UL 412

STANDARD FOR SAFETY

Refrigeration Unit Coolers

UL Standard for Safety for Refrigeration Unit Coolers, UL 412

Fifth Edition, Dated August 22, 2011

Summary of Topics

This revision to ANSI/UL 412 includes the following changes in requirements:

Revisions To Controls Requirements.

Alternate Compliance Option for EMI Filters.

Revisions to Include Switch Mode Power Supply Units.

Clarification to Marking Requirements.

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 22, 2018.

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Standard for Refrigeration Unit Coolers

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Fifth Edition

August 22, 2011

This ANSI/UL Standard for Safety consists of the Fifth edition including revisions through August 28, 2018.

The most recent designation of ANSI/UL 412 as an American National Standard (ANSI) occurred on August 28, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 412 on April 9, 1992. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

ELECTRICAL COMPONENTS

SPACINGS

REFRIGERATION SYSTEM

PERFORMANCE

MANUFACTURING AND PRODUCTION TESTS

MARKING

Appendix A

Informational

APPENDIX B Normative

INTRODUCTION

1 Scope

1.1 These requirements cover unit coolers intended for use in refrigerators, freezers, refrigerated warehouses, walk-in coolers, and the like. They are designed for connection to alternating current (ac) circuits rated not more than 600 volts.

1.2 These requirements do not apply to fan-coil units intended for comfort cooling, heating, or both, or to other air-conditioning equipment or components covered by individual requirements.

1.3 Requirements for installation of unit coolers are included in the National Electrical Code, NFPA 70, and the Safety Standard for Refrigeration Systems, ASHRAE Standard 15.

2 General

2.1 Units of measurement

2.1.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.2 Undated reference

2.2.1 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 this Standard, the following definitions apply.

3.2 ACCESSORY – An optional electrical device or other component intended for installation in or connection to a unit cooler for the purpose of modifying or supplementing the functions of the unit cooler. It may be factory installed or intended for installation by service personnel.

3.3 BARRIER – A partition for isolating high-voltage electrical components, separating ignition sources from flammable materials, isolating moving parts and protection of wiring.

3.4 CABINET – The part of the equipment that provides physical protection to insulated wiring, enclosures, moving parts, motors, enclosed electrical parts, refrigeration tubing or other parts that may cause injury to persons.

3.4.1 CAPACITOR, CLASS Y – Capacitor or resistor-capacitor unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock. (Examples would include capacitors connected across the primary and secondary circuits where electrical isolation is required to prevent an electric shock or between hazardous live parts and accessible parts.)

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

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

3.7 CIRCUITS, ELECTRICAL –

a) Extra-Low-Voltage – A circuit that has an AC potential of not more than 42.4 V peak (30 V rms), and power of 100 VA or less; or a 30 V dc circuit:

1) Supplied by a primary battery,

2) Supplied by a Class 2 transformer, or

3) Supplied by a combination of a transformer and fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer.

A circuit that is derived from a circuit that exceeds 30 V by connecting resistance or impedance, or both, in series with the supply circuit to limit the voltage and current, is not an extra-low-voltage circuit.

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

3.8 COMPONENT – A device or fabricated part of the unit cooler covered by the scope of a safety standard dedicated to that purpose. When incorporated in a unit cooler, equipment otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as aluminum or copper, are not considered components. Generally, components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under specific, limited conditions, such as certain temperatures not exceeding specified limits.

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

3.10 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the risk of electric shock, fire, or injury to persons, is considered an operating control. Operating controls are also referred to as “regulating controls”. Appendix B specifies control functions that are not considered to result in a risk of fire, electric shock or injury to persons.

3.11 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as “limiting controls” or “safety controls” and are investigated under normal and single-fault conditions. Appendix B specifies control functions that are considered to result in a risk of fire, electric shock or injury to persons.

3.12 CONTROL, TEMPERATURE-LIMITING – A control which serves to prevent excessive temperature and is not intended to function during normal defrost cycle.

3.13 DESIGN PRESSURE – The maximum acceptable working pressure for which a unit cooler is designed.

3.13.1 ELECTRONIC COMPONENT – A part in which electrical conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor. A Metal Oxide Varistor (MOV) is considered to be an electronic component, but neon indicators are not.

3.13.2 ELECTRONIC DISCONNECTION – The de-energizing of a load within an appliance by an electronic device of a circuit. No electro-mechanical component having an air gap, such as a switch, contactor or relay is used to de-energize the load.

3.14 ENCLOSURE – The part of the equipment that does one or more of the following:

a) Isolates ignition sources,

b) Renders inaccessible all or any part(s) of the equipment that may otherwise present a risk of electric shock,

c) Retards propagation of flame initiated by electrical disturbances occurring within.

3.15 FUNCTIONAL PART – A part other than an enclosure or cabinet used to maintain the intended relative physical position of fixed or moving parts, or maintain the integrity of the structure.

3.15.1 GROUNDING, FUNCTIONAL – Grounding of a point in an appliance which is necessary for a purpose other than safety.

3.16 IGNITION SOURCE – Any high-voltage electrical component not located within an enclosure.

3.17 NONFUNCTIONAL PART – A part of the equipment that does not perform a specific function.

3.18 NONFUNCTIONAL PART, SMALL – A nonfunctional part having an area of less than 1 ft^2 (0.093 m^2) located so it cannot propagate flame from one area to another, and does not connect a possible source of ignition to the other ignitable parts.

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

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

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

3.21.1 PROTECTIVE ELECTRONIC CIRCUIT (PEC) – An electronic circuit that prevents a risk of fire, electric shock or injury to persons under abnormal operating conditions.

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

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

3.23.0 SWITCH MODE POWER SUPPLY UNIT – Electronic device incorporating transformer(s) and electronic circuitry(ies), that converts electrical power into single or multiple power outputs by rapidly switching a solid-state device on and off. It may also isolate the input circuit from the output circuit and regulate and/or convert the output voltage and current. The device may consist of one or more individual units with identical or different waveforms and frequencies including dc output.

3.23.1 THERMISTOR – A thermally sensitive semiconductor resistor, which shows over at least part of its resistance/temperature characteristic a significant non-linear change in its electrical resistance with a change in temperature. A thermistor may be either of the positive temperature coefficient (PTC) type or of the negative temperature coefficient (NTC) type.

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

3.25 UNIT COOLER – A direct-cooling, factory-made encased assembly, including a cooling element, fan(s) and motor(s). It may also incorporate means for defrosting of the cooling element.

3.26 VESSEL, PRESSURE – Any refrigerant-containing receptacle of a refrigerating system, other than evaporators [each separate section of which does not exceed 1/2 cubic foot (0.014 m^3) of refrigerant-containing volume], evaporator coils, compressors, condensers coils, controls, headers and piping.

3.27 VOLTAGE FOLDBACK – A circuit design feature intended to protect the power supply output transistors. When overcurrent is drawn by the load, the supply reduces the output voltage and current to within the safe power dissipation limit of the output transistors.

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4 Installation and Operating Instructions

4.1 A unit cooler shall be provided with instructions containing directions and information which the manufacturer considers necessary for installation, use, and maintenance of the unit cooler.

4.2 A copy of the manufacturer's operating and installation instructions, or equivalent information intended to accompany each unit cooler, is to be furnished with the sample submitted for investigation. These instructions are to be used as a guide in the examination and test of the unit cooler. 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 A unit cooler intended to utilize carbon dioxide (R744) in a secondary loop or a cascade system shall provide instructions indicating that:

a) If the refrigerating system is de-energized, venting of the R-744 through the pressure regulating relief valves in the system can occur. In such cases, the system may need to be recharged with R744, but in any case, pressure regulating relief valve(s) are not to be defeated or capped. The relief setting shall not be altered; and

b) A sufficient number of pressure relief and pressure regulating relief valves may need to be provided based on the system capacity and located such that no stop valve is provided between the relief valves and the parts or section of the system being protected.

CONSTRUCTION

5 Components

5.1 A component shall:

a) Comply with the safety standard covering that component;

b) Be used in accordance with its rating(s) established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability;

d) Comply with the applicable requirements of this end product standard; and

e) Not contain mercury.

Exception: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product, or

b) Is superseded by a requirement in this standard, or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

5.2 A component that is also required to perform other necessary functions, such as overcurrent protection, ground-fault circuit interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) covering products that provide those functions.

6 General

6.1 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.

6.2 All nonmetallic parts except for small nonfunctional parts shall comply with Sections 8 – 10, and Table 48.1.

6.3 In addition to the requirement in 6.2, nonmetallic materials that serve as electrical insulation or that directly support live parts shall comply with the requirements for electric insulation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7 Gaskets and Seals

7.1 If a unit cooler uses gaskets or seals for compliance with any of the requirements in this standard, the gaskets or seals shall comply with the Standard for Gaskets and Seals, UL 157.

8 Nonmetallic Material Classification

8.1 Materials shall be classified with respect to flammability characteristics that are established by the tests specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

8.2 Materials shall be assigned flammability ratings based on greatest to least resistance to flame and are identified as: 5VA, 5VB, V-0, V-1, V-2, HF-1, HF-2, HB, and HBF.

8.3 In reference to 8.2, the assigned flammability rating shall comply with Nonmetallic Material – Ignition Source Separation, Section 9 and Table 48.1.

9 Nonmetallic Material – Ignition Source Separation

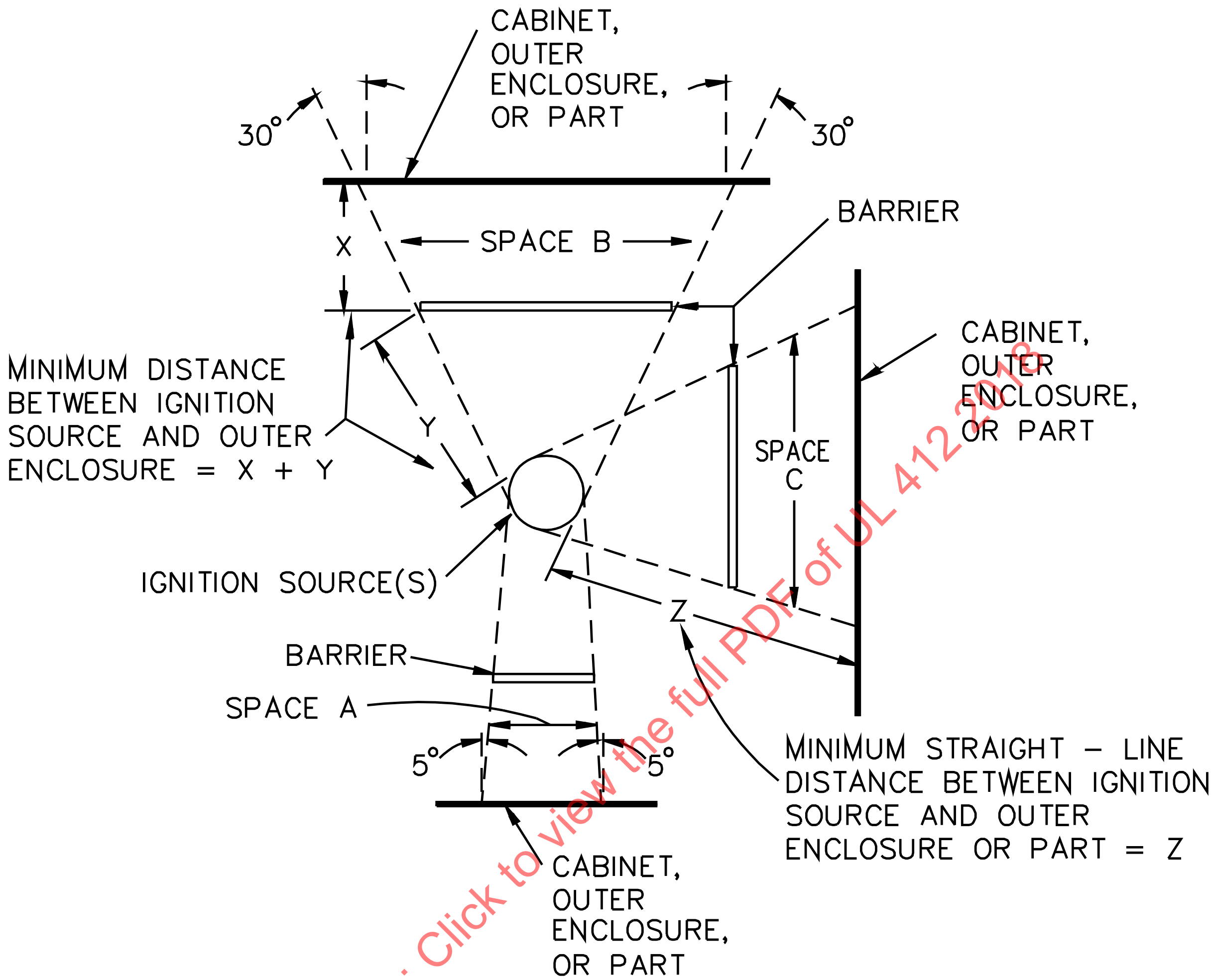
9.1 Parts formed from nonmetallic materials that are rated HB or HBF and positioned as shown in Figure 9.1 shall be separated from ignition sources by means of a barrier, extending at least to the boundary surface of the space whenever such parts are located:

a) Below an ignition source and within Space A,

b) Above an ignition source and within Space B, and

c) In the vertical plane relative to an ignition source and within Space C.

Figure 9.1
Separation of ignition sources from nonmetallic materials



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Notes:

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

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

9.2 The HB or HBF materials shall be located such that the distance between:

a) High-voltage wiring not employing VW-1 insulation and the HB or HBF materials shall be a minimum of 2 inches (51 mm), and

b) Any other ignition source and the HB or HBF materials shall be a minimum of 4 inches (102 mm).

9.3 In reference to the measurement of the separation of ignition source indicated in 9.2, the minimum distance for HB or HBF materials located:

a) Above the ignition source shall be as shown in Figure 9.1, Distance X + Y; and

b) In the vertical plane relative to the ignition source shall be as shown in straight-line Figure 9.1, Distance Z.

10 Nonmetallic Material Application and Location

10.1 Nonmetallic materials shall comply with the tests determined as described in Table 48.1.

10.2 Nonmetallic fasteners used as part of the enclosure shall comply with the Fastener Strength Test, Section 69.

10.3 Thermal insulation located between a cabinet and inner liner of a unit cooler shall be rated HF-1 or the unit cooler shall comply with (a) and (b) as follows:

a) All holes within the cabinet and inner liner shall be closed unless:

1) No more than two openings are provided,

2) The total opening area does not exceed 1 in^2 (645.2 mm^2), and

3) Wiring is not routed through the opening(s).

b) The enclosure surfaces shall be securely fastened such that the maximum spacing between screws, spot welds, or other securement means does not exceed 6 inches (152.4 mm).

11 Assembly

11.1 Mechanical protection

11.1.1 Louvers and other openings shall be constructed and located to reduce the risk of unintentional contact with moving parts and hot surfaces that may cause injury. In determining compliance with this requirement, parts, such as covers, panels, or grilles shall be removed unless tools are required for their removal.

11.1.2 The requirement of 11.1.1 does not apply to parts, such as covers, panels, or grilles which serve as guards provided:

a) A warning marking as described in 76.2 identifies the guarded moving or hot part;

b) The part is intended to be removed only by an attendant or serviceman; and

c) The part is secured by four or more fasteners or a combination of two such fasteners and two hinges, two tabs, or the like. Disengagement of any one of the fasteners, hinges or tabs of a guard shall not result in exposure of moving parts or hot parts.

11.1.3 With reference to the fasteners in 11.1.2(c):

a) Fasteners 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 intended for this application.

b) Disengagement of any one of the fasteners, hinges or tabs of a guard shall not result in exposure of moving parts or hot parts.

11.1.4 Fasteners shall be subjected to the Fastener Strength Test, Section 69, when they are used to:

a) Secure parts required to maintain electrical spacings,

b) Reduce the risk of unintentional contact with moving parts and hot surfaces, or

c) Engage a nonmetallic part.

11.1.5 The rotor of a motor, a pulley, a gear, a belt, a fan blade, or other moving part shall be guarded or enclosed so that the minor dimension of any opening does not exceed the values indicated in 11.1.6 or 11.1.7.

