UL 471

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Commercial Refrigerators and Freezers

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Commercial Refrigerators and Freezers, UL 471

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

The new and/or revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated November 10, 2000 and August 3, 2001. The bulletin(s) is now obsolete and may be discarded.

The revisions dated November 27, 2001 include a reprinted title page (page1) for this Standard.

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

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

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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

This Standard consists of pages dated as shown in the following checklist:

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UL 471

Standard for Commercial Refrigerators and Freezers

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Second Edition – June, 1962
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Fourth Edition – September, 1975
Fifth Edition – May, 1978
Sixth Edition – January, 1985
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November 27, 1995

The most recent designation of ANSI/UL 471 as an American National Standard (ANSI) occurred on September 6, 1996.

This ANSI/UL Standard for Safety is under periodic maintenance, whereby the ANSI approval is updated approximately every five years. The eighth edition is ANSI approved; other revisions are not part of the ANSI designated text. To obtain a copy of the originally approved ANSI version of the Standard, contact *comm 2000* at www.comm-2000.com.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI approved standard.

The Department of Defense (DoD) has adopted UL 471 on March 23, 1976. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

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

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

1.2 revised November 27, 2001

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

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

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

1.6 Deleted November 27, 2001

2 General

2.1 Components

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

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

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.1.2 revised November 27, 2001

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

2.1.3 revised November 27, 2001

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

2.1.4 revised November 27, 2001

2.2 Units of measurement

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

2.2.1 revised November 27, 2001

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.

3.5 CIRCUITS, ELECTRICAL –

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

b) Low-Voltage – A circuit involving a potential of not more than 30 volts alternating current, 42.4 volts peak or direct current, and supplied by a primary battery, a standard Class 2 National Electrical Code, ANSI/NFPA 70-1993 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 70-1993 transformer.

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

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

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

3.9 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.

3.10 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.

3.11 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 Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1989.

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

3.13 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.

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

3.15 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.

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

3.17 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.

3.18 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.

3.18 added November 27, 2001

3.19 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).

3.19 added November 27, 2001

3.20 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).

3.20 added November 27, 2001

4 Installation And Operating Instructions

4.1 A refrigerator shall be provided with installation and operating instructions. The instructions shall contain such directions and information that the manufacturer considers necessary for installation, maintenance, and use of the refrigerator.

4.2 A copy of the manufacturer's operating and installation instructions, or equivalent information, intended to accompany each refrigerator shall be furnished with the sample submitted for investigation. These instructions are to be used as a guide in the examination and test of the refrigerator. For this purpose, a printed edition is not required initially if rough draft instructions or information as to what the instructions will include are submitted for review as part of the investigation.

4.3 The following information shall be provided with equipment with two power supply cords:

a) The instruction shall clearly indicate that the use of two cords is involved and caution against unplugging only one during movement, testing or repair of the product.

b) If the attachment plug caps are different, the installation manual shall clearly state that different attachment plugs are used (indicating the ratings). If individual branch circuits are involved, the manual shall clearly state that individual branch circuits (indicating the ratings) are to be employed to supply the product and indicate what actions are required for a proper installation.

4.3 added November 27, 1995

CONSTRUCTION

5 General

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

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

5.2 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.

5.3 If 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.

5.4 A superstructure intended to be shipped separately for field installation shall comply with requirements for accessories as specified in 7.1 – 7.5.

5.5 Unless provided with other means of exit, door(s) intended for entrance of persons into the refrigerated compartment of a refrigerator shall be provided with a latch release mechanism that will open the door(s) from the inside by a force applied outwardly to the door or to a release actuator. If the latch is provided with a key lock, the latch release mechanism shall be constructed so that the lock can be opened from the interior. See Door Latch Release Test, Section 69.

5.6 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.

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

5.8 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 69.

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6 Assembly

6.1 General

6.1.1 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.

6.1.2 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.

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

6.1.4 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.

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

6.2 Pressurized product system

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

6.2.2 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 64.2.2.

Exception: A pressure relief valve is not required if:

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 64.2.2, and

c) The refrigerator is marked in accordance with 79.4.7.

6.3 Mechanical protection

6.3.1 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.

6.3.2 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 67.

6.3.3 When installed in its intended manner (see Installation and Operating Instructions, Section 4), 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 40.1. 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 8.2.1.

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 the like.

6.3.4 Parts such as covers, panels, or grilles that serve as guards may be removable without tools if a warning marking as described in 79.3.6 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 (0.81 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.

6.3.5 The fasteners reference in 6.3.4(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.

6.3.6 Components of a sectional refrigerator, such as end closures, are to be in place when judging compliance with 6.3.3 and 6.4.1, if they are:

a) Required to make the section functional and

b) Secured by means requiring tools for removal.

6.3.6 revised April 9, 1999

6.3.7 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 6.3.8 or 6.3.9. Except as indicated in 6.3.4, each guard shall be secured by means requiring tools for removal unless functioning of the refrigerator requires the guard to be in place.

6.3.8 A fan blade employing a guard with openings having a minor dimension less than 1 inch (25.4 mm) shall be guarded such that the probe illustrated in Figure 6.1 cannot contact any part of the fan blade when inserted through openings in the guard with a force of 2.5 pounds (11.1 N).

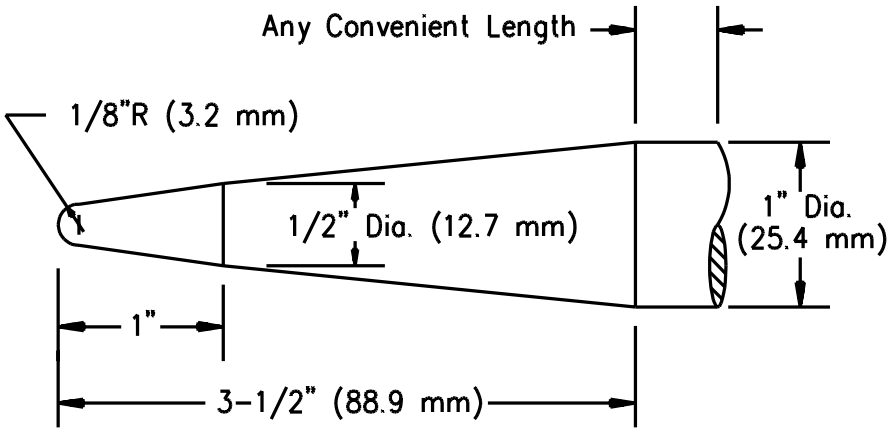
Exception: The probe illustrated in Figure 6.1 may contact the trailing edge of a fan blade if the relationship between weight (w) in pounds, radius (r) in inches and speed (n) in revolutions per minute of the fan blade is such that K in the equation:

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

is less than 100.

Figure 6.1
Probe for fan blades

Figure 6.1 revised April 27, 1998



PA 160

6.3.9 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 6.1. 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 6.1
Clearance from openings

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

[a] Openings less than 1/4 inch (6.4 mm) are not to be considered.
[b] But not more than 3 inches (76.2 mm). See 6.3.9.
[c] Also applies to hot parts. See 6.3.11 and 6.3.12.
[d] For fan blade guards that have openings with minor dimensions less than 1 inch, see 6.3.8.

6.3.10 A moving part is not to be considered when determining compliance with 6.3.7 – 6.3.9 if:

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

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

6.3.11 When tested according to Sections 40 – 43, surfaces having temperatures that exceed the temperature rise of items 2 and 3 of item D of Table 40.1 shall be guarded as specified in 6.3.7 – 6.3.10.

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 the like) 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.

6.3.12 If 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 40.1, whichever is appropriate, it shall be guarded in accordance with 6.3.7 – 6.3.10 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 6.3.7 – 6.3.10 may exceed the temperature permitted by subitem 2 or 3 of item D of Table 40.1, provided that:

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 80.29.

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6.4 Electrical protection

6.4.1 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 6.4.2 and 8.2.1.

6.4.2 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 6.2 shall not touch any uninsulated live parts and

b) The probe illustrated in Figure 6.3 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 the like, when a force of 5 pounds (22.3 N) is applied.

Figure 6.2
Probe

Figure 6.2 revised April 27, 1998

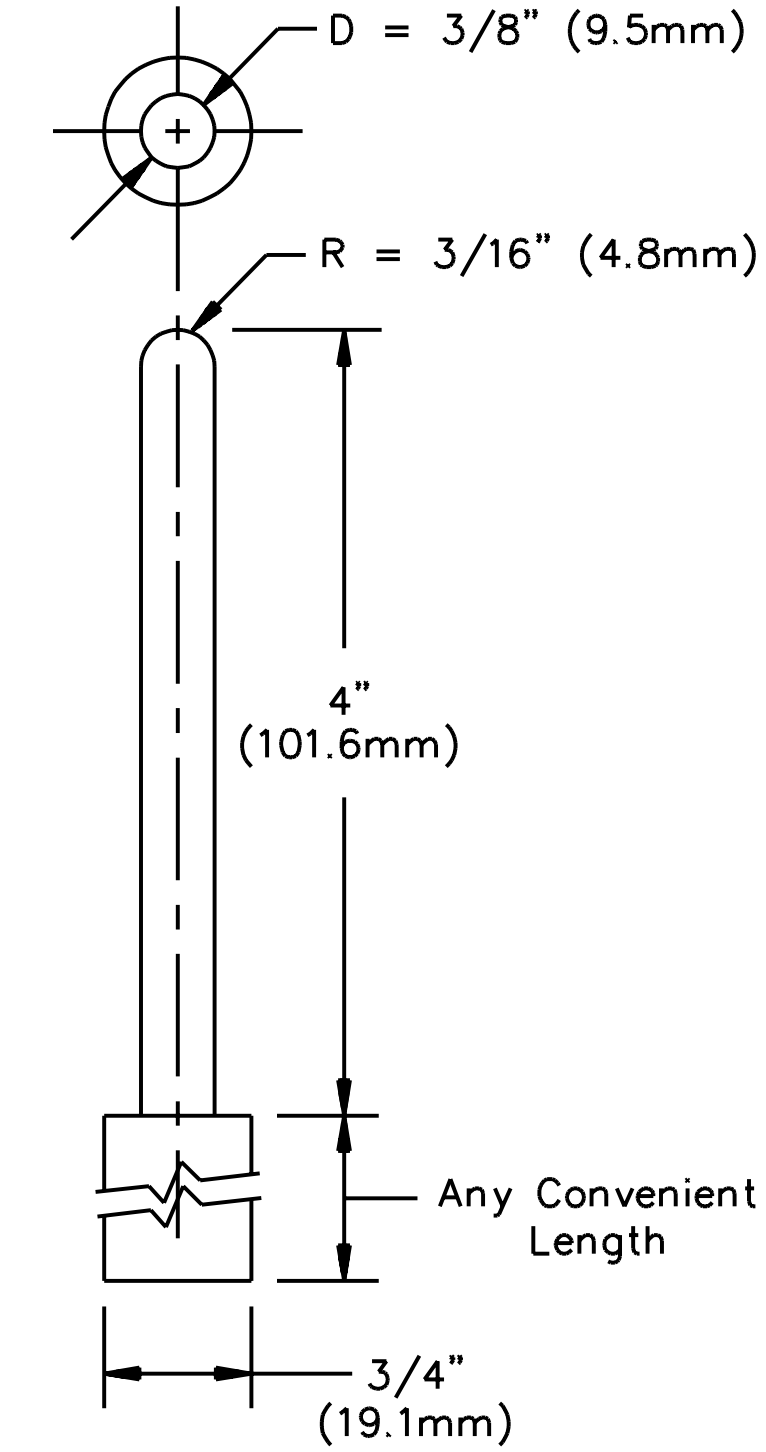

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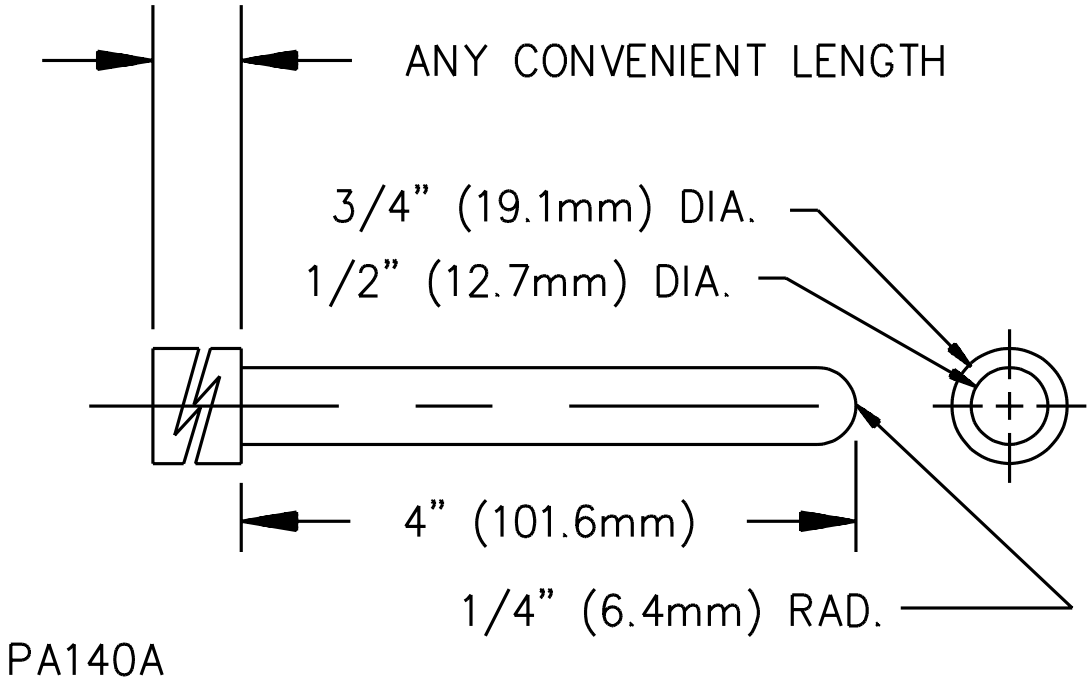
Figure 6.3
Probe

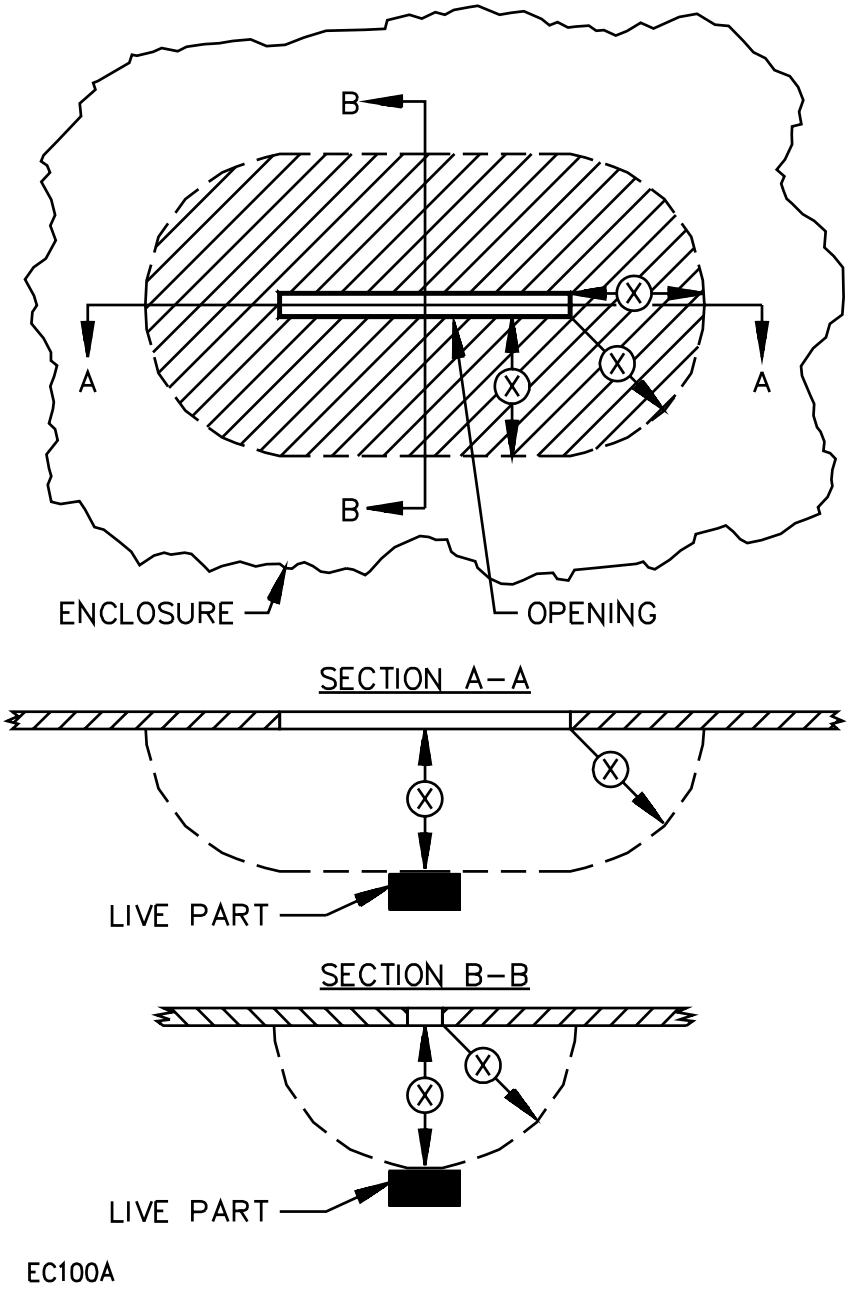
Figure 6.3 revised April 27, 1998



6.4.3 If an opening in the enclosure permits the entrance of a 3/4 inch (19.1 mm) diameter rod, the conditions described in Figure 6.4 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 6.4
Opening in enclosure

Figure 6.4 revised April 27, 1998



The opening is acceptable if, 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).

6.4.4 In addition to the requirements of 6.4.2 and 6.4.3, 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 79.3.6.

6.4.5 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.

6.4.6 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.

6.4.7 A condensate pan shall be constructed and located so that overflow due to a blocked rain 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.

6.4.8 An overflow spout, drain hole, cutout, or the like, in the condensate pan is acceptable if dripping of water on electrical parts is not likely to occur. An overflow test, see 48.1 and 48.2, is to be conducted if it is not evident that the refrigerator complies with the requirements of 6.4.7.

6.4.9 A switch, lampholder, an attachment-plug receptacle, or similar component shall be secured in position and shall be prevented from turning. See 6.4.10.

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 if rotation cannot reduce electrical spacings below the minimum acceptable values. See Spacings, Sections 27 and 28.

6.4.10 The means for preventing rotation mentioned in 6.4.9 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.

6.4.11 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 if such motion may result in a reduction of electrical spacings below the minimum acceptable values. See Spacings, Sections 27 and 28. 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 6.4.10 is acceptable.

6.4.12 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated live parts. See 61.2.1.

7 Accessories

7.1 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 79.4.1 and 79.4.2.

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

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

7.4 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.

7.5 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 if intended to be a cord-connected accessory.

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

7.5 added November 27, 1995

7.6 If 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 if the equipment and accessory are marked in accordance with 79.4.9.

7.6 added November 27, 1995

7.7 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.

7.8 Strain-relief means shall be provided for the wiring in the accessory if there is a possibility of transmitting stress to the terminal connections during installation. See Strain Relief Test, Section 52.

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

a) Accessory,

b) Refrigerator if connections are to be made between the accessory and the refrigerator, and

c) Wiring diagram(s).

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

Exception: If 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.

7.11 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.

8 Enclosures

8.1 General

8.1.1 An enclosure shall be formed and assembled so that it will have the strength and rigidity necessary to resist the conditions of intended use without 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.

8.1.2 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.

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

Exception No. 1: If the total unbroken surface area is 25 square feet (2.32 m^2) or less, a material having a FSI of not more than 200 when tested in accordance with the radiant panel method in the Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162-1990 is acceptable.

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

8.1.3 revised April 27, 1998

8.1.4 The requirement in 8.1.3 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.

8.1.5 For the purpose of the requirement in 8.1.3 and 8.1.4, the surface area is considered to be broken if 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.

8.1.6 With reference to 8.1.3, the interior liner of an open type refrigerator is not considered part of the outer enclosure.

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

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

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

8.1.10 Electrical components, such as controls, solenoids, starting relays, and switches, shall be individually enclosed except terminals unless it can be determined that failure of a component will not result in a risk of fire. See Burnout Tests – Components, Section 56.

8.1.11 Electrical parts, see 8.1.10, within the outer cabinet need not be individually enclosed if the assembly complies with (a) – (c):

a) Their design and location with respect to openings in the outer cabinet will not result in the emission of flame or molten metal through openings in the cabinet, or 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 the like, on flammable material, and

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

8.1.12 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 the like, into the wall space or floor area enclosing the refrigerator.

8.1.13 The requirement of 8.1.12 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.

8.1.14 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 the like, and has a noncombustible solid bottom without openings may be employed in lieu of the individual enclosures referred to in 8.1.13.

8.1.15 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 68.1 – 68.4) and shall be supported or secured in place.

8.1.16 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 shall be not less than 0.026 inch (0.66 mm) thick if uncoated or 0.029 inch (0.74 mm) if 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.

