the time, in seconds, is to be measured with a stopwatch until the dropping solution dissolves off the protective metallic coating and exposes the base metal. The initial appearance of the base metal is recognizable by the change in color at that point.

79.7 Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface, and at an equal number of points on the outside surface, at points where the metallic coating may be expected to be the thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

79.8 To calculate the thickness of the coating being tested, the thickness factor appropriate for the temperature at which the test was conducted is to be selected from Table 79.1 and multiplied by the time, in seconds, required to initially expose base metal as determined in 79.6.

Table 79.1
Thickness of coating factors

Temperature		Thickness factors, 0.00001 inches (0.0003 mm) per second	
°F	°C	Cadmium platings	Zinc platings
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042

Table 79.1 Continued on Next Page

Table 79.1 Continued

Temperature		Thickness factors, 0.00001 inches (0.0003 mm) per second	
°F	°C	Cadmium platings	Zinc platings
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

80 Fastener Strength Test

80.1 This test applies to nonmetallic materials, as determined in footnotes (e), and (f) of Table 82.1, secured by:

a) Ultrasonic, solvent, or heat welds;

b) Nonmetallic screws and nuts; and

c) Metal screws threaded into nonmetallic materials.

80.2 The tightening torque and pull-off strength of such fasteners shall be not less than 50 percent of the as-received value.

80.3 Three sets of samples, each set consisting of three specimens, is to be conditioned as indicated in Table 80.1 and Table 80.2.

Table 80.1
Test specifications

Sample Set	No. of Samples	Test Specifications
1	3	As-received (no conditioning).
2	3	Oven aging – 300 hours at the service temperature plus 10°C (18°F) but not less than 70°C (158°F). Service temperature is considered to be the temperature measured during the Temperature and Pressure Test, Section 44.
3	3	Heat cycling – 40 cycles of alternate heating and cooling at the temperatures specified in Table 80.2. Each cycle is to consist of 4 hours at the upper temperature followed by 4 hours at the lower temperature.

Table 80.2
Temperature cycling parameters

Location	Upper Temperature	Lower Temperature
Nonrefrigerated Areas	Service temperature plus 10°C (18°F) but not less than 70°C (158°F)	25°C (77°F)
Refrigerated Area	32°C (90°F)	0°C (32°F)
Low Temperature Area	32°C (90°F)	minus 17.8°C (0°F)

81 Burnout Test – Impedance Protected Motors

81.1 This test is to be conducted on impedance protected motors when such motors are not enclosed in metal or in 5V material and are located adjacent to other than 5V materials. One sample is to be tested as described in 81.2.

81.2 Each motor to be equipped with a thermocouple for measurement of the winding temperature. The rotor is to be locked. The motor is to be mounted as intended in use, completely wrapped in dry absorbent surgical cotton, and connected to a variable voltage source. The motor is then to be energized at rated voltage and operated until the winding temperature stabilizes. The voltage is then to be progressively increased in 5 volt increments, allowing the winding temperature to stabilize after each increase in voltage. Operation is to continue until burnout occurs.

81.3 There shall be no ignition of cotton surrounding the motor.

81.4 As an alternate to testing the individual motor as described in 81.2, the test is to be conducted on the complete unit. The test arrangement and the test method is to be as described in 81.2 except that the motor is not to be wrapped in cotton. There shall be no ignition of flammable materials.

82 Tests on Nonmetallic Materials

82.1 Nonmetallic materials are to be evaluated as indicated in Table 82.1.

Table 82.1
Tests on nonmetallic materials

Test Group	Applicable Test Number
Group 1 A part serving as an ultimate enclosure for ignition sources.	1[a], 2[b], 3[c], or 4[d], 6, 7[e,f], 8[g], 9, 10, 11, 12, 13
Group 2 An enclosure not serving as an ultimate enclosure for ignition sources.	Minimum 4, 6, 7[e,f], 8[g], 9, 10, 11, 12, 13
Group 3 A functional part.	3[h], 4[d], 6, 7[e,f], 8[g], 10, 11, 12
Group 4 A nonfunctional part.	3[h], 4[d], 5[d], 9
NOTES 1. 5 inch end product flame test [i]. 2. 5V rated material.	