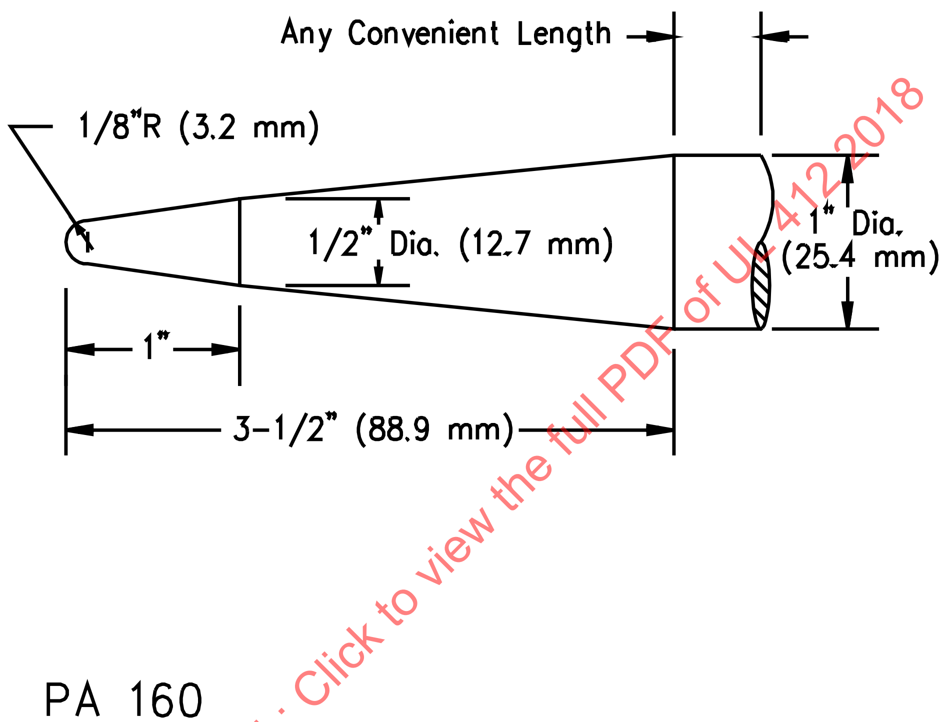
11.1.6 A fan blade employing a guard with openings having a minor dimension less than 1 inch (25.4 mm) shall be guarded such that the probe illustrated in Figure 11.1 cannot contact any part of the fan blade when inserted through openings in the guard with a force of 2.5 pounds (11.1 N).

Exception: The probe illustrated in Figure 11.1 may contact the trailing edge of a fan blade if the relationship between weight (w) in pounds, radius (r) in inches and speed (n) in revolutions per minute of the fan blade is such that K in the equation:

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

is less than 100.

Figure 11.1
Probe for fan blades



11.1.7 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 11.1. 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 11.1
Clearance from openings

Minor dimensions of opening[a,d] Inches	(mm)	Minimum distance from opening to moving part[c] 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 11.1.7.
[c] Also applies to hot parts. See 11.1.9.
[d] For fan blade guards that have openings with minor dimensions less than 1 inch see 11.1.7.

11.1.8 A moving part is not to be considered when judging compliance with 11.1.5, 11.1.6, and 11.1.7 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.

11.1.9 When tested according to the Temperature Test – Cooling Mode, Section 50, and the Electric Defrost Test, Section 51, surfaces which exceed the temperature rises of Table 50.1(d)(2) and (d)(3) shall be guarded in accordance with 11.1.5 – 11.1.7.

Exception: The sheath of a defrost heater, which is not guarded in accordance with 11.1.3 – 11.1.8, may exceed the temperature permitted by Table 50.1 (d)(2) and (d)(3) if the heater is in direct contact with the fins of the evaporator coil for the exposed length of the heater and:

a) The unit cooler is intended for installation such that the lowest part of the exposed defrost heater is 7 feet (2.1 m) or more above floor level and is marked in accordance with 76.5 and 76.7, or

b) The unit cooler is for use with a walk-in cooler or refrigerated warehouse and is marked in accordance with 76.6 and 76.7.

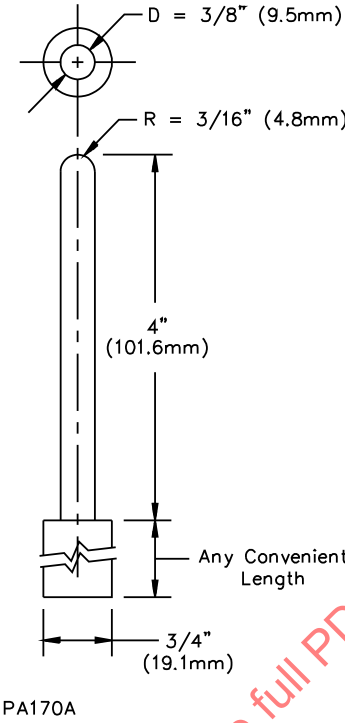
11.1.10 A heater element, as installed in the complete unit cooler, shall be protected against mechanical damage. A copper or steel sheath that:

a) Is at least 0.016 inches (0.41 mm) thick, or

b) Cannot be contacted when the probe illustrated in Figure 11.2 is inserted with a force of 5 pounds (22.2 N),

is considered as protected against mechanical damage.

Figure 11.2
Probe

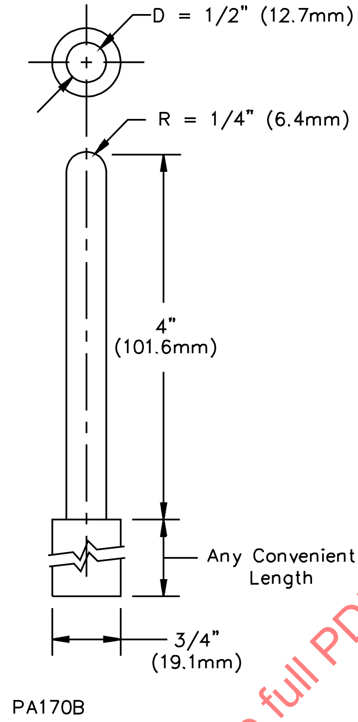


11.2 Protection from live parts

11.2.1 Louvers and other openings shall be constructed and located to reduce the risk of accidental contact with uninsulated high-voltage live parts. Parts, such as covers, panels, or grilles shall be removed unless tools are required for their removal or an interlock is provided.

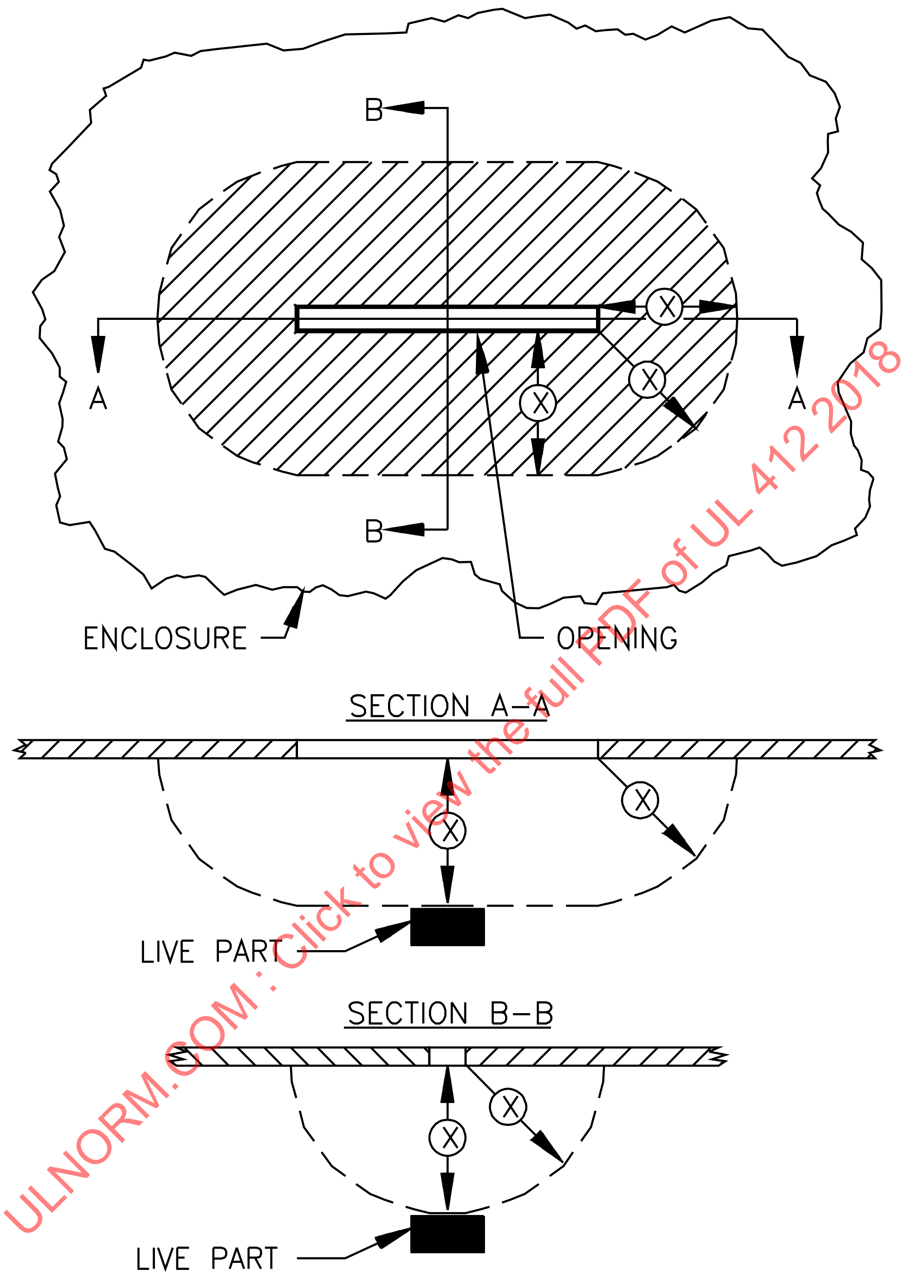
11.2.2 If an opening will not permit the entrance of a 3/4 inch (19.1 mm) diameter rod, the probe illustrated in Figure 11.2 shall not touch any uninsulated live parts, and the probe illustrated in Figure 11.3 shall not touch any film coated wire when inserted through the opening. The probe shall not pass through grilles, screens, louvers, or the like, when a force of 5 pounds (22.2 N) is applied.

Figure 11.3
Probe



11.2.3 If an opening permits the entrance of a 3/4 inch (19.1 mm) diameter rod, the conditions described in Figure 11.4 shall be used in determining compliance with the requirements. The minor dimension of the opening shall not exceed 1 inch (25.4 mm) in any case.

Figure 11.4
Openings near uninsulated live parts



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An opening is acceptable if there is no uninsulated live metal part or enamel-insulated wire:

a) Less than X inches (mm) from the perimeter of the opening, as well as

b) 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).

11.2.4 In addition to the requirements of 11.2.1 – 11.2.3, uninsulated live parts which are likely to be contacted by persons performing operations, such as replacing fuses, resetting manual-reset devices, oiling motors, or other such service operations, shall be located, guarded, or enclosed to reduce the risk of accidental contact unless tools are required to expose the live part. See 77.2.

11.2.5 A fuseholder shall be installed or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing fuses. A barrier of vulcanized fiber or similar material employed as a guard for uninsulated high-voltage live parts shall be not less than 1/32 inch (0.8 mm) in thickness. A separation less than 4 inches (102 mm) from the insulating body of a fuse is considered to be adjacent.

11.2.6 Electrical components shall be located or enclosed to reduce the risk of wetting of uninsulated live parts by liquids due to accumulation, overflow, splashing, leakage, or defrost.

11.2.7 With regard to 11.2.6, it is assumed that drippage may occur from any portion of the evaporator. Accordingly, electrical components located beneath any portion of the evaporator including tubing, hairpin turns, return bends, fins, end plates and inlet and outlet tubes will require the use of barriers, baffles, or the like.

11.2.8 A condensate pan shall be constructed and located so that overflow due to a blocked drain will not wet uninsulated live parts or enameled wire. An overflow spout, drain hole, cutout, or the like, in the condensate pan may be acceptable for preventing dripping of water on electrical parts. The Overflow Test, Section 54, is to be conducted if it is not evident that the unit cooler complies with this requirement.

11.3 Mounting of parts

11.3.1 A switch, grounding lug, terminal board, or similar component shall be secured in position and shall be prevented from turning. See 11.3.2 – 11.3.4.

11.3.2 The requirement that a switch be prevented from turning will be waived if all of the following conditions are met:

a) The switch is 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 turn the switch during the operation of the switch,

b) The means of mounting the switch make it unlikely that operation of the switch will loosen it,

c) The spacings are not reduced below the minimum required values if the switch rotates, and

d) The operation of the switch is by mechanical means rather than direct contact by persons.

11.3.3 With reference to 11.3.1, the means for preventing rotation is to 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 means from turning.

11.3.4 An uninsulated live part or a part that supports a live part shall be secured to its mounting surface so that it will be prevented from turning or shifting in position if such motion results in a reduction of spacings below the minimum values. See the spacing requirements in High-Voltage Circuits, Section 39 and Extra-Low-Voltage Circuits, Section 40. Friction between surfaces is not a means to prevent shifting or turning of a live part, but a lock washer does meet the intent of this requirement.

11.3.5 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated live parts. See 64.2.

12 Accessories

12.1 A unit cooler having provisions for the use of electrical accessories to be attached in the field shall comply with the requirements of this section, and shall comply with the requirements of this standard with or without the accessory installed.

12.2 The installation of accessories by service personnel shall be by means of receptacles, plug-in connectors, insulated wire connectors, wiring terminals, or by connection to existing wiring terminals.

12.3 With reference to 12.2, any installation that requires the cutting of wiring or the soldering of connections by the installer is not acceptable. Installations that require cutting, drilling, or welding are not acceptable in enclosures and in other areas where such operations may damage electrical or refrigeration components and wiring.

12.4 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. The strain relief shall be evaluated to the Strain Relief Test, Section 70.

12.5 All terminals and wiring intended to be field connected shall be identified on the accessory, on the unit cooler if connections are made between the accessory and the unit cooler, and on the wiring diagram(s).

12.6 The mounting location of the accessory shall be indicated on the unit cooler. If the mounting location is fixed due to the function of the accessory and arrangement of the unit cooler and instructions are provided covering the installation and location for the accessory, the mounting location of the accessory need not be indicated on the unit cooler.

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

a) Their installation is feasible, and

b) That the instructions are detailed and correct.

13 Cabinets and Enclosures

13.1 General

13.1.1 Steel cabinets and enclosures shall be protected against corrosion by metallic or nonmetallic coatings, such as plating or painting.

13.1.2 The electrical components within the cabinet, such as controls, solenoids, relays, switches, and impedance protected motors shall comply with one of the following:

a) Electrical components shall be individually enclosed, except for terminals,

b) Failure of an electrical component shall not result in a risk of fire or emission of flame or molten metal from the cabinet, or

c) Electrical components other than switches or motors shall comply with the Burnout Test – Other Components, Section 57.2.

13.1.3 Compliance with 13.1.2 shall be based on the design and location of the components with respect to openings in the cabinet.

13.1.4 In reference to 13.1.3, openings in the bottom of the cabinet shall be arranged to prevent glowing or flaming particles from falling out of the cabinet.

13.1.5 Barriers used to comply with 11.1.4 shall be horizontal and located as indicated in Figure 23.1 with respect to unenclosed electrical components located within the cabinet.

13.1.6 A cabinet is to be evaluated with respect to its size, shape, material, thickness and use in a particular application.

13.1.7 Sheet steel shall have a thickness of not less than 0.026 inch (0.66 mm) if uncoated, and not less than 0.029 inch (0.74 mm) if galvanized. Nonferrous sheet metal shall have a thickness of not less than 0.036 inch (0.91 mm).

13.1.8 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 inch (0.81 mm) if uncoated steel, not less than 0.034 inch (0.86 mm) if galvanized steel, and not less than 0.045 inch (1.14 mm) if nonferrous.

13.1.9 If threads for the connection of conduit are tapped all the way through a hole, or if an equivalent construction is employed, there shall be not less than three or more than five threads, and the construction of the device does not prohibit the functional part (i.e. conduit bushing) from being attached. If threads for the connection of conduit are not tapped all the way through a hole in the functional part (i.e. enclosure wall, conduit hub) there shall be not less than 3-1/2 threads and there shall be a rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing and which shall have an internal diameter corresponding with the trade size of rigid conduit.

13.1.10 A knockout in an enclosure shall be secured in place, but shall be capable of being removed without deformation of the enclosure to the extent that the deformation results in damage to electrical components and/or reduction in electrical spacings.

13.1.11 A knockout shall remain in place when a force of 10 pounds (44 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.

13.1.12 A knockout shall be provided with a flat surrounding surface for seating of a conduit bushing and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those required by this standard.

13.1.13 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 13.1 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 13.1
Knockout or hole sizes and dimensions of bushings

Trade size of conduit, nominal ID	Conduit Size, O.D.		Knockout or hole diameter		Bushing dimensions			
					Overall diameter		Height	
Inches	Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
1/2	0.84	(21.3)	7/8	(22.2)	1	(25.4)	3/8	(9.5)
3/4	1.05	(26.7)	1-3/32	(27.8)	1-15/64	(31.4)	27/64	(10.7)
1	1.31	(33.4)	1-23/64	(34.5)	1-19/32	(40.5)	33/64	(13.1)
1-1/4	1.67	(42.3)	1-23/32	(43.7)	1-15/16	(49.2)	9/16	(14.3)
1-1/2	1.90	(48.3)	1-31/32	(50.0)	2-13/64	(56.0)	19/32	(15.1)
2	2.37	(60.3)	2-15/32	(62.7)	2-45/64	(68.7)	5/8	(15.9)

13.2 Doors and covers

13.2.1 Service covers shall require the use of tools for removal or shall be provided with an interlocking mechanism if they give access to uninsulated high-voltage live parts.

13.2.2 With reference to 13.2.1, a required interlocking mechanism shall comply with 25.12 and shall:

a) Be engaged with the cover in the closed position before parts are energized, and

b) Secure the cover in the closed position when engaged.

13.2.3 A hinged or pivoted panel or cover shall be positioned or arranged so that, when it is in an open position to facilitate servicing, it is not subject to falling or swinging due to gravity or vibration so as to cause injury to persons from the panel or cover, from moving parts, or from uninsulated live parts.