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

a) Not less than 0.032 inch (0.081 mm) thick if uncoated steel,

b) Not less than 0.034 inch (0.86 mm) thick if galvanized steel, and

c) Not less than 0.045 inch (1.14 mm) thick if nonferrous.

8.1.18 If 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. If threads for the connection of conduit are not tapped through a hole in an enclosure wall, conduit hub, or the like, 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.

8.1.19 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 8.1.21.

8.1.20 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.

8.1.21 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.

8.1.22 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 8.1 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 8.1
Knockout or hole sizes and dimensions of bushings

Trade size of conduit		Knockout or hole diameter		Bushing dimensions			
				Overall			
				Diameter		Height	
inches	mm O.D.	inches	mm	inches	mm	inches	mm
1/2	21.3	7/8	22.2	1	25.4	3/8	9.5
3/4	26.7	1-3/32	27.8	1-15/64	31.4	27/64	10.7
1	33.4	1-23/64	34.5	1-19/32	40.5	33/64	13.1
1-1/4	42.3	1-23/32	43.7	1-15/16	49.2	9/16	14.3
1-1/2	48.3	1-31/32	50.0	2-13/64	56.0	19/32	15.1
2	60.3	2-15/32	62.7	2-45/64	68.7	5/8	15.9

8.1.23 Steel enclosures shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting. See 8.3.1 – 8.3.5.

8.2 Doors and covers

8.2.1 A door, cover, or panel may be provided with an interlock in accordance with 6.3.3 or 6.4.1. 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) Will secure the cover in the closed position when engaged.

8.2.2 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.

8.2.3 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.

8.2.4 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.

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

Exception: A hinged cover is not required if 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.

8.2.6 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.

8.2.7 With reference to the requirements of 8.2.6, a spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the cover closed and will require 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 8.2.1 is also acceptable.

8.2.8 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.

8.2.9 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.

8.3 Enclosures exposed to weather

8.3.1 Sheet steel cabinets and electrical enclosures exposed to the effects of weathering shall be protected against corrosion by the means specified in Table 8.2 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 8.2
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	8.3.2	8.3.3
Inside enclosures which protect current-carrying parts other than motors	8.3.2	8.3.3
Outer cabinets which are the sole enclosure of current-carrying parts	8.3.3	8.3.3

8.3.2 To comply with the requirements of 8.3.1, one of the following coatings shall be used:

a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G60 or A60 in Table 1 of the Standard for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process, General Requirements, ASTM A653/A653M-94, 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 for the Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90-1991. An A60 (alloyed) coating shall also comply with 8.3.4.

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 73. An annealed coating shall also comply with 8.3.4.

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.

8.3.3 To comply with 8.3.1, one of the following coatings shall be used:

a) Hot-dipped mill-galvanized sheet steel conforming with the Coating Designation G90 in Table 1 of the Standard for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process, General Requirements, ASTM A653/A653M-94, 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 for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90-1991.

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 71. An annealed coating shall also comply with 8.3.4.

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 73.

d) A zinc coating conforming with 8.3.2(a) or (b) with one coat of outdoor paint as specified in 8.3.2(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 73, and the paint shall be as specified 8.3.2(c).

8.3.4 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.

8.3.5 With reference to the requirements of 8.3.4, simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes shall comply with 8.3.4.

8.3.6 With reference to the requirements of 8.3.1, other finishes, including paints, special metallic finishes, and combinations of the two, are acceptable if comparative tests with galvanized sheet steel without annealing, wiping, or other surface treatment complying with 8.3.2(a) or 8.3.3(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.

8.3.7 Nonferrous enclosures may be employed without special corrosion protection. See 8.1.2.

8.3.8 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 8.3.9, and shall comply with the requirements of 72.1 – 72.4. Sealing compounds required to seal electrical enclosures shall comply with the requirements of 72.5. Adhesives required to secure gaskets shall comply with the requirements of 72.6. Gaskets shall be neoprene, rubber, or thermoplastic. Other materials may be used if they have equivalent properties.

8.3.9 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.

ELECTRICAL SYSTEM

9 Field Supply Connections

9.1 General

9.1.1 If 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 20.1 and 20.2.

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) Deleted.

c) Deleted.

d) 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.

e) 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 80.27 is required for dispensers that are electronically connected to the condensing unit.

f) A built-in refrigerator.

9.2.1 revised November 27, 2001

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 ft (0.91 – 1.83 m) long. An outlet box or conduit fitting shall be provided at the free end of the conduit.

9.2.3 revised November 27, 2001

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. If more than six conductors will be involved or if 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. If necessary, a trial installation is to be made.

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

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 80.13. It is to be assumed that branch circuit conductors rated 60°C (140°F) will be used when the required circuit ampacity is 100 amperes or less and that conductors rated 75°C (167°F) will be used when the required ampacity is more than 100 amperes.

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

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9.2.10 For No. 8 AWG (8.4 mm^2) and larger conductors, pressure wire connectors shall be used. For No. 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 No. 14 AWG (2.1 mm^2) or smaller conductor.

9.2.12 According to the National Electrical Code, ANSI/NFPA 70-1993, No. 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 No. 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 No. 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 if a lesser number of threads results in a connection in which the threads will not strip when tightened in accordance with the torques indicated in the Standard for:

a) Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL 486A and

b) Wire Connectors for Use with Aluminum Conductors, UL 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 No. 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 natural 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 if 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 52.

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

9.3 Cord-connected refrigerators

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

a) A flexible cord of a type, length, and ampacity and an attachment plug of a type and rating complying with the requirements of 9.3.2 – 9.3.8; 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.

9.3.1 revised November 27, 1995

9.3.2 The marked rating of a cord-connected refrigerator, see 81.1, shall not exceed 80 percent of the rating of the attachment plug.

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

Exception: Refrigerators rated 250 volts or less and intended for connection to circuits rated other than 60 hertz, or other than the voltages specified in the first column of Table 36.1, or both, may employ a grounding-type attachment plug acceptable for the circuit involved.

9.3.3 revised November 27, 2001

Table 9.2
Attachment plugs

Table 9.2 revised November 27, 2001

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

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	3	12.0	15 amperes, 250 volts	15 – 15P
200 – 240	3	16.0	20 amperes, 250 volts	15 – 20P
200 – 240	3	24.0	30 amperes, 250 volts	15 – 30P
200 – 240	3	40.0	50 amperes, 250 volts	15 – 50P

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

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

9.3.4 A cord-connected refrigerator may employ Type S, SE, SO, SOO, ST, STO, STOO, SJ, SJE, SJO, SJOO, SJT, SJTO, or SJTOO power supply cord rated for use at a voltage not less than the rated voltage of the refrigerator. The ampacity of the cord as given in the National Electrical Code, ANSI/NFPA 70-1993, shall be not less than that required by the ampere input measured in the Temperature and Pressure Test, Section 40, or the Defrost Test, Section 43. The ampere input value shall include the loads for convenience outlets and the current drawn by accessories intended for use with the refrigerator. See 79.3.1 and 79.3.2.

9.3.5 Deleted November 27, 2001

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 16.5 shall be not less than 80 percent of the maximum continuous current of the motor-compressor determined in accordance with Protective Devices – Maximum Continuous Current Test, Section 63, plus the sum of all other loads, including accessories, which may operate concurrently.

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

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

9.3.7 revised April 27, 1998

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 will not be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 52. A metallic strain relief shall not contact uninsulated live parts or reduce spacings within the enclosure if the cord is moved inward. The cord shall not be subject to damage by moving parts if it can be moved inward.

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 consisting of two separate units joined together or two of the same unit in a single structure may be provided with more than one power supply cord if all of the following conditions are met:

a) Not more than two cords are provided.

b) Each cord is of the type, size and rating required or permitted for the type of product and the load supplied to each unit.

c) Each attachment plug cap is sized based on the load supplied to each unit.

d) Both cords shall carry the system ground.

e) If 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.

f) The marking specified in 81.3(a) and 81.3(c) shall be provided.

g) The instructions shall contain information as indicated in 4.3.

9.3.11 added November 27, 1995

9.3.12 Where the rated current input to both units exceeds 80 percent of the branch circuit to which the equipment will be connected, the unit with the highest rated current input shall be marked adjacent to its cord in accordance with 81.3(b).

9.3.12 added November 27, 1995

9.3.13 The remote dispensing head of a beverage cooler/dispenser may be cord and plug connected if there are no electrical connections or refrigerant line connections between the beverage cooler and the dispensing head. The requirement of 9.3.11 shall also apply if the beverage cooler dispenser is also cord connected.

9.3.13 added November 27, 1995

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 12.5, 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 70-1993.

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, provided that:

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

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 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 the like. Clamping means shall have smooth, rounded surfaces.

Exception: Wires and cords may contact a vibrating part provided that:

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.

10.1.2 A refrigerator shall employ conductors no smaller than No. 18 AWG (0.82 mm^2).

Exception No. 1: Short integral leads of small electrical components such as relay coils, clock motors, and indicator lights may be No. 20 (0.52 mm^2) or No. 22 AWG (0.32 mm^2).

Exception No. 2: Conductors in low-voltage (NEC Class 2) circuits, other than those incorporating protective devices (see 10.1.17) may be less than No. 18 AWG.

10.1.3 Wiring that is green or green with one or more yellow stripes shall be used only for grounding conductors, and wiring used for other purposes shall not be so identified.

10.1.4 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 if intended for outdoor use, rain exposure, from entering wiring enclosures and electrical enclosures.

Exception: Water may enter an enclosure provided that:

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

b) The live parts are not wetted.

10.1.5 Resistance-type heater wire employed to prevent condensation is considered in compliance with 10.1.11 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 41.

10.1.5 revised April 9, 1999

10.1.6 Parallel conductor appliance wiring material of the integral type shall not be ripped more than 3 inches (76 mm) unless the minimum wall thickness of the conductor insulation after ripping is at least 0.058 inch (1.47 mm).

Exception: 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.

10.1.7 If cords or appliance wiring material are employed in the user accessible refrigerated compartment, such wiring shall be of a type as indicated by Group B of Table 10.1 and shall be located or protected so as not to be damaged by product containers, removable shelves, or the like.

Table 10.1
Typical wiring material

Table 10.1 revised November 27, 1995

Group	Type of wire, cord, or cable[a]	Wire size		Insulation thickness	
		AWG No.	mm^2	Inch	mm
A	Appliance wiring material[b] having thermoplastic insulation, with insulation thicknesses shown at the right corresponding to wire sizes indicated, or Type AC, ACT, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RH, RHH, RHW, THW, XHHW, MTW, THW-MTW, THWN, PF, PGF, PFF, PGFF, TW	10 and smaller	5.3	2/64	0.8
		8	8.4	3/64	1.2
		6	13.3	4/64	1.6
		4	21.2	4/64	1.6
		3	26.7	4/64	1.6
		2	33.6	4/64	1.6
		1	42.4	5/64	2.0
		1/0	54.0	5/64	2.0
		2/0	67.0	5/64	2.0
		3/0	85.0	5/64	2.0
		4/0	107.2	5/64	2.0
B	Appliance wiring material[b] 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
C	Appliance wiring material[b] having thermoset insulation with insulation thicknesses shown at the right corresponding to wire sizes indicated, or cord Type S, SJ, SP-3	Same as for Group B			

[a] The designated cord or cable or types of wire other than appliance wiring material may be used without regard to the values specified in this table.

[b] Appliance wiring material acceptable for refrigeration use.

10.1.8 If 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. If the wiring is exposed to the user or attendant, the wiring shall be one of the S series of cord specified in Group B of Table 10.1 and shall be provided with strain relief so that stress will not be transmitted to terminals or splices. See Strain Relief Test, Section 52.

10.1.9 With reference to 10.1.8, 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 44, and the wiring is to be visually examined for damage to determine if individual strands have penetrated the insulation.

10.1.10 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 52. 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 Group B of Table 10.1.

10.1.11 Wire insulation shall be of a material rated for the potential involved and for the temperature to which it may be subjected in intended use. The required temperature rating for wiring is to be based on the temperatures measured in the Temperature and Pressure Test, Section 40; Heating Test – Condensation Wiring, Section 41; Heating Test – Ballasts and Wiring, Section 42; and Defrost Test, Section 43.

10.1.12 Wiring insulation rated for 60°C (140°F) or higher and employed for incandescent light circuits, other than circuits with enclosed gasketed fixtures, is considered in compliance with the temperature requirement of 10.1.11 if the lighting load does not exceed the allowable current carrying capacity of the wire or cord. In determining the lighting load, an intermediate-base lampholder is considered to require 25 watts, a medium-base lampholder 60 watts, and a mogul-base lampholder 500 watts.

10.1.13 Wiring insulation rated for 60°C (140°F) and used for electric-discharge light circuits is considered in compliance with the temperature requirement of 10.1.11 if the lighting load marked on the ballast does not exceed the allowable current-carrying capacity of the wire and if the wiring in the ballast compartment is permanently spaced not less than 3 inches (76 mm) from any ballast.

a) Wiring insulation rated for 75°C (167°F) with an outer braid or for 90°C (194°F) without a braid is not required to be spaced from the ballast.

b) Wiring insulation rated for 80°C (176°F) without a braid shall be permanently spaced so as not to contact any ballast except at the point of entry to the ballast.

c) Permanently attached leads provided as a part of a ballast and electric-discharge lampholder shall be rated for 75°C.

10.1.14 Electric-discharge light circuit wiring that does not comply with the temperature or spacing requirements in 10.1.13 is to be subjected to the Heating Test – Ballasts and Wiring, Section 42.

10.1.15 Conductors supplying general purpose receptacles are considered as complying with the temperature requirement of 10.1.10 if the conductors are sized according to Table 10.2. See 40.6.

Table 10.2
Conductors supplying receptacles

Marked rating, amperes[a]	Conductor size, AWG (mm^2)	
7.0 or less	18	(0.82)
10.0 or less	16	(1.3)
15.0 or less	14	(2.1)
20.0 or less	12	(3.3)

[a] As marked on the refrigerator. See 79.3.1 and 79.3.2.

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

10.1.17 If damage, short-circuiting, or grounding of low-voltage wiring may cause malfunctioning of a pressure-limiting device, a motor overload protective device, or other protective device, such wiring shall be enclosed as specified in 10.2.1 or shall be Type SPT-2 or SP-2 cord or one of the types specified in Group B or C of Table 10.1.

Exception: Wires of types specified in Group A of Table 10.1, or wires having equivalent characteristics may be used if such wiring is located in a cavity or compartment of the refrigerator and is shielded from damage.

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

10.1.19 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 the like. 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.

10.1.20 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.

10.1.21 Splicing devices, such as pressure-type wire connectors, may be employed if they comply with the Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL 486A.

10.1.22 A quick-connecting assembly shall form a secure electrical connection, such as by detents in the mating parts, and shall be acceptable for carrying the current involved during the Temperature and Pressure Test, Section 40, and Defrost Test, Section 43. Securement of connections may be determined by engagement/disengagement tests as specified in the Standard for Electrical Quick-Connect Terminals, UL 310.

10.1.23 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.

10.1.24 Open-slot type connectors shall not be used unless they are constructed to prevent disconnection resulting from loosening of the clamping means. If required spacings may be 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 27.9.

10.1.25 Holes for passage of wires and cords through walls, panels, or barriers shall have smooth, rounded surfaces or be provided with smoothly rounded bushings fabricated from materials, such as ceramic, phenolic, cold-molded composition, or fiber.

10.1.26 A wiring enclosure formed between the cabinet shell, liner, molding, trim strips, or the like shall be constructed of metal or of nonmetallic material, see 8.1.8, 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.

10.1.27 A printed wiring board for high-voltage circuits shall have a flammability level of at least V-1 when tested according to the method outlined in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

10.1.27 revised April 27, 1998

10.2 Permanently connected refrigerators

10.2.1 Except as indicated in 10.1.7 and 10.2.2, wiring shall be of the type indicated in Group A of Table 10.1 and enclosed by means such as conduit, electrical metallic tubing, metal raceway, or control boxes. Fittings shall be constructed for use with the type of wiring enclosure employed in the application.

10.2.2 Cords or appliance wiring material of a type indicated in Group A or B of Table 10.1 may be employed if the wiring is enclosed by the cabinet to reduce the risk of:

a) Damage to wiring,

b) Ignition of flammable material, or

c) Emission of flame or molten metal through openings in the cabinet.

10.2.3 With regard to 10.2.2 wiring shall be positively routed, isolated, or both, from openings in the cabinet as follows:

a) Openings Below Wiring – Wiring shall be located such that an opening is not located below the wiring within a space similar to that shown in Space A in Figure 10.1 (that is, the space generated by a 5 degree angle) unless a barrier is placed between the wiring and the opening. The barrier does not have to be larger than the opening within the generated space.

Exception: A condenser coil employing flat plate fins with at least 12 fins per inch (25.4 mm) and two rows of tubing in depth is acceptable as a bottom enclosure.

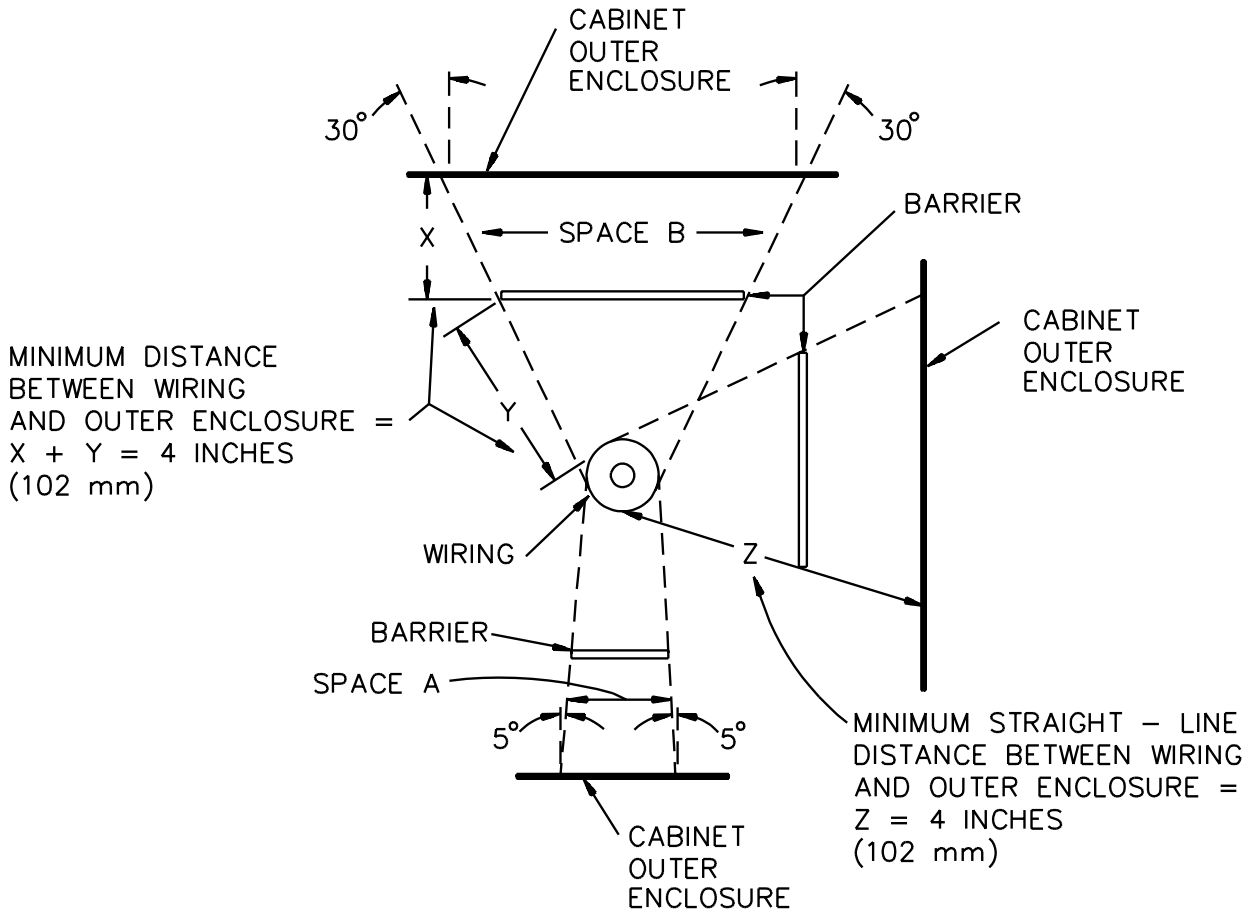
b) Openings Above Wiring – Wiring shall be located such that an opening is not located above the wiring within a space similar to that shown as Space B in Figure 10.1 (that is, the space generated by a 30 degree angle) unless a barrier is placed between the wiring and the opening. The barrier does not have to be larger than the opening within the generated space.

c) Openings in the Vertical Plane of the Enclosure – Wiring shall be located such that an opening in the vertical plane of the enclosure is not within 4 inches (102 mm) of the wiring unless a barrier is placed between the wiring and the opening.

Exception: A finned condenser coil is acceptable as a barrier in a vertical plane if the wiring cannot be a contacted by a rod 1/4 inch (6.35 mm) in diameter and 2 inch (50.8 mm) long.