Table 82.1 Continued on Next Page

Table 82.1 Continued

Test Group	Applicable Test Number
3. V-0, V-1, V-2, HF-1, HF-2 rated materials 3/4 inch End Product Flame Test or 12 mm End Product Flame Test [i].	
4. HB or HBF rated material or a material with a flame spread rating of 25 or less and a smoke developed rating of 50 or less.	
5. HBF, HF-1, HF-2 rated materials.	
6. Mold Stress-Relief Test [i].	
7. Fastener Strength Test, Section 80.	
8. Adhesive Test [i].	
9. Radiant Panel or Surface Burning Characteristic Test (See 7.1.3) – Applies only to parts forming portions of the external enclosure, or of a decorative part if the total area of the enclosure exceeds 10 square feet (0.93 m^2).	
10. Volume Resistivity Test [i] – Applies only if electrical spacings between uninsulated live parts and the material are less than specified in line-voltage circuits, and extra-low voltage (Class 2) circuits, or if the part is used as indirect support of an uninsulated live part.	
11. High Current Arc Ignition Test [i] – Applies only if the material is used to enclose uninsulated live parts or to provide indirect support of uninsulated live parts. This test need not be conducted if the uninsulated live parts are located a minimum of 1/32 inch (0.79 mm) from the enclosure or functional part.	
12. Hot Wire Ignition Test [i] – Applies only if the material is within 1/2 inch (12.7 mm) of electrically-heated wires or resistors.	
13. Impact Tests [i] – 5 ft-lb (6.8 J) impact for enclosures containing uninsulated live parts, 1.5 ft-lb (2.0 J) impact for enclosures containing moving and hot parts. If an enclosure of uninsulated live parts is protected because of it's location within the confines of the refrigerator, it shall withstand an impact of 1.5 ft-lb (2.0 J).	
[a] An enclosure provided with a barrier interposed between the material and an ignition source will be tested with the barrier in place.	
[b] A material with a V-2 minimum rating is able to be used to enclose an ignition source if the ignition source is only energized as a result of a continuous action by an attending operator. The lens of a high voltage Light Emitting Diode (LED) luminaire may be rated V-1 if all ignition sources other than the LEDs themselves are isolated from the lens in accordance with 8.3.3 and 8.3.4.	
[c] These materials are able to be used if ignition sources are separated or isolated in accordance with 8.3.3 and 8.3.4. When the ignition source is line voltage wiring, the wiring need not be separated or isolated from enclosures formed from a material with a minimum V-2 rating.	
[d] If line voltage wiring without VW-1 insulation is the only ignition source and it is separated or isolated in accordance with 8.3.3 and 8.3.4, materials having a minimum HB or HBF rating are able to be used.	
[e] Applies only to the ultrasonic welds, or heat welds; polymeric screws or nuts; metal screws threaded into a polymeric part; or other means where degradation of a polymeric material affects securement.	
[f] Applies to an enclosure that serves only to reduce the risk of electric shock.	
[g] Applies only if the adhesive is relied on to maintain the integrity of an enclosure or functional part.	
[h] If ignition sources are separated or isolated in accordance with 8.3.3 and 8.3.4, materials having a minimum HB or HBF rating are able to be used as a functional or non-functional part.	
[i] Tested or rated as described in UL 746C, except that when a nonmetallic part is used within a freezer compartment, three samples are to be conditioned in a temperature of minus 18 ±1.4 °C (0 ±2.5 °F) for a period of 3 hours and impacted while still cold.	

83 Label Adhesion Tests

83.1 A marking secured by cement or adhesive shall comply with the applicable portions of the requirements in the Standard for Marking and Labeling Systems, UL 969.

83A Static Pressure Test

83A.1 This test is applicable to laboratory refrigerators and freezers employing a limited charge system as referenced in 68.1.1(h) and 87.2.9. The test will determine the pressure in the refrigeration system so the design pressures and ultimate strength of the limited charge system can be determined.

83A.2 A pressure gauge is to be attached to the refrigeration system as indicated in 39.2. The entire product or refrigeration system shall then be placed in an environmental chamber. The compressor shall not be energized.

83A.3 The temperature in the chamber shall be increased to the required temperature. See 68.1.1(h) and 87.2.9. This temperature shall be maintained for 4 hours.