13.2.4 The assembly shall be arranged so that an overcurrent protective device, such as a fuse, can be replaced and manual-reset devices can be reset without removing parts other than a service cover(s) or panel(s).

13.2.5 A required protective device shall not be accessible without opening a door or cover.

Exception: The operating handle of a circuit breaker, the reset button of a manually resettable motor protector and similar parts may project outside the enclosure.

13.2.6 An opening around a handle, reset button, or other control member is acceptable if the clearance between the control member and the edge of the opening is not more than 1/8 inch (3.2 mm) for any setting or position of the control member.

13.2.7 Covers over fuses in high-voltage circuits shall be hinged. Covers over manual-reset overload-protective devices shall be hinged if it is necessary to open the cover to reset the device.

Exception: A hinged cover is not required where the only fuses enclosed are:

a) Supplementary type control circuit fuses, provided the fuses and control circuit loads, other than a fixed control circuit load, such as a pilot lamp, are within the same enclosure,

b) Supplementary type fuses of 2 amperes or less for small auxiliary resistance heaters with a maximum rating of 100 watts,

c) An extractor-type fuse with its own enclosure, or

d) Fuses in extra-low-voltage circuits.

13.2.8 Hinged covers, where required, shall not depend solely upon screws or other similar means to hold them closed, but shall be provided with a latch or the equivalent.

13.2.9 A spring latch, magnetic latch, dimple, or any other mechanical arrangement that will hold the door in place and will require some effort on the user's part to open it is considered to be a means for holding the door in place as required in 13.2.8. A cover interlocking mechanism, as described in 13.2.2, provided as the sole means for securing the cover or panel, is considered to comply with 13.2.8.

13.2.10 A door or cover giving direct access to fuses in other than extra-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 proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A special construction such as a fuse enclosure, located within a cabinet, or a flange and rabbet combination meet the intent of this requirement.

13.2.11 Strips used to provide rabbets, or angle strips fastened to the edges of a door shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings, not more than 6 inches (152 mm) apart.

14 Barriers

14.1 Except as specified in 11.2.5 and 39.9, a barrier shall be formed from one or more of the following:

a) Metal, minimum 0.005 inch (0.13 mm) thick;

b) Fiberglass, minimum 0.5 inch (12.7 mm) thick;

c) A nonmetallic material rated 5VA; or

d) A nonmetallic material evaluated to the 127 mm (5 inch) End Product Flame Test as described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

14.2 A barrier shall be secured to the mounting surface such that tools are required for its removal.

14.3 A barrier that isolates ignition source(s) shall comply with the enclosure requirements of Table 48.1.

15 Field-Supply Connections

15.1 General

15.1.1 As used in 15.1.2 – 15.1.7, Terminals, Section 15.2, and Leads, Section 15.3, field-wiring connections are considered to be the terminals or leads to which power supply, control, or equipment grounding connections will be made in the field when the unit cooler is installed.

15.1.2 A unit cooler shall have provision for connection of one of the wiring methods that, in accordance with the National Electrical Code, NFPA 70, would be suitable for it.

15.1.3 A knockout for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying Table 15.1.

Table 15.1
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)	1-1/2	(48.3)	2	(60.3)	2	(60.3)

NOTES –

1 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.

Table 15.1 Continued on Next Page

Table 15.1 Continued

Wire size AWG	(mm²)	Number of wires 2	3	4	5	6
2 Trade size per Standard for Electrical Rigid Steel Conduit (ERSA), NEMA C80.1.						

15.1.4 The location of a terminal box or compartment in which power supply connections are to be made shall be such that these connections may be inspected after the unit cooler is installed. The connections are to 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.

15.1.5 A terminal box or compartment intended for the connection of field wiring shall be secured in position and shall be prevented from turning.

15.1.6 Space shall be provided in the field-wiring compartment or outlet box for installation of conductors of the number and size required by 15.1.7, using Type TW or THW wire, when at least a 6 inch (152 mm) length of each conductor is 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.

15.1.7 The unit cooler shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity of not less than that indicated in 75.4. It is assumed that branch circuit conductors rated 60°C (140°F) will be used.

15.2 Terminals

15.2.1 For field-wiring terminals intended for 8 AWG (8.4 mm^2) and larger conductors, pressure wire connectors shall be used. For field-wiring terminals intended for 10 AWG (5.3 mm^2) and smaller conductors, the parts to which wiring connections are made may consist of clamps or wire binding screws with cupped washers, terminal plates, or the equivalent to hold the wire in position.

15.2.2 It should be noted that according to the National Electrical Code, NFPA 70, 14 AWG (2.1 mm^2) is the smallest conductor which may be used 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.

15.2.3 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 15.1.7 and 75.4, but no smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

15.2.4 Wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with 15.2.5 – 15.2.10 or with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

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

15.2.6 A wire binding screw at a field-wiring terminal shall be not smaller than No. 8 (4.2 mm diameter), except that a No. 6 (3.5 mm diameter) screw may be used for the connection of one 14, 16, or 18 AWG (2.1, 1.3, or 0.82 mm^2) conductor.

15.2.7 A terminal plate for a wire binding screw shall be of metal not less than 0.030 inch (0.76 mm) in thickness for a 14 AWG (2.1 mm^2) or smaller wire and not less than 0.050 inch (1.27 mm) in thickness for a wire larger than 14 AWG (2.1 mm) and in either case, there shall be not less than two full threads in the metal.

15.2.8 A terminal plate formed from stock having the minimum required thickness may have the metal extruded at the tapped hole for the binding screw to provide two full threads, except that 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 torque values indicated in the Standard for Wire Connectors, UL 486A-486B.

15.2.9 A wire binding screw shall thread into metal.

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

15.3 Leads

15.3.1 Leads intended for connection to an external extra-low-voltage safety circuit or to any high-voltage circuit shall comply with all of the following:

a) Be one of the types of wiring specified in 16.1;

b) Be 6 inches (152 mm) or more in length, as measured from the lead end to the strain relief means, unless the use of a shorter lead is required to prevent damage to the lead insulation;

c) Be provided with strain relief if stress on the lead may be transmitted to terminals, splices, or internal wiring. In such cases, leads shall comply with the Strain Relief Test, Section 70; and

d) Not be connected to wire binding screws or pressure wire connectors located in the same compartment as the lead ends (that are intended for spliced connections to the field-wiring) unless the screws or connectors are rendered unusable for field-wiring connections or the lead ends are insulated.

15.3.2 A lead intended for the connection of a grounded conductor shall be finished to show a white or gray color, shall be distinguishable from other leads, and no other lead shall be so identified.

15.4 Grounding

15.4.1 A unit cooler shall have an equipment grounding terminal or lead for grounding.

14.4.2 A terminal used for the connection of an equipment grounding conductor shall be capable of securing a conductor of the size required by the National Electrical Code, NFPA 70, for the particular application.

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

15.4.4 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 15.4.5 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 unit cooler. The wire binding screw or pressure wire connector shall be secured to the frame or enclosure of the unit cooler and shall be located so that it is unlikely to be removed during normal service operations such as replacing fuses, resetting manual-reset devices, or oiling motors.

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

15.4.6 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.

16 Internal Wiring and Wiring Methods

16.1 Wiring shall comply with one of the following:

a) Standard for Appliance Wiring Material, UL 758;

b) Standard for Thermoset-Insulated Wires and Cables, UL 44;

c) Standard for Flexible Cords and Cables, UL 62; or

d) Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

16.2 Wire insulation shall be rated for the potential involved and for the temperature to which it may be subjected in use. Compliance shall be determined in accordance with any of the following:

a) Wiring temperature acceptability shall be based on the temperatures measured in the Temperature Test – Cooling Mode, Section 50, and the Electric Defrost Test, Section 51.

b) For other than motor wiring, all wiring shall:

1) Have an ampacity of the conductors in accordance with Table 16.1 and

2) Not be exposed to heat from radiating sources or heated components.

c) Motor wiring shall have an ampacity not less than 125 percent of the motor full load current rating in addition to complying with (b).

Table 16.1
Wiring material ampacity

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

NOTE – The ampacities shown apply to appliance wiring materials with insulation rated not less than 90°C (194°F). For types of wires other than appliance wiring materials, the ampacity shall be determined from Tables 310-16 and 310-21 in the National Electrical Code, ANSI/NFPA No. 70 for the type of wire employed. The correction factors of the referenced tables need not be applied.

16.3 Wiring which is color coded green or green with one or more yellow stripes shall be used only for grounding conductors. Wiring used for other purposes shall not be identified with the above color codes.

Exception: Any insulation color may be used for internal conductors in assemblies, such as ribbon cables, flexible printed wiring, etc., if during installation and servicing the conductor is:

a) Not accessible and is not visible, or

b) Part of a low voltage energy limiting circuit.

16.4 Internal wiring of unit coolers shall be of the type indicated in Table 16.2. The insulation of wires or cords connected to fan motors and other auxiliary motors shall be of an oil resistant type, such as Type SJO, SJT, SPT-3, or appliance wiring materials having oil resistant insulation.

Table 16.2
Typical wiring materials

Group	Type of wire, cord, or cable[a]	Wire size		Insulation thickness	
		AWG	(mm²)	Inch	(mm)
A	Appliance wiring material[b], with thermoplastic insulation thicknesses shown at the right corresponding to wire sizes indicated, or Type ACHH, ACTH, ACTHH, FFH-2, TF, TFF, TFN, TFFN, SF-2, SFF-2, RHH, RHW, THW, XHHW, 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] with rubber insulation thickness shown at the right corresponding to wire sizes indicated, or 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.

16.5 Wiring of the type indicated in Table 16.2, Group A, shall be enclosed by means such as conduit, electrical tubing, raceways, or control boxes. Fittings shall be constructed for use with the type of wiring enclosure employed in the application.

16.6 Cords or appliance wiring material of a type indicated in Table 16.2, Group B, shall be positively routed, isolated or both from openings in the cabinet to prevent damage of wiring, or emission of flame or molten metal through openings in the cabinet.

16.7 With reference to 16.5 and 16.6, if the compartment enclosing the wiring has no openings, other than for conduit or piping, and contains no flammable material, other than electrical insulation, the cord or appliance wiring material referenced in Table 16.2, Group C, may be employed.

16.8 Wiring shall be positively routed, isolated, or both from openings in the cabinet.

16.9 With regard to 16.6, wiring shall be separated from nonmetallic materials in accordance with Nonmetallic Material – Ignition Source Separation, Section 9.

16.10 Wiring which extends to a panel, pan, or accessory, and is subjected to movement during servicing shall be flexible cord and shall be provided with a strain relief so that stress is not transmitted to terminals or splices. The strain relief shall be evaluated to the Strain Relief Test, Section 70.

16.11 The wiring shall be routed or protected to prevent damage to the insulation.

16.12 If any failure of extra-low-voltage wiring causes malfunctioning of a motor overload protective device or other protective device, such wiring shall be:

a) Insulated as indicated in 16.4,

b) Shall be Type SPT-2, or SP-2 cord, or

c) One of the types indicated in Group B or C of Table 16.2. Wires of types specified in Group A of Table 16.2, or low-energy safety control wire are to be used if such wiring is located in a cavity or compartment of the unit cooler and is shielded from damage.

16.13 All wires and cords used in a unit cooler shall be routed and supported to prevent damage due to:

a) Sharp edges,

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

c) Moving parts, and

d) Parts which can be expected to vibrate such as motors, refrigerant lines, and the like. Clamping means shall have smooth, rounded surfaces.

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

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 which might abrade the insulation, and

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

16.14 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. The wiring arrangement shall be such as to prevent water caused by condensation or defrosting from entering wiring enclosures and electrical enclosures.

Exception: Water may enter an enclosure providing:

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

b) The uninsulated live parts are not wetted.

16.15 A wiring enclosure shall provide a smooth wireway with no sharp edges or projecting screws which might damage the insulation.

16.16 To prevent abrasion of insulation, holes for passage of wires or cords through walls, panels, or barriers shall have smooth, rounded surfaces or shall be provided with smoothly rounded bushings. Bushings shall be fabricated from material, such as ceramic, phenolic, cold-molded composition, or fiber.

16.17 Parallel conductor appliance wiring material of the integral type shall not be ripped more than 3 inches (76.2 mm) unless the minimum wall thickness of the conductor insulation after ripping is at least 0.058 inches (1.47 mm) in thickness. 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.

16.18 All splices and connections shall be mechanically secured and electrically bonded. A soldered connection shall be made mechanically secure before being soldered.

16.19 Splices shall be located within the unit cooler 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, or the like. Strain relief shall be provided on the conductors if the wiring is likely to be moved during normal service operations, such as replacing fuses, resetting manual-reset devices, or oiling motors.

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

16.21 Splicing devices, such as wire connectors, may be employed if they provide mechanical security and employ electrical insulation rated for the voltage to which they are subjected.

16.22 Quick-connecting assemblies are to form a secure electrical connection, such as by detents in the mating parts, and are to be capable of carrying the current involved.

16.23 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. Open-slot type connectors shall not be used unless they prevent disconnection resulting from loosening of the clamping means. The shanks of terminal connectors shall be protected by electrical insulation if the spacings may be reduced below the minimum acceptable values by loosening of the clamping means. The insulating material shall be secured in position. The thickness of the insulation on the shanks shall be not less than 0.028 inch (0.71 mm) except as permitted by 39.9.

16.24 Conductors of motor circuits having two or more thermal- or overcurrent-protected motors wired for connection to one supply line shall comply with one of the following:

a) A conductor shall have an ampacity of not less than one-third the ampacity of the branch circuit conductors as determined in 15.1.7;

b) A conductor shall be:

1) Size 18 AWG (0.82 mm^2) or larger,

2) Not more than 4 feet (1.2 m) in length, and

3) Protected by a fuse or equivalent overcurrent protective device rated not more than 60 amperes;

c) A conductor shall serve as a jumper lead between controls and shall not exceed 3 inches (76.2 mm) in length;

d) A conductor shall serve as a jumper lead between controls and is located in an electrical control enclosure; or

e) A conductor shall withstand the Limited Short Circuit Test, Section 61.

16.25 Wire positioning devices shall comply with the Standard for Positioning Devices, UL 1565.

16.26 Wire insulating bushings shall comply with the Standard for Insulating Bushings, UL 635.

17 Separation of Circuits

17.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of different circuits, (i.e., 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.

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

17.3 Field-installed conductors of any circuit shall be segregated or separated by barriers from field-installed 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.

17.4 Field-installed conductors of a high-voltage circuit or an extra-low-voltage circuit with Class 1 National Electrical Code, NFPA 70, wiring shall be segregated or separated by barriers as follows:

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

b) From any uninsulated live parts of electrical components, such as a motor overload protective device or other protective device, where short-circuiting or grounding results in a risk of fire or electrical shock, except at wiring terminals.

17.5 Field-installed conductors of an extra-low-voltage circuit with Class 2 National Electrical Code, NFPA 70; wiring shall be segregated or separated by barriers as follows:

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

b) From wiring terminals and any other uninsulated live parts of extra-low-voltage electrical components, such as a motor overload protective device or other protective device, where short-circuiting or grounding results in a risk of fire or electrical shock.

17.6 If a barrier is used to provide separation between the wiring of different circuits, it shall comply with Section 14, Barriers.

18 Bonding for Grounding

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

18.2 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 other refrigerant-containing parts, and plumbing accessories, are to be bonded for grounding if they may be contacted by the user or serviceman.

Exception: Metal parts described as follows need not be grounded:

a) Adhesive-attached metal-foil markings, screws, handles, and the like, which 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, which are positively separated from wiring and uninsulated live parts.

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

d) Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar materials, not less than 1/32 inch (0.8 mm) in thickness, 0.028 inch (0.71 mm) minimum, and which are secured in place. If a material having a lesser thickness is used, consideration is to be given to such factors as its electrical, mechanical, and flammability properties when compared with materials in thicknesses specified above.

18.3 Metal-to-metal hinge bearing members for a door or cover are considered to be a means for bonding a door or cover for grounding if a multiple-bearing, pin-type hinge(s) is employed.

18.4 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 the 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.

18.5 A factory-installed quick connect terminal with the dimensions specified in Table 18.1, is not prohibited from being used as an internal connection for bonding internal parts to the metal enclosure for grounding, when:

a) The connector is located where there is not a risk of displacement and

b) The component is limited to use on a circuit having the branch circuit protective device indicated in Table 18.1.

Table 18.1
Quick connect terminal used in internal bonding for grounding

Quick connect terminal dimensions inches	(mm)	Rating of protective device amperes
0.020 by 0.187 by 0.250	(0.51 by 4.75 by 6.35)	20 or less
0.032 by 0.187 by 0.250	(0.81 by 4.75 by 6.35)	20 or less
0.032 by 0.205 by 0.250	(0.81 by 5.2 by 6.35)	20 or less
0.032 by 0.250 by 0.312	(0.81 by 6.35 by 7.92)	60 or less

18.6 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 18.8.

18.7 With reference to 18.6, 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.

18.8 A connection that depends upon the clamping action exerted by rubber or other nonmetallic material may be acceptable if it complies with the provisions of the Current Overload Test – Bonding Conductors and Connections, Section 60, and the Limited Short-Circuit Test, Section 61, under any normal degree of compression permitted by a variable clamping device and also following exposure to the effects of oil, grease, moisture, and thermal degradation, which may occur in service. Also, a clamping device is to be considered with particular emphasis on the likelihood of the clamping device being reassembled in its intended fashion.