Figure 10.1
Separation of wiring from outer enclosure openings

Figure 10.1 revised April 27, 1998



S2514A

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

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

10.2.4 With regard to 10.2.3, louvers or openings other than in the bottom of the wiring compartment shall not permit entrance of a rod having a diameter of 1/2 inch (12.7 mm).

10.2.5 With regard to 10.2.2 and 10.3.3, wiring shall be separated from flammable material in accordance with 10.2.6 and 10.2.7.

Exception No. 1: Wiring need not be separated from materials classed as V-0, V-1, V-2, V-5V, HF-1, or HF-2 as determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 2: This requirement does not apply to:

a) Materials used as electrical insulation, or

b) Small parts such as insulating bushings, resilient mounts, clamps and wiring straps.

Exception No. 3: Wiring need not be isolated as indicated above if it complies with the VW-1 flame test or the vertical flame test described in the reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

10.2.5 revised April 27, 1998

10.2.6 A polymeric material classified HB or HBF in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, and located:

a) Below the wiring and within Space A of Figure 10.2 shall be separated by means of a horizontal barrier, extending at least to the boundary surface of the space.

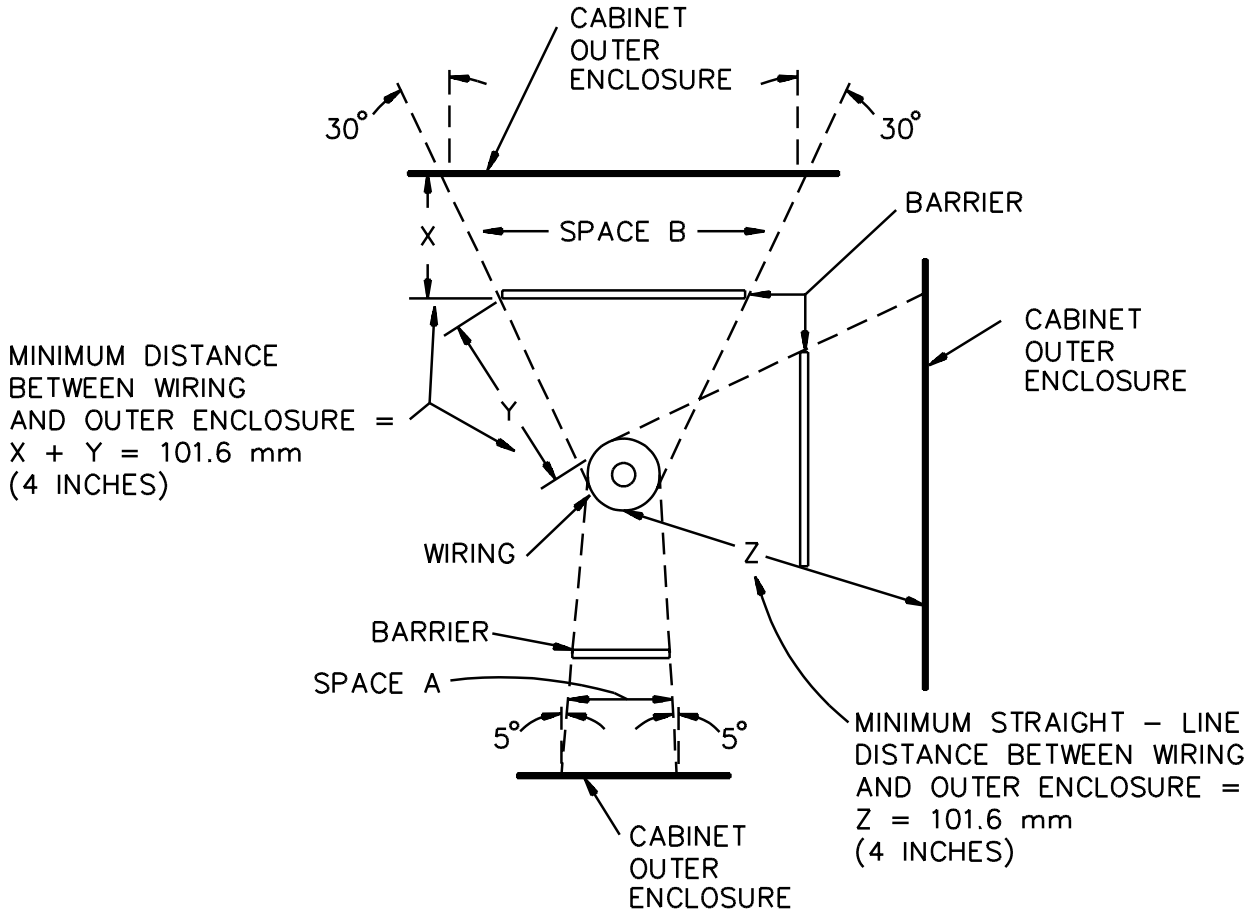
b) Located above the wiring and within Space B of Figure 10.2 shall be isolated by means of a barrier, extending at least to the boundary surface of the space and so located that the minimum distance between the wiring and the material is 4 inches (101 mm).

c) Essentially in the vertical plane and adjacent to wiring is considered separated from the wiring if it is at least 4 inches (102 mm) from the wiring. A barrier may be used for separation provided the size of the barrier is such that the minimum straight-line distance between the material and wiring is at least 4 inches. See Figure 10.2.

10.2.6 revised April 27, 1998

Figure 10.2
Separation of wiring from flammable materials

Figure 10.2 revised April 27, 1998



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

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

10.2.7 A barrier required by 10.2.3, and 10.2.6 shall be secured in place and shall be formed of:

a) Metal,

b) A 5V material, or

c) A material which complies with the requirements in the section for enclosure flammability – 5 inch flame test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

10.2.7 revised April 27, 1998

10.2.8 With reference to 10.2.1 and 10.2.2, if the compartment enclosing the wiring has no (1) openings other than for conduit or piping and (2) flammable material other than electrical insulation, the cord or appliance wiring material referenced in Group C of Table 10.1 may be employed.

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10.2.9 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 No. 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 ″HACR Type″ 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 62.

10.3 Cord connected refrigerators

10.3.1 A cord connected refrigerator shall be wired by either of the following means or combinations of the two:

a) Cords or appliance wiring material as referenced in Group B or C of Table 10.1,

b) Wiring material as referenced in Group A of Table 10.1, enclosed in conduit, electrical metallic tubing, metal raceways, control boxes, or cabinet walls.

Exception: Wiring material in Group A of Table 10.1 need not be enclosed as indicated above, if it is cabled, routed, located or secured to reduce the likelihood of damage to the wiring during routine servicing such as replacing fuses, adjusting the settings of controls, or the like.

10.3.2 With reference to 10.3.1(a), and the exception to 10.3.1(b), the wiring shall be:

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

b) 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.

10.3.3 Wiring shall be separated from HB or HBF materials in accordance with 10.2.5–10.2.7.

10.3.3 revised April 27, 1998

11 Separation Of Circuits

11.1 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 19.4) need not 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.

11.1 revised April 9, 1999

11.2 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.

11.3 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.

11.4 Field-installed conductors of a high-voltage circuit or a low-voltage circuit with National Electrical Code, ANSI/NFPA 70-1993, 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.

11.5 Field-installed conductors of a low-voltage circuit with National Electrical Code, ANSI/NFPA 70-1993, 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.

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

12 Bonding For Grounding

12.1 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.

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

Exception: The following metal parts need not be grounded:

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

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

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

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

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

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12.4 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.

12.5 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 12.7.

12.6 With reference to 12.5, a bolted or screwed connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

12.7 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 60, and the Limited Short-Circuit Test, Section 62, 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.

12.8 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 12.11 and 12.12.

12.9 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 12.11, the size of the conductor or strap shall be in accordance with Table 12.1.

Table 12.1
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.

12.10 A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in 12.9, is acceptable provided that the minimum cross-sectional conducting area is equivalent to the wire sizes indicated in Table 12.1.

12.11 A smaller conductor may be used if the bonding conductor and connection comply with the provisions of the Current Overload Test, Section 60, and the Limited Short-Circuit Test, Section 62.

12.12 The size of a bonding conductor to a motor or other electrical component need not be larger than the size of the motor-circuit conductors or the conductors supplying the component. See 10.2.9.

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

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

12.15 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.

Added 12.15 effective January 2, 1997

12.16 With reference to 12.15, the size of the bonding conductor used to bond the secondary conductor that is to be grounded shall be in accordance with 12.12. If one of the secondary circuit conductors is white or natural gray in color and located in a field wiring compartment, the white or natural gray conductor shall be the one that is grounded.

Added 12.16 effective January 2, 1997

ELECTRICAL COMPONENTS

13 Current-Carrying Parts

13.1 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 need not be inherently resistant to corrosion.

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

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

Exception: Iron or steel, if provided with a corrosion resistant coating, or stainless steel may be used for a current-carrying part if permitted in accordance with 2.1.1, or within a motor.

14 Insulating Material

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

14.2 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.

14.3 Polymeric materials may be used for the sole support of uninsulated live parts if found to have mechanical strength and rigidity, resistance to heat, flame resistance, dielectric-voltage withstand, and other factors involved with conditions of intended service. All these factors are to be considered with respect to aging.

15 Switches And Controllers

15.1 General

15.1.1 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 15.2.3. Such switches shall have a marked OFF position (the international symbol “O” may be used), and, if the switch does not control the complete refrigerator, shall indicate which load it controls, such as compressor, fan motor, or the like. The switch shall be accessible without the use of tools.

Exception: Laboratory refrigerators may be provided with a key-operated switch.

15.1.1 revised November 27, 2001

15.1.2 A switch or other control device shall be rated for the load it controls as determined by the Temperature and Pressure Test, Section 40, and the Defrost Test, Section 43.

15.1.3 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.

15.1.4 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.

15.1.5 A switch is acceptable for use with tungsten-filament lamp loads if it has a T or L rating equal to the tungsten-filament lamp load. A general-use alternating current 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 six of times or more of the tungsten-filament lamp load is also acceptable for use with that tungsten-filament lamp load without additional test.

15.1.6 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.

15.1.7 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.

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

15.1.9 Circuit breakers used as switches in 120 volt fluorescent lighting circuits shall be rated as indicated in 15.1.3 and shall be marked ″SWD.″

15.1.10 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 if the switching device or the pilot device that controls the switching device has a marked ON or OFF position.

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

15.1.12 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.

15.1.13 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 80.30, (2) complies with the Defrost Test, Section 43, without the switch, or (3) complies with the Burnout Test – Electric Defrost Heater, Section 53, without exceeding the temperature rises specified in the defrost test without the switch.

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

15.1.15 A switch provided as an interlock shall have an endurance rating of 100,00 cycles of operation at not less than the load it controls.

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

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

15.1.18 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 and Circuit-Breaker Enclosures, UL 489, may be used as the protection for each undgrounded conductor supplying line-to-line connected loads of a product rated for connection to a circuit of a grounded system.

Added 15.1.18 effective January 2, 1997

15.2 Motor Controllers

15.2.1 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 15.2.3 and 15.2.5.

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

15.2.3 The attachment plug and receptacle may serve as the controller on a cord connected refrigerator if the marked ampere rating does not exceed the values shown in Table 15.1 for the voltage indicated.

Table 15.1
Ampere rating

Amperes	Voltage
7.2	115
4.0	208
3.6	230

15.2.4 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 16.4.

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

15.2.6 If 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.

15.2.7 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 16.4.

15.2.8 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.

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

15.2.10 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.

16 Motors And Motor Overload Protection

16.1 All motors shall be protected against overload by thermal or overcurrent protective devices.

Exception: Direct-drive motors employing impedance protection and that comply with the locked-motor requirements specified in the Standard for Overheating Protection for Motors, UL 2111, may be used, provided that it is determined that the motor will not overheat under intended conditions of use.

16.1 revised February 3, 1998

16.2 For a motor other than a hermetic motor-compressor acceptable overload protection is provided by a separate overcurrent device that is responsive to motor current and is rated or set to trip at no more than the percentage of the motor nameplate full-load current rating shown in column A of Table 16.1. For an overload relay if the percentage protection indicated in column A of Table 16.1 does not correspond to the percentage value resulting from selection of a standard size of relay, the next higher size of overload relay may be used, provided that it provides protection no greater than the percentage protection indicated in column B of Table 16.1.

Table 16.1
Overload relay size

Motor rating	Maximum percentage 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 (104°F)	125	140
Any other motor	115	130

16.3 A hermetic refrigerant motor-compressor complies with the requirement of 16.1 if the protection complies with (a), (b), (c), or (d).

a) 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 marked on the refrigerator nameplate.

b) A thermal protector integral with the motor-compressor that complies with 16.5.

c) A fuse or circuit breaker responsive to motor current and rated-load current of the motor-compressor marked on the refrigerator nameplate. The refrigerator shall start and operate as intended with the fuse or circuit breaker provided.

d) A protective system that complies with 16.5.

16.4 For a cord-connected refrigerator or a permanently connected refrigerator marked with a single-ampere rating, the rated-load current of the motor-compressor is the current drawn by the motor-compressor during the Temperature and Pressure Test, Section 40.

16.5 The thermal protection and the protective system specified in 16.3 shall:

a) Comply with the Standard for Hermetic Refrigerant Motor Compressors UL 984; and

b) Not permit a continuous current in excess of 156 percent of the rated load current of the motor-compressor (or 156 percent of the branch-circuit-selection current if the latter value is marked). The values of rated-load current and branch-circuit-selection current referred to are the values marked on the refrigerator nameplate. See 63.1.

Exception: A refrigerator employing a hermetic refrigerant motor-compressor equipped with a thermal protective device is not required to comply with the 156 percent limitation if the equipment is intended for connection to a 15 or 20 ampere, 120 volt or a 15 ampere, 208 or 240 volt, single-phase branch circuit.

16.6 Each component of the ″protective system″ mentioned in 16.3(d) shall be provided as part of the refrigerator.

16.7 Thermal protective devices used with nonhermetic motors shall comply with the Standard for Overheating Protection for Motors, UL 2111.

Exception: Motors, such as direct-drive fan motors, that are not subjected to overloads and determined to be protected against overheating due to locked-rotor current by a thermal or overcurrent protective device are acceptable if it is determined that the motor will not overheat under conditions of intended use.

16.7 revised February 3, 1998

16.8 Three-phase motors shall be provided with overcurrent protection as specified in (a) or (b):

a) Three overcurrent units rated in accordance with 16.2 or 16.3, or

b) Thermal protectors, combinations of thermal protectors and overcurrent units, or other methods of protection may be employed where the specific protective arrangement has been investigated and found to provide protection under primary single-phase failure conditions when supplied from transformers connected wye-delta or delta-wye. Assemblies so investigated shall be marked as described in 80.26.

16.9 A fuse shall not be used as a motor overload protective device unless the motor is protected by the largest fuse that can be inserted in the fuseholder.

16.10 Each overcurrent protective device and thermal protective devices for motors shall comply with applicable short-circuit requirements for the class of protective device and shall, in addition, comply with the requirements of the Limited Short-Circuit Test, Section 62.

16.11 Nonhermetic motors shall comply with the requirements in the Standard for Electric Motors, UL 1004. Hermetic motor-compressors shall comply with the Standard for Hermetic Refrigerant Motor-Compressor, UL 984.

16.12 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 8.1.12 – 8.1.14.

16.13 The requirement in 16.12 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:

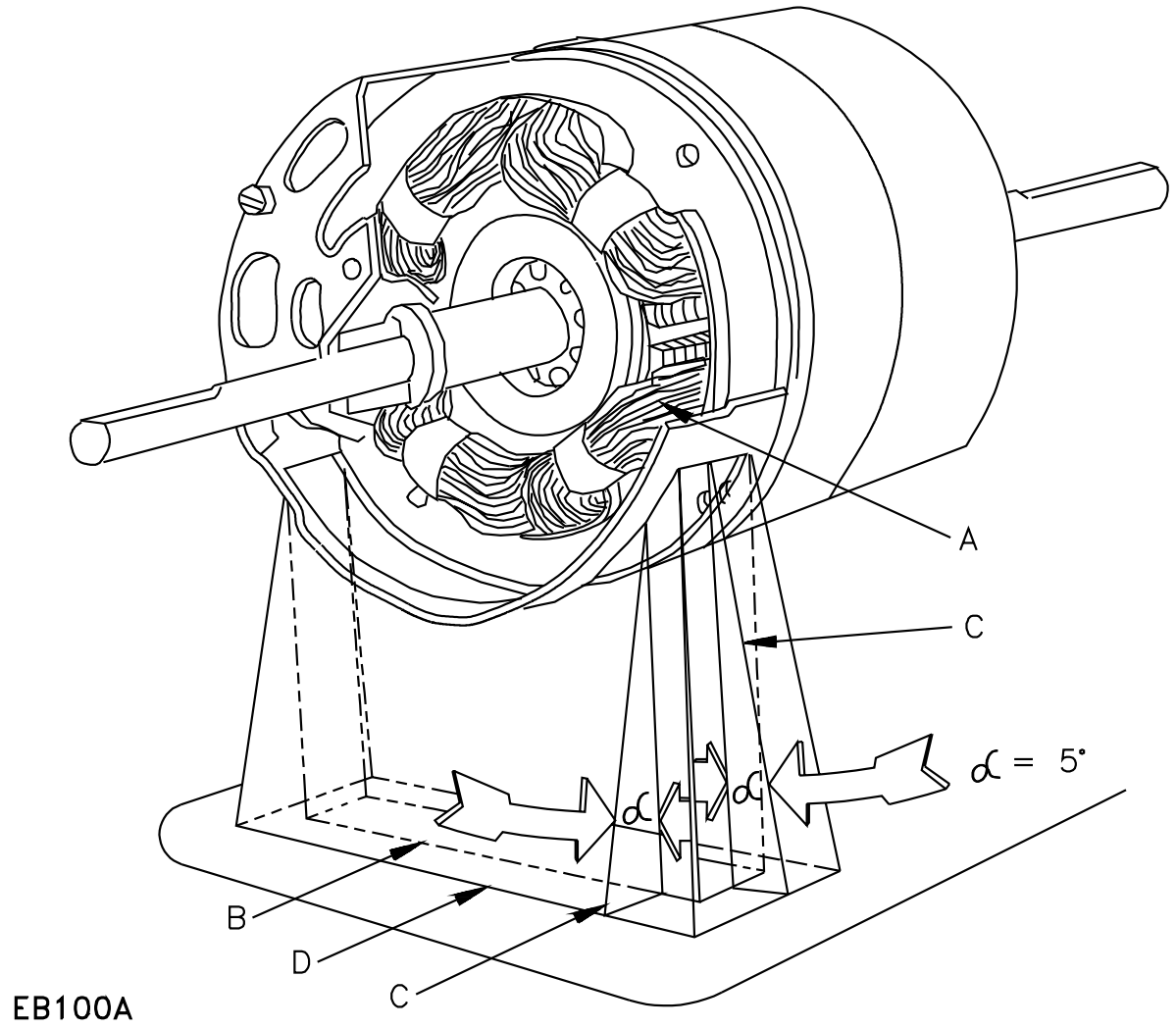
1) 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle, and

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

16.14 The barrier mentioned in 16.13 shall be horizontal, shall be located as indicated in Figure 16.1, and shall have an area not less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier provided that such openings would not permit molten metal, burning insulation, or the like, to fall onto flammable material.

Figure 16.1
Location and extent of barrier

Figure 16.1 revised April 27, 1998



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

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

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

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

17 Electric Defrost Heaters

17.1 Heater elements

17.1.1 An electric 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.

17.1.2 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 17.1.4.

17.1.3 A heater element, installed in the complete refrigerator, shall be protected against mechanical damage. The heater is considered to be protected if 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 6.1 when inserted with a force of 5 pounds (22.2 N).

17.1.4 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 if the coating is corrosion resistant and will withstand the temperatures to which it may be subjected. Aluminum tubing may be employed if the alloy withstands the Burnout Test – Electric Defrost Heater, Section 55, without melting or other malfunction. Stainless steel tubing of the austenitic grades, such as ASTM Type 304, is acceptable for defrost heater sheaths.

17.1.5 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.

17.1.6 Insulating material employed in a heating element shall be acceptable as the sole support of live parts. Materials, such as magnesium oxide, may be used in conjunction with other insulating materials if located and protected so that mechanical damage is prevented and if 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 61.1.1 – 61.1.3), 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.

17.1.7 Each heater case or terminal seal of rubber, neoprene, or thermoplastic materials shall comply with the Accelerated Aging Test – Electric Heaters, Section 70.

17.1.8 Each electric heater assembly shall be sealed to prevent entrance of moisture. See Insulation Resistance Test, Section 61. Molded seal caps, vulcanized to the heater leads and heater sheath, shall have a wall thickness equivalent to that required for the heater leads.

17.2 Heater control

17.2.1 If 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. See Burnout Test – Electric Defrost Heater, Section 55. Thermal cutoffs shall comply with the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020.

17.2.2 A temperature-limiting control that is required to reduce the risk of fire in the refrigerator (see Burnout Test – Electric Defrost Heater, Section 55) shall be an integral part of the refrigerator and shall:

a) Control each defrost heater directly, or

b) Control each defrost 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 53.1.1(b) or (c)).