83A.4 The refrigeration system pressure shall be monitored and recorded. The maximum pressure shall be used as the basis for the ultimate strength as referenced in 68.1.1(h) and the design pressure(s) as referenced in 87.2.9.

83B Reserved

83C Component Failure Test

83C.1 A single malfunction (short or open) of any circuit component, such as a resistor, capacitor, solid state device, and the like, shall not result in a risk of fire or electric shock or increased risk of personal injury.

83C.2 With reference to 83C.1, each circuit component is to be open- or short-circuited one at a time. For a discrete device having more than two terminals, such as a transistor, SCR, triac, or similar device, any combination of two terminals shall be open- or short-circuited. For an integrated circuit device, the following combination of terminals shall be tested:

a) Each pair of adjacent terminals shorted;

b) Each input terminal shorted to (referenced) ground terminal;

c) Each output terminal shorted to (referenced) ground terminal;

d) Each input terminal shorted to each power supply;

e) Each output terminal shorted to each power supply; and

f) Each terminal open-circuited.

Exception No. 1: Components in a Class 2 circuit that is not a safety circuit are not required to be open- or short-circuited.

Exception No. 2: A resistor investigated for acceptability with respect to end-use conditions and incorporating insulation complying with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, spacings, or both to reduce the risk of a short circuit or reduction in resistance is not required to be open- or short-circuited.

Exception No. 3: A capacitor, capristor (parallel combination of a capacitor and resistor), or similar circuit component, complying with requirements for antenna coupling and line bypass components in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, and investigated for acceptability with respect to end-use conditions, is not required to be short-circuited.

Exception No. 4: Component failure testing is not required if circuit analysis indicates that no other component or portion of the circuit will be seriously overloaded and that a risk of fire, electric shock, or injury to persons will not occur as a result of the assumed open- or short-circuiting of another component.

83C.3 During these tests, the control or the end-use product is to be covered with a single layer of cheesecloth and then placed on a softwood surface that has been covered with white tissue paper. The sample is to be connected to a source of supply as indicated in Clause 40.1. Dead metal parts of the control, end-use product, or both are to be earth grounded through a 3-A nontime-delay fuse. The control is to be operated in any normal mode (for example, full power, partial power, standby, or similar mode) to cause the most adverse results.

83C.4 If a circuit element or printed wiring foil opens to terminate a test, the test is to be repeated two additional times.

Exception: Operation of a thermal or overcurrent device that is rated for the application does not require repeating the test.

83C.5 Following the abnormal conditions specified in Clause 83C.2, the sample shall be subjected to the applicable dielectric voltage-withstand test, Section 48. The dielectric voltage withstand test need be conducted only after the last abnormal operation test unless it is necessary to replace components after conducting the other tests.

83C.6 At the conclusion of the test, a risk of fire or electric shock shall be considered to exist if the test results in any of the following:

a) Ignition of the cheesecloth or the tissue paper;

b) The 3 A fuse connected to earth ground opens;

c) Any opening is developed in the overall enclosure that is larger than those permitted by accessibility requirements as covered by electrical protection, Clause 5.4; or

d) The appliance/control does not comply with the dielectric voltage-withstand test, Clause 48.

83C.7 Rather than the component failure tests specified in Clause 83C.2, a component evaluation study may be used to determine the result of specific open- and short-circuits.

83D Tests on Thermoelectric Refrigerators and Freezers

83D.1 General

83D.1.1 Except as specified in 83D.1.4, a thermoelectric cooling appliance without a fan, when tested in accordance with 83D.2.1shall not emit any flame or molten metal from the appliance.

83D.1.2 A thermoelectric cooling appliance with fan(s), when tested in accordance with 83D.3.1:

a) Shall not emit any flame or molten metal from the appliance; and

b) If the fan motor (s) are not protected in accordance with Section 18, shall not develop temperatures exceeding 302 °F (150 °C) on the fan motor winding of an open type motor or of the fan motor enclosure of a totally enclosed motor. This requirement also applies to fan motors supplied by a low voltage Class 2 or Limited Power Source circuit.