18.9 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. The size of the conductor or strap shall be in accordance with Table 18.2.

Exception No. 1: A smaller conductor may be used if the bonding conductor and connection comply with the provisions of the Current Overload Test – Bonding Conductors and Connections, Section 60, and the Limited Short-Circuit Test, Section 61.

Exception No. 2: A bonding conductor to a motor or other electrical component need not be larger than the size of the motor-circuit conductors or the size of the conductors supplying the component. See 16.24.

18.10 A clamp or strap used in place of a separate wire conductor as required in 18.9 is considered acceptable provided the minimum cross-sectional conducting area is equivalent to the wire size indicated in Table 18.2.

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

Table 18.2
Bonding wire conductor size

Rating of overcurrent device amperes	Minimum 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.

18.12 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 unit cooler, a bonding conductor for that motor is sized on the basis of the overcurrent device intended for ground-fault protection of the motor.

18.13 Functional grounding shall not be relied upon for equipment grounding or bonding.

ELECTRICAL COMPONENTS

19 Capacitors

19.1 Except as specified in 19.5, capacitors shall comply with the Standard for Capacitors, UL 810, or shall comply with 19.2 – 19.3.

19.2 A motor starting or running capacitor shall be housed within a cabinet, enclosure or other similar container to reduce the risk of mechanical damage to the plates and which will reduce the risk of emission of flame or molten material resulting from malfunctioning of the capacitor. The container shall be:

a) Made of coated or uncoated sheet steel having a thickness of not less than 0.020 inch (0.51 mm); or

b) Mounted within the unit cooler cabinet or enclosure if the sheet steel is thinner than 0.020 inch (0.51 mm) or if materials other than metal are used as the capacitor container.

c) Protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements of this standard, including faulted overcurrent conditions as specified in the Limited Short-Circuit Test, Section 61. The conditions for the Limited Short-Circuit Test shall be:

1) Based on the circuit on which the capacitor is used; or

2) If the available fault current is limited by other components in the circuit, such as a motor start winding, the capacitor may be tested using a fault current less than the test current specified in Table 61.1 but not less than the current established by dividing the circuit voltage by the impedance of the other component(s).

19.3 If the container of an electrolytic capacitor is metal, the container shall be considered to be a live part and shall be provided with moisture-resistant electrical insulation to isolate it from dead-metal parts and to reduce the risk of contact by persons during servicing operations. The insulating material shall be not less than 1/32 inch (0.8 mm) in thickness except as indicated in 39.9.

19.4 *Deleted*

19.5 If capacitor is connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, it shall comply with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

19.6 In reference to 19.5, if a capacitor complies with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, it shall have specifications as follows:

a) Operating voltage – Not less than 110 percent of the unit cooler rated voltage;

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

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

d) Upper category temperature – Based on the maximum capacitor surface temperature measured during the Temperature Test, Section 50 and the Electrical Defrost Test, Section 51, but not less than 185ºF (85ºC);

e) Lower category temperature – Based on the minimum surface temperature for which the capacitor has been designed to operate when installed within a unit cooler as intended, but not greater than 14ºF (-10ºC).

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

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

19.7 In reference to 19.5, a capacitor shall consist of a single Class Y1 capacitor or two Class Y2 capacitors connected in series if it is connected between:

a) Two line conductors in a primary circuit;

b) One line conductor and the neutral conductor;

c) Primary and accessible secondary circuits; or

d) The primary circuit and protective earth (equipment grounding conductor connection).

20 Current-Carrying Parts

20.1 All current-carrying parts of a unit cooler shall be of silver, copper, a copper alloy, or other material acceptable for use as an electrical conductor.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not be inherently resistant to corrosion.

20.2 Aluminum may be used as a current-carrying part if investigated and found to be treated to resist oxidation and corrosion.

20.3 Ferrous metal parts, if provided with a corrosion resistant coating, or stainless steel may be used for a current-carrying part:

a) If permitted in accordance with 2.1.1, or

b) If within a motor, but the use of ferrous materials not inherently protected or provided with a corrosion resistant coating for current-carrying parts elsewhere in the unit cooler is not acceptable.

21 Electric Defrost Heaters

21.1 Heater elements

21.1.1 An electric defrost heater shall be an encased assembly constructed of materials which will not be damaged by the temperature to which they will be subjected in the unit cooler.

21.1.2 A sheath heating element shall be constructed of corrosion resistant material or shall be plated, dipped, or coated to resist external corrosion, and shall be capable of being used at the temperatures to which it is subjected. See 21.1.3.

21.1.3 Uncoated copper tubing may be employed 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 considered acceptable as a heater sheath. Plated steel tubing may be employed if the coating is determined to be corrosion resistant and will withstand the temperatures to which it may be subjected. Aluminum tubing may be employed if the alloy withstands a burnout test without melting or other failure. Stainless steel tubing of the austenitic grades such as ASTM Type 304 is generally acceptable for defrost heater sheaths.

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

21.1.5 An insulating material(s) employed in a heating element shall provide direct support to the live parts. Materials such as magnesium oxide that are used in conjunction with other insulating materials shall be located and protected so that mechanical damage is prevented. An insulating material shall have the mechanical strength, dielectric strength, insulation resistance (see 64.1.1 – 64.1.3), and heat and moisture resistant qualities, for the degree to which it is enclosed or protected. All of these factors are to be evaluated, with respect to thermal aging.

21.1.6 To comply with 21.1.1, a heater case or a terminal seal of rubber, neoprene, or thermoplastic materials shall have suitable aging properties for temperatures measured during heating tests. See Accelerated Aging Test – Electric Heaters, Section 62.

21.1.7 An electric heater assembly shall be sealed against entrance of moisture. See Insulation Resistance Test, Section 64. Molded seal caps vulcanized to the heater leads and heater sheath shall have a wall thickness equivalent to that required for the heater leads.

21.2 Heater temperature limiting control

21.2.1 If malfunctioning of a defrost cycle control could result in the risk of fire, electric defrost heaters shall be provided with a thermal protective device or a replaceable thermal cutoff. See Burnout Test, Section 57. Thermal cutoffs shall comply with the requirements in the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

21.2.2 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 21.2.3.

21.2.3 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 the cutoff itself or to a heating element assembly on which the cutoff is mounted.

22 Insulating Material

22.1 Insulating materials shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, or shall comply with 22.2 – 22.4.

22.2 Material for the mounting of uninsulated live parts shall be porcelain, phenolic composition, or other material with consideration given to its electrical and mechanical properties.

22.3 When polymeric materials are used for the direct support of uninsulated live parts, the polymeric material shall have the mechanical strength and rigidity, resistance to heat, resistance to flame propagation, dielectric withstand, and the other properties required for the application. These properties are to be considered with respect to thermal aging.

22.4 Vulcanized fiber shall not be used for the direct support of uninsulated live parts when there is a risk of shrinkage or warpage that would reduce electrical spacings.

23 Motors

23.1 Motors shall comply with the Standard for Rotating Electrical Machines - General Requirements, UL 1004-1.

23.2 Motors having openings in the enclosure or frame shall be arranged to prevent particles from falling out of the motor onto flammable material within or under the assembly.

23.3 In reference to 23.2, equipment shall use a barrier of nonflammable material underneath an open-type motor unless :

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

b) The motor protective overload device provided with an open-type motor is such that no burning insulation or molten material falls to the surface that supports the unit cooler 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,

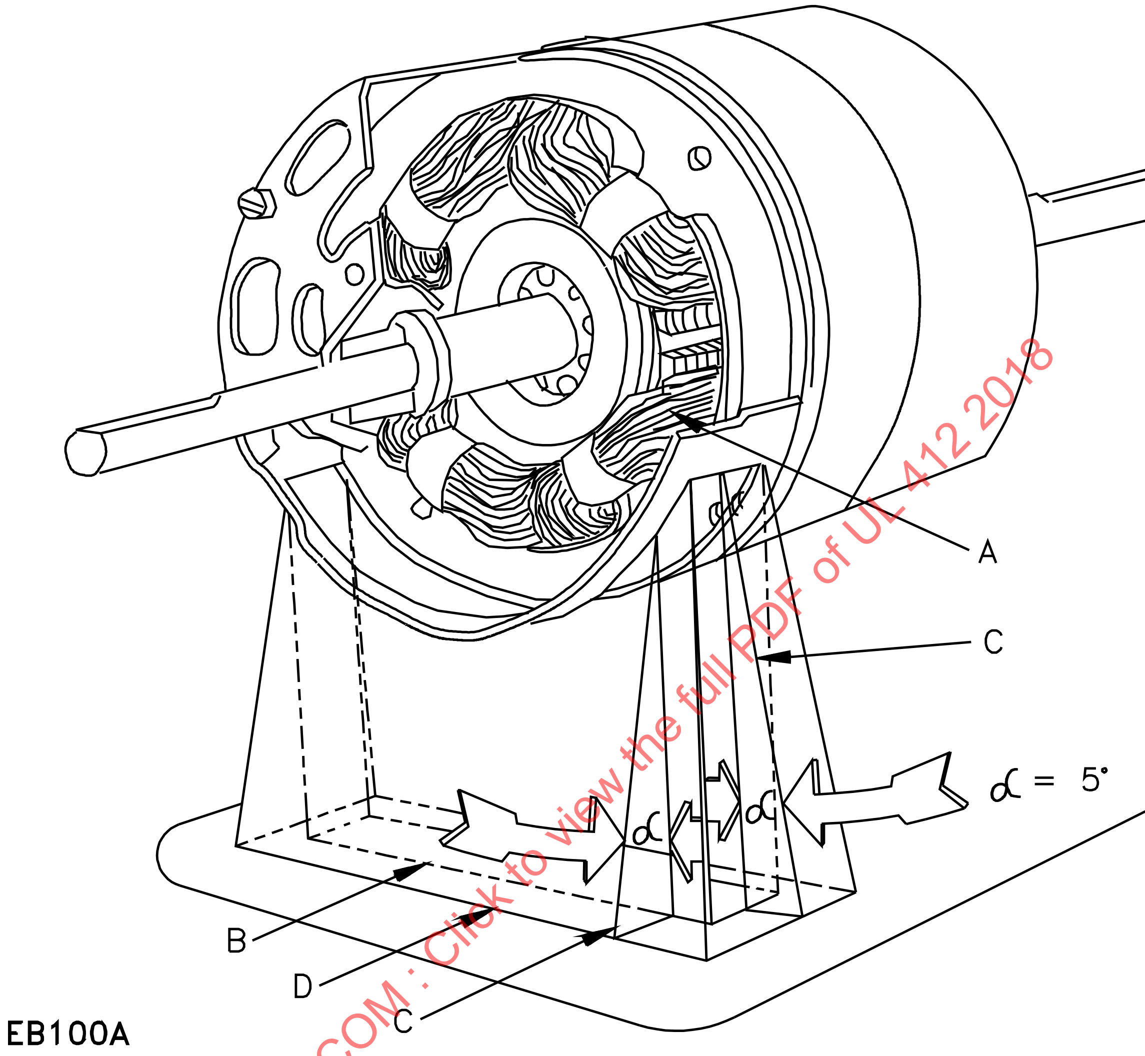
3) Starting switch short-circuited,

4) Capacitor shorted (permanent-split capacitor type); or

c) The open-type 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 becoming more than 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from becoming more than 150°C (302°F) with the rotor of the motor locked.

23.4 The barrier mentioned in 23.3 shall be horizontal, shall be located as indicated in Figure 23.1, 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 on flammable material.

Figure 23.1
Location and extent of barrier



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:

a) Tangent to the motor winding,

b) Five degrees from the vertical, and

c) 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.

24 Motor Overload Protection

24.1 General

24.1.1 A fuse shall not be used as a motor protective device unless the motor is protected by the largest size fuse that can be inserted into the fuseholder.

24.1.2 Equipment shall start and operate as intended when a fuse or circuit breaker provides the required motor protection.

24.1.3 Overcurrent protective devices 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 61.

24.2 Protection of single-phase motors

24.2.1 All single-phase motors shall be protected by one or more of the following:

a) A separate device responsive to motor current and rated or set to trip at not more than the percentage of the motor nameplate full-load current rating as specified in Table 24.1.

b) A separate overload device which combines the functions of overload and overcurrent protection and is responsive to motor current. Such a device shall be set at values not greater than the percentages of the motor nameplate full-load current rating as specified in Table 24.1.

c) *Deleted*

d) Impedance protection complying with the Standard for Impedance Protected Motors, UL 1004-2.

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

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

g) Protective electronic circuits that comply with 24.2.3.

h) Other protection that is shown by test to be equivalent to the protection specified in (a) to (g).

Exception: Overload protection of a single-speed, continuous duty fan motor having a marked rating over 746 W output (1 hp) is not required as part of the unit cooler if all of the following conditions exist:

a) The motor is located where it is not affected by an external source of heat;

b) The motor is to be field-wired to a separate circuit that does not supply any other loads within the product;

c) The motor overload protection is part of separate, field-provided motor control equipment that does not require wiring interconnection to the product, except for the motor circuit;

d) Energization of electric heating elements does not occur without motor operation or evidence of air flow; and

e) The unit is marked as specified in 76.9.

Table 24.1
Overload relay size

Motor nameplate marking	Maximum percentage protection	
	A	B
Motor with marked service factor no less than 1.15	125	140
Motor with marked temperature rise no more than 40°C (72°F)	125	140
Any other motor	115	130

24.2.2 In reference to 24.2.1 (a) and (b), if the percentage protection specified in Column A of Table 24.1 does not correspond to the percentage value of an overload device of a standard size, the device of the next higher size may be used. However, the device of the next higher size shall provide protection no higher than that indicated in Column B of Table 24.1

24.2.3 Except as indicated in 24.2.1 ~~(c) and~~(f), a protective electronic circuit providing motor protection shall comply with one of the following:

a) *Deleted*

b) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 as well as the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9;

c) 25.21 and the protective electronic circuits tests in Section 70A; or

d) Not create any risk of fire, electric shock or injury to persons under abnormal conditions with the protective electronic circuit rendered ineffective (open or short-circuited), e.g. use of a redundant circuit or control.

24.2.4 With reference to 24.2.3, the factors outlined in Table 24.2 shall be considered when evaluating a protective electronic circuit.

Table 24.2
Factors to be considered when evaluating protective electronic circuits

No.	Factor
1	Conducting failure-mode and effect analysis (FMEA) for the protective circuits and functions.
2	Electrical supervision of critical components resulting in the control becoming permanently inoperative and disconnecting power.
3	Temperature ranges as follows: minus 35.0 ±2°C (minus 31.0 ±3.6°F) and 40.0 ±2°C (104 ±3.6°F)
4	Cycling test duration: 14 days
5	Endurance test duration: 100,000 cycles
6	Radio-frequency electromagnetic field immunity: A. To conducted disturbances – test level 3 B. To radiated electromagnetic fields – Evaluate in accordance with 70A.3.4 and 70A.3.2
7	Humidity exposure: 21.1 – 26.7°C (70 – 80°F) and minimum 98 percent relative humidity
8	Electrical fast transient/burst immunity: test level 4
9	Surge immunity: installation Class 4
10	Electrostatic Discharge with a Severity Level of 3 having contact discharge at 6 kV to accessible metal parts and Air discharge at 8 kV to accessible parts of insulating material
11	Voltage Dips and Interruptions: Evaluate in accordance with 70A.3.8 and 70A.3.2.
12	Harmonics and Interharmonics: Evaluate in accordance with 70A.3.9 and 70A.3.2.
13	Calibration (deviation and drift): Evaluate in accordance with 25.11.5 for a temperature protective control or 25.11.6 for a pressure protective control.

24.2.5 Software in a protective electronic circuit required as part of a motor protective device or system shall comply with one of the following:

a) *Deleted*

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 as well as the specific applicable Part 2 and be software Class B;

c) Annex R of the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 and be software Class B; or

d) Not create any hazard under abnormal conditions with the software rendered ineffective, e.g. use of independent redundant protective devices.

24.3 Protection of three-phase motors

24.3.1 Three-phase motors shall be protected by:

a) Three overcurrent protective devices, of the type, rating and set to trip in accordance with 24.2; or

b) Other protective methods if the methods provide protection under primary single-phase failure conditions. Equipment with such protective methods shall be marked as described in 73.14.

25 Switches and Controllers

25.1 A switch or other control device shall be rated for the load which it controls as determined by the Temperature Test – Cooling Mode, Section 50, and the Electric Defrost Test, Section 51. Items to consider in determining the device rating could include the voltage, current, power factor, control device ambient temperature and other similar parameters. Power factor requirements for each specific load type are specified in 60A.5 (a) – (d).

25.2 A switch or a similar device that controls an inductive load such as a transformer shall have a current rating not less than twice the total current rating of the inductive load that it controls and a voltage rating of 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 not exceeding the ampere rating of the switch at rated voltage.

25.3 A switch, relay, or similar device that controls one or more motors and may also control other loads shall have a horsepower or equivalent locked rotor ampere rating not less than that of the motor being controlled plus the full load ampere ratings for any other controlled loads.