17.2.3 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 17.2.4 and 17.2.5.

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17.2.4 Replacement of a thermal cutoff shall not necessitate:

a) Removal of the heater from its installation.

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

or

b) Disconnection of the field-wiring system.

17.2.5 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.

18 Fuseholders And Circuit Breakers

18.1 Fuseholders

18.1.1 Each fuseholder shall be constructed, 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 a fuse. A separation of less than 4 inches (102 mm) from the insulating body of a fuse is considered to be adjacent. A barrier of vulcanized fiber or similar material employed as a guard for uninsulated high-voltage live parts shall be not less than 0.028 inch (0.71 mm) thick.

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

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

18.2 Circuit breakers

18.2.1 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.

19 Electric-Discharge Lighting Systems

19.1 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.

19.1 revised April 9, 1999

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

19.3 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.

19.4 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.

19.5 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.

19.5 revised April 9, 1999

19.6 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.

19.7 Deleted April 9, 1999

19.8 Deleted April 9, 1999

19.9 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.

19.9 revised April 9, 1999

19.10 Deleted April 9, 1999

19.11 Compliance with 19.9 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.

19.11 revised April 9, 1999

19.12 Deleted April 9, 1999

19.13 Deleted April 9, 1999

19.14 Deleted April 9, 1999

19.15 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.

Added 19.15 effective April 28, 2000

20 Incandescent Lighting Systems

20.1 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.

20.2 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.

21 Guarding Of Lamps

21.1 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.

21.2 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. If lamp guards are employed, see 21.3 and 21.4.

21.3 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 21.4, is capable of retaining any broken glass.

21.4 If a guard is required, it shall not become damaged to the extent that the lamp is no longer protected in accordance with 21.1 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.

22 Receptacles

22.1 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.

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

22.3 Receptacles 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.

23 Receptacle And Lighting Circuits Overcurrent Protection

23.1 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 if the receptacle or lighting circuit is intended to be connected to a power supply separate from that supplying the refrigerator. See 80.28.

Exception No. 2: Overcurrent protection is not required if 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 70-1993, and

b) Is not marked as specified in 79.3.2.

23.2 The overcurrent protection specified in 23.1 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 provided the rating equals the receptacle load which is marked on the refrigerator. See 79.3.2. If 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.

23.2 revised April 9, 1999

24 Capacitors

24.1 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: If 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.

24.2 If exposed to the effects of weathering, ferrous metal capacitor enclosures shall be protected against corrosion in accordance with 8.3.1. See also 8.1.23.

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24.3 If the container of an electrolytic capacitor is metal, the container shall be considered as a live part and shall be provided with moisture-resistant electrical insulation to isolate it from dead metal parts and to prevent contact during servicing operations. The insulating material shall be at least 1/32 inch (0.8 mm) thick except as indicated in 27.9.

24.4 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 62.

Exception: If 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 62.1 but not less than the current established by dividing the circuit voltage by the impedance of the other component(s).

25 Transformer Protection

25.1 General

25.1.1 A transformer (including an autotransformer), other than one as described in 25.3.4 is considered to be a high-voltage transformer and shall:

a) Be provided with thermal overload protection in accordance with the requirements in 25.2.1,

b) Be protected by an overcurrent device in accordance with the requirements in 25.3.1, or

c) With the Burnout Test – High-Voltage Transformers, Section 57.

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.

25.2 High-voltage transformers – thermal protection

25.2.1 If a high-voltage transformer is provided with a thermal overload protective device, the device shall be arranged to interrupt primary current and shall limit temperatures of the transformer windings, under overload conditions, to that permitted for the class of insulation employed in the windings. See Overload Test – High-Voltage Transformers, Section 58.

Exception: If the thermal overload protective device provided is a nonrenewable thermal cutoff, a burnout test is to be conducted in place of the overload test. See Burnout Test – High-Voltage Transformers, Section 57.

25.2.2 A thermal cutoff shall comply with the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020. 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, pertaining to the calibration of temperature limiting controls.

25.3 High-voltage transformers – overcurrent protection

25.3.1 If a high-voltage transformer is protected by an overcurrent device, such protection shall comply with the requirements specified in 25.3.2, 25.3.3, and 25.4.1 – 25.4.3.

25.3.2 Except as noted in 25.3.3, 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 25.1. See 25.4.1.

Exception: If the rated primary current of the transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device may be used. Standard ratings of protective devices are specified in Section 240-6 of the National Electrical Code, ANSI/NFPA 70-1993.

Table 25.1
Rating of overcurrent devices

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

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

25.3.3 If the circuit supplying a transformer other than an autotransformer is provided with overcurrent protection rated or set at not more than 250 percent of the rated primary current of the transformer, additional overcurrent protection is not required in the primary circuit provided the secondary circuit is protected at not more than 125 percent of the rated secondary current of the transformer. See 25.4.2.

Exception No. 1: If the rated secondary current of the transformer is 9 amperes or more and 125 percent of this current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating of protective device may be used in the secondary circuit. Standard ratings of protective devices are specified in Section 240-6 of the National Electrical Code, ANSI/NFPA 70-1993.

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

25.3.4 A transformer that directly supplies a National Electrical Code, ANSI/NFPA 70-1993, Class 2 circuit (see 3.5) shall, in accordance with the Standard for Class 2 and Class 3 Transformers, UL 1585, either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer).

25.4 Overcurrent protective device

25.4.1 Overcurrent protection in the primary circuit of a transformer, as described in 25.3.2, need not be provided as part of the refrigerator if, 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 25.3.2.

25.4.2 Overcurrent protection in the secondary circuit of a transformer, as required by 25.3.3, shall be provided as part of the refrigerator.

25.4.3 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 25.3.2 and 25.3.3, 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 79.3.9.

Exception: If 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 62.1. If the supplementary type device used is a fuse, the refrigerator shall be marked in accordance with the requirements in the exception to 79.3.9.

25.4.3 revised April 9, 1999

26 High-Voltage Control Circuit Conductor Overcurrent Protection

26.1 General

26.1.1 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. If a control-circuit is supplied through a transformer provided as part of the refrigerator, see Transformer Protection, Section 25, for additional requirements.

26.2 Direct-connected high-voltage control circuit

26.2.1 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 80.31.

26.3 Tapped high-voltage control circuit

26.3.1 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.

26.3.2 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 26.1.

Exception No. 1: Nos. 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 ″HACR Type″ 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 62.

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

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

a) This protection is in accordance with requirements specified in Transformer Protection, Section 25, and

b) The rating of the device does not exceed the applicable value specified in Table 26.1 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 70-1993.

Table 26.1
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 70-1993.
[c] 300 percent of value specified for 60°C conductors in Table 310-16 of National Electrical Code, ANSI/NFPA 70-1993.

26.3.3 Overcurrent protection for a tapped high-voltage control circuit conductor, as required by 26.3.2 shall be provided as part of the refrigerator.

Exception: The overcurrent device(s) need not be provided as part of the refrigerator if, 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 26.1.

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

a) Be provided for all ungrounded conductors,

b) Be sized in accordance with requirements in 26.3.2 and

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

26.3.5 The device(s) mentioned in 26.3.4 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 79.3.9.

Exception: If 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 62.1. If the supplementary type device used is a fuse, the refrigerator shall be marked in accordance with the exception to 79.3.9.

SPACINGS

27 High-Voltage Circuits

27.1 The spacing requirements in 27.2 – 27.10 apply to high-voltage circuits, defined in 3.5(a).

27.1 revised November 27, 1995

27.2 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 27.1.

27.2 revised November 27, 1995

Table 27.1
Electrical spacings in refrigerated and/or air-handling compartments

Table 27.1 revised November 27, 1995

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.

27.3 The ″Through Air″ and ″Over Surface″ spacings specified in Tables 27.1 and 27.2 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.

27.3 revised November 27, 1995

27.4 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.

27.4 revised November 27, 1995

27.5 With reference to 27.2 and 27.3, the ″To Enclosure″ spacings specified in Table 27.1 do not apply to an individual enclosure of a component part within an outer enclosure or cabinet.

27.5 revised November 27, 1995

27.6 The spacings indicated in Table 27.2 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 27.1 apply.

27.6 added November 27, 1995

Table 27.2
Spacings in non-refrigerated and non-air handling compartments

Table 27.2 added November 27, 1995

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 27.6.

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

27.7 The spacings specified in 27.6 do not apply to the inherent spacings of a component part of the refrigerator, such as a snap switch, controller, attachment plug, and the like, for which spacing requirements are given in a standard for the component. However, the electrical clearance resulting from the assembly of the components into the complete product, including clearance to dead metal or enclosures, shall be those indicated.

27.7 revised November 27, 1995

27.8 If 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: If 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.

27.8 revised November 27, 1995

27.9 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) if the potential is 600 volts or less and not less than 3/4 inch (19.1 mm) if the potential is 601 – 1000 volts.

27.10 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 if it has equivalent insulating, mechanical, and flame resistance properties when compared with materials in required thicknesses.

27.10 revised November 27, 1995

28 Low-Voltage Circuits

28.1 The following spacing requirements apply to low-voltage circuits, as defined in 3.5 (b).

28.1 revised November 27, 1995

28.2 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.

28.3 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.

28.3 revised November 27, 1995

28.4 The spacings in low-voltage circuits that do not contain devices such as indicated in 28.3 are not specified.

REFRIGERATION SYSTEM

29 Refrigerants

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

29.1 revised February 3, 1998

30 Pump-Down Capacity

30.1 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 32.2°C (90°F).

31 Refrigerant Tubing And Fittings

31.1 The wall thickness of copper or steel tubing used to connect refrigerant-containing components shall be not less than indicated in Table 31.1.

Exception: 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 31.1
Minimum wall thickness for copper and steel tubing

Outside diameter,		Copper				Steel	
		Protected within refrigerator		Unprotected			
Inches	mm	Inches	mm	Inches	mm	Inches	mm
1/4	6.35	0.0245	0.623	0.0265	0.673	0.025	0.635
5/16	7.94	0.0245	0.623	0.0265	0.673	0.025	0.635
3/8	9.53	0.0245	0.623	0.0265	0.673	0.025	0.635
1/2	12.70	0.0245	0.623	0.0285	0.724	0.025	0.635
5/8	15.88	0.0315	0.799	0.0315	0.799	0.032	0.813
3/4	19.05	0.0315	0.799	0.0385	0.978	0.032	0.813
7/8	22.23	0.0410	1.041	0.0410	1.041	0.046	1.168
1	25.40	0.0460	1.168	0.0460	1.168	–	–
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.

31.2 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.

31.3 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 60.

31.4 Special alloys or constructions used in refrigerant-containing components, including tubing with a wall thickness less than indicated in 31.1 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 Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994, as compared to tubing of the minimum wall thicknesses indicated in Table 31.1.

31.5 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, ANSI/SAE J513-June 90.

32 Refrigerant-Containing Parts

32.1 Parts of a refrigerator subjected to refrigerant pressure shall withstand, without failure, the pressure indicated in the Strength Tests – Pressure Containing Components, Section 64.

32.2 In addition to the requirement of 31.1, 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.

32.3 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.

32.4 Pressure vessels bearing the ASME Code ″U″ symbol complying with 32.3 are considered acceptable without tests.

32.5 Pressure vessels bearing the ASME Code ″UM″ symbol are to be tested to determine compliance with the Strength Tests – Pressure Containing Components, Section 64. The manufacturer shall submit evidence compliance of these vessels with ASME Boiler and Pressure Vessel Code, Section VIII.

33 Pressure-Limiting Device

33.1 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.

33.1 revised June 24, 1997

33.2 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.

33.2 revised June 24, 1997

33.3 Deleted June 24, 1997

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

33.4 revised June 24, 1997

34 Pressure Relief

34.1 General

34.1.1 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.

34.1.1 revised June 24, 1997

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

34.1.3 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, shall be protected by a pressure-relief device or fusible plug.

34.1.4 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) shall be protected by a pressure-relief device.

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

34.1.5 revised June 24, 1997

34.1.6 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.

34.1.7 Fusible plugs may be located either above or below the liquid refrigerant level.

34.2 Required discharge capacity

34.2.1 Deleted June 24, 1997

34.3 Relief valves

34.3.1 Pressure-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.

34.3.2 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.

34.3.3 The marked discharge capacity shall be not less than the minimum required discharge capacity as computed from 34.4.1.

34.3.3 revised April 9, 1999

34.4 Fusible plugs or rupture members

34.4.1 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 Mechanical Refrigeration Code, ANSI/ASHRAE 15-1994.

Revised 34.4.1 effective June 24, 1998

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

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

PERFORMANCE

35 Instrumentation

35.1 Temperature measurements

35.1.1 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 40.4. The thermocouples are to consist of No. 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 is to comply with the requirements for ″special thermocouples″ as listed in the Table of Limits of Error of Thermocouples in the Standard for Temperature Measurement Thermocouples, ANSI MC96.1-1982.

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

35.1.3 If thermocouples are used in the determination of temperatures in connection with the heating of electrical equipment, thermocouples consisting of No. 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of indicating instrument are to be used whenever referee temperature measurements by means of thermocouples are necessary.

35.1.4 If 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:

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

where:

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.

35.1.5 When it is necessary 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.

35.2 Pressure measurements

35.2.1 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.

35.2.2 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.

35.2.3 The instrumentation and test procedures specified in Sections 34, 40, 43, 45, and 46 may be modified for the investigation of a remote refrigerator, as such a unit does not include a complete refrigeration system.

36 Test Voltage

36.1 Unless otherwise specified, a refrigerator is to be tested at 60 hertz voltages maintained at the refrigerator's supply connections in accordance with Table 36.1.

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

Table 36.1
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 Fan Motor Failure Test, Section 45, and Condenser Water Failure Test, Section 46.

37 Leakage Current Test – Cord Connected Refrigerators

37.1 The leakage current of a cord connected refrigerator shall be no more than 0.75 milliamperes when tested in accordance with requirements in 37.7 – 37.11.

37.2 Leakage current refers to all currents, including capacitively-coupled currents, that may be conveyed between exposed conductive surfaces of a refrigerator and ground or other exposed conductive surfaces.

37.3 All exposed conductive surfaces are to be tested for leakage currents. Leakage currents are to be measured between:

a) The grounded supply conductor and:

1) Each exposed surface individually,

2) All exposed surfaces collectively when the surfaces are simultaneously accessible;

b) Simultaneously accessible surfaces. Surfaces are exposed unless guarded by an enclosure that provides protection as specified in 6.4.1 and 6.4.2. Surfaces are simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time.

Exception: These measurements do not apply to terminals operating at voltages that are low-voltage.

37.3 revised April 9, 1999

37.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil having dimensions of 3.9 by 7.8 inches (10 by 20 cm), in contact with the surface. If the surface is less than 3.9 by 7.8 inches, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the refrigerator.

37.5 The measurement circuit for leakage current is shown in Figure 37.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument and need not have all of the attributes of the defined instrument.

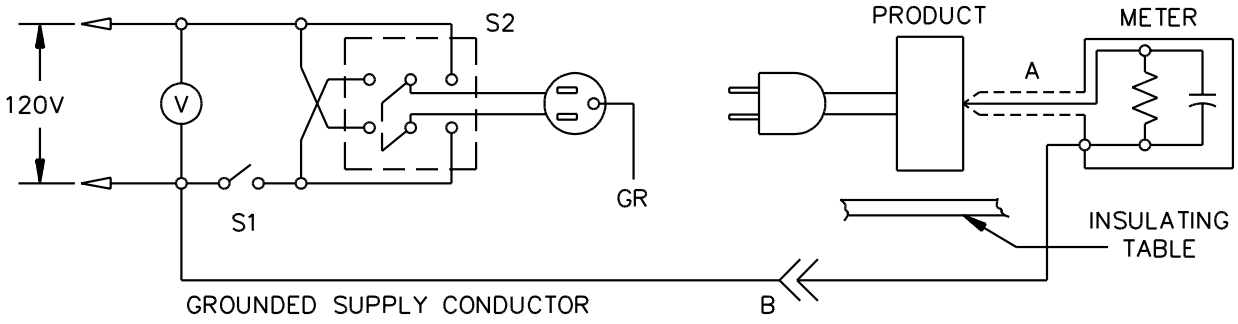
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

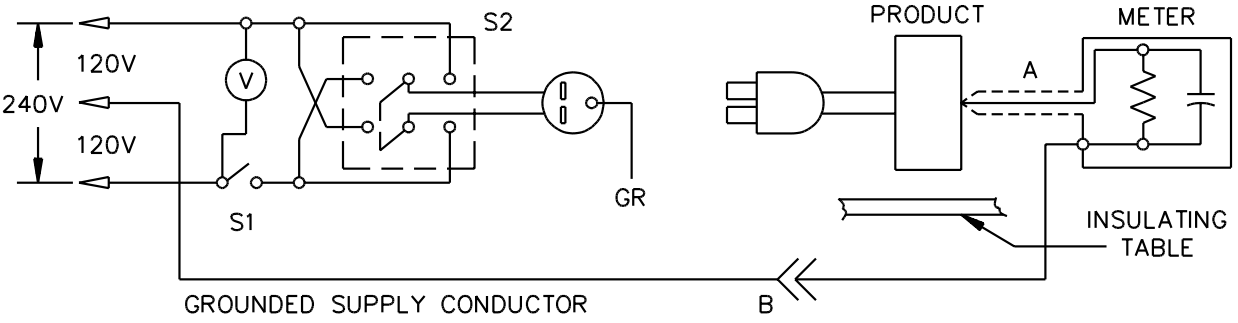
c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500 ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.75 milliampere, the measurement error is not to be more than 5 percent.

Figure 37.1
Leakage current measurement circuits

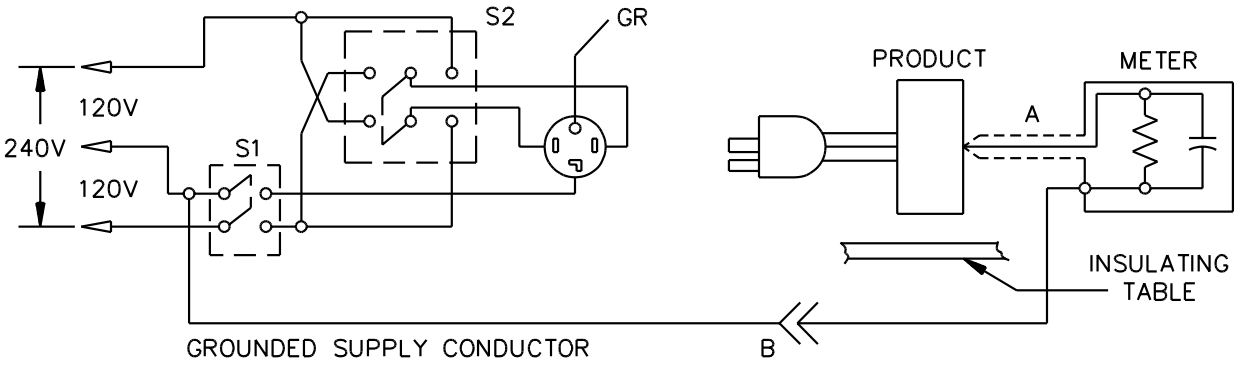
Figure 37.1 revised April 27, 1998



Product intended for connection to a 120–volt power supply, as illustrated above.



Product intended for connection to a 3–wire, grounded neutral power supply, as illustrated above.



Product intended for connection to a 3–wire, grounded neutral power supply, as illustrated above.

LC300J

A – Probe with shielded lead

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

37.6 Unless the meter is being used to measure leakage from one part of a refrigerator to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

37.7 The refrigerator is to be prepared and conditioned for leakage current measurement as specified in (a) and (b):

a) The grounding conductor is to be open at the attachment plug and the refrigerator is to be isolated from the ground.

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

37.8 The test is to be conducted at the ambient conditions specified by 37.7 (b).

37.9 The supply voltage is to be adjusted to the voltage indicated in Table 36.1.

37.10 A refrigerator, such as a beverage cooler or beverage cooler-dispenser, is to be filled with water. If make-up water is required, water is to be supplied to the unit using nonconductive tubing.

37.11 With reference to the measuring circuit in Figure 37.1, the leakage current test sequence shall be as described in (a) – (d) below. If the compressor stalls during sequence b) or c) due to changing the position of switch S2, the sequence is to be conducted in its entirely in one position of switch S2 and then repeated in the second position of switch S2.

a) With switch S1 open, the unit is to be connected to the measuring circuit. The leakage current is to be measured using both positions of switch S2 and with manually operated unit switching devices successively placed in each mode (refrigeration, defrost, cleaning, and the like).

b) With unit controls set for maximum refrigeration, switch S1 is to be closed to energize the unit. Within 5 seconds, leakage current is to be measured using both positions of switch S2. Following this and using both positions of switch S2, manual switching devices are to be operated as quickly as possible through all modes, but not in the OFF position, to determine the maximum leakage current condition.

c) With switching devices set at the position that causes the highest leakage current, the unit is to be operated continuously until the measured leakage current stabilizes or decreases. Both positions of switch S2 are to be used.

d) Switch S1 is to be opened to de-energize the unit. Measurement of leakage current is to continue, using both positions of switch S2, until values stabilize or begin to decrease.