83D.1.3 Except as specified in 83D.1.4, a thermoelectric cooling appliance with a semiconductor thermoelectric module powered by other than a low voltage Class 2 or Limited Power Source supply shall comply with the Dielectric Voltage Withstand test referenced in 83D.4.1. No dielectric breakdown shall occur.

83D.1.4 With regards to 83D.1.1 and 83D.1.3, if the thermoelectric circuit is powered by other than a low voltage Class 2 or Limited Power Source circuit, the thermoelectric cooling appliance shall comply with 83D.1.1 and 83D.1.3 or the thermoelectric module shall comply with the dielectric withstand test of 83D.5.1.

83D.2 Thermoelectric cooling appliances without fans

83D.2.1 Unless tested in accordance with 83D.5.1, a thermoelectric cooling appliance without a fan shall be connected to a supply circuit maintained as indicated in 40.1. Any heat sink on the hot side of the thermoelectric module shall be removed, but any fuses within the thermoelectric circuit may remain. The appliance shall be operated for not less than 7 hours or until fuses within the thermoelectric circuit open or burnout of the thermoelectric module occurs. The appliance shall comply with 83D.1.1.

83D.3 Thermoelectric cooling appliances with fans

83D.3.1 This test is applicable to any thermoelectric appliance that uses a fan to cool the thermoelectric module if the fan motor, including a motor supplied by a Class 2 or Limited Power Source circuit, is not protected in accordance with Section 18.2. The appliance shall be connected to a supply circuit maintained as indicated in 40.1. The heat sink shall be in place, as intended. The heat sink fan motor shall be electrically energized but the fan shall be locked to prevent turning. If multiple fans are provided, only one fan shall be locked at a time. The appliance shall be operated until temperatures on the fan motor stabilize, until any fuse within the thermoelectric circuit opens or burnout of the thermoelectric module occurs. The appliance shall comply with 83D.1.2 (a) and (b).

83D.4 Thermoelectric circuits powered by other than a low voltage class 2 or limited power source supply

83D.4.1 For a thermoelectric cooling appliance powered by other than a Class 2 or Limited Power Source supply, immediately following the tests in 83D.2.1 or 83D.3.1, while the appliance is still in a heated condition, the Dielectric Voltage Withstand test in Section 48 shall be conducted. The test potential shall be applied between the live parts of the thermoelectric module and dead metal parts.

83D.5 Dielectric voltage withstand – 5000 volt test

83D.5.1 This test applies to a thermoelectric appliance in which the thermoelectric module is powered by other than a low voltage Class 2 or Limited Power Source supply and the tests of 83D.2.1 and 83D.4.1 have not been conducted.

83D.5.2 Two sample modules shall be used for this test. One sample shall be conditioned for 40 hours at 23.0 ± 2.0 °C (73.4 ± 3.6 °F) and 50 ± 5 percent relative humidity. The other sample shall be conditioned for 96 hours to moist air having a relative humidity of 90 ± 5 percent at a temperature of 35.0 ± 2.0 °C (95.0 ± 3.6 °F).

83D.5.3 Immediately following the conditioning, each thermoelectric module sample, including any sealant at the wiring lead connections, shall be wrapped with aluminum foil and a potential of 5000 volts shall be applied between the high-voltage live parts of the module and the foil. No dielectric breakdown shall occur.

MANUFACTURING AND PRODUCTION TESTS

84 Pressure Tests

84.1 Each refrigerator shall be tested and proved tight at not less than the design pressure(s) marked on the refrigerator. See 87.2.7.

Exception: A method other than pressure testing at the design pressure may be employed if it can be demonstrated that the alternate test method produces results that are at least equivalent to the pressure test method.

84.2 If the final assembly of a self-contained refrigerator is completed with flare-type fittings or telescoped tubing joints that are sealed with solder, brazing, or the equivalent, the pressure test of the complete system may be at the low-side design pressure provided that the high-side parts are individually tested either by the refrigerator manufacturer or by the manufacturer of the part at not less than the high-side design pressure.

84.3 At least once each year, the manufacturer shall conduct a strength test on refrigerant-containing or carbon dioxide-pressured parts of the shell type, including compressor shells that have an inside diameter greater than 3 inches (76 mm). The test is to be conducted on at least one sample of each size and type. The sample shall be proved tight when subjected to pressures indicated in the Strength Tests – Pressure Containing Components, Section 68.