Exception: The following devices are not required to have a horsepower or equivalent locked rotor ampere rating:

a) A switch, relay or other similar device, if the only load controlled by the device is a clock-motor.

b) An ac general-use snap switch, if the motor load being controlled does not exceed 80 percent of the ampere rating of the switch at its rated voltage.

25.3.1 As an alternative to complying with 25.1 – 25.3, a switch or other similar controlling device shall comply with the Overload and Endurance Test – Switching Devices, Section 60A.

25.4 A switching device that interrupts the main power supply circuit to a heater of a unit cooler shall be such that, when open, the device will disconnect all ungrounded conductors of the power supply circuit if the switching device itself or the pilot device that controls the switching device has a marked ON or OFF position (the use of the international symbols “ | ” or “O” may be used).

25.5 A single-pole switching device shall not be connected to the identified (grounded) conductor.

Exception: An automatic control which does not have a marked OFF position need not comply with this requirement.

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

25.7 If operation of an electric defrost heater(s) is terminated by a clock-operated switch, the unit cooler shall be marked in accordance with 76.8 unless:

a) The switch is provided as an integral part of the unit cooler, or

b) The unit cooler complies with the Electric Defrost Test, Section 51, without the switch.

25.8 A defrost cycle control may control the defrost heaters directly or through other switching devices. The switching devices need not be provided with the unit cooler.

25.9 A temperature-limiting control that is required to reduce the risk of fire in the unit cooler (see the electric heater defrost requirements contained in the Burnout Test, Section 57) shall be an integral part of the unit cooler and shall:

a) Control the defrost heater(s) directly, or

b) Control the defrost heater(s) indirectly through a switching device that is also an integral part of the unit cooler. The switching device shall comply with the endurance test requirements for temperature limiting controls [see 56.1.2(b) or (c)].

25.10 Defrost cycle and temperature-limiting controls for an electric defrost heater or any other protective controls except for motor protective controls shall comply with one of the following:

a) *Deleted*

b) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

c) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6.

d) *Deleted*

e) Standard for Switches for Appliances – Part 1 General Requirements, UL 61058-1.

f) Standard for Clock-Operated Switches, UL 917.

g) Standard for Industrial Control Equipment, UL 508.

h) 25.21 and the protective electronic circuits tests in Section 70A.

25.11 A protective control other than a motor-protective control shall comply with the endurance test in 56.1 and the calibration test in 56.2 as required for each type of control. These tests may be conducted during the testing of each control in accordance with 25.10.

25.11.1 In reference to 25.10 (b), (c), (e), and (h), when determining the acceptability of a protective control, the control pollution degree shall be as specified in 40A.3 (a) – (d). If the protective control:

a) Has a protective electronic circuit, the factors in Table 24.2 shall be considered; and,

b) Uses software as a required part of the protective electronic circuit, the software shall comply with 24.2.5 (b) or (c).

25.11.2 In reference to 25.10 and 25.11, a device providing motor overload protection shall comply with the requirements in Section 24.

25.11.3 Protective controls other than those referenced in 24.2.1(a), 24.2.1(b) and 25.9(b) shall:

a) Be an integral part of the appliance;

b) Control the load(s) directly other than as specified in 25.11.4; and

c) Comply with the endurance cycle requirements as specified for temperature-limiting controls in 56.1.2 (b) or (c).

25.11.4 In reference to 25.11.3(b), if a protective control indirectly controls the load through a switching device, the switching device shall be an integral part of the appliance and comply with the endurance cycle requirements specified for temperature-limiting controls in 56.1.2 (b) or (c).

25.11.5 The cutout calibration temperature of a heater protective (temperature-limiting) or defrost cycle control shall be ±10°F (±6°C) of its maximum marked set-point temperature.

25.11.6 The cutout calibration pressure of a pressure protective control (pressure-limiting device) shall not exceed 105 percent of its maximum marked setting.

25.12 A switch or control provided as an interlock or interlocking mechanism shall comply with 25.10, 25.11.1, 25.11.3, and 25.11.4.

25.12.1 Appendix B, Operating and Protective (″Safety Critical″) Control Functions, shall be referenced to determine whether a control function is considered to result in a risk of fire, electrical shock or injury to persons.

25.13 Female devices (such as receptacles, appliance couplers, and connectors) that are intended, or that may be used, to interrupt current, shall be rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

25.14 Except as specified in 25.16, an operating control, including of the electronic type, shall comply with:

a) One of the standards specified in 25.10 (a) – (g);

b) The requirements in this Standard as far as they reasonably apply; or

c) One of the following standards:

1) Standard for Solid-State Controls for Appliances, UL 244A

2) Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the applicable Part 2 standard from the UL 60730 series; or

3) Standard for Power Conversion Equipment, UL 508C.

25.15 A general-use snap switch shall comply with the Standard for General-Use Snap Switches, UL 20.

25.16 An operating control not complying with 25.14:

a) Shall be powered entirely by no more than one extra-low-voltage circuit; comply with the Limiting Impedance Test in the Standard for Industrial Control Equipment, UL 508; or comply with the low-power test requirement determined as specified in Clause 19.11.1 of the Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1; and

b) if used to control a motor-compressor, shall comply with the endurance cycle requirements in 56.1.2(a).

25.17 An operating control that complies with 25.14 shall also comply with the following:

a) For electronic controls – Installation Class 2 for electromagnetic Compatibility (EMC) shall be in accordance with the voltage surge testing in 70A.3.6 and comply with the results specified in 70A.3.2;

b) Category II shall be the overvoltage category;

c) Insulating materials shall have a minimum comparative tracking index (CTI) of 100 (Material Group III);

d) The applicable pollution degree shall be as specified in 40A.3 (a) – (d); and,

e) The endurance cycle requirements specified by either:

1) Table CC.2 of the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the operating control (limiters) endurance cycle requirements being applied; or,

2) The Overload and Endurance Test – Switching Devices, Section 60A.

25.18 If an operating control complying with 25.14 indirectly controls a load through a switching device, the switching device endurance cycle requirements shall be as specified in:

a) 56.1.2(a) if the switching device controls a motor-compressor; or

b) 25.17(e) if the switching device controls a load other than a motor-compressor.

25.18.1 If an operating control referenced by 25.16 indirectly controls a motor-compressor through a switching device, the switching device endurance cycle requirements shall comply with 56.1.2(a).

25.19 If a control can be used to reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the appliance, but a redundant control (of similar or different design) operates to perform the identical function, the circuit shall be evaluated to determine which control will be relied upon as the protective control. The control determined to be the protective control shall comply with the protective control requirements in 25.10. The control determined to be the operating control is not required to comply with the protective control requirements but shall comply with the operating control requirements in 25.16 or with 25.14 and 25.17.

25.20 A thermistor shall comply with Annex J of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 or the Standard for Thermistor-Type Devices, UL 1434. The calibration shall be as specified in 25.11.5. If a thermistor is used:

a) To reduce the risk of fire, electric shock or injury to persons under abnormal operating conditions of the appliance, the minimum number of endurance cycles shall be 100,000.

b) In other sensing applications of the appliance, the minimum number of endurance cycles shall be 6,000.

25.21 A protective control as referenced in 24.2.3(c) or 25.10(h) and having a protective electronic circuit:

a) In which electronic disconnection of the circuit could fail, shall have at least two components whose combined operation provides the load disconnection;

b) Shall prevent a risk of fire, electric shock or injury to persons under the relevant fault conditions specified in Section 70A.2;

c) In which an overcurrent protective device opens during application of any of the fault conditions specified in 70A.2, shall utilize an overcurrent protective device complying with the requirements applicable to that component. The fault condition causing the overcurrent protective device to open shall be repeated and the overcurrent protective device shall again open the protective electronic circuit. If the overcurrent protective device complies with Standard for Miniature Fuses: Part 1, Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links, IEC 60127-1 as well as an applicable Part 2, then the protective device shall additionally comply with the Fuse-Link Test in Section 70A.5;

d) In which a conductor of the printed wiring board becomes open-circuited during the fault conditions test in 70A.2, then:

1) The printed wiring board shall comply with the Needle-Flame Test in Annex E of Standard for Safety of Household and Similar Electrical Appliances, Part 1: General Requirements, UL 60335-1 or have a minimum flammability rating of V-0 when tested in accordance with the vertical flame test described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;

2) Any loosened conductor shall not reduce spacings below the values specified in the relevant Sections 39 – 40A; and

3) The specific test in which the printed wiring became open-circuited shall be repeated a second time. There shall be no risk of fire, electric shock or injury to persons and spacings shall not be reduced below the values specified in the relevant Sections 39 – 40A;

e) Shall maintain its required functions when subjected to the EMC related stresses specified in the Electromagnetic Compatibility (EMC) Tests, Section 70A.3; and,

f) That relies upon a programmable component for one or more of its safety functions shall be subjected to the Programmable Component Reduced Supply Voltage Test, Section 70A.4, unless restarting at any point in the operating cycle after interruption of operation due to a supply voltage dip will not result in a risk of fire, electric shock or injury to persons. The test shall be carried out after removal of all batteries and other components intended to maintain the programmable component supply voltage during supply source (mains) voltage dips, interruptions and variations.

25A Remotely Operated Unit Coolers

25A.1 Any unit cooler function enabled in response to wireless external communication or data signals shall be considered when determining normal and abnormal conditions of the unit cooler.

25A.2 Except as specified in 25A.3, a manual control shall be provided on a unit cooler such that actuation of the control is required before the unit cooler can be operated in any mode that permits remote operation, external communication or receiving/sending data signals.

25A.3 In reference to 25A.2, a unit cooler not provided with a manual control for actuating remote operation, external communication or receiving/sending data signals shall be:

a) Capable of remote operation, external communication or receiving/sending data signals only within line-of-sight; or,

b) Limited only to monitoring external communication or data signals.

25A.4 A unit cooler shall include a means to manually disconnect, disable or override any remote operation commands, external communication or data signals.

25A.5 A control that operates in response to remote operation commands, external communication or data signals shall not introduce an operating condition or state that could lead to a risk of fire, electric shock or injury to persons. In addition, such a control shall not:

a) Render inoperative any protective control or protective control function within the unit cooler;

b) Alter the order of control response such as by forcing a protective control to operate instead of another control that would normally be intended to respond;

c) Reset any protective manual reset feature;

d) Supersede the response of any protective control; or

e) Alter the response to or expected performance of:

1) User actuation of controls, movement of doors, covers, grills, filters or the like; or

No Text on This Page

2) User interaction with any parts of the unit cooler that could result in exposure of hazardous electrical parts, moving parts, hot parts or radiation.

25A.6 Compliance with 25A.5 shall be determined by one of the following:

a) Using methods appropriate for determining the performance and reliability of protective control functions in accordance with Section 25; or

b) Examining the unit cooler circuit diagram(s) to determine that a control which operates in response to remote operation commands, external communication or data signals operates wholly independent of the unit cooler protective controls and therefore is incapable of adversely affecting the operation of any protective controls.

26 Transformers

26.1 A power transformer shall:

a) Comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1;

b) Comply with the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2; and

c) have a secondary rating not less than the connected load, except the load may be greater than the marked rating if the transformer does not exceed the maximum allowable temperature during the Temperature Test – Cooling Mode, Section 50 and the Electric Defrost Test, Section 51.

26.2 The primary circuit of a power transformer which supplies a motor load shall be protected by an overcurrent device rated or set at not more than 250 percent of the full-load primary current of the transformer.

Exception: The power transformer is not required to be protected by an overcurrent device if there is no manifestation of fire in the event the motor locks or fails to start.

26.3 A transformer that directly supplies a National Electrical Code, NFPA 70, Class 2 circuit shall, in accordance with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3, either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer).

27 Valves and Solenoids

27.1 The coil of an electrically operated valve or solenoid shall not overheat when the unit cooler is subjected to the Temperature Test – Cooling Mode, Section 50, and the Electric Defrost Test, Section 51.

27.2 An electrically operated valve or solenoid shall comply with the Standard for Electrically Operated Valves, UL 429 or comply with 27.3 and the other components requirements contained in the Burnout Test, Section 57.

27.3 Coil windings of electrically operated valves or solenoids shall be impregnated, dipped, varnished, or otherwise treated to resist absorption of moisture.

28 Circuit Breakers, Fusing Resistors and Supplementary Protectors

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

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

28.3 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

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

28.5 A fusing resistor or supplementary protector shall not be used in place of a circuit breaker or protective control.

29 Connectors, Receptacles and Terminals

29.1 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977.

29.2 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B.

29.3 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

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

29.5 Quick-connect terminals shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

30 Electrical Cable, Conduit and Tubing

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

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

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

31 Electrical Insulation Systems

31.1 Film-coated wire or materials used in an insulation system that operates at or above Class 105 (Class A) shall comply with the Standard for Systems of Insulating Materials – General, UL 1446. The requirements for film-coated wire or materials used in insulation systems that operate below Class 105 (Class A) are unspecified.

31.2 Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510.

31.3 Insulating sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441.

31.4 Insulating tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

32 Electromagnetic Interference Filters

32.1 Electromagnetic interference filters shall comply with:

a) Standard for Electromagnetic Interference Filters, UL 1283; or

b) Standard for Passive Filter Units for Electromagnetic Interference Suppression – Part 3: Passive Filter Units for Which Safety Tests are Appropriate, UL 60939-3.

33 Fuses and Fuseholders

33.1 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, in conjunction with any of the associated standards tabulated below, as applicable for the class of fuse:

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

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

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

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

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

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

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

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

i) The Outline of Investigation for Low-Voltage Fuses – Part 17: Class CF Fuses, UL 248-17.

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

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

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

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

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

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

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

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

i) The Outline of Investigation for Fuseholders – Part 17: Class CF Fuseholders, UL 4248-17.

33.3 A plug fuseholder in a unit cooler intended to be connected to a 125 or a 125/250 volt, 3-wire circuit shall be wired in the unidentified (ungrounded) conductor with the screw shell connected toward the load.

34 Lighting Systems

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

34.2 Lighting ballasts shall comply with one of the following:

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

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

34.3 Light Emitting Diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use in Lighting Products, UL 8750.

35 Optical Isolators and Semiconductor Devices

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

a) Primary and secondary circuits;

b) Extra-low-voltage safety circuits; or

c) Other high-voltage circuits.

35.1.1 In addition to complying with 35.1, an optical isolator relied upon to provide feedback between primary and secondary circuits of a switch mode power supply unit shall have a minimum isolation voltage of 1500V.

35.2 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. If the switching semiconductor is used as part of a switch mode power supply unit, it shall have a minimum isolation voltage of 1500V.

36 Outlet Boxes

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

37 Power Supplies

37.1 A power supply shall comply with one of the following:

a) For a Class 2 Power Supply:

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

2) Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 and with the Class 2 or limited power source requirements.

b) For a power supply that is other than Class 2:

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

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

c) For a switch mode power supply unit not complying with (a) or (b), the relevant requirements in this Standard, including the Switch Mode Power Supply Units – Overload Test, Section 61A, shall be applied.

37.2 *Deleted*

38 Terminal Blocks

38.1 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059. A terminal block intended for field wiring shall comply with the requirements in UL 1059 that are applicable to field wiring.

38.2 Power distribution blocks shall comply with the Outline of Investigation for Power Distribution Blocks, UL 1953.

38.3 In reference to 38.1, if a fabricated part performs the function of a terminal block, the part shall comply with Terminals, Section 15.2, Current-carrying parts, Section 20, Insulating material, Section 22, and the spacing requirements in High-voltage circuit spacings, Section 39, or Extra-low voltage circuit spacings, Section 40.

38A Information Technology Equipment

38A.1 Information technology equipment such as a printer, visual display unit, router, communication connectors/data ports or computer shall comply with the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

SPACINGS

39 High-Voltage Circuits

39.1 The following electrical spacing requirements apply to high-voltage circuits, as defined in 3.7(b).

39.2 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 39.1.

Table 39.1
Electrical spacings in refrigerated and/or air-handling compartments

Ratings		Minimum spacing					
		Through air[a]		Over surface[a]		To outer enclosure or cabinet[c]	
Volt-Amperes	Volts	inches	(mm)	inches	(mm)	inches	(mm)
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)

Table 39.1 Continued on Next Page

Table 39.1 Continued

Ratings		Minimum spacing					
		Through air[a]		Over surface[a]		To outer enclosure or cabinet[c]	
Volt-Amperes	Volts	inches	(mm)	inches	(mm)	inches	(mm)

[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 be not 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.

39.3 The ″Through Air″ and ″Over Surface″ spacings given in Tables 39.1 and 39.2 as measured at an individual component part are to be based on the total volt-ampere consumption of the load or loads which the component controls. For example, the spacings at a component which controls only the compressor motor are based on the volt-amperes of the compressor motor. The spacings at a component which controls loads in addition to the compressor motor are based on the sum of the volt-amperes of the loads so controlled, except that spacings at a component which independently controls separate loads are based on the volt-amperes of the larger load. The volt-ampere values for the loads referred to above are to be determined by the marked rating of the load, except that for loads which are not required to have a marked rating, the measured input is to be used in determining the volt-ampere values.

39.4 The spacings indicated in Table 39.2 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 39.1 apply.

Table 39.2
Spacings in non-refrigerated and/or non-air handling compartments

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

Note – See 39.4.

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

39.5 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 above and shall be based on the highest voltage involved.

39.6 With reference to 39.2 and 39.3, the "To outer enclosure or cabinet" spacings are not to be applied to an individual enclosure or cabinet of a component part within the outer enclosure or cabinet.