38 Input Test

38.1 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 40, and the Defrost Test, Section 43.

38.2 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 40, and the Defrost Test, Section 43.

38.3 With reference to the requirements of 38.1 and 38.2, 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 operation. For a beverage cooler as described in 40.13, 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.

38.4 With reference to 38.3, 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 if a single receptacle is employed.

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

c) By 100 percent of the load(s) marked on or adjacent to the receptacle(s) if the refrigerator is marked as indicated in 79.3.2 and is provided with overcurrent protection as specified in the exception to 23.2.

38.4 revised April 9, 1999

38.5 With reference to 38.1 and 38.2, 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, if such a load exceeds 125 percent of the marked nameplate rating, it shall be included in the marked rating of the refrigerator.

38.6 The load described in 38.5 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.

39 Starting Test

39.1 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 62.1.4, no starting test is required.

39.2 The refrigerator, with four fuses connected in series, is to be operated under the conditions described in the Temperature and Pressure Test, Section 40, and if provided with a defrost system, operated under the conditions described in the Defrost Test, Section 43. See 39.7.

39.3 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 62.1.4, the fuse rating is to be as marked on the nameplate.

39.4 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.

39.5 If it is determined that time-delay fuses are required for starting, the refrigerator shall be marked in accordance with 80.16 or 81.2, whichever is appropriate.

No Text on This Page

39.6 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 39.4 and 39.5.

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

39.8 If 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 if a single receptacle is employed.

b) The load is to be equal to 100 percent of the rating of the largest receptacle if 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 79.3.2 and is provided with overcurrent protection as specified in the exception to 23.2.

39.8 revised April 9, 1999

40 Temperature and Pressure Test

40.1 The temperature rises measured on the electric components and surfaces of a refrigerator shall not exceed those specified in Table 40.1.

Table 40.1
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 hermetric 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

Table 40.1 Continued on Next Page

Table 40.1 Continued

Device or material					°C	°F
	3.	Fuses				
		a.	Class CC, G, J, L, and T			
			Tube		100	180
			Ferrule or blade		85	153
		b.	Other classes[g]		65	117
	4.	Hermetic motor-compressor enclosure[f]			150	302
	5.	Relay, solenold, 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 the like)				
		Metal			35	63
		Nonmetallic			60	108
	3.	Surfaces of refrigerator subjected to casual contact by persons (enclosure, grille, and the like)				
		Metal			45	81
		Nonmetallic[h]			65	117

Table 40.1 Continued on Next Page

Table 40.1 Continued

Device or material			°C	°F
	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).

[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 if the refrigerator is clearly marked with the following statement or its equivalent: ″For supply connections, use No. ___ 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 6.3.11 and 6.3.12.

40.2 The maximum pressure developed in a refrigeration system, including equalization pressures after compressor shutdown, shall be used as a basis for the Strength Test – Pressure Containing Components, Section 64.

40.3 Motor-compressors 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.

40.4 The refrigerator is to be fitted with pressure gauges on the high- and low-sides. Thermocouples are to be secured to electrical components, such as the compressor motor enclosure, fan-motor windings, starting-relay coil, capacitors, and wiring insulation, and to surfaces as indicated in item D of Table 40.1. 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.

40.5 The refrigerator is to be installed in accordance with the manufacturer's instructions, see 4.1 and 4.2, and operated under the conditions specified in 40.7 – 40.13, as applicable. The test potential is to be as indicated in Table 36.1.

40.6 If the wiring to a general purpose receptacle does not comply with the requirements of 10.1.14, 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 39.8 (a), (b), or (c).

40.7 A built-in type 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.

40.8 The 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. See 40.11 and 40.12.

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).

40.8 revised November 27, 2001

40.9 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 36.1. 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.

40.10 For the test of a refrigerator of the water-cooled type, the condenser water flow is to be maintained at 26.7°C (80°F) inlet and 37.8°C (100°F) outlet temperatures. If the outlet water cannot attain a temperature of 100°F because of product construction considerations, the refrigerator is to be tested at 80°F inlet water and 35 psig (241 kPa) nominal pressure.

40.11 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 40.9.

40.12 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. If water is to be added to the ingredients, the temperature of the water is to be 26.7°C (80°F). The refrigerator then is to be tested in accordance with 40.9 under ″no-draw″ conditions.

40.13 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 26.7°C (80°F). The refrigerator then is to be tested in accordance with 40.9 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.

40.14 The refrigerator shall comply with the Dielectric-Voltage Withstand Test, Section 44, following this test.

41 Heating Test – Condensation Wiring

41.1 This test is conducted only on cabinets supplied with mullion heater wire or similar condensation wiring that does not comply with 10.1.16.

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

41.3 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 36.1 until constant temperatures are attained, as determined by thermocouples on the insulation. The test is to be conducted at approximately 25°C (77°F) ambient temperature with the refrigerator in the OFF position.

41.4 The condensation wiring system is to comply with the Dielectric-Voltage Withstand test, Section 44, following this test.

42 Heating Test – Ballasts And Wiring

42.1 Ballasts are to be tested in accordance with the 42.2 – 42.7 if 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.

42.2 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 40.1 under the test conditions described in 42.3 – 42.7.

42.3 The test is to be conducted only on cabinets with electric-discharge lamp systems that are not exempt by the provisions of 42.6.

42.4 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 if 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.

42.5 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 approximately 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.

42.6 Except as indicated in 42.1, 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).

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.

42.7 The ballasts and wiring are to comply with the Dielectric-Voltage Withstand Test, Section 44, following this test.

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43 Defrost Test

43.1 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 40.1. A hot-gas defrost system of a self-contained refrigerator shall to 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 44.

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

a) 43.4 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.

43.2 The test voltage is to be as specified in Table 36.1. The maximum high- and low-side pressures are to be recorded as reference values for requirements of the Strength Tests – Pressure Containing Components, Section 64.

43.2 revised April 9, 1999

43.3 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 43.4(b).

43.4 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 4.1).

b) The refrigerator is to be operated in a room maintained at a temperature of 21.1 – 26.7°C (70 – 80°F) dry-bulb and approximately 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 than 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: If agreeable to all concerned, (b) may be omitted if 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 43.1 and 43.2.

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 23.3°C (42°F) and the resulting values are to be used to determine compliance with 43.1.

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

43.5 With reference to 43.4(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. If 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 43.1.

Exception: For a remote refrigerator:

a) If 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 80.30) but not less than 15 minutes.

b) If the defrost cycle control is not an integral part of the refrigerator and the marking specified in 80.30 is not provided, the defrost test is terminated when stabilized temperatures are reached on electrical components, wiring and enclosure surfaces.

44 Dielectric-Voltage Withstand Test

44.1 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 shall 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: If 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.

44.1 revised November 27, 1995

44.2 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 shall be 500 volts at any frequency between 40 and 70 hertz. If components specified in 28.3 are employed in the low-voltage circuit, the dielectric voltage withstand test is also to be conducted between live parts of opposite polarity.

44.2 revised November 27, 1995

44.3 With reference to 44.2, 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.

44.3 revised November 27, 1995

44.4 A 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with 44.1 – 44.3. 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 if the high potential testing equipment maintains the specified high potential voltage at the equipment during the duration of the test.

44.4 revised November 27, 1995

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

44.5 added November 27, 1995

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

44.6 added November 27, 1995

44.7 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.

44.7 added November 27, 1995

45 Condenser Fan Motor Failure Test

45.1 A refrigerator 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 64. An assembly employing a pressure-limiting device complying with 33.2 or 33.3, as applicable, is considered to comply with the high-side pressure requirement.

b) The maximum temperature of the compressor enclosure of the fan motor winding (open type) or of the fan motor enclosure (enclosed type) shall not exceed 150°C (302°F). Compressors and condenser fan motors equipped with thermal protective devices as specified in Motors and Motor Overload Protection, Section 16, are considered to comply with this requirement.

45.2 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 low-side pressure is to be recorded both while the compressor is operating and after shutdown. If 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.

45.2 revised April 9, 1999

45.3 The ambient air temperature is to be approximately 25°C (77°F). The test potential is to be maintained as indicated in Table 36.1. If two or more condenser fan motors are employed, the test is to be conducted with one motor locked.

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

46 Condenser Water Failure Test

46.1 During failure of the cooling water supply, a water-cooled refrigerator 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 64.

b) The maximum temperature of the compressor enclosure shall not exceed 150°C (302°F). If the compressor is equipped with a thermal protective device(s) as specified in Motors and Motor Overload Protection, Section 16, this temperature measurement may be waived.

46.2 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 45.2. 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 approximately 25°C (77°F). The potential is to be maintained as indicated in Table 36.1.

46.3 If a pressure-limiting device is provided, the test need not be conducted to determine compliance with 46.1. The maximum cutout pressure to which the pressure-limiting device may be readily adjusted by the adjusting means provided shall be employed in determining compliance with 46.1. See 64.1.1.

47 Evaporator Fan Motor Failure Test

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

47.2 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.

47.3 The test arrangement is to be as described in the Burnout Test – Electric Defrost Heaters, Section 55, except that the defrost shutoff control is to be operable as in the Defrost Test, Section 43, and the evaporator fan motor is to be locked. The potential is to be maintained as indicated in 36.1.

47.4 If 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.

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

48 Overflow Test

48.1 With reference to 6.4.7, 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.

48.1 revised April 9, 1999

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

48.3 Compliance with 48.1 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 44.

49 Rain Test

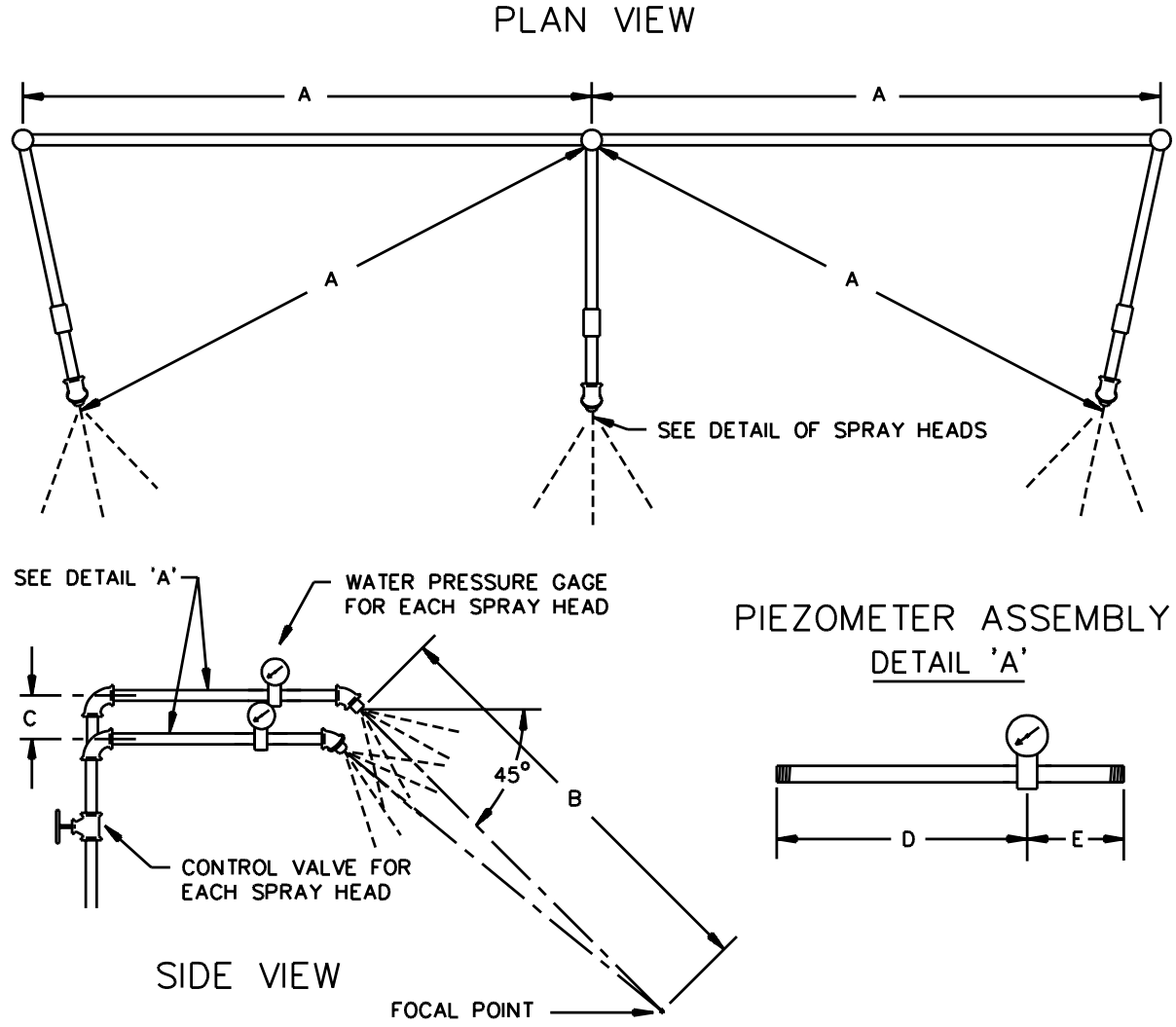
49.1 A refrigerator exposed to weather is to be subjected to a rain exposure without creating a risk of electric shock due to current leakage or insulation breakdown. Following the rain test exposure, the refrigerator shall have an insulation resistance of not less than 50,000 ohms measured between current-carrying parts and noncurrent-carrying parts, and shall withstand the Dielectric-Voltage Withstand Test, Section 44.

49.2 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.

49.3 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as shown in Figure 49.1. Spray heads are to be constructed in accordance with the details shown in Figure 49.2. 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 49.1
Rain-test spray-head piping

Figure 49.1 revised April 27, 1998



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

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

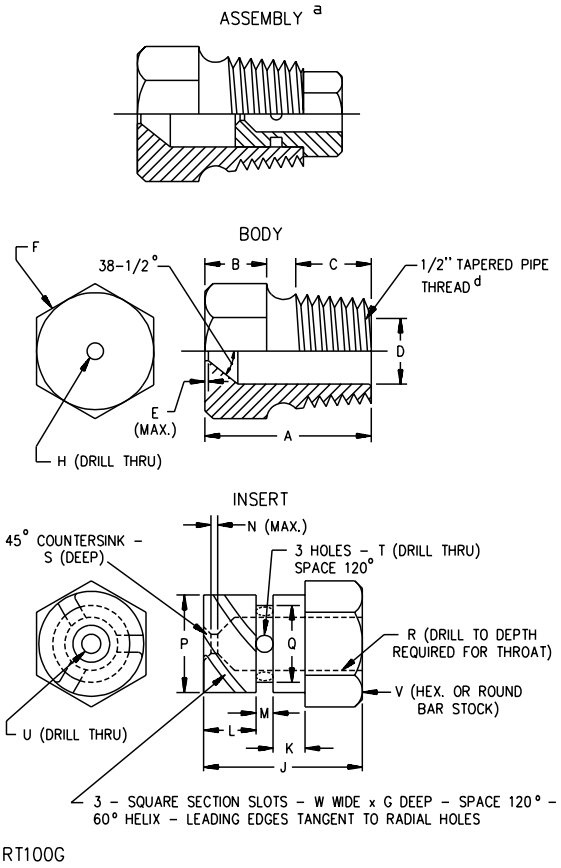
a) Motor windings may be judged on the basis of the insulation resistance (see 49.1) and by the Dielectric-Voltage Withstand Test, Section 44, if the motors are within the outer enclosure and are shielded from openings in the top of the outer enclosure.

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

49.4 revised April 27, 1998

Figure 49.2
Rain-test spray head

Figure 49.2 revised April 27, 1998



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 (1993), Twist Drills.

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

[d] ASME B1.20.1 (1983) (R1992), Pipe Threads, General Purpose (Inch).

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50 Stability Test

50.1 A refrigerator shall be stable when tested in accordance with 50.2 – 50.5. 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.

50.2 A freestanding 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 50.3 may be used for the test described in (b). The refrigerator shall not overturn under the conditions specified in (a) and (b):

1) 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, if any, are to be oriented so that the tendency to overturn is maximum, or

2) An empty refrigerator weighing 50 pounds (22.7 kg) or more with accessories installed, is to be placed on a horizontal surface. If leveling screws are provided, they are to be adjusted equally to raise the refrigerator 1 inch (25.4 mm) above the floor level. If swivel-type casters are provided, they are to be oriented so that the tendency to overturn is maximum. 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. 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. If leveling screws are provided, they are to be adjusted equally to raise the refrigerator 1 inch above floor level. If 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. If it is provided with tiers of doors, only every other door in one tier is to be opened.

50.3 If required for compliance of 50.2(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 79.3.8.

50.3 revised April 9, 1999

50.4 The manufacturer's instructions are to be used to install the refrigerator for tests to determine compliance with 50.3. 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.

50.5 If 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.

51 Static Load Test

51.1 A refrigerator intended to be suspended from a wall or ceiling shall withstand the test described in 51.2 without collapse of the mounting means and severance of its securement to the mounting means.

51.2 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 66.3.

52 Strain Relief Test

52.1 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.

52.2 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.

52.3 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.

53 Defrost Heater Control Tests

53.1 Endurance test

53.1.1 A control for an electric defrost 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. If 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 55.2 and 55.3. The test need not be conducted if short-circuiting of the control does not result in a risk of fire or electric shock. See Burnout Test – Electric Defrost Heater, Section 55.

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 Burnout Test – Electric Defrost Heater, Section 55.

53.1.2 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.

53.2 Calibration test

53.2.1 Defrost cycle controls (53.1.1(a)) and temperature-limiting controls (53.1.1(b) and (c)) shall comply with the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, pertaining to the calibration of temperature-limiting controls.

54 Condensate Water Evaporator Test

54.1 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 54.2.

54.2 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 Defrost Heater Control Tests, see 53.1.1, 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. If a manual-reset control is used, temperatures are to be measured at the time the control opens the circuit.

54.3 The assembly shall comply with the Dielectric-Voltage Withstand Test, Section 44, following this test.

55 Burnout Test – Electric Defrost Heater

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

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

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

55.4 Opening of a sheath-type heater element is acceptable if 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.

55.5 The ambient air temperature is to be approximately 25°C (77°F). The defrost heater is to be energized at the voltage specified in Table 36.1.

55.6 If an automatic-reset temperature-limiting control 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. If 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 need not be conducted if the temperature-limiting control is calibrated to open the circuit at a temperature of 25°C (77°F) or less.

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55.7 If 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.

56 Burnout Tests – Electromagnetic Components

56.1 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.

56.2 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 if a risk of fire does not exist.

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

56.4 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 36.1. 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.

57 Burnout Test – High-Voltage Transformers

57.1 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 57.2 and 57.3.

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 25.2.1) or that is protected by an overcurrent device(s) in accordance with the requirements in 25.3.1.

57.2 Three samples of the transformer are to be operated continuously at the normal test voltage indicated in Table 36.1 and rated frequency with the enclosure grounded. The test ambient temperature is to be approximately 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.

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

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

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

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

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

58 Overload Test – High-Voltage Transformers

58.1 This test applies to a high-voltage transformer provided with thermal protection of other than the nonrenewable thermal cutoff type. See 25.2.1.

58.2 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 58.3 and 58.4. Insulation temperature rating is defined as the rating for the class of insulation; such as, 105°C for Class 105 insulation, 130°C for Class 130 insulation, and the like. The transformer shall comply with the Dielectric Voltage-Withstand Test, Section 44, following the test specified in 58.3 and 58.4.

58.3 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 36.1. If the protective device controls a switching device that, in turn, interrupts primary current to the transformer, the switching device is to be in the circuit. The test ambient temperature is to be approximately 25°C (77°F). The resistance load is to be adjusted so that the transformer winding is brought to a stabilized temperature of approximately 10°C (18°F) below its insulation rating. The load is then to be gradually increased until operation of the protector occurs.

58.4 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).

59 Overvoltage And Undervoltage Tests

59.1 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. If 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 36.1.

Exception: If 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.

59.2 If 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 59.1 under any condition that might result from operation of the protective device and de-energization of the circuit.

59.3 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.

60 Current Overload Test

60.1 When required by 12.7 or 12.11, 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 60.1.

Table 60.1
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

61 Insulation Resistance Test

61.1 Defrost heaters

61.1.1 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 61.1.2 and 61.1.3 and the heater shall comply with the Dielectric Voltage-Withstand Test, Section 44, following exposure.

61.1.2 If 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 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 approximately 1-1/2 minutes on and 13-1/2 minutes off.

61.1.3 If 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 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.

61.2 Thermal and acoustical insulating material

61.2.1 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).

62 Limited Short-Circuit Test

62.1 General

62.1.1 The components specified in (a) – (c) shall comply with the requirements of 62.2.1 – 62.4.1, 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 12.7 and 12.11.

62.1.1 revised April 9, 1999

62.1.2 For a cord-connected unit, the branch-circuit protection specified in 62.1.1 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.

62.1.3 For a permanently-connected unit, the branch-circuit protection specified in 62.1.1 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.

62.1.4 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 at 225 percent of the full-load current of the largest hermetic motor of the group plus an amount equal to the sum of any additional loads supplied. If a hermetic motor is not supplied, the branch-circuit overcurrent protective device is to be rated 400 percent of the full-load current of the largest motor of the group plus an amount equal to the sum of any additional loads supplied.