Exception: ASME Code vessels bearing the Code "U" symbol need not be retested.

85 Production Line Dielectric Voltage Withstand Tests

85.1 Each product shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 hertz, or a dc potential:

a) Between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized; and

b) Between primary wiring and accessible low-voltage, 42.4 volts peak or less, metal parts, including terminals.

85.2 The production-line test shall be conducted in the time and at the potential specified in either Condition A or Condition B of Table 85.1.

Table 85.1
Production-line test conditions

Product rating	Condition A			Condition B		
	Potential, volts		Time, seconds	Potential, volts		Time, seconds
	VAC[c]	VDC		VAC[c]	VDC	
250 volts or less with no motor rated more than 1/2 horsepower (373 watts output)	1000	1400	60	1200	1700	1
250 volts or less with a motor rated more than 1/2 horsepower (373 watts output)	1000 + 2V[a]	1400 + 2.8V[a]	60	1200 + 2.4V[a]	1700 + 3.4V[a]	1
251 – 600 volts	1000 + 2V[b]	1400 + 2.8V[b]	60	1200 + 2.4V[b]	1700 + 3.4V[b]	1

[a] Maximum marked voltage but not less than 120 volts if the maximum marked voltage is within the range 105 – 120 volts, and not less than 240 volts if the maximum marked voltage is within the range 210 – 240 volts.

[b] Maximum marked voltage.

[c] Where there are capacitors across the insulation under test (e.g radio-frequency filter capacitors), it is recommended that d.c. test voltages are used.

85.3 For equipment employing low-voltage circuits, the test is to be conducted with the low-voltage circuit connected to the cabinet, chassis, or other dead metal part so that the potential applied between the

high-voltage live parts and dead metal parts will simultaneously be applied between high-voltage live parts and low-voltage circuits.

85.4 The test shall be conducted when the product is fully assembled. It is not intended that the product be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a snap cover or friction-fit knob, that would interfere with performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly when the test represents that for the complete product. Any component not included shall not affect the results with respect to determination of possible risk of electric shock resulting from miswiring, defective component, insufficient spacings, and similar conditions.

85.5 Solid-state and similar components that might be damaged by a secondary effect (induced voltage surge, excessive heating, and similar effects), of the test may be short-circuited by means of a temporary electrical jumper or the test may be conducted without the component electrically connected, providing the wiring and terminal spacings are maintained. Additionally, components providing a d.c. path in parallel with the insulation to be tested (primary to dead-metal) may be disconnected during the test. Examples of such components are discharge resistors for filter capacitors and voltage limiting devices such as transient voltage suppressors (other than capacitors).

85.6 The test equipment shall have a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually reset device to restore the equipment after electrical breakdown or an automatic reject feature of any unacceptable unit. When an ac test potential is applied, the test equipment shall include a transformer having an essentially sinusoidal output.

85.7 When the output of the test-equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

85.8 When the output of the test-equipment transformer is 500 volt-amperes or more, the test potential may be indicated:

a) By a voltmeter in the primary circuit or in a tertiary-winding circuit,

b) By a selector switch marked to indicate the test potential, or

c) For equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential. If marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually reset switch has been reset following a dielectric breakdown.

85.9 Test equipment other than that described in the preceding paragraphs may be used when found to accomplish the intended factory control.

85.10 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the product are to be connected together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal.

Exception: A product having circuitry – resistive, high-impedance winding, or similar circuitry – not subject to excessive secondary-voltage build-up in case of electrical breakdown during the test may be tested:

a) With a single-pole primary switch, if used, in the off position, or

b) With only one side of the primary circuit connected to the test equipment when the primary switch is in the on position, or when a primary switch is not used.

86 Grounding Continuity Tests

86.1 The manufacturer shall test each refrigerator that has a power supply cord to verify electrical continuity between the device and the grounding blade of the attachment plug as required by 13.1.

86.2 An indicating device, such as an ohmmeter, low-voltage battery- and buzzer-combination, or similar indicating device, may be employed in the test mentioned in 86.1.