39.7 The electrical clearance resulting from the assembly of the components into the complete machine, including clearance to dead metal, metal enclosures or metal cabinets, shall be those indicated.

39.8 If higher than rated potential is developed in a motor circuit through the use of capacitors, the rated voltage of the system shall be employed in applying the spacings indicated in this section.

Exception: If developed steady-state potential as determined in the Temperature Test – Cooling Mode, Section 50, exceeds 500 volts; in which case, the developed potential is to be used in determining the spacings for the parts affected.

39.9 An insulating lining or barrier of fiber or similar material, employed where spacings would otherwise be less than the required values, shall be no less than 0.028 inch (0.7 mm) in thickness and shall be so located or of such material that it will not be adversely affected by arcing.

Exception No. 1: Fiber no less than 0.013 inch (0.3 mm) thick may be used in conjunction with an air spacing of no less than 50 percent of the spacing required for air alone.

Exception No. 2: Material having a lesser thickness may be used if it has equivalent insulating, mechanical, and flammability properties when compared with materials in thicknesses specified above.

39.10 The spacing between uninsulated live terminals of the components in an electric-discharge lamp circuit and a dead metal part, metal enclosure or cabinet shall not be 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.

40 Extra-Low Voltage Circuits

40.1 The following electrical spacing requirements apply to extra-low-voltage circuits, as defined in 3.7(a).

40.2 A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not an extra-low-voltage circuit.

40.3 The spacings for extra-low-voltage electrical components which are installed in a circuit which includes a motor overload protective device or other protective device where a short or grounded circuit may result in a risk of fire or electrical shock shall comply with the following:

a) The spacing between an uninsulated live part and the wall of a metal enclosure or metal cabinet, 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 a metal enclosure or cabinet and fittings for the connection of conduit which is not prohibited from being 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 a metal enclosure or cabinet which is not prohibited from being grounded when the device is installed, shall be not less than 1/32 inch (0.8 mm) provided that the construction of the parts is such that spacings will be maintained.

40.4 The spacings in extra-low voltage circuits which do not contain devices such as indicated in the previous paragraphs are not specified.

40A Alternate Spacings – Clearances and Creepage Distances

40A.1 Other than as specified in 40A.2, the spacings requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, are applicable as an alternative to the specified spacings requirements in the following:

a) High-Voltage Circuits, Section 39; and

b) Extra-Low Voltage Circuits, Section 40.

40A.2 The spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, shall not be used for spacings between field wiring terminals or between uninsulated live parts and a metal enclosure.

40A.3 The items specified in (a) – (f) shall be considered when evaluating a refrigeration unit cooler to the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840:

a) Hermetically sealed or encapsulated enclosures are identified as pollution degree 1.

b) Coated printed wiring boards are identified as pollution degree 1 if they comply with one of the following:

1) The Printed Wiring Board Coating Performance Test in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840; or

2) Conformal coating requirements as outlined in the Standard for Polymeric Materials – Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring Boards, UL 746E.

c) Indoor use unit coolers are identified as pollution degree 2.

d) Outdoor use unit coolers are identified as pollution degree 3.

e) Category II is the overvoltage category.

f) Printed wiring boards are considered as having a minimum comparative tracking index (CTI) of 100 unless further investigated for a higher CTI index.

40A.4 Clearance B (Controlled Overvoltage) clearances as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, shall be achieved by providing an overvoltage device or system as an integral part of the unit cooler.

REFRIGERATION SYSTEM

41 Refrigerant

41.1 The kind of refrigerant intended for use with the unit cooler shall:

a) Have flammability characteristics that have been evaluated in accordance with the Standard for Refrigerants, UL 2182; or,

b) Be subjected to a compositional analysis to confirm a composition consistent with a refrigerant specified in the Standard for Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34.

41.2 In reference to 41.1(b), the chemical composition of the refrigerant, including the nominal composition (types and percentages) of a blended refrigerant, shall be determined by analytical testing in accordance with 70B using:

a) Infrared analysis for single component refrigerants; or

b) Gas chromatography for blended refrigerants.

42 Refrigerant Tubing and Fittings

42.1 The wall thickness of aluminum, copper or steel tubing including capillary used to connect refrigerant-containing components shall not be less than indicated in Table 42.1.

Exception No. 1: Copper or steel capillary tubing that is protected against mechanical damage by the cabinet or assembly shall have a wall thickness not less than 0.020 inch (0.51 mm).

Exception No. 2: Special alloys used for refrigerant-containing component tubing shall be evaluated for their:

a) Resistance to mechanical abuse,

b) Strength against internal pressure,

c) Resistance to corrosion,

d) Protection against refrigerant contamination, and

e) Conformity with the requirements in the Safety Standard for Refrigeration Systems, ASHRAE Standard 15, as compared to tubing of the minimum wall thickness indicated in Table 42.1.

Table 42.1
Minimum wall thickness for aluminum, copper, and steel tubing

Outside diameter		Copper				Steel		Aluminum	
		Protected[a]		Unprotected		Protected or unprotected		Protected or unprotected	
Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
1/4	(6.4)	0.0245	(0.622)	0.0265	0.673	0.025	(0.64)	0.0350	(0.89)
5/16	(7.9)	0.0245	(0.622)	0.0265	0.673	0.025	(0.64)	0.0350	(0.89)
3/8	(9.5)	0.0245	0.622)	0.0265	(0.673)	0.025	(0.64)	0.0350	(0.89)
1/2	(12.7)	0.0245	(0.622)	0.0265	0.724	0.025	(0.64)	0.0350	(0.89)
5/8	(15.9)	0.0315	(0.800)	0.0315	0.800	0.032	(0.81)	0.0488	(1.24)
3/4	(19.1)	0.0315	(0.800)	0.0385	0.978	0.032	(0.81)	0.0488	(1.24)
7/8	(22.2)	0.0410	(1.041)	0.0410	1.041	0.046	(1.17)	0.0650	(1.65)
1	(25.4)	0.0460	(1.168)	0.0460	1.168	–	–	0.7200	(1.83)
1-1/8	(28.6)	0.0460	(1.168)	0.0460	1.168	0.046	(1.17)	–	–
1-1/4	(31.8)	0.0505	(1.283)	0.0505	1.283	0.046	(1.17)	–	–
1-3/8	(34.9)	0.0505	(1.283)	0.0505	1.283	–	–	–	–
1-1/2	(38.1)	0.0555	(1.410)	0.0555	1.410	0.062	(1.57)	–	–
1-5/8	(41.3)	0.0555	(1.410)	0.0555	1.410	–	–	–	–
2-1/8	(54.0)	0.0640	(1.626)	0.0640	1.626	–	–	–	–
2-5/8	(66.7)	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.

[a] Within the unit cooler.

42.2 Tubing shall be constructed of corrosion resistant material, such as copper, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion. Aluminum is not prohibited from being used where the material is not subject to galvanic corrosion. Copper or brass tubing shall not be used to handle R717 (ammonia).

42.3 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 conform to the Standard for Refrigeration Tube Fittings – General Specifications, SAE J513.

Exception: Joints in tubing intended to handle R717 (ammonia) shall be brazed or welded.

43 Refrigerant-Containing Parts

43.1 Parts of a unit cooler subjected to refrigerant pressure shall withstand, without failure, the pressure indicated in the Strength Tests – Pressure Containing Components, Section 65, or shall comply with the Standard for Refrigerant-Containing Components and Accessories, Nonelectrical, UL 207.

43.2 Parts of a unit cooler subjected to refrigerant pressure shall be constructed of corrosion resistant material, such as copper or stainless steel, or shall be plated, dipped, coated, or otherwise treated to resist external corrosion.

43.3 Copper or brass shall not be used in parts intended for use with ammonia (R717).

43.4 Magnesium alloys shall not be used in parts intended to handle any of the halogenated refrigerants.

43.5 A pressure vessel that contains liquid refrigerant and is over 3 inches (76 mm) inside diameter but does not exceed 3 cubic feet (0.085 m^3) internal gross volume, shall have a pressure-relief device or fusible plug.

43.6 A pressure vessel that contains liquid refrigerant, exceeding 3 cubic feet (0.085 m^3), and has less than 10 cubic feet (0.283 m^3) internal gross volume, shall have a pressure-relief device.

43.7 A pressure vessel of 10 cubic feet (0.283 m^3) internal gross volume or larger, other than an evaporator, which contains liquid refrigerant, shall be protected by a relief system consisting of a pressure-relief valve in parallel with a second pressure-relief valve, or shall have provisions, such as a fitting(s), for the installation of such a system. Each relief valve shall have a discharge capacity as determined by 44.1. See 43.8 and 43.9.

43.8 A single pressure-relief valve, or a fitting for its installation, shall not be on a pressure vessel having an internal gross volume of 10 cubic feet (0.0283 m^3) or more.

Exception: The vessel is intended to be used in a system where the pressure-relief valve is to discharge into the low side of the refrigeration system, and the valve is of a type not adversely affected by back pressure.

43.9 A pressure vessel intended to be used as an evaporator or part of an evaporator and having an inside diameter between 3 – 6 inches (76 – 152 mm) inclusive shall have a pressure-relief device or fusible plug.

43.10 A pressure vessel intended to be used as an evaporator or part of an evaporator and having an inside diameter greater than 6 inches (152 mm) shall have a pressure-relief device.

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

Exception: When parallel relief devices are so arranged that only one is rendered inoperative at a time for testing or repair purposes.

43.12 A pressure-relief device shall:

a) Be connected as close as possible to the pressure vessel or part of the system that it is intended to protect;

b) Be installed so that it is accessible for inspection and repair, and cannot be rendered inoperative so that it will not perform its intended function; and

c) Have its discharge opening located and directed so that:

1) Operation of the device does not deposit moisture on bare live parts or on insulation or components detrimentally affected by moisture, and

2) The risk of scalding persons is reduced.

43.13 Unit coolers intended to utilize carbon dioxide (R744) in a secondary loop or a cascade system shall be protected by the following pressure relief devices:

a) A pressure relief valve set to open as indicated in 45.2.

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

43.14 The requirements for a pressure relief device indicated in 43.13 are:

a) Not to be located on the unit cooler.

b) Shall comply with the refrigeration condensing unit requirements in the Standard for Heating and Cooling Equipment, UL 1995, for (R744) in a secondary loop or cascade system.

43.15 Unit coolers intended to utilize carbon dioxide (R744) in a secondary loop or cascade system shall not include a pressure vessel.

44 Required Discharge Capacity

44.1 The minimum required discharge capacity and the rated discharge capacity of a relief valve shall be in accordance with calculations specified in the ASME Boiler and Pressure Vessel Code.

45 Relief Valves

45.1 Pressure-relief valves shall comply with the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII. Valves shall bear the authorized Code ″UV″ symbol together with the set pressure, capacity, and pipe size of the valve inlet.

Exception: For valves of less than nominal 1/2 inch pipe size where the pipe's surface area is not large enough for the code symbol, the code symbol is to be omitted and the set pressure and capacity is to be stamped on the valve or on a metal plate attached to it. Manufacturers of valves which do not bear the code symbol shall provide evidence of certification of the valve and its pressure and capacity rating by proper code authorities.

45.2 Pressure-relief valves shall be set and sealed with a start-to-discharge pressure not exceeding the marked design pressure of the pressure vessel protected.

45.3 The marked discharge capacity of a pressure-relief valve installed on a pressure vessel shall be not less than the minimum required discharge capacity required for that pressure vessel as computed from 44.1.

46 Fusible Plugs or Rupture Members

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

PERFORMANCE

47 General

47.1 Test voltage

47.1.1 Unit coolers are to be tested at 60 hertz (Hz) potentials maintained at the unit cooler supply connections in accordance with Table 47.1.

Exception: Unit coolers rated at frequencies other than 60 Hz shall be tested at their rated voltages and frequencies.

Table 47.1
Test voltages

Name plate voltage rating	Normal test voltage
110 to 120	120
208	208
220 to 240	240
254 to 277	277
440 to 480	480
550 to 600	600
Other	Rated

47.2 Temperature measurements

47.2.1 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 50.2. The thermocouples are to consist of 24 – 30 AWG (0.21 – 0.05 mm^2) wires. The thermocouples and related instruments are to be accurate and calibrated. The thermocouple wire is to conform to the requirements for ″special tolerance thermocouples″ as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

47.2.2 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.

47.2.3 If the thermocouple are used in the determination of temperatures in connection with the heating of electrical equipment, it is a standard practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer type of indicating instrument. This equipment will be used whenever referee temperature measurements by means of thermocouples are necessary.

47.2.4 Except as specified in 47.2.5, during any test in which temperatures are measured, temperatures are to be monitored until maximum temperatures are attained. Thermal equilibrium is to be considered to exist when three successive readings indicate the same or decreasing temperatures. Readings are to be taken at the end of not less than three consecutive periods, the duration of each period is to be not less than 5 minutes.

47.2.5 In reference to 47.2.4, if temperatures on the component being monitored cycle between higher and lower temperatures due to the component cycling as part of the test (for example a load cycling on and off due to operation of a protective device), equilibrium is to be considered obtained when three successive peak temperatures indicate the same or decreasing temperatures.

47.2.6 In reference to 47.2.4 and 47.2.5, the recorded temperature is to be the highest of the three readings.

48 Tests on Nonmetallic Materials

48.1 Nonmetallic materials are to be evaluated as indicated in Table 48.1.

Table 48.1
Tests on nonmetallic materials – Based on nonmetallic requirements in Nonmetallic Material Classification, Section 8, and Nonmetallic Material - Ignition Source Separation, Section 9

Nonmetallic component	Applicable test number
A part serving as an enclosure for ignition sources.	1[a], 2[a], 3[b], or 4[h], 6, 7[c], 8[d], 9, 10, 11, 12, 13
A part serving as a cabinet.	Minimum 4[h], 6, 7[c], 8[d], 9, 10, 11, 12, 13
A functional part.	Minimum 4[h], 6, 7[c], 8[d], 10, 11, 12
A nonfunctional part.	Minimum 4[h], 9

NOTES

1. 5 inch end product flame test [e].
2. 5V rated material [f].
3. V-0, V-1, V-2, HF-1, HF-2 rated materials [f] 3/4 inch End Product Flame Test[e] or 12 mm End Product Flame Test [e].
4. HB or HBF rated material[f] or a material with a flame spread rating of 25 or less and a smoke developed rating of 50 or less [g].
5. HBF, HF-1, HF-2 rated materials [f].
6. Mold Stress-Relief Test [e].
7. Fastener Strength Test, Section 69.
8. Adhesive Test [e].
9. Radiant Panel or Surface Burning Characteristic Test [g] – A flame spread index (FSI) of not more than 200 applies only to parts forming portions of the external enclosure, or of a decorative part if the total area of the enclosure exceeds 10 ft^2(0.93 m^2).
10. Volume Resistivity Test [e] – Applies only if electrical spacings between uninsulated live parts and the material are less than specified in line-voltage circuits, and extra-low voltage (Class 2) circuits, or if the part is used as indirect support of an uninsulated live part.
11. High Current Arc Ignition Test [e] – Applies only if the material is used to enclose uninsulated live parts or to provide indirect support of uninsulated live parts. The test does not apply if uninsulated live parts are located a minimum of 1/32 inch (0.79 mm) from the part. When the High Current Arc Ignition test is conducted, no ignition shall occur to V-0 materials subjected to 15 arcs; V-1, V-2, or 5V materials subjected to 30 arcs; or to HB materials subjected to 60 arcs.
12. Hot Wire Ignition Test [e] – Applies only if the material is within 1/2 inch (12.7 mm) of electrically-heated wires or resistors. If applicable, ignition shall not occur in less than 10 seconds for V-0 materials; 15 seconds for V-1 or 5V materials; or 30 seconds for V-2 or HB materials.
13. Impact Tests [e] – 5 ft-lb (6.8 J) impact for enclosures containing uninsulated live and hot parts, 1.5 ft-lb (2.0 J) impact for enclosures containing moving parts.

[a] An enclosure provided with a barrier interposed between the material and an ignition source will be tested with the barrier in place.

[b] A material with a V-2 minimum rating is able to be used to enclose an ignition source if the ignition source is only energized as a result of a continuous action by an attending operator.

[c] Applies to an enclosure that serves only to reduce the risk of electric shock and having ultrasonic welds, heat welds, polymeric screws or nuts, metal screws threaded into a polymeric part, or other means where degradation of a polymeric material affects securement.

[d] Applies only if the adhesive is relied on to maintain the integrity of an enclosure or functional part.

[e] Tested or rated as described in Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

[f] Tested or rated as described in Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Table 48.1 Continued on Next Page

Table 48.1 Continued

Nonmetallic component	Applicable test number
[g] Tested or rated as described in Standard Test Method of Surface Flammability of Materials Using a Radiant Heat Energy Source, ASTM E162 or Test for Surface Burning Characteristics of Building Materials, UL 723.	
[h] These materials are able to be used if ignition sources are separated or isolated in accordance with Nonmetallic Material - Ignition Sources Separation, Section 9.	

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49 Input Test

49.1 The measured input to a unit cooler 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 Test – Cooling Mode, Section 50, and the Electric Defrost Test, Section 51.

50 Temperature Test – Cooling Mode

50.1 The temperature rises measured on the electric components and surfaces of a unit cooler shall not exceed those specified in Table 50.1.