Exception No. 1: The 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 39.

Exception No. 2: If the unit incorporates a branch-circuit overcurrent device as described in 62.1.3(a), the test is to be conducted with that device.

62.1.5 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 and HACR Type circuit breakers of the same rating are considered to be interchangeable. Fuses and circuit breakers are not considered to be interchangeable. Circuit breakers of other than HACR Type are not considered interchangeable with each other nor are they interchangeable with HACR Type circuit breakers.

62.1.6 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 62.1. 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 62.1
Short-circuit test currents

Full-load amperes				Circuit capacity amperes
Single phase				
115 V	208 V	230–240 V	277 V	
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.0	6.65 or less	1000
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 40.0	–	3500
Over 80.0	Over 44.0	Over 40.0	Over 6.65	5000
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

62.1.7 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.

62.2 Motor overload protective device

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

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

62.3 Bonding conductors and connections

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

62.4 Motor circuit conductors and connections

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

63 Protective Devices – Maximum Continuous Current Test

63.1 To determine if a thermal protector or if a protective system complies with the requirement specified in 16.5(b), the refrigerator is to be tested as specified in 59.2, unless the motor-compressor has been separately tested as described in 63.4.

63.2 The refrigerator is to be connected to a circuit of rated voltage and operated under the conditions described in Table 63.1 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 16.1, 16.3(b) and 16.3(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 63.1
Test conditions for calibration of thermal protectors and protective systems in refrigerators

Location	Temperature	
	°C	(°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.

63.3 The voltage reductions mentioned in 63.2 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 63.2 is to be the higher of the two ratings.

63.4 The motor-compressor and its protective system, as employed in the refrigerator, may be separately tested as described in 63.2 under the conditions described in Table 63.2. This separate test may be used as a basis for judging compliance with the requirements in 16.1, 16.3(b) and 16.3(d).

Table 63.2
Test conditions for calibration of thermal protectors and protective systems separately from refrigerator

Table 63.2 revised April 9, 1999

Location	°C	°F	°C	°F	°C	°F
Back Pressure Category	**Medium**		**Low**		**Extra Low**	
Return Gas						
Saturated vapor temperature	0	32	-12	10	-29	-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 16.6.

64 Strength Tests – Pressure Containing Components

64.1 Refrigeration system

64.1.1 High-side parts of the refrigeration system shall have an ultimate strength not less than the highest of the following:

a) Five times the marked high-side design pressure. See 79.2.6.

b) Five times the maximum pressure developed in the Temperature and Pressure Test, Section 40, and the Defrost Test, Section 43.

c) Five times the start-to-discharge pressure of a pressure relief valve or five times the set-pressure of a rupture member.

d) For a unit containing more than 22 pounds-mass (10 kg) of refrigerant, three times the maximum adjustable setting of the pressure-limiting device.

e) Deleted June 24, 1997

f) 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.

g) For an air-cooled unit, three times the maximum high-side pressure developed in the Condenser Fan Motor Failure Test, Section 45.

h) For water-cooled units, five times the pressure developed in the Condenser Water Failure Test, Section 46.

i) One and one-half times the vapor pressure of the refrigerant at 60°C (140°F).

64.1.1 revised June 24, 1997

64.1.2 Pressure vessels bearing the ASME Code ″U″ symbol and having a working pressure not less than required by 64.1.1 or 64.1.4, as applicable, are acceptable without test.

64.1.3 A refrigerant-containing component having a marked working pressure shall have an ultimate strength equal to five times the marked working pressure.

64.1.4 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 79.2.6.

b) Three times the maximum low-side pressure developed in the Temperature and Pressure Test, Section 40, including equalization pressure developed after compressor shutdown.

c) For an air-cooled unit, three times the maximum low-side pressure developed in the Condenser Fan Motor Failure Test, Section 45, including discharge pressure relieved to the low-side and equalization pressure developed after compressor shut-down.

d) For a water-cooled unit, three times the maximum low-side pressure developed in the Condenser water Failure Test, Section 46, including discharge pressure relieved to the low-side and equalization pressure developed after compressor shut-down.

e) One and one-half times the vapor pressure of the refrigerant at 60°C (140°F).

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 40; maximum pressure developed during the Defrost Test, Section 43; 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 43.

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.

64.1.5 With reference to 64.1.1(i) and 64.1.4(e) vapor pressures of R12, R22, R134a, R500, and R502 at 60°C (140°F) are 207, 337, 229, 248, and 362 psig (1427, 2323, 1579, 1710, and 2496 kPa), respectively.

64.1.5 revised June 24, 1997

64.1.6 With reference to the requirements of 64.1.1 and 64.1.4, 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 31.1.

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64.1.7 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: If gaskets are employed in components of refrigeration systems employing Refrigerant 12, 22, 134a, 500, or 502, 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.

64.1.7 revised June 24, 1997

64.1.8 Pressure-actuated refrigeration controllers rated for the application are exempt from strength test requirements for pressure containing components.

64.2 Beverage product system

64.2.1 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 64.2.2 or 64.2.3.

64.2.2 Except as specified in 64.2.5, 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 6.2.2) shall withstand a pressure of five times the maximum allowable pressure marked on the equipment. However, the system shall withstand a test pressure of not less than 650 psig (4.5 MPa).

64.2.3 Except as specified in 64.2.5, parts that are pressurized by a pump shall withstand a pressure equal to five times the maximum pressure that the pump can develop.

64.2.4 The requirements of 64.2.3 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 64.1.8. Parts that are not pressurized are exempt from this requirement.

64.2.5 Leakage at valves, tubing, and connections is acceptable if tests on three samples demonstrate that:

a) Leakage occurs at a pressure greater than 40 percent of the pressure required by 64.2.2 or 64.2.3 and

b) Liquid from such leakage does not impinge on uninsulated live parts.

64.2.6 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 if 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.

65 Start-To-Discharge Test

65.1 A pressure-relief device used in the carbonation system shall relieve at a pressure not exceeding its rated start-to-discharge pressure.

65.2 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 65.1.

66 Shelf Strength Test

66.1 A food storage component shall remain in position and comply with 66.3 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 66.3, but not exceeding the weight of ten of the cylinders described in 66.3. The height of the drop is to be a measured to the bottom of the bag.

b) If 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.

66.2 The lead shot is to be trade size No. 9 to 6, or approximately 0.08 to 0.11 inch (0.2 to 0.3 mm) diameter. The bag is to be approximately spherical and is to impact the food storage component approximately at the center.

66.3 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) If 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) If 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 approximately equally spaced during this test.

Exception: This requirement does not apply to food storage components in chest-type refrigerators.

66.4 Other loading means may be used in lieu of cylinders, provided the load is equivalent to that calculated on the basis of 66.3.

66.5 The tests in 66.1 and 66.3 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 66.1 and 66.3 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.

67 Component Restraint Test

67.1 A slideout food storage component (drawer, shelf, or the like) 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 66.3;

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.

67.2 The restraint specified in 67.1 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 66.3, but not more than 30 pounds (13.6 kg). The component is to be loaded in accordance with 66.3 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 pully and attached to the center of the load edge of the component.

68 Glass Strength Test

68.1 Except as indicated in 68.4 and 68.5, 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 68.2, if applicable, and 68.3.

68.2 Exterior glass having an exposed minor dimension exceeding 12 inches (305 mm) and an area greater than 144 square inches (929 cm^3) shall:

a) Be of a nonshattering or tempered type that when broken complies with the Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings, ANSI Z97.1-1984, 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.

68.3 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. If 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) if 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.

68.4 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.

68.5 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 if 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.

69 Door Latch Release Test

69.1 An interior latch release device shall permit the door to open 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 69.4.

69.2 If the test in 69.1 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.

69.3 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.

Exception: If 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.

69.4 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 (if either or both are applicable, depending on the component construction). The test force is to be applied by dropping a 20 pound weight (9.1 kg) through a distance of 6 inches (152 mm).

70 Accelerated Aging Test – Electric Heaters

70.1 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 70.1 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 40, Defrost Test, Section 43, or both.

Table 70.1
Accelerated Aging Test Criteria

Table 70.1 revised August 2, 1996

<table>
<tr><th colspan="2">Measured temperature rise</th><th colspan="2">Test program</th></tr>
<tr><th>°C</th><th>(°F)</th><th>Rubber or Neoprene</th><th>Thermoplastic</th></tr>
<tr><td>35</td><td>(63)</td><td>Air oven aging for 70 hours at 100 ±2°C (212 ±3.6°F)</td><td>7 days in an air circulated oven at 100°C (212°F)</td></tr>
<tr><td>50</td><td>(90)</td><td>Air oven aging for 168 hours at 100 ±2°C</td><td>10 days in an air circulated oven at 100°C (212°F)</td></tr>
<tr><td>55</td><td>(99)</td><td colspan="2">7 days in an air circulated oven at 113°C (235.4°F)</td></tr>
<tr><td>65</td><td>(117)</td><td>10 days in an air circulated oven at 121°C (249.8°F)</td><td>7 days at 121°C (249.8°F) or 60 days at 97°C (206.6°F) in an air circulated oven</td></tr>
<tr><td>80</td><td>(144)</td><td colspan="2">7 days in an air circulated oven at 136°C (276.8°F)</td></tr>
<tr><td>100</td><td>(180)</td><td colspan="2">60 days in an air circulated oven at 136°C (276.8°F)</td></tr>
<tr><td>125</td><td>(225)</td><td colspan="2">60 days in an air circulated oven at 158°C (316.4°F)</td></tr>
<tr><td>175</td><td>(315)</td><td colspan="2">60 days in an air circulated oven at 210°C (410°F)</td></tr>
</table>

71 Reliability Test – Heater Terminations

71.1 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.

72 Accelerated Aging Tests

72.1 Gaskets and sealing compounds of neoprene or rubber required for use with electrical enclosures as determined during the Rain Test, Section 49, 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 72.1.

Exception: These requirements do not apply to foamed materials.

72.1 revised August 2, 1996

Table 72.1
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

72.2 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).

72.2 revised August 2, 1996

72.3 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.

72.4 With reference to 72.3, 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.

72.5 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.

72.6 If 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.

73 Metallic Coating Thickness Test

73.1 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.

73.2 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 approximately 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 approximately 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.

73.3 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).

73.4 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.

73.5 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 approximately 45 degrees from horizontal.

73.6 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.

73.7 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.

73.8 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 73.1 and multiplied by the time, in seconds, required to initially expose base metal as determined in 73.6.

Table 73.1
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
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

74 Horizontal Burning Test

74.1 General

74.1.1 This test is conducted for the purpose of classifying foamed polymeric materials as HBF, HF-1, or HF-2.

74.1.1 revised April 27, 1998

74.2 Test specimens and conditioning

74.2.1 Test specimens are to be obtained from the finished part and in the thickness used in the part. The specimens are to be 6 inches (152 mm) long and 2 inches (50.8 mm) wide. Edges are to be smooth and the radius on the corners is not to exceed 0.05 inch (1.27 mm). Any loose particles are to be removed from the specimen surfaces.

74.2.2 Two sets of specimens are to be tested after conditioning as indicated below:

a) One set of five specimens is to be conditioned for at least 48 hours at a temperature of 23 ±2°C (73 ±3.6°F) and a relative humidity of 50 ±5 percent prior to testing.

b) One set of five specimens is to be conditioned in a circulating air-oven for 168 hours at 70 ±1°C (158 ±1.8°F) and then cooled in a desiccator, over anhydrous calcium chloride, for at least 4 hours at room temperature prior to testing.

74.3 Apparatus

74.3.1 The test apparatus is to consist of the following:

a) Draft-free test chamber, enclosure, or laboratory hood.

b) Laboratory Burner – A Bunsen or Tirrill burner, having a tube with a length of 4.0 inch (101.1 mm) and an inside diameter of 3/8 inch (9.5 mm), and provided with a wing tip [dimensions of slit approximately 1-7/8 by 0.05 inch (47.6 by 1.27 mm)].

c) Ring Stands – Two laboratory ring stands with clamps adjustable to the desired angles and heights, or equivalent equipment.

d) Gas Supply – A supply of technical grade methane gas with suitable regulator and meter for uniform gas flow. Natural gas having a heat content of approximately 1000 Btu per cubic feet (37 MJ/m^3) has been found to provide similar results.

e) Wire Cloth (Plain Weave, Low Carbon, Plain Steel) – Four mesh (four openings per 25.4 mm), 0.035 ±0.002 inch (0.89 ±0.05 mm) diameter steel wire. An 8.5 by 3.0 inch (216 by 76 mm) piece of wire cloth is to be formed to provide a 90 degree upward bend, 0.5 inch (13 mm) high, at one end. The cloth mesh and wire diameter are to be determined as described in Specifications for Industrial Wire Cloth and Screens (Square Opening Series), ASTM E437-80, Appendix A3. The wire diameter is to be measured perpendicular to its corrugations to the nearest 0.001 inch (0.03 mm), using a micrometer or caliper.

f) Stopwatch or other suitable timing device.

g) A supply of dry absorbent surgical cotton.

h) A desiccator containing anhydrous calcium chloride.

i) Conditioning room or chamber capable of being maintained at 23 ±2°C (73 ±3.6°F) and a relative humidity of 50 ±5 percent.

j) Conditioning Oven – A full draft circulating air-oven capable of being maintained at 70 ±1°C (158 ±1.8°F).

74.4 Test method

74.4.1 The burning test is to be conducted in a chamber, enclosure, or laboratory hood that is free from drafts. An enclosed laboratory hood with a heat resistant glass window and an exhaust fan for removing products of combustion after the test is recommended.

74.4.2 The formed steel wire cloth is to be held by the clamps and ring stands so that the 8 by 3 inch (203 by 76 mm) section is horizontal, 1/2 inch (12.7 mm) above the top of the burner wing tip. A typical method of mounting the wire cloth in place is to secure it to a 4 inch (102 mm) diameter ring support so that the upturned end extends approximately 3 inches past the end of the ring.

74.4.3 Each specimen is to be marked across its width with three lines: 1, 2.25, and 5 inches (25.4, 57, and 127 mm) from one end. The test specimen is to be placed flat on the wire cloth with the 6 by 2 inch (152 by 50.8 mm) surface of the specimen horizontal. The end of the specimen closest to the 1 inch mark is to be placed in contact with the upturned end of the wire cloth. Specimens with a high density exterior on one side are to be tested with that exterior facing downward. Specimens with adhesive on one side are to be tested with the adhesive side facing upward.

74.4.4 In tests for classifying HF-1 and HF-2 materials, a 3 inch (76 mm) square layer of dry absorbent surgical cotton, thinned to a maximum freestanding thickness of 1/4 inch (6.4 mm), is to be placed 12 inches (305 mm) below the test specimen. The cotton layer is to be horizontal and located so that one edge of the square is below the upturned end of the wire cloth.

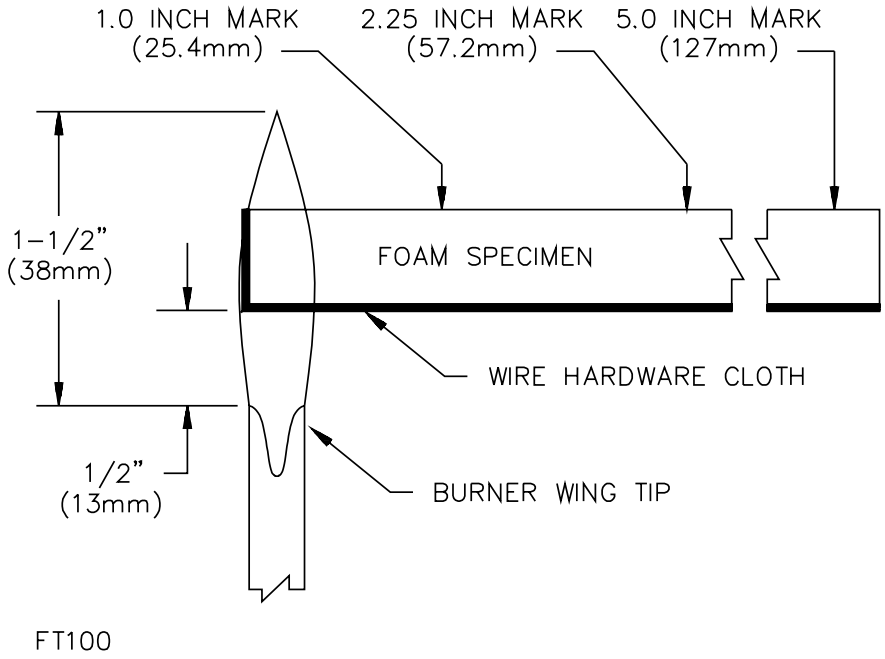
74.4.4 revised April 27, 1998

74.4.5 If new wire cloth is not used for each test, any material remaining on the wire cloth from previous tests is to be burned off, and the wire cloth is to be allowed to cool before conducting the test.

74.4.6 The burner, with wing tip, then is to be placed remote from the specimen, ignited, and adjusted to provide a blue flame with a maximum height of 1-1/2 inches (38 mm) when measured in subdued light. The flame is to be obtained by adjusting the gas supply and the air port of the burner until a 1-1/2 inch yellow-tipped blue flame is produced. The air supply then is to be increased until the yellow tip disappears. The height of the flame is to be measured once again and corrected, if necessary. The burner then is to be quickly placed in position beneath the wire cloth, under the upturned end of the specimen support, so that one edge of the flame is in line with the upturned end of the wire cloth and the other edge of the flame extends into the front end of the specimen. See Figure 74.1. The center of the width of the wing tip is to be in line with the longitudinal axis of the specimen.

Figure 74.1
Horizontal burning test

Figure 74.1 revised April 27, 1998



74.4.7 The flame is to be applied for 60 seconds and then removed from the specimen. If the material continues to burn after removal of the test flame, the time for the flame to travel from the 1 inch (25.4 mm) mark to the 5 inch (127 mm) mark is to be determined. If the specimen ceases to burn before the 5 inch mark is reached, the duration of burning after removal of the test flame and the distance of burning from the end exposed to the test flame are to be recorded.

74.5 Material classification

74.5.1 Materials classified HBF shall either:

a) Not have any specimens with a burning rate exceeding 1.5 inch (38.1 mm) per minute, measured between the 1 and 5 inch (25.4 and 127 mm) reference marks, or

b) Have each specimen cease to burn before the flaming or glowing reaches the 5 inch reference mark.

Exception: If only one specimen from a set of five specimens does not comply with (a) or (b), another set of five specimens, subjected to the same conditioning (see 74.2.2), shall be tested. All specimens from this second set shall comply with (a) or (b).

74.5.1 revised April 27, 1998

74.5.2 Materials classified as HF-1 or HF-2 shall:

a) Not continue to flame for more than 2 seconds after the test flame is removed.

Exception: One specimen in each set of five may continue to flame for more than 2 seconds but not more than 10 seconds.

b) Not have any specimens affected for a distance greater than 2.25 inch (57 mm) from the end exposed to the test flame.

c) Not have any specimens with glowing combustion that (1) continues for more than 30 seconds after removal of the test flame, and (2) travels past the 2.25 inch reference mark.

d) For HF-1 material, not have any specimens drip flaming particles that ignite the layer of cotton located below the specimen.

Exception: If, for any one of the following reasons, a set of specimens does not comply with (a) – (d), another set of five specimens, subjected to the same conditioning (see 74.2.2), is to be tested. All specimens in this second set shall comply with (a) – (d).

1) A single specimen in the set flames for more than 10 seconds, or

2) The specimens in the set flame for more than 2 seconds but less than 10 seconds, or

3) One specimen in the set flames for more than 2 seconds but less than 10 seconds; and a second specimen flames for more than 10 seconds, or

4) One specimen in the set does not comply with (b) or (c), or

5) For HF-1 material, one specimen in the set does not comply with (d).

74.5.2 revised April 27, 1998

75 Label Adhesion Tests

75.1 A marking secured by cement or adhesive shall comply with the applicable portions of the requirements for marking and labeling systems, UL 969.

MANUFACTURING AND PRODUCTION TESTS

76 Pressure Tests

76.1 Each refrigerator shall be tested and proved tight at not less than the design pressure(s) marked on the refrigerator. See 79.2.6.

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.

76.2 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.

76.3 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 64.

Exception: ASME Code vessels bearing the Code "U" symbol need not be retested.

77 Production Line Dielectric Voltage Withstand Tests

77.1 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.

77.1 revised November 27, 1995

77.2 The production-line test shall be conducted in the time and at the potential specified in either Condition A or Condition B of Table 77.1.

77.2 added November 27, 1995

Table 77.1
Production-line test conditions

Table 77.1 added November 27, 1995

Product rating	Condition A			Condition B		
	Potential, volts		Time,	Potential, volts		Time,
	VAC[c]	VDC	seconds	VAC[c]	VDC	seconds
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.

77.3 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.

77.3 added November 27, 1995

77.4 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 if 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 the like.

77.4 added November 27, 1995

77.5 Solid-state and similar components that might be damaged by a secondary effect (induced voltage surge, excessive heating, and the like), 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).

77.5 added November 27, 1995

77.6 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.