MARKING

87 General

87.1 Details

87.1.1 A marking required to be permanent shall be molded, die-stamped, paint-stenciled, stamped, or etched in permanently-secured metal, or indelibly stamped on pressure-sensitive labels secured by adhesive. Pressure-sensitive labels shall comply with the Standard for Marking and Labeling Systems, UL 969.

87.1.2 Each refrigerator shall be legibly and permanently marked with:

a) The manufacturer's name, trade name, or trademark or other descriptive marking by which the organization responsible for the product may be identified;

b) A distinctive (“catalog” or “model”) number or the equivalent;

c) The electrical rating;

d) The kind and amount of refrigerant in pounds, or ounces, or both.

e) The high- and low-side design pressures.

f) The date or other dating period of manufacture not exceeding any three consecutive months.

Exception No. 1: The manufacturer's identification may be in a traceable code if the product is identified by the brand or trademark owned by a private labeler.

Exception No. 2: The date of manufacture may be abbreviated; or may be in a nationally accepted conventional code or in a code affirmed by the manufacturer, provided that the code:

a) Does not repeat in less than 20 years, and

b) Does not require reference to the production records of the manufacturer to determine when the product was manufactured.

87.1.3 With reference to (d) and (e) of 87.1.2, refrigerators may be marked with equivalent SI units in addition to the USA customary units of measure.

87.1.4 A Type I Display Refrigerator or Freezer shall be permanently marked to indicate that the equipment is intended for use in a controlled ambient location such that the ambient temperature does not exceed 24°C (75°F).

87.1.5 A Type II Display Refrigerator or Freezer shall be permanently marked to indicate that the equipment is intended for use in a controlled ambient location such that the ambient temperature does not exceed 27°C (80°F).

87.1.6 A refrigerator intended for outdoor use shall be permanently marked to so indicate. The marking shall be located on or adjacent to the refrigerator's nameplate.

87.1.7 When a manufacturer produces refrigerators at more than one factory, each refrigerator shall have a distinctive marking to identify it as the product of a particular factory.

87.1.8 Refrigerators shall be marked with the operating voltage, the frequency, and the total or individual loads as indicated in 88.1 and 89.1. Permanently connected refrigerators shall also be marked with the number of phases.

87.1.9 The information specified in 87.1.2, 87.1.8, and 87.2.5 – 87.3.11. shall be on a nameplate or plates located where they will be visible and legible after installation of the refrigerator without requiring the use of keys or tools for removal of panels, and the like. The nameplate shall be constructed and fastened so as to form a permanent part of the assembly.

87.2 Refrigerant

87.2.1 Refrigerators equipped with more than one refrigeration system shall be marked to indicate the amount of refrigerant in each system. When different refrigerants are used, the kind of refrigerant and design pressures for the high- and low-pressure sides shall be shown for each system. Stirling refrigeration systems shall indicate the amounts, kinds and charge pressures at an ambient of 25°C (77°F) of the refrigerants used in the engine and thermosiphon(s), if equipped. The design pressures for each item shall be marked ‘design pressure’ and indicated separately for each item as referenced in 87.2.10.

87.2.2 With reference to 87.1.2 and 87.2.1, the amount of refrigerant need not be indicated on the nameplate of a remote refrigerator. See 3.19. Except as indicated in 87.2.3, the type of refrigerant also need not be marked, unless the remote refrigerator employs a holding charge of refrigerant, if a tag is provided indicating that the design pressure(s) shall not be less than the values marked on the condensing unit or as outlined in ASHRAE 15 for the refrigerant used in the system. The marking shall also indicate that after charging, the equipment shall be marked with the refrigerant used and the oil used.

87.2.3 In reference to 87.2.2, refrigerators intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or remote transcritical system shall be marked with the types of refrigerants used.

87.2.4 A remote refrigerator that does not have the type of refrigerant marked on the nameplate shall have a tag or marking attached indicating that the remote refrigerator is not suitable for use with ammonia (R717).

87.2.5 The kind of refrigerant shall be designated by number according to the Standard for Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34. The number shall be prefixed or suffixed with the word “Refrigerant” or it shall be prefixed with the letter “R” or the trade name of the refrigerant. Combinations of these marks may be used, except that employing the letter “R” and the word “Refrigerant” in the same marking group is not acceptable.