Table 50.1
Maximum temperature rises

Device or material	Degrees C	Degrees 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[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)[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		
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 system on coil windings of alternating-current motors having a frame diameter of more than 7 inches (178 mm)		
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 types[c]	40	72
Other types[d]	65	117
2. Field wiring	35	63
3. Relay, solenoid, and other coils (except motor coil windings) with:[b]		
a. Class 105 insulated winding –		

Table 50.1 Continued on Next Page

Table 50.1 Continued

Device or material	Degrees C	Degrees F
Thermocouple method	65	117
Resistance method	85	153
b. Class 130 insulation –		
Thermocouple method	85	153
Resistance method	105	189
4. Solid contacts	65	117
5. Transformer enclosures – with		
a. Class 2 transformers	60	108
b. Power transformers	65	117
6. 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:		
Temperature Rating		
Degrees C / **Degrees F**		
60 / 140	35	63
75 / 167	50	90
80 / 176	55	99
90 / 194	65	117
105 / 221	80	144
D. Surfaces		
1. Surfaces of unit coolers at points of zero clearance to test enclosure	65	117
2. Surfaces of unit coolers contacted by persons in operating it (control knobs, pushbuttons, levers etc.)		
Metal	35	63
Nonmetallic	60	108
3. Surfaces of unit coolers subject to casual contact by persons (enclosure, grille, etc.)		
Metal	45	81
Nonmetallic	65	117
4. Surfaces of test enclosure where clearance to flammable material is specified	65	117
E. Electrical Insulation – General		
1. Fiber used as electrical insulation or cord bushings	65	117
2. Phenolic composition used as electrical insulation or as parts where failure will result in a hazardous condition	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 be not more than 65°C (117°F).

[d] A capacitor which operates at a temperature higher than a 65°C (117°F) rise may be judged on the basis of its marked temperature rating.

50.2 Thermocouples are to be secured to various electrical components of a representative unit cooler, including fan-motor windings, relay coils, drain pan heaters, wiring insulation, and to surfaces as indicated in Table 50.1(D). The temperature of motor windings or coils may be measured by the resistance method, but the primary method of temperature measurement is to be the thermocouple method. The electrical input is also to be measured (voltage and current).

50.3 The unit cooler is to be mounted or positioned in accordance with the manufacturer's instructions, see 4.1 and 4.2, and operated continuously until temperatures stabilize. The test potential is to be as indicated in 47.1.1. The test ambient temperature is to be approximately 25°C (77°F).

50.4 The unit cooler is to comply with the Dielectric Voltage Withstand Test, Section 52, following the Temperature Test – Cooling Mode Test.

51 Electrical Defrost Test

51.1 Temperature rises measured on the components and surfaces of a unit cooler during an electric defrost cycle shall not exceed the limits tabulated in Table 50.1. A temperature-limiting control provided for compliance with 21.2.1 shall not open.

51.2 Thermocouples are to be attached to motors, components, insulated conductors, surfaces and electrical insulation as indicated in Table 50.1, which may be affected by operation of the defrost system.

51.3 The unit cooler is to be mounted or positioned in accordance with the manufacturer's instructions. See 4.1 and 4.2. The test potential is to be as indicated in 47.1.1. The defrost cycle is started by closing the circuit to the electric heater. The test ambient temperature is to be 25 ±3°C (77 ±5°F).

51.4 If neither a defrost cycle control nor a temperature-limiting control are provided as part of the unit cooler and the unit cooler is not marked in accordance with 76.8, the defrost heater is to be allowed to operate until the temperatures stabilize. The stabilized temperatures are to be used in judging compliance with 51.1.

51.5 If the defrost cycle is time-terminated, the unit cooler is to be operated:

a) For the maximum adjustable length of time permitted by an integral control arrangement, or

b) For a period equal to 125 percent of the time specified on the unit cooler (see 76.8) but not less than 15 minutes.

If a unit cooler with an integral 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 51.1.

51.6 If a temperature-terminated defrost cycle control is provided as part of the unit cooler, the cut-in/cut-out temperature differential of the control is to be determined. The control(s) 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 51.1.

51.7 The temperatures and electrical inputs are to be measured at intervals during the cycle.

51.8 The defrost system is to comply with the Dielectric Voltage Withstand Test, Section 52, following the Electric Defrost Test.

52 Dielectric Voltage Withstand Test

52.1 A complete unit cooler and all electrical components shall be capable of withstanding for a period of 1 minute, without breakdown, the application of a test potential 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 shall be 1000 volts for units rated at not more than 1/2 horsepower (hp) (373 W output).

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

Exception No. 3: If agreeable to all parties concerned, the test potential may be a direct-current (dc) potential as specified in Table 72.1, Condition A and applied for 1 minute.

52.2 A unit cooler employing an extra-low-voltage circuit shall be capable of withstanding for 1 minute, without breakdown, the specified test potential applied between extra-low-voltage live parts and dead-metal parts. The test potential is to be:

a) A dc potential of 700 volts, or

b) An ac potential of 500 volts at any frequency between 40 and 70 hertz.

52.2.1 In reference to 52.2, if components specified in 40.3 are employed in the extra-low-voltage circuit, the dielectric voltage-withstand test, is to be:

a) Conducted on the components with the dielectric potential applied between live parts of opposite polarity; or

b) The components are to be separately subjected to the Dielectric voltage-withstand test.

52.3 In reference to 52.2.1, the test between extra-low-voltage parts of opposite polarity is to be conducted on magnet coil windings of the transformer after breaking the inner coil lead where it enters the layer.

52.4 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 the previous paragraphs. 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 used is such that it maintains the specified high potential voltage at the equipment for the duration of the test.

52.5 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 52.6.

52.6 The capacitors and capacitor-type filter mentioned in 52.5 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.

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52.7 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.

53 Evaporator Fan Motor Failure Test

53.1 This test is to be conducted only if the evaporator fan motor(s) operates during the defrost period.

53.2 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.

53.3 The test arrangement is to be as described in the electric defrost heater requirements contained in the Burnout Test, Section 57, except that the defrost cycle control is to be operable as in the Electric Defrost Test, Section 51, and the evaporator fan motor is to be locked. The potential is to be maintained as indicated in 47.1.1.

53.4 If more than one evaporator fan motor is employed, the test is to be conducted by locking the fan motor which would result in the most severe condition.

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

54 Overflow Test

54.1 With reference to 11.2.8, a unit cooler in which condensate water may accumulate or overflow due to a blocked waste outlet shall not allow the water to wet uninsulated live parts of the windings of motors or coils.

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

54.3 Compliance with 54.1 is to be determined by visual examination, dielectric withstand, or insulation resistance.

Exception: Motor windings are to have an insulation resistance of not less than 50,000 ohms and are to comply with the Dielectric Voltage Withstand Test, Section 52.

55 Static Loading Test

55.1 A unit cooler suspended from a wall or ceiling shall withstand the test described in 55.2 without:

a) Collapse of the mounting means, and

b) Severance of its securement to the mounting means.

55.2 A representative unit cooler is to be installed with its mounting hardware in accordance with the manufacturer's instructions. A load equal to three times the weight of the unit cooler, but not exceeding 400 pounds-mass (181.6 kg), acting vertically downward, is to be applied uniformly to the unit cooler.

56 Defrost Heater Control Tests

56.1 Endurance test

56.1.1 In addition to complying with 25.10, a control for an electric defrost heater shall be capable of withstanding an endurance test under the load which it controls for the number of cycles indicated in 56.1.2.

56.1.2 The number of cycles for the test is to be as follows:

a) An automatic-reset defrost cycle control which operates during each defrost cycle is to withstand 30,000 cycles of operation under load.

b) An automatic-reset temperature limiting control is to withstand 100,000 cycles of operation under load if its short-circuiting results in a risk of fire or electric shock, see 57.1.2 and 57.1.3. The test may be waived if short-circuiting of the control does not result in such a risk of fire or electric shock. See Burnout Test, Section 57.

c) A manual-reset temperature limiting control is to withstand 1000 cycles of operation under load plus an additional 5000 cycles without load. The test may be waived if short-circuiting of the control does not result in a risk of fire or electric shock. See Burnout Test, Section 57.

56.2 Calibration test

56.2.1 A defrost cycle control and temperature limiting control, shall comply with the requirements pertaining to the calibration of temperature limiting controls as specified in 25.11.5 for a temperature protective control. A pressure protective control shall comply with the calibration requirements in 25.11.6.

57 Burnout Test

57.1 Burnout defrost heater

57.1.1 An electric defrost heater shall not become a risk of fire or electric shock in the unit cooler.

57.1.2 A risk of fire is considered to exist if there is any emission of flame or molten metal from the unit cooler, or glowing or flaming of flammable material. Opening of the supply circuit fuse is not considered to be a failure if a risk of fire does not exist.

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

57.1.4 The unit cooler is to be mounted or positioned in accordance with the manufacturer's instructions. See 4.1 and 4.2. The test sample is to include only those controls provided by the manufacturer as part of the unit cooler. If a control does not meet the endurance test requirements of 56.1.2(b) or (c) and the calibration test requirements of 56.2.1, it is to be shorted out of the circuit during the test. If a control contains a clock motor or mechanical linkage, the control is to be shorted out of the circuit. If the control is a replaceable thermal cutoff, it is to remain in the circuit and the test is to be conducted in accordance with 57.1.7.

57.1.5 The test ambient temperature is to be 25 ± 3°C (77 ± 5°F). A double layer of cheesecloth is to be placed around the unit cooler so that it adheres closely to all surfaces. The cloth is to be bleached cheesecloth 36 inches (0.91 m) wide, running 14 – 15 yards per pound (28.2 – 30.2 m/kg) and having what is known in the trade as a ″count of 32 × 28.″ The defrost system is to be connected to a supply circuit maintained as indicated in 47.1.1 and energized until stabilized temperatures are reached. Each ungrounded conductor in the supply circuit is to be provided with a fuse of the maximum rating which may be used, except that 20 amperes is the minimum size for unit coolers rated 120 volts, single phase, or less.

57.1.6 The cut-in/cut-out temperature of the temperature-limiting control is to be determined. The temperature-limiting control is then to be shunted out of the circuit and a thermocouple placed at the location where the control senses the temperature. The heater is to be energized and allowed to operate until the temperature rise at the control sensing location is equal to the temperature differential previously determined. The heater is then to be de-energized and allowed to cool until the temperature drop at the control sensing location is equal to the temperature differential previously determined at which time the heater is to be energized again. The test is to be continued in this manner until temperatures of motors, components, insulated conductors, surfaces and electrical insulation have stabilized.

57.1.7 If a replaceable thermal cutoff is employed, the test is to be conducted five times using different samples of the thermal cutoff in each test. The thermal cutoff is to open the circuit in the intended manner 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 through a 3 ampere fuse to ground, and any thermally operated control devices in the heater circuit other than the thermal cutoff are to be short-circuited.

57.2 Other components

57.2.1 A burnout test is to be conducted on components, such as intermittent-duty relays, solenoids, and electrically-operated valves to determine that a risk of fire or electric shock (see 57.1.2 and 57.1.3) does not exist. The tests should be made with the component installed as intended in the unit cooler. The unit cooler is to be connected to a supply circuit maintained as indicated in 47.1.1. Each ungrounded conductor in the supply circuit is to be provided with a fuse of the maximum rating which may be used.

57.2.2 If a single component malfunction may result in an intermittent-duty relay or solenoid being continuously energized, such a malfunction shall not result in a risk of fire or electric shock. The test is to be conducted with the relay or solenoid continuously energized until the ultimate result is determined.

57.2.3 Blocking of a relay, solenoid, or electrically operated valve in the de-energized position shall not result in a risk of fire or electric shock. The component is to be blocked in the position assumed when it is de-energized and then energized continuously until the ultimate result is determined.

58 Burnout Test – Impedance Protected Motors

58.1 Nonmetallic materials evaluation

58.1.1 When an impedance protected motor is not provided within an enclosure and is located adjacent to nonmetallic materials other than those rated 5V, the adjacent materials shall not ignite.

58.1.2 The test is to be conducted on one sample motor installed as intended within the unit cooler. For the testing, the motor is to:

a) Have a minimum of one thermocouple secured to the motor winding for measurement of the winding temperature;

b) Be evaluated in the locked rotor condition;

c) Be energized at rated voltage and operated until the winding temperature stabilizes at which time, the voltage shall is to be progressively increased in 5-volt increments. The winding temperature is to be allowed to stabilize after each increase in voltage; and

d) Be operated continuously until burnout occurs.

Exception: For the test in 58.1.2, installation of the motor within the unit cooler is not required if the motor is wrapped in dry absorbent surgical cotton and mounted in a manner consistent with its installation. The surgical cotton shall not ignite.

59 Overvoltage and Undervoltage Tests

59.1 An electromagnet such as employed on a relay or solenoid shall be able to withstand 10 percent above rated voltage without damage to the coil and shall operate at 15 percent below rated voltage. The test voltages are to be as indicated in Table 59.1.

Table 59.1
Test voltages

Rated voltage	Overvoltage	Undervoltage
110 – 120	132	102
208	229	177
220 – 240	264	204
254 – 277	305	235
440 – 480	528	408
550 – 600	660	510
Other	110 percent Rated	85 percent Rated

59.2 A relay or solenoid that has been separately investigated for the voltage and operating conditions involved, including ambient temperature conditions, is not required to be tested in the unit cooler to determine if it complies with the requirement in 59.1.

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 reach constant temperature. The potential is then to be reduced to the test voltage specified in 47.1.1, and each relay and solenoid is to operate at this voltage. The potential is to be maintained at this test voltage until the coils reach constant temperatures. The potential is then to be reduced to the undervoltage condition, and each relay and solenoid is to operate at this voltage. If relays and solenoids are energized through a transformer, the voltage adjustments described are to be made at the transformer primary. A relay or solenoid which will not be subject to continuous operation is to be energized at the overvoltage condition and at the test voltage specified in 47.1.1 for the maximum time permitted by its duty cycle or until constant temperature is reached, whichever occurs first.

60 Current Overload Test – Bonding Conductors and Connections

60.1 If required by 18.8 or 18.9, bonding conductors and connections shall carry, without opening, twice the current equal to the rating of the branch circuit overcurrent-protection 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

60A Overload and Endurance Test – Switching Devices

60A.1 This test applies to switches or other similar control devices as specified in 25.1, 25.2 or 25.3.

60A.2 A switching device in a refrigeration unit cooler shall perform acceptably when tested as follows for overload and endurance. There shall be no electrical or mechanical failure nor undue burning, pitting or welding of contacts, or striking of an arc to dead metal parts.

60A.3 The tests on switching devices shall be conducted by:

a) Evaluating the control devices within a refrigeration unit cooler by operating the controlling device mechanisms in accordance with 60A.4 and 60A.6, using the normal switching device loads of the appliance; or

b) Cycling the switching devices individually or collectively while controlling the loads specified in 60A.5 – 60A.7.

60A.4 If the test in 60A.3(a) is conducted, the:

a) Enclosure of the appliance shall be connected through a 30 ampere cartridge fuse to the electrical test circuit pole considered least likely to strike (arc) to ground;

b) Switching device shall be mounted as intended in service; and

c) Test cycling shall be as specified in 60A.6 unless a slower rate is required by the design of the refrigeration unit cooler. A faster rate may be used if agreeable to all concerned.

60A.5 If the test in 60A.3(b) is conducted, the switching device shall be subjected to an overload test at the ambient temperature for which it is intended. The overload test shall consist of making and breaking the connected load for 50 cycles of operation, with 1 second ON and 9 seconds OFF. The current, power factor and voltage used for testing each type of load shall be as follows:

a) Noninductive load(s) – 150 percent of the total connected load current. The power factor shall be 1.0 and the voltage shall be as specified in 47.1.1.

b) One or more motors together with one or more other loads – 100 percent of the locked-rotor current of the largest motor plus 100 percent of the full load currents of all other motors and/or other loads. The power factor shall be 0.4 – 0.5 and the voltage shall be as specified in 47.1.1.

c) One or more inductive loads, such as a transformer or ballast, with or without other noninductive or pilot duty loads – 100 percent of the total inductive and other noninductive/pilot duty loads. The power factor shall be 0.7 – 0.8 and the voltage shall be as specified in 47.1.1.

d) One or more pilot duty loads, such as coils within a relay or electric valve – 100 percent of the total connected pilot duty loads. The power factor shall not exceed 0.35 and the voltage shall be 110 percent of the value specified in 47.1.1.

60A.6 A switching device shall be subjected to an endurance test at the ambient temperature for which it is intended. The endurance test voltage shall be as specified in 47.1.1 and the current shall be 100 percent of the total connected load current. The endurance test cycling shall consist of making and breaking the connected load for:

a) 6000 cycles of operation with 1 second ON and 9 seconds OFF for a switching device other than one used to control a motor-compressor; or

b) 24,000 cycles of operation with 1 second ON and 9 seconds OFF followed by 6,000 cycles of operation with 1 second ON and 59 seconds OFF for a switching device used to control a motor-compressor.

60A.7 For a switching device tested in accordance with 60A.3(b), the power factor for the endurance cycling specified in 60A.6 shall be as specified in 60A.5 for each type of load.

60A.8 At the conclusion of the test in 60A.3, each switching device shall be subjected to the Dielectric Voltage Withstand Test, Section 52.