77.6 added November 27, 1995

77.7 If 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.

77.7 added November 27, 1995

77.8 If 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.

77.8 added November 27, 1995

77.9 Test equipment other than that described in the preceding paragraphs may be used if found to accomplish the intended factory control.

77.9 added November 27, 1995

77.10 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 the like – 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.

77.10 added November 27, 1995

78 Grounding Continuity Tests

78.1 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 12.1.

78.2 An indicating device, such as an ohmmeter, low-voltage battery- and buzzer-combination, or the like, may be employed in the test mentioned in 78.1.

MARKING

79 General

79.1 Details

79.1.1 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.

79.1.2 Each refrigerator shall be permanently marked with the following:

a) The manufacturer's or private labeler's name or identifying symbol.

b) A distinctive type or model designation.

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 of manufacture that will enable the product to be identified as being manufactured within a consecutive 3-month period. This information may be in code and shall be located on or near the nameplate. A date code marking shall be such that it does not repeat in less than 20 years. The date code shall not require reference to the manufacturer's records to determine when the product was manufactured.

79.1.3 With reference to (d) and (e) of 79.1.2, refrigerators may be marked with equivalent SI units in addition to the USA customary units of measure.

79.1.4 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).

79.1.4 added November 27, 2001

79.1.5 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).

79.1.5 added November 27, 2001

79.2 Refrigerant

79.2.1 Refrigerators equipped with more than one refrigeration system shall be marked to indicate the amount of refrigerant in each system. If different refrigerants are used, the kind of refrigerant and factory test pressures for the high- and low-pressure sides shall be shown for each system.

79.2.2 With reference to 79.1.2 and 79.2.1, the amount of refrigerant need not be indicated on the nameplate of a remote refrigerator. See 3.11. 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 Section 8.2 of ANSI/ASHRAE 15-1994 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.

79.2.3 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).

79.2.4 The kind of refrigerant shall be designated by number. 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.

79.2.4 revised November 27, 1995

79.2.5 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 Number Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34-1992.

79.2.5 revised November 27, 1995

79.2.6 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 40, nor less than the applicable value indicated in Table 79.1.

79.2.6 revised November 27, 1995

Table 79.1
Minimum design pressure

Table 79.1 revised November 27, 1995

Refrigerant	Minimum design pressure, psig (kPa)					
	Low-side		High-side			
			Air-cooled		Water cooled	
12	85	(586)	169	(1165)	127	(876)
22	144	(993)	278	(1917)	211	(1455)
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)
[a] For other refrigerants, the minimum design pressure shall not be less than the saturation pressure of the refrigerant at the following temperatures:						

Table 79.1 Continued on Next Page

Table 79.1 Continued

Refrigerant	Minimum design pressure, psig (kPa)		
	Low-side	High-side	
		Air-cooled	Water cooled
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			

79.2.7 Refrigerators shall be marked with the operating voltage, the frequency, and the total or individual loads as indicated in 80.1 and 81.1. Permanently connected refrigerators shall also be marked with the number of phases.

79.2.8 The information specified in 79.1.2 and 79.2.4 – 79.2.7 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.

79.3 Receptacles

79.3.1 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 79.3.2.

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79.3.2 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 23.2 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.

79.3.3 If parts or sections of a refrigerator are separately shipped from the factory, the primary nameplate for the refrigerator shall comply with the requirements of 79.2.8, 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.

79.3.4 A refrigerator that incorporates a hermetic motor-compressor with a thermal protector that provides protection in accordance with the requirements in 16.3(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.″

79.3.5 A refrigerator that incorporates a complete protective system that provides protection in accordance with the requirements specified in 16.3(d) shall be marked ″Motor-Compressor Thermally Protected System,″ or with an equivalent statement to reference the motor-compressor(s) involved.

79.3.6 If 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″ and the appropriate statement(s) indicated in Table 79.2. 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 the like 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 79.2
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.		

79.3.7 With respect to 79.3.6, if 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.

79.3.8 If a supporting device as described in 50.3 is required for compliance with the Stability Test, Section 50, 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.

79.3.9 If a replaceable fuse is provided for overcurrent protection of a transformer or control circuit conductor (see 25.4.3 and 26.3.5), 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: If supplementary fuses are used in accordance with the exception to 25.4.3 and 26.3.5, the marking shall also include the fuse manufacturer's or private labeler's name, catalog designation, and fuse voltage rating.

79.3.9 revised November 27, 2001

79.4 Accessories

79.4.1 An electrical accessory intended for field installation in or on a refrigerator shall be marked with the name or identifying symbol of the manufacturer or private labeler, with a catalog number or equivalent designation, and with the type of equipment with which it is intended to be used. The refrigerator shall be marked to indicate the catalog number or equivalent designation of such an accessory and the name of the manufacturer or private labeler of that accessory.

79.4.2 If an electrical accessory is intended for use with specific equipment but is to be connected to a power supply separate from that of the equipment, the accessory shall be permanently marked with its electrical rating and with the model number and name of the manufacturer or private labeler of the refrigerator.

79.4.2 added November 27, 1995

79.4.3 With reference to 79.4.1, instructions for installing the accessory shall be provided on or with the accessory. A statement shall be included in the instructions warning the user that the refrigerator must be disconnected from the source of electrical supply before attempting the installation and that the accessory is intended for use only with the refrigerator that is marked to indicate such use. See 79.4.4.

79.4.4 If the accessory is designed to be installed by means of receptacles and plug-in connectors that have been investigated to make and break circuits under loads, and if such connection or disconnection does not result in exposure of uninsulated live parts, the statement that the refrigerator must be disconnected from the source of electrical supply need not be employed.

79.4.5 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.

79.4.6 If 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.

79.4.7 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.

79.4.8 Additional marking requirements are specified in 9.2.17, 9.4.5, 9.4.6 and 34.3.1.

79.4.8 revised April 9, 1999

79.4.9 With regard to 7.6, accessories that are provided with a separate power-supply shall be marked with the word ″CAUTION″ and with the following or equivalent wording: ″Risk of electric shock. More than one power-supply. Disconnect all power-supplies before servicing.″

79.4.9 added November 27, 1995

No Text on This Page

80 Permanently Connected Refrigerators

80.1 Except as indicated in 80.5 – 80.7, a permanently connected refrigerator shall be marked with the individual loads in amperes. The marking shall clearly indicate which loads operate concurrently unless it is obvious that the total load is the sum of the individual loads.

Exception No. 1: The loads of lighting circuits, heater circuits, or small fan motors and other motors rated less than 1/8 horsepower (93.2 W output) may be marked in watts.

Exception No. 2: A heater load of less than 1 ampere and pilot duty loads need not be marked.

80.2 With regard to 80.1, a sectional refrigerator is to be rated as a separate refrigerator.

80.3 With reference to 80.1, the individual loads shall be marked as follows:

a) For a motor other than a hermetic refrigerant motor-compressor:

1) Full-load amperes, and

2) Horsepower, except as noted in 80.4.

b) For a hermetic refrigerant motor-compressor:

1) Rated-load amperes.

2) Locked-rotor amperes, except as noted in 80.4.

3) The branch-circuit-selection current in amperes, if required in accordance with requirements specified in 80.17.

c) For a resistance-type heater rated 1 ampere or more: in amperes, watts or kilowatts.

d) For a pilot duty load, no marking is required.

80.4 With reference to 80.3(a)(2), a horsepower marking is not required under the following conditions:

a) The motor is rated less than 1/8 horsepower (93.2 W output), or

b) The motor is a shaded-pole or a permanent-split-capacitor type fan or blower motor used under either of the following conditions:

1) The motor is connected on the same supply circuit as a hermetic refrigerant motor compressor.

2) The motor or the refrigerator nameplate is marked with the motor type.

80.5 The nameplate ampere rating for a refrigerator provided with a single power supply and consisting of a combination of loads that includes a hermetic refrigerant motor-compressor may be a single ampere value provided:

a) The single load rating (amperes), the marked maximum size of supply-circuit overcurrent device and the marked minimum supply circuit ampacity do not exceed the values in Part A of Table 80.1; and

b) The single marked ampere rating is not less than the sum of the individual load ratings (at the maximum concurrent load condition) that would be required to be marked on the refrigerator if the individual load ratings were shown.

Table 80.1
Nameplate Ratings

Part	Maximum ampere rating	Maximum voltage rating	Phase	Maximum size of branch-circuit overcurrent device, amperes	Minimum circuit ampacity, amperes
A	12	120	1	15	15
	16	120	1	20	20
	12	208 or 240	1	15	15
B	12	600	1 or 3	15	15
	16	120	1	20	20

80.6 The nameplate ampere rating for a refrigerator provided with a single power supply and consisting of more than one motor or a motor and other loads, such as heaters, lighting, or both, but not including a hermetic refrigerant motor-compressor may be a single ampere value under all the conditions in (a) and (b):

a) The single load rating (amperes), the marked maximum size of supply-circuit overcurrent device and the marked minimum supply circuit ampacity do not exceed the values in Part B of Table 80.1:

b) The single marked ampere rating is not less than the sum of the individual load ratings (at the maximum concurrent load condition) that would be required to be marked on the refrigerator if the individual load ratings were shown.

80.7 If a refrigerator is provided with more than one power supply, each circuit consisting of a motor(s) and other load(s) is to be judged for compliance with the requirements specified in 80.5 and 80.6, whichever is applicable. 80.5 applies to circuits that include a hermetic refrigerant motor-compressor and 80.6 applies to circuits that do not include such a compressor.

80.8 Except where a single ampere rating is specified in by 80.5 – 80.7, a permanently connected refrigerator shall be marked with the locked-rotor current of:

a) Single-phase compressors having full-load currents of more than 9 amperes at 115 volts and more than 4.5 amperes at 230 volts,

b) Compressors rated above 230 volts, or

c) Polyphase compressors.

80.9 A permanently-connected refrigerator employing more than one motor, or a motor and other loads shall be marked on the nameplate with the minimum circuit ampacity and the maximum rating of the branch circuit fuse. If the refrigerator is intended for use on two or more circuits, the nameplate shall include this information for each circuit. Also, see 80.10 – 80.14.

Exception: The marking may additionally specify a maximum HACR Type circuit-breaker size if required short-circuit tests have been conducted (see the Limited Short-Circuit Test, Section 62) using an HACR Type circuit breaker.

80.10 With respect to 80.9, a circuit breaker may be specified for overcurrent protection of the supply circuit provided that:

a) The branch circuit is protected at not more than 20 amperes at 125 volts or less, or not more than 15 amperes at 126 – 600 volts, and

b) The rating of any motor in the circuit does not exceed 1 horsepower (746 W output) and 6 full load amperes.

80.11 The marking required in 80.9 may specify a maximum fuse size or a maximum circuit-breaker size or both, or it may refer to the maximum rating of a overcurrent protective device without referring to fuses or circuit breakers if the internal motor circuit involved is protected by:

a) A circuit breaker provided as part of the unit, that has been subjected to short-circuit tests, in combination with the motor-circuit wiring and components, and found to provide short-circuit and ground-fault protection for the motor circuit wiring and component, or

b) A fuse, provided as part of the equipment, of a type and rating found to provide short-circuit and ground-fault protection for the motor circuit wiring and components. See Limited Short Circuit Test, Section 62.

80.12 The marking required in 80.9 may specify a maximum fuse or circuit-breaker size or both, or it may refer to the maximum rating of an overcurrent-protective device without referring to fuses or circuit breakers, if the unit complies with (a) – (c), inclusive:

a) Each motor overload-protective device complies with the requirements of the Limited Short-Circuit Test, Section 62. Compliance may be established by one of the following means:

1) The internal motor circuit involved is protected by an overcurrent device, provided as part of the equipment, of a type and rating acceptable for short-circuit and ground-fault protection of the motor circuit involved, or

2) A short-circuit test on the motor overload-protective device is not required (for example, if the motor overload-protective device is located at the center point of a wye-connected, 3-phase motor, or is located inside a hermetic motor-compressor enclosure), or

3) The motor overload-protective device has been subjected to the Limited Short-Circuit Test, Section 62, using a fuse of such rating that the circuit impedance during the test is the same or less than could be anticipated using a circuit breaker rated not more than the marked maximum rating of the overcurrent device; and (1) the results of the test are such that the motor overload-protective device opens the circuit and (2) the fuse does not open during the test.

b) The marked maximum rating of the overcurrent-protective device does not exceed 225 percent of the full-load current rating of any motor controller protected against short circuits and ground-fault by the overcurrent device.

c) The marked maximum rating of the overcurrent-protective device does not exceed 180 percent of the ampacity of motor-circuit conductors protected by that overcurrent-protective device, except as specified in 10.2.9(c). Ampacities of conductors are to be determined from the ampacity tables in the National Electrical Code, ANSI/NFPA 70-1993, for the type of wire or cord employed or the wire or cord equivalent to appliance-wiring material.

80.13 The minimum ampacity required in accordance with 80.9 shall be at least equal to 125 percent of the rated current of the largest motor plus the rated current ratings of other motors and loads supplied. The largest motor is determined by its rated current. The ampacity marked on the nameplate shall be the highest of those calculated for each concurrent load condition.

80.14 With reference to 80.9, the maximum rating of a supply-circuit overcurrent-protective device shall not exceed 225 percent of the rated current of the largest hermetic motor plus an amount equal to the sum of any additional concurrent loads. For a circuit involving other than hermetic motors, the rating of the overcurrent-protective device shall not exceed 400 percent of the full-load current of the largest motor plus an amount equal to the sum of any additional concurrent loads.

80.15 The concurrent load mentioned in 80.13 and 80.14 need not include periodic short-time loads as defined in 38.5.

80.16 A refrigerator that must be connected to a circuit protected by fuses shall be marked ″Use Time Delay Fuse″ if when subjected to the Starting Test, Section 39, it did not start and run when using ordinary, not time-delay, fuses. The marking shall be located so it can be read without requiring the use of tools for removal of panels, and the like.

Exception: If the unit may be connected to a circuit protected by circuit breakers (see 80.5 and 80.9 – 80.12), the marking may be as specified in 81.2.

80.17 If a thermal protector or protective system for a hermetic motor-compressor permits a continuous current of more than 156 percent of the rated-load current of the motor-compressor as marked on the refrigerator nameplate, and the refrigerator is intended for use on a circuit that exceeds the limitation specified in 16.3, the refrigerator shall also be marked with a ″branch-circuit-selection current″ rating, in amperes. The marked value of this rating shall be least 64.1 percent of the maximum continuous current determined in accordance with Protective Devices – Maximum Continuous Current Test, Section 63.

80.18 Unless correct field-wiring connections are evident, a wiring diagram shall be attached to each permanently-connected refrigerator to show the intended method of making field-wiring connections. A paper sticker, glued or shellacked to an accessible cover, is acceptable.

80.19 A refrigerator with field-wiring terminals shall be marked:

a) ″Use Copper Conductors Only: if the refrigerator is not intended for field connection with aluminum wire,″ or

b) ″Use Copper Or Aluminum Conductors,″ ″Use Copper Or Copper-Clad Aluminum Conductors,″ or ″Use Copper, Copper-Clad Aluminum, Or Aluminum Conductors″ if the refrigerator is intended for field connection with either copper or aluminum wire.

In either case, an equivalent statement that identifies the intended wiring material may be used. The marking shall be independent of any marking on the terminal connector and may appear on an attached wiring diagram. The marking shall be visible during installation of the refrigerator and also when the terminals are exposed for inspection after the unit has been installed.

80.20 A refrigerator intended for permanent connection to a wiring system other than metal-clad cable or conduit shall be marked to indicate each system for which it is intended. The marking shall be located so that it will be visible while making power supply connections to the refrigerator.

80.21 A refrigerator with a wireway as described in 9.2.21 shall be marked: ″Wireway For End-To-End Installation.″ The marking shall be on the wireway in the vicinity of the field-wiring connection to the refrigerator.

80.22 On a remote refrigerator, a controller for an external load shall have its electrical rating shown on the refrigerator nameplate unless the marking on the controller can be read without requiring the use of tools for removal of panels.

80.23 The information specified in (a) – (c) shall appear on the refrigerator or wiring diagram:

a) If a refrigerator is controlled by a specific-use controller that is not installed on the assembly, the marking on the refrigerator or wiring diagram shall show the identifying designation of the controller. The rating of the proper overcurrent (heater) element to be used shall be shown if a thermal overload relay is part of the controller.

b) If a refrigerator is provided with magnetic or thermal motor running overload protective devices mounted remote from the protected motor, one of the following markings, visible on removal of parts to enter the device enclosure, shall be employed:

1) The tripping current marked on the overload device. If a replaceable heater element is employed, the marking shall be on the heater element.

2) A designation on the device and an adjacent tabulation showing the tripping current, identified with the device marking. For a device employing a replaceable heater element, the motor full-load current and percent protection shall also be shown.

c) If a refrigerator is intended to be connected to a low-voltage supply source, the minimum rating of the supply transformer shall be shown if a transformer rated 5 volt-amperes or more is required.

80.24 If a rating of a field-installed disconnect switch is shown on the wiring diagram, the indicated rating shall be not less than that required in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

80.25 If a low-voltage device or part of a device is intended to be wired in the field to become only part of a Class 1 circuit, or a Class 2 circuit wired as a Class 1 circuit, the terminals of the device or part of the device shall be marked accordingly. A low-voltage switching or power consuming device or part of a device that is intended to be wired in the field to become part of a Class 2 circuit only shall be marked accordingly.

Exception No. 1: A low-voltage power supply device that includes a transformer is not required to be marked to indicate that it is acceptable for use in a Class 2 circuit only.

Exception No. 2: A low-voltage device or part of a device that is designed for connection to either a Class 1 or a Class 2 circuit is not required to be so marked.

80.26 If other than three overcurrent units are employed for protection of a three-phase motor, a marking shall appear on the refrigerator to indicate that the motor is protected under primary single-phasing conditions. This marking may be a separate paper sticker or decal or may be on the attached wiring diagram.

80.27 If more than one disconnect switch is used to disconnect all power within a control panel or compartment of a permanently-connected refrigerator, the panel or compartment shall be marked with the word ″CAUTION″ and with one of the following or equivalent statements, as applicable. The warning marking shall be permanent, in letters no less than 1/8 inch (3.2 mm) high, and located so as to be visible before or immediately upon removal of the cover over the panel or compartment. The marking shall not be on the back of a removable cover.

a) For refrigerators that may be provided with two or more disconnect switches:

   ″Risk of Electric Shock. Disconnect All Power. May Have More Than One Disconnect Switch.″

b) For refrigerators that require two or more disconnect switches:

   ″Risk of Electric Shock. Disconnect All Power. ___[a] Disconnect Switches Provided.″

[a]The number of disconnect switches required for the refrigerators is to be specified by the manufacturer in the blank space in (b).

80.28 If a general purpose receptacle is provided on a refrigerator, but is intended to be connected to a power supply separate from that supplying the refrigerator, the refrigerator is to be permanently marked with the following or equivalent wording: ″General Purpose Receptacle Is To Be Supplied From A Separate Electrical Source And Installed In Accordance With The National Electrical Code.″ The marking shall be on or adjacent to the refrigerator nameplate.

80.29 If required by the exception to 6.3.12, a refrigerator shall be marked with the word ″CAUTION″ and with the following or equivalent statement, ″HOT PART – DO NOT CONTACT HEATER SURFACE DURING DEFROST cycle.″ The warning marking shall be visible, permanent, in letters not less than 1/4 inch (6.4 mm) high, and located on or adjacent to the surface of the evaporator coil containing the exposed defrost heater.

80.30 If controls for electric defrost operation are not provided as part of a remote refrigerator but are required as determined during the Defrost Test, Section 43, the refrigerator shall be marked ″Do Not Exceed $\underline{x}$ Minutes On Defrost cycle″ or with an equivalent statement. Where x is the maximum time recommended by the manufacturer for defrost operation. The marking shall be:

a) Permanent,

b) In letters not less than 1/4 inch (6.35 mm) high, and

c) Located on or adjacent to the refrigerator nameplate.

80.31 If a refrigerator employs a direct-connected high-voltage control circuit (see 26.2.1), it shall be marked with the maximum size of overcurrent device(s) for the control circuit. The rating of overcurrent device shall be based on the ampacity of the control circuit conductors, as determined from ampacity tables contained in the National Electrical Code, ANSI/NFPA 70-1993 for No. 14 AWG or larger conductors and shall not exceed 7 amperes for No. 18 AWG conductors or 10 amperes for No. 16 AWG conductors. The marking shall appear on the wiring diagram, adjacent to the field wiring terminals or on the refrigerator nameplate. See 80.32.

80.32 With reference to 80.31, the type of overcurrent protective device shall also be specified in the marking if required in order to comply with the requirements in 80.9.

81 Cord Connected Refrigerators

81.1 A cord connected refrigerator shall be marked with the total load in amperes. The marked ampere load shall include all individual loads that may operate concurrently.

81.2 If as a result of the Starting Test, Section 39, a refrigerator did not start and run when connected to a circuit protected by ordinary, not time-delay fuses, it shall be marked, either, ″If Connected To A Circuit Protected By A Fuse, Use Time-Delay Fuse″ or ″Use Circuit Breaker or Time-Delay Fuse″ or with an equivalent wording. The marking shall be located so it can be read without requiring the use of tools for removal of panels, and the like.