Exception: The designation of a Proprietary Refrigerant or any refrigerant not designated by number according to ANSI/ASHRAE 34 need not be prefixed by the letter “R” or the trade name of the refrigerant and may be identified by the product designation or trade name prefixed by the word “Refrigerant”.

87.2.6 Examples for refrigerant marking are as follows: R 12, Refrigerant 12, or 12 Refrigerant; (Trade Name) 12, (Trade Name) R 12, or (Trade Name) 12 Refrigerant, as shown in the Standard for Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34.

87.2.7 Except as indicated in 87.2.8 and 87.2.9, the high- and low-side design pressures marked on the refrigerator shall be not less than the values recorded during the Temperature and Pressure Test, Section 44, nor less than the applicable value indicated in Table 87.1.

Table 87.1
Minimum design pressure

Refrigerant[a]	Minimum design pressure, psig (kPa)					
	Low-side		High-side			
			Air-cooled		Water cooled	
134A	88	(606)	186	(1282)	135	(930)
401A	85	(586)	182	(1255)	133	(917)
401B	93	(641)	195	(1344)	143	(986)
402A	183	(1262)	347	(2394)	265	(1828)
402B	170	(1172)	324	(2234)	247	(1703)
404A	174	(1200)	331	(2281)	253	(1745)
502	162	(1117)	300	(2067)	232	(1599)
507	180	(1242)	344	(2374)	262	(1808)
744[b]	955	(6685)	1058	(7295)	1058	(7295)

[a] For other refrigerants, the minimum design pressure shall not be less than the saturation pressure of the refrigerant at the following temperatures:

26.5°C (80°F) for low-sides

40.5°C (105°F) for water-cooled high-sides

51.7°C (125°F) for air-cooled high-sides

[b] Used in a self-contained or unitary system.

87.2.8 In reference to 87.2.7, the design pressures marked on a refrigerator intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or remote transcritical system shall be not less than 500 psig (3448 kPa).

Exception: If the refrigerator does not use a hot gas defrost system, then the marked minimum low-side design pressure may be not less than 300 psig (2069 kPa).

87.2.8.1 With reference to 87.2.7, the high-side design pressure of a self-contained transcritical refrigeration system using carbon dioxide (R-744) as the refrigerant and equipped with a pressure relief or pressure limiting device in accordance with 36.1.1 shall be not less than the values recorded during the Temperature and Pressure Test, Section 44 nor less than 2030 psig (14 MPa).

87.2.8.2 Equipment having a transcritical refrigeration system and employing an intermediate pressure section shall be marked with the design pressure of the intermediate side.

87.2.9 The design pressures marked on a laboratory refrigerator or freezer with a limited charge system shall be not less than the values recorded during the temperature and pressure test, Section 44, nor less than the static pressure of the refrigeration system recorded during the Static Pressure Test, Section 83A, when measured at the appropriate temperature referenced in note a to Table 87.1.

87.2.10 The design pressures marked on refrigerator or freezer with a Stirling refrigeration system shall be not less than the values recorded during the Temperature and Pressure Test, Section 44.

87.3 Other markings

87.3.1 Refrigerators incorporating accessible general purpose receptacles connected to the same electrical source as that supplying the refrigerator shall be marked to include the receptacle load as follows:

a) A load equal to 80 percent of the receptacle rating if a single receptacle is supplied.

b) A load equal to the rating of the largest receptacle if more than one receptacle is supplied.

Exception: This marking need not be provided if the refrigerator is marked as specified in 87.3.2.

87.3.2 A refrigerator incorporating an accessible general purpose receptacle that is connected to the same electrical circuit as that supplying the refrigerator and protected by an overcurrent protective device rated less than the rating of the receptacle as specified in the Exception to 26.2 shall be marked as follows:

a) With the receptacle load(s), in amperes, as part of the refrigerator nameplate rating, and

b) With the load for each individual receptacle, in amperes, on or adjacent to the receptacle where it is clearly visible to the user.

87.3.3 When parts or sections of a refrigerator are separately shipped from the factory, the primary nameplate for the refrigerator shall comply with the requirements of 87.1.9, and the section incorporating the primary nameplate shall be permanently marked in a manner that will relate the sections to one another when they are installed in the field. The parts or sections shall be permanently marked with the manufacturer's or private labeler's name or identifying symbol and a distinctive model or type designation.

87.3.4 A refrigerator that incorporates a hermetic motor-compressor with a thermal protector that provides protection in accordance with the requirements in 17.3(b) shall be marked “Motor-Compressor Thermally Protected” or with an equivalent statement to reference the motor-compressor(s) involved, unless the motor-compressor(s) is marked “Thermally Protected.”

87.3.5 A refrigerator that incorporates a complete protective system that provides protection in accordance with the requirements specified in 17.3(d) shall be marked “Motor-Compressor Thermally Protected System,” or with an equivalent statement to reference the motor-compressor(s) involved.

87.3.6 When a refrigerator is intended to be disassembled by means of a tool for the purpose of cleaning or similar servicing and if such disassembly involves the exposure of persons to unintentional contact with any otherwise enclosed or protected moving part, hot part, or uninsulated live part, the refrigerator shall be permanently marked with the word “CAUTION” or “WARNING”and the applicable statement(s) indicated in Table 87.2. The warning marking shall be in letters no less than 1/8 inch (3.2 mm) high and shall be located so as to be visible before or immediately upon removal of a cover, panel, or similar part that encloses or protects the moving part, hot part, or live part. The marking shall not be on the back of a removable cover or panel.

Table 87.2
Warning markings

Moving parts	Uninsulated live parts	Hot parts
Moving Parts. Do Not Operate Unit With [a] Removed	Risk of Electric Shock. Disconnect Power Before Servicing Unit	Hot Parts. Do Not Operate Unit With [a] Removed
[a] Specify appropriate part.		

87.3.7 With respect to 87.3.6, when the marking is located on a removable panel or cover, the design of the panel or cover, or its means of attachment is to be such that replacement will not obscure the warning.

87.3.8 When a supporting device as described in 54.3 is required for compliance with the Stability Test, Section 54, and is not permanently fixed in position, the refrigerator shall be marked with the word "CAUTION" and the following or equivalent text: "Door Support Device Needed For Stability. Do Not Defeat Its Function." The warning marking shall be located adjacent to the supporting member so as to be visible when the door is opened at an angle of 90 degrees with the cabinet.

87.3.9 When a replaceable fuse is provided for overcurrent protection of a transformer or control circuit conductor (see 11.3.3 – 11.3.6, 28.4.3 and 29.3.5), the refrigerator shall be marked with the maximum current rating of the fuse. This marking, which may be a paper sticker or decal, shall be adjacent to the fuseholder.

Exception: When supplementary fuses are used in accordance with the Exception to 28.4.3 and 29.3.5, the marking shall also include the fuse manufacturer's or private labeler's name, catalog designation, and fuse voltage rating.

87.3.10 A pressurized product system consisting only of tubing, hose, or both (with or without dispensing valves), and that does not incorporate a pressure relief valve, shall be marked with the maximum acceptable pressure to be employed in the system.

87.3.11 A refrigerator intended to utilize carbon dioxide (R744) in a secondary loop, cascade, or remote transcritical system shall be provided with markings which indicate:

a) That the refrigerator is for use with R744 (carbon dioxide) system components where the design pressure of the refrigerator is not less than the design pressure of the associated components; and

b) If such a refrigerator contains a pressure vessel within the R744 loop or system but is not provided with any pressure relief or pressure regulating relief valves, a marking shall be located where visible to the installer indicating that the refrigerator is not provided with any pressure relief or pressure regulating relief valves and that a sufficient number of valves having capacity deemed adequate shall be field-installed on the system. The marking should refer to the installation instructions provided by the equipment manufacturer.

87.3.12 Pressure regulating relief valves shall be provided with the following or equivalent marking: "Do not defeat, cap, add piping to the outlet of the valve or attempt to change the relief setting".

87.3.13 Additional marking requirements are specified in 9.2.17, 9.4.5, 9.4.6 and 38.2.1.

87.3.14 For products intended to be used within a motor fuel dispensing facility, "See installation Instructions for Suitable Mounting Location", or equivalent, shall be marked in a location that is visible during installation of the unit.

87.3.15 For products intended to be used within a motor fuel dispensing facility and intended for installation in accordance with 5.5.1(b) or for use with a stand as referenced in 5.5.4, the marking "For use