81.3 The following permanent markings shall be provided on equipment that contains two power supply cords. Each marking shall be visible after installation.

a) ″CAUTION – Risk of Electric Shock. This equipment has two power supply cords. Unplug all cords before moving or servicing this equipment.″

b) ″CAUTION – Risk of Electric Shock. This equipment has two power supply cords. Connect this plug to a single outlet circuit.″ (Only for equipment as indicated in 9.3.12).

c) The equipment nameplate electrical rating shall be given separately for each cord.

81.3 added November 27, 1995

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SUPPLEMENT SA - COMMERCIAL REFRIGERATORS AND FREEZERS FOR MARINE USE

INTRODUCTION

SA1 Scope

SA1.1 This supplement cover commercial refrigerators and freezers for marine use intended for installation in enclosed accommodation spaces aboard a vessel. These requirements are in addition to the applicable requirements in Sections 1 – 81.

SA1.2 The refrigerators covered by this supplement are intended for installation in accordance with the requirements of the Standard for Fire Protection of Pleasure and Commercial Motorcraft, NFPA 302; the applicable requirements of the American Boat and Yacht Council, Inc.; and the United States Coast Guard Regulations as specified in 33 CFR 183 Subpart I – Electrical Systems or 46 CFR Subchapter J – Electrical Engineering, as applicable.

CONSTRUCTION

SA2 General

SA2.1 Provisions such as mounting holes, clamps, lugs, or equivalent means shall be provided for securement of the refrigerator to the vessel.

SA3 Protection Against Corrosion

SA3.1 All iron or steel parts of a refrigerator including bolts, nuts, screws, washers, and the like shall be provided with a corrosion-resistant finish by a coating of cadmium (only in areas where there is no likelihood of food contact), chromium, nickel, silver, or zinc applied by electroplating, sheradizing, hot-dip galvanizing, enameling if the surface has been treated by bonderizing or the equivalent and by the application of zinc chromate primer prior to enameling, or other types of paint or coatings that provide equivalent resistance to corrosion (see the Salt-Spray Corrosion Test, Section SA11).

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

SA3.2 A refrigerator shall be made of the following materials:

a) Silver,

b) Copper,

c) Brass,

d) Bronze,

e) Copper-nickel,

f) Aluminum alloys with a copper content of 0.4 percent or less,

g) Wood,

h) Polymeric material, or

i) A material that complies with the Salt-Spray Corrosion Test described in Section SA11.

SA4 Supply Connections

SA4.1 Supply leads provided for connection to the branch circuit shall utilize only stranded copper conductors employing insulation of the flame retardant and moisture resistant type as specified in Article 310 of the National Electrical Code, ANSI/NFPA 70-1993, or that has been investigated for marine use, or that complies with the mechanical water absorption and applicable flame tests of the Standard for Thermoplastic-Insulated Wires and Cables, UL 83. The conductors shall be at least No. 16 AWG (1.3 mm^2), if separate, or No. 18 AWG (0.82 mm^2) if in a multiconductor sheath.

SA5 Wiring

SA5.1 All internal wiring shall be Type 2 stranded copper or stranded tinned copper in accordance with Table 8-14.4 of the Fire Protection Standard for Pleasure and Commercial Motor Craft, NFPA 302-1989.

SA5.2 The insulation of internal and external wiring shall be:

a) Rated for the voltage and temperature to which they may be exposed,

b) Moisture resistant and fire retardant, and

c) Acceptable for the marine environment (resistant to oil, solvents, and salt water).

SA6 Insulating Material

SA6.1 Porcelain shall not be used as a base for mounting uninsulated live parts if the material is rigidly fastened by machine screws or the like.

SA7 Electrical Connections

SA7.1 Aluminum or aluminum alloys shall not be used for terminal connections or for parts in direct contact with copper conductors even if the aluminum alloy parts are plated.

PERFORMANCE

SA8 Vibration Test

SA8.1 A refrigerator system shall withstand 12 hours of vibration without leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons; reduction of electrical spacings to less than minimum acceptable values; defeat of the ignition-protected feature, if provided; and the door opening. After the sample has been subjected to the vibration, shock, and pitch and roll tests, the sample is to be subjected to the Temperature and Pressure Test, Section 40.

Exception: A product marked in accordance with the requirement in SA13.1 need not be subjected to the Vibration Test.

SA8.2 A sample is to be mounted to the platform of a vibration machine in accordance with the manufacturer's installation instructions and connected to a source of rated supply.

SA8.3 The sample is to be subjected to a variable-frequency vibration test along each of three rectilinear axes (two perpendicular horizontal axes and a vertical axis) for 4 hours in each plane at a peak-to-peak amplitude (total platform displacement) of 0.020 ±0.002 inch (0.51 ±0.06 mm). The frequency of vibration is to be continuously varied, at a uniform rate, from 10 to 60 to 10 cycles per second every 4 minutes.

SA9 Shock Test

SA9.1 A refrigerator system shall withstand 1000 shock impacts without leakage, cracking, displacement, breakage, or damage to components to an extent that presents a risk of fire, electric shock, or injury to persons; reduction of spacings to less than the minimum acceptable values; defeat of the ignition protected feature, if provided; and the door opening. After the sample has been subjected to the vibration, shock, and pitch and roll tests, the sample is to be subjected to the Temperature and Pressure Test, Section 40.

Exception: A product marked in accordance with the requirement in SA13.1 need not be subjected to the Shock Test.

SA9.2 The sample used for the Vibration Test, Section SA8 is to be used for this test. The sample is to be mounted on the platform of a shock machine, as specified in SA8.2, with its center of gravity of the machine platform as possible, and connected to a source of rated power supply.

SA9.3 The sample is to be subjected to 1000 vertical shock impacts, each having a 10 g peak acceleration [322 feet per second per second (98 m/s^2)] and a duration of 20 to 25 milliseconds as measured at the base of the half sine shock envelope.

SA10 Pitch And Roll Tests

SA10.1 General

SA10.1.1 A refrigerator is to be subjected to the pitch and roll tests described in SA10.2.1 and SA10.3.1. At the conclusion of the vibration, shock, and pitch and roll tests, the refrigerator shall comply with the requirements of the Temperature and Pressure Test, Section 40. Also, the door shall not open and the mounting means shall not become loose.

Exception: A product marked in accordance with the requirement in SA13.1 need not be subjected to the Pitch and Roll Tests.

SA10.1.2 The refrigerator is to be secured to the platform of a rocker assembly, in accordance with the manufacturer's installation instructions, to simulate an intended refrigerator installation. Any door securement means provided with the refrigerator is to be engaged for this test.

SA10.1.3 The sample is to be energized during the cycling.

SA10.2 Pitch

SA10.2.1 The refrigerator is to be subjected to 250,000 cycles of rocking motion at a rate of 15 to 20 cycles per minute. Each cycle is to include a 15 degree rotation to each side of a horizontal axis of rotation located not more than 6 inches above or below the bottom of the refrigerator. These axes are to be located such that they intersect the geometric vertical center line of the refrigerator.

SA10.3 Roll

SA10.3.1 The refrigerator is then to be rotated 90 degrees around the geometric vertical center line. The refrigerator is to be secured to the platform and subjected to an additional 250,000 cycles of rocking as described in SA10.2.1.

SA11 Salt-Spray Corrosion Test

SA11.1 Metal alloys and corrosion-resistant finishes not known to be inherently resistant to corrosion are to be tested for equivalence to the materials specified in SA3.2. The metal alloys are to be subjected to 200 hours of salt spray exposure in accordance with SA11.2 – SA11.5. The results are acceptable if there is no pitting, cracking, or other deterioration more severe than that resulting from a similar test on passivated AISI Type 304 stainless steel.

SA11.2 The test is to be conducted with components of the refrigerator or with representative samples of the material.

SA11.3 The sample is to be subjected to 200 hours of exposure using a 5 percent by weight sodium chloride solution in deionized water. The pH value of the collected solution is to be between 6.5 and 7.5 and with a specific gravity of 1.0255 – 1.0400 at 25°C (77°F). The temperature of the chamber is to be maintained at 35 ±2°C (95±4°F) throughout the test.

SA11.4 The apparatus for salt spray (fog) testing is to consist of a fog chamber with inside dimensions of 48- by 30- by 36-inches (1.2- by 0.8- by 1.0-m), a salt solution reservoir, a supply of conditioned compressed air, one dispersion tower constructed in accordance with Salt Spray (Fog) Testing, ASTM B117-73(1990) for producing a salt fog, specimen supports, provision for heating the chamber, and the necessary means of control.

SA11.5 The dispersion tower for producing salt fog is to be located in the center of the chamber and is to be supplied with humidified air at a pressure of 17 – 19 psig (0.12 – 0.13 MPa), so that the salt solution is aspirated as a fine mist or fog into the interior of the chamber.

SA12 Ignition Protection Test

SA12.1 A refrigerator intended for installation in an area requiring ignition protection shall not ignite a surrounding propane-air mixture when tested in accordance with the requirements for ignition protection test for marine products, UL 1500. Also, see SA12.2.

SA12.2 For a refrigerator not marked as specified in SA13.1, the sample subjected to the Vibration Test, Section SA8, and the Shock Test, Section SA9, is to be used for this test.

MARKING

SA13 General

SA13.1 A refrigerator not shown to comply with the requirements of the Vibration Test, Section SA8, Shock Test, Section SA9, or Pitch and Roll Test, Section SA10, shall be permanently marked, where readily visible after installation, with the following or the equivalent: ″For Use on Vessels Over 20 Meters in Length.″

SA13.2 Only a refrigerator that is considered to be acceptable in accordance with the requirements of the Ignition Protection Test, Section SA12 may be marked ″Ignition Protected.″

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APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard − UL Standard Designation

Armored Cable – UL 4
Attachment Plugs and Receptacles, – UL 498
Cables, Nonmetallic-Sheathed – UL 719
Conduit, Flexible Metal – UL 1
Conduit, , Rigid Metal – UL 6
Controls, Limit – UL 353
Cooking Appliances, Commercial Electric – UL 197
Cord Sets and Power-Supply Cords – UL 827
Fittings for Conduit and Outlet Boxes – UL 514B
Flexible Cord and Fixture Wire – UL 62
Fuseholders – UL 512
Industrial Control Equipment, Electric – UL 508
Marking and Labeling Systems – UL 969
Motor-Compressors, Hermetic Refrigerant – UL 984
Motors, Electric – UL 1004
Outlet Boxes, Flush-Device Boxes and covers, Nonmetallic – UL 514C
Outlet Boxes, Metallic, – UL 514A
Overheating Protection for Motors – UL 2111
Plastic Materials for Parts in Devices and Appliances, Tests for Flammability of – UL 94
Polymeric Materials – Short Term Property Evaluations – UL 746A
Polymeric Materials – Use in Equipment Evaluations – UL 746C
Protectors, Thermal, for Electric Motors – UL 547
Refrigerant-Containing Components and Accessories, Nonelectrical – UL 207
Switches, Clock-Operated – UL 917
Switches, Snap, General-Use – UL 20
Switches, Special-Use – UL 1054
Temperature-Indicating and -Regulating Equipment, Electrical – UL 873
Terminals, Electrical Quick-Connect – UL 310
Thermal Cutoffs for Use in Electrical Appliances and Components – UL 1020
Transformers Class 2 and Class 3 – UL 1585
Tubing, Electrical Metallic – UL 797
Valves, Electrically-Operated – UL 429
Wire Connectors and Soldering Lugs for Use With Copper Conductors – UL 486A
Wire Connectors for Use With Aluminum Conductors – UL 486B
Wires and Cables, Rubber-Insulated – UL 44
Wires and Cables, Thermoplastic-Insulated – UL 83
Wireways, Auxiliary Gutters, and Associated Fittings, Electrical – UL 870

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CANADIAN REQUIREMENTS COMPARISON GUIDE CRG 471

UL AND CANADIAN STANDARDS FOR COMMERCIAL REFRIGERATORS AND FREEZERS

c UL Underwriters Laboratories Inc.®

Product Category: Commercial Refrigerators and Freezers
UL Category Control Number: SFWY, SGKW, SLKQ2, SOSR, SOVQ, SQTV

UL Standard:

Standard for Commercial Refrigerators and Freezers
UL 471
Eighth Edition

Canadian Standard:

Refrigeration Equipment
CAN/CSA-C22.2 No. 120-M91
First Edition

This Canadian Requirements Comparison Guide is only intended to identify Canadian requirements that must be applied in addition to the requirements in the UL Standard to obtain a c-UL Mark. The guide is not intended to replace a thorough review and comparison of the requirements applicable to the product category as contained in the applicable UL and Canadian Standards. Where requirements are not specifically addressed, compliance with the requirements in the UL Standard satisfy the requirements in the Canadian Standard.

The actual requirements applied for a c-UL product investigation may differ from those identified in this guide based on the specific features, characteristics, components, materials, or systems used in the product.

CRG: 471
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Revisions of this guide will be made by issuing revised or additional pages bearing their date of issue. A Canadian Requirement Comparison Guide is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revision pages for the Guide.

The following outlines the requirements contained in CSA C22.2 No. 120 that are in addition to the requirements in UL 471 that must be met in order for a product to bear the appropriate UL Marking. UL provides a certification program for products that meet the Canadian requirements. The c-UL Mark is the manufacturers assurance that products as evaluated by UL, continue to comply with the appropriate Canadian requirements.

Requirements Topics	CSA Clause	Comparison
Scope	Sec. 1	CSA 120 covers commercial refrigerators, walk-in coolers, beverage dispensers, water coolers, milk coolers, ice makers, door panels, ice cream makers. UL 471 only covers commercial refrigerators, beverage coolers, and door panels.
General Requirements	3.1	See C22.2 No. 0.
Components	3.2	Look for CSA Certified Components. If not, refer to the appropriate standard.
Construction	4.1	No fiberglass insulation in food storage/air handling areas.
	4.1.6	Contains requirements for the maximum amount of lead in solder used in liquid dispensing systems.
Mechanical Strength	4.2	Enclosures of uninsulated live parts need 5.2 ft-lb impact. See 6.16.
		5.9 ft-lb impact test may be necessary on heated glass or glass that encloses live parts. See 4.2.4.2 for exceptions.
Fire Hazard	4.3	With respect to ignition sources and flammability of polymeric parts, UL 471 and Spec. 120 are virtually identical.
Shock Hazard	4.4	CSA Spec. 120 uses an articulate probe to check for contact with live parts, UL 471 uses 3/8 inch OD probe.
Mechanical Hazards	4.6	CSA Spec. 120 uses CSA articulate probe to check for contact with any moving parts and hot parts. UL 471 uses a probe for fan blade contact. Any other moving part is evaluated to Table 6.1. UL 471 requirements are more stringent.
	4.6.5	Units with storage compartments over 2 ft^3 shall have a door that can be opened from the inside. See Clause 6.22. UL 471, Par. 5.5 and Sec. 69 deal specifically with walk-in coolers.
Mechanical Assembly	4.7.3	A lock washer is not considered a suitable means for the prevention of rotation of a stem-mounted rotary switch or control.

Table Continued

Requirements Topics	CSA Clause	Comparison
	4.7.9.3	Electrical enclosure drainage is specified.
Refrigerating System	4.8.1	Refrigerants shall be one of the types listed in CSA Standard B52.
	4.8.3	Low side parts shall withstand a pressure equal to 5 times the maximum normal working pressure. UL 471 only requires 3 times.
Maximum Working Pressure	4.9	Same as UL 471, except design pressures (Clause 4.9.3) can also be 3/5 of the pressure recorded during the condenser fan failure test.
Water Heating Tanks	4.12	Not (usually) applicable to UL 471.
Pressurized Product Systems	4.13	The CSA requirements are more restrictive. A pressure regulating device is required. A relief device is also required – no exceptions.
Freezing Chambers under Pressure	4.14	CSA requires a pressure relief device.
Cord-Connected Equipment	4.15	Cord connected equipment rated greater than 125 V, 1/3 hp must have a disconnect switch.
Wiring		
	4.22.1.5	Wire nuts not acceptable in semi-enclosed location.
Types of Wiring	4.23	Any accessible wire needs 0.060 or 0.078 inch thick insulation. Wiring in conduit, wireways, or other adequate enclosures may have 0.030 inch thick insulation.
	4.23.4	Class 2 low voltage wiring is considered to be an ignition source unless FT1 wire is used.

Table Continued

Requirements Topics	CSA Clause	Comparison
Wiring to Doors and Lids	4.23.8.2	Wiring to doors and lids must be flex tested 150,000 normal cycles and 1000 abnormal cycles. UL 471, Par. 10.1.9 specifies 100,000 cycles. See also 6.14.
Control Circuits	4.23.10	″Low″ voltage is less than 1000 V. This section is comparable to Sec. 26 of UL 471.
	4.25	All motors shall be CSA certified. Note that CSA Standard C22.2 No. 100 appears to be a construction standard, similar to UL 1004, Standard for Electric Motors.
Transformers	4.26	Class 2 transformers – same requirements. High Voltage Transformers – check CEC for fusing requirements.
Lighting Requirements	4.27	Lamps in walk-in coolers shall have gasketed fixtures – 4.27.1.5.
		All other requirements are considered comparable.
Switches	4.29	A switch that performs a safety function shall be connected in the hot conductor, 4.29.8. All other requirements are comparable.
Protection of Water Heaters	4.30	Not generally applicable to commercial refrigerators.
Heater Elements	4.31	Heater elements shall comply with C22.2 No. 72.
Electric Grid Heaters	4.33	Not applicable
Spacings	4.35	Except for spacings at field wiring terminals, the spacings requirements are comparable. See Table 3 for required spacings on printed wiring boards.
Receptacles	4.38	General purpose receptacles shall comply with C22.2 No.42. Special use receptacles shall comply with C22.2 No.182.3. A fuse is required if the unit is connected to a branch circuit greater than 15 A. See 4.38.2 (b). UL 471, Par. 23.1 indicates 20 A.

Table Continued

Requirements Topics	CSA Clause	Comparison
Plumbing Requirements	4.39	Not applicable to commercial refrigerators.
Markings	5	Monthly date code is required (not quarterly).
	5.4.2	Time delay fuse marking is slightly different.
		Caution & Warning markings require French wording.
		The maximum fuse size calculation is different. See App. C of the Standard. If the UL and CSA smaller values are also different, the smallest value should be marked on the unit.
	5.9	Type and rating of incandescent lamps shall appear near and lampholder.
		ON and OFF positions of switches or controls must be marked unless the application of the switch is obvious.
Tests	6	Tests and test conditions in UL 471 are considered comparable except for the following:
	6.2.3.6.1	Temperature of liquid withdrawal for beverage coolers may be different.
	6.2.7.1	Testing of absorption refrigerators is different.
Rating	6.3.1	Rating input is the stabilized input.
Temperature	6.4.1, Table 5	Maximum allowable temperatures may be somewhat different.
Ballasts	6.5.1	Ballast temperatures must be taken. UL 471, Sec. 42, contains a waiver.
Defrost	6.7.4	Need to examine the evaporator area of the unit after defrost to determine if defrost water has contacted uninsulated live parts.
Leakage Current	6.9.1	Leakage current – Maximum 0.5 mA. Note that units rated over 150 V are not tested.
	6.9.10	Leakage current conditioning at 85% relative humidity for 24 hours.

Table Continued

Requirements Topics	CSA Clause	Comparison
Temperature (Abnormal)	6.11.1, 6.11.5	During the condenser fan failure test, compressor enclosure temperatures must not exceed 150°C and condenser fan motor temperatures are not to exceed the following:

	Insulation system, °C							
	Maximum				Average*			
	Class A	Class B	Class F	Class H	Class A	Class B	Class F	Class H
(1) Automatic Reset Protector								
(a) During first test hour with the test started at room temperature	200	225	250	275	–	–	–	–
(b) After first test hour	175	200	225	250	150	175	200	225
(2) Manual reset protector	200	225	250	275	–	–	–	–
(3) Impedance protected	150	175	–	–	–	–	–	–

* The average temperature shall be determined as follows: The curve or graph of motor temperature, plotted against time, shall be obtained for the second hour and also for the seventy-second hour. The average temperature is determined by taking the arithmetic mean of the maximum temperatures and the minimum temperatures during each of these periods.

Requirements Topics	CSA Clause	Comparison
	6.11.6	Additional abnormal tests may be necessary.
Starting	6.13.3	Time delay fuse marking is slightly different (5.4.2).
Flexing	6.14	See 4.23.8.2 comments.
Cabinet Strength	6.15	Static load and deflection test may be necessary. Tests may be waived based on visual examination.
Impact	6.16	Impact test on metallic enclosures may be necessary if reduction of spacings can occur. Plastic enclosures enclosing uninsulated live parts shall withstand 5.2 or 1.5 ft-lb impact.
Glass Impact	6.17	See comments under 4.2.
Gaskets and Adhesives	6.19	Tests, if required, are different than those in UL 471.
Moisture Absorption Resistance	6.20	Tests on insulating material are somewhat different. See 61.2.1 of UL 471.
Door Latch Release	6.22	See comments on 4.6.5.
Overflow	6.23.1c	Water line connections are tested.