61A Switch Mode Power Supply Units – Overload Test

61A.1 The test applies to switch mode power supply units as specified in 37.1(c).

61A.2 Each output winding, or section of a tapped winding, is overloaded in turn, one at a time, while the other windings are kept loaded or unloaded, whichever load conditions of normal use is the least favorable.

61A.3 Overloading is carried out by connecting a variable resistor (or an electronic load) across the power supply output. The resistor is adjusted as quickly as possible and readjusted, if necessary, after 1 minute to maintain the applicable overload. No further readjustments are then permitted.

61A.4 For this test, any protective devices such as a fuse, manual reset circuit protector, thermal protector, etc. are allowed to remain in the circuit.

61A.5 If overcurrent protection is provided by an overcurrent protection device, the overload test current is the maximum current which the overcurrent protection device is just capable of passing for 1 hr. If this value cannot be derived from the specification, it is to be established by test.

61A.6 If no overcurrent protection is provided, the maximum overload is the maximum power output obtainable from the power supply.

61A.7 In case of voltage foldback, the overload is to be slowly increased to the point which causes the output voltage to collapse. The overload is then established at the point where the output voltage recovered and held for the duration of the test.

61A.8 The duration of the test is to be for 7 hours or until ultimate results are reached. At the conclusion of the test, there shall be no charring or burning of electrical insulation, no opening of any protective device or any circuit component.

61 Limited Short-Circuit Test

61.1 General

61.1.1 The following shall withstand short-circuit conditions when protected by either:

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

b) A branch-circuit protective device of the type and maximum rating specified on the unit cooler nameplate:

1) A motor overload protective device that is connected in the motor circuit.

2) A motor-circuit conductor or connection as required by 16.24.

3) A bonding conductor or connection as required by 18.8 and 18.9, Exception No. 1.

61.1.2 For the purpose of these tests:

a) Circuit breakers and fuses are not considered to be interchangeable,

b) Fuses of the same rating are considered to be interchangeable, and

c) Circuit breakers of the same rating are considered to be interchangeable.

61.1.3 The motor overload protective device, and the bonding conductor, bonding connection, or both, or the motor circuit conductor and connection is to be connected in a circuit having a capacity based on the full-load current and voltage rating of the unit cooler. See Table 61.1. When the full-load current rating of the unit cooler is between two values in the table, the larger value is to be used in determining the circuit capacity. If the unit cooler nameplate shows individual loads, the full-load current of the device is the total of all individual loads which 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 ac supply. The power factor of the test circuit is to be 0.9 – 1.0 unless a lower power factor is agreeable to those concerned. The circuit capacity is to be measured without the device in the circuit.

Table 61.1
Short circuit test currents

Full load amperes[a]				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
	Three 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	1.8 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

[a] Unit Coolers.

61.1.4 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.

61.2 Motor overload protective devices

61.2.1 A motor overload protective device in a unit cooler having:

a) More than one motor, or

b) One or more motors and other loads,

wired for connection to one supply shall withstand short-circuiting when protected by a branch-circuit overcurrent device rated not more than 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. See 61.2.2. There shall be no ignition of cheesecloth surrounding the enclosure of the protective device when samples are subjected to the test.

Exception: The short-circuit tests may be waived if a thermally protected motor or a separately enclosed motor overload protective device is:

a) Within an outer cabinet,

b) The assembly is so constructed that it can be determined that flame and molten metal will be confined within the cabinet, and

c) There is no flammable material except electrical insulation within the cabinet.

61.2.2 A branch-circuit overcurrent protective device of the nearest standard size rated not higher than the current specified in 61.2.1 is to be employed for the test. If the calculated size is less than 15 amperes, a 15 ampere overcurrent device is to be used.

Exception: For unit coolers rated 150 volts or less, the minimum size of overcurrent device shall be 20 amperes.

61.3 Bonding conductors and connections

61.3.1 Bonding conductors and connections shall not open when samples are subjected to the conditions of this test.

61.4 Motor circuit conductors and connections

61.4.1 Motor circuit conductors and connections shall not be damaged when samples are subjected to the conditions of this test.

62 Accelerated Aging Test – Electric Heaters

62.1 The requirement in 62.2 applies to the cases of heater assemblies and terminal seals of metallic sheath heaters.

62.2 Rubber, neoprene, or thermoplastic compounds used as a heater casing or for the sealing of terminals shall withstand accelerated aging as indicated in Table 62.1 for the maximum temperature rise measured on the device during a temperature and/or defrost test conducted in an ambient temperature of 25 – 40°C (77 – 104°F) without deteriorating to a degree which will affect its use.

Table 62.1
Accelerated aging test criteria

Measured temperature rise		Material	Test program
°C	(°F)		
35	(63)	Rubber or Neoprene	70-hour air oven aging test at 100 ±2°C (212 ±3.6°F)
35	(63)	Thermoplastic	7 days in an air circulating oven at 100°C (212°F)
50	(90)	Rubber or Neoprene	168-hour air oven aging test at 100 ±2°C (212 ±3.6°F)
50	(90)	Thermoplastic	10 days in an air circulating oven at 100°C (212°F)
55	(99)	Rubber, Neoprene or Thermoplastic	7 days in an air circulating oven at 113°C (235.4°F)
65	(117)	Rubber or Neoprene	10 days in an air circulating oven at 121°C (249.8°F)
65	(117)	Thermoplastic	7 days at 121°C (249.8°F) or 60 days at 97°C (206.6°F) in an air circulating oven
80	(144)	Rubber, Neoprene or Thermoplastic	7 days in an air circulating oven at 136°C (276.8°F)
100	(180)	Rubber, Neoprene or Thermoplastic	60 days in an air circulating oven at 136°C (276.8°F)
125	(225)	Rubber, Neoprene or Thermoplastic	60 days in an air circulating oven at 158°C (316.4°F)

Table 62.1 Continued on Next Page

Table 62.1 Continued

Measured temperature rise °C	(°F)	Material	Test program
175	(315)	Rubber, Neoprene or Thermoplastic	60 days in an air circulating oven at 210°C (410°F)

63 Reliability Test – Heater Terminations

63.1 Electric heaters employing integrally molded leads or molded terminal assemblies shall withstand a test load of 20 pounds-mass (9.1 kg) applied for 1 minute. The load is to be applied in the same direction at which the lead exits the heater case or molded connection and is not to result in displacement of insulation or separation of the connection between the lead and heater.

64 Insulation Resistance Test

64.1 Electric heaters

64.1.1 The insulation resistance of an encapsulated heater or a sheath-type heater that is exposed to moisture in a unit cooler shall not be less than 50,000 ohms when tested as described in 64.1.2 and 64.1.3. The heater shall comply with the Dielectric Voltage-Withstand Test, Section 52, following exposure.

64.1.2 If an encapsulated heater or heater terminal seal is intended to be immersed in water as it is used in the unit cooler, 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 95 ±5°C (203 ±9°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.

64.1.3 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 unit cooler, the test is to be conducted by cycling the heater assembly or terminal seal in an atmosphere of not less than 98 percent 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 and 13-1/2 minutes off.

64.2 Thermal and/or acoustical insulating material

64.2.1 A unit cooler employing insulating material likely to be affected by moisture under conditions of use 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 ±2°C (90 ±4°F).

65 Strength Tests – Pressure Containing Components

65.1 Parts of a unit cooler exposed to refrigerant pressure shall withstand, without failure, a pressure equal to three times the marked design pressure, but not less than 1-1/2 times the vapor pressure of the refrigerant at 60°C (140°F).

Exception No. 1: Sections of the refrigerant system constructed of continuous tubing or of lengths of tubing connected by hard-soldered, brazed, or welded joints will be considered as meeting this requirement provided the tubing conforms with 42.1.

Exception No. 2: Evaporators used in unit coolers intended to utilize carbon dioxide (R744) in a secondary loop or a cascade system shall have an ultimate strength of not less than three times the start-to-discharge value of the pressure relief valve.

Exception No. 3: The higher of 1-1/2 times the vapor pressure of the refrigerant at 60°C (140°F) or the marked design pressure may equal or exceed the critical pressure of some refrigerants. In this case, the test is to be conducted at a pressure equal to three times the marked design pressure.

65.2 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.

66 Rupture Member Test

66.1 A rupture member shall burst at a pressure within 5 percent of its nominal rated rupture pressure.

66.2 Three samples of each size are to be tested as follows. Each sample is to be connected to a pressure source (carbon dioxide, air, or other non-flammable gas) and the pressure increased until rupture occurs. The rate of pressure increase is to be not greater than 5 percent of the minimum marked bursting pressure per minute after the pressure reaches 90 percent of the minimum marked bursting pressure.

66.3 The nominal rated rupture pressure is the average of the minimum and maximum marked bursting pressures.

67 Fusible Plug Test

67.1 A fusible plug shall function within 5.6°C (10°F) of its marked temperature rating when tested as described in 67.2 and 67.3.

67.2 Three samples of each size are to be tested. Each sample is to be attached to a length of coiled copper tubing, 10 feet (3.05 m) long, within which air pressure of not less than 40 psig (276 kPa) is to be maintained. The coil and test sample is to be immersed in a fluid and maintained at a temperature of 11.1°C (20°F) below the marked temperature of the plug. After 5 minutes, the temperature is to be increased at a rate of 0.5°C (1°F) per minute. The relief temperature occurs when the test pressure is relieved and complete blowout of the fusible element occurs.

67.3 A blowout is complete when the area of the relief opening is such that the resulting discharge capacity complies with the requirements of 45.3 and 46.1.

68 Marking Label Adhesion Tests

68.1 A marking secured by cement or adhesive shall comply with the applicable requirements of the Standard for Marking and Labeling Systems, UL 969.

69 Fastener Strength Test

69.1 With reference to the requirement in 10.2, nonmetallic fasteners that can degrade and affect the integrity of an enclosure shall comply with 69.2 and 69.3.

69.2 The tightening torque and pull-off strength of such fasteners shall be not less than 50 percent of the as-received value.

69.3 Three sets of samples, each set consisting of three specimens, is to be temperature conditioned as indicated in Tables 69.1 and 69.2.

Table 69.1
Test specifications

Sample Set	No. of Samples	Test Specifications
1	3	As-received (no conditioning).
2	3	Oven aging – 300 hours at the service temperature plus 10°C (18°F) but not less than 70°C (158°F). Service temperature is considered to be the temperature measured during the Temperature Test – Cooling Mode, Section 50; and Electric Defrost Test, Section 51.
3	3	Heat cycling – 40 cycles of alternate heating and cooling at the temperatures specified in Table 69.2. Each cycle is to consist of 4 hours at the upper temperature followed by 4 hours at the lower temperature.

Table 69.2
Temperature cycling parameters

Location	Upper temperature	Lower temperature
Nonrefrigerated Areas	Service temperature plus 10°C (18°F) but not less than 70°C (158°F)	25°C (77°F)
Refrigerated Area	32°C (90°F)	0°C (32°F)
Low Temperature Area	32°C (90°F)	minus 17.8°C (0°F)

70 Strain Relief Test

70.1 When tested in accordance with 70.2 and 70.3, the strain relief means stressed from any angle that the unit cooler makes possible shall be capable of withstanding the direct pull without any displacement of the cord (conductors, insulation or both) or deformation of its anchoring surface that would result in a potential risk of fire, electric shock, or injury to persons.

70.2 The primary connections within the unit cooler are to be disconnected. A 35 pounds-force (156 N) is to be applied to the cord and supported by the unit cooler.

70.3 The initial test is to be conducted with the force vector parallel to the longitudinal axis of the cord and perpendicular to the surface having the cord entry hole. The force is to be applied for 1 minute. Each test at other angles of stress are to also be conducted for periods of 1 minute.

70A Protective Electronic Circuit Tests

70A.1 General

70A.1.1 The tests in 70A.2 – 70A.2.5 are applicable to appliances provided with a protective electronic circuit and intended to comply with 24.2.3(c) or 25.10(h)

70A.1.2 User adjustable controls shall be adjusted to their most unfavorable setting.

70A.2 Fault Conditions Abnormal Test

70A.2.1 Following the application of the operational fault conditions in accordance with 70A.2.2 – 70A.2.5, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage Withstand Test in Section 52.

70A.2.2 In accordance with 25.21(b), an appliance provided with a protective electronic circuit intended to comply with 24.2.3(c) or 25.10(h) shall be operated as specified in the Temperature Test – Cooling Mode, Section 50 with the room ambient maintained at 21.1 – 26.7°C (70 – 80°F). The appliance protective electronic circuit shall then be subjected any one of the following relevant operational fault conditions, each consecutively applied one at a time:

a) Open circuit at the terminals of any component;

b) Short circuit of capacitors, unless they comply with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14;

c) Short circuit of any two terminals of an electronic component, including a metal oxide varistor (MOV). For the test applicable to an integrated circuit, see (e);

d) Failure of triacs in the diode mode;

e) Failure of microprocessors and integrated circuits except components such as thyristors and triacs. All possible output signals occurring within the component which may result in the appliance not complying with 70A.2.1 shall be considered;

f) Failure of an electronic power switching device, such as a field effect transistor and a bipolar transistor (including the insulated gate type) in a partial turn-on mode with loss of gate (base) control;

g) Short-circuiting of any circuit that differs in voltage from the supply source of the protective electronic circuit by connecting the different voltage circuit to the supply source.

70A.2.3 In reference to 70A.2.2, the following items shall be considered:

a) If the fault specified in 70A.2.2(c) is not applied:

1) Between two circuits of an optical isolator, then the optical isolator shall comply with the Standard for Optical Isolators, UL 1577.

2) To the short circuiting of an electronic surge protective device such as a metal oxide varistor (MOV), then the MOV shall comply with the Type 4 requirements in the Standard for Surge Protective Devices, UL 1449.

b) For evaluating encapsulated or similar components, if the circuit and/or components cannot be evaluated by other methods, then 70A.2.2(e) shall be applied.

c) For evaluating the components in 70A.2.2(f), one method for simulating this mode is to disconnect the electronic power switching device gate (base) terminal and then connect an external adjustable power supply between the gate (base) terminal and the source (emitter) terminal of the electronic power switching device. The power supply can then be varied to obtain the current which is the most severe but which does not damage the electronic power switching device.

d) Step-function positive temperature coefficient thermistors (PTC-S) shall be short-circuited unless they comply with the DC PTC Thermistors requirements in Clause 14.6.4 of the Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements, UL 60065, Eighth edition.

e) If more than one of the operational fault conditions in 70A.2.2 (a) – (g) are applicable to the appliance, the appliance shall be allowed to cool down to room temperature after the application of each fault condition unless such cooling is determined not to adversely impact the test results.

70A.2.4 The operational fault conditions specified in 70A.2.2 (a) – (g) shall be considered completed if a manual reset (non-self-resetting) device opens the supply circuit. If the supply circuit is not opened by such a device, then the fault conditions shall be applied until thermal equilibrium is established.

70A.2.5 An appliance provided with a protective electronic circuit intended to comply with 24.2.3(c) or 25.10(h) shall additionally be operated as specified 70A.2.2 except that the appliance shall first be subjected to the relevant abnormal condition(s) addressed by Sections 11, 24, 53, and 57. The appliance protective electronic circuit shall then be subjected to any one of the relevant operational fault conditions as outlined in 70A.2.2 (a) – (g), each consecutively applied one at a time.

70A.3 Electromagnetic Compatibility (EMC) Tests

70A.3.1 In accordance with 25.21(e), an appliance having a protective electronic circuit intended to comply with 24.2.3(c) or 25.10(h) shall be subjected to the electromagnetic phenomena specified in 70A.3.3– 70A.3.9, each applied one at a time. Each test shall be carried out:

a) After a protective electronic circuit has operated during the relevant abnormal condition(s) addressed by Sections 11, 24, 53, and 57 taking into account the most severe results (e.g. highest temperatures, pressures, etc.);

b) At conditions specified in the Temperature Test – Cooling Mode, Section 50 with the room ambient maintained at 21.1 – 26.7°C (70 – 80°F) unless different conditions are required by the specific abnormal condition being applied; and

c) With surge protective devices disconnected unless they incorporate spark gaps.

70A.3.2 Following the application of each electromagnetic stress, a protective electronic circuit shall continue to operate as intended. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage-Withstand Test in Section 52.

70A.3.3 Electrostatic discharges shall be applied in accordance with IEC 61000-4-2, Standard for Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity shall be applied at each preselected point.

70A.3.4 Radiated fields shall be applied in accordance with IEC 61000-4-3, Standard for Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test. The frequency ranges tested shall be 80 MHz to 1000 MHz, test level 3; 1.4 GHz to 2.0 GHz, test level 3; and 2.0 GHz to 2.7 GHz, test level 2. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

70A.3.5 Fast transient bursts shall be applied in accordance with IEC 61000-4-4, Standard for Electromagnetic Compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test. Test level 3 with a repetition rate of 5 kHz is applicable for signal and control lines. Test level 4 with a repetition rate of 5 kHz is applicable for the power supply lines. The bursts are applied for 2 min with a positive polarity and for 2 min with a negative polarity.

70A.3.6 Voltage surges shall be applied to the appliance power supply terminals in accordance with IEC 61000-4-5, Standard for Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test with five positive impulses and five negative impulses being applied at the selected points. An open circuit test voltage of 2 kV is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 ohms being used. An open circuit test voltage of 4 kV is applicable for the line-to-ground coupling mode, a generator having a source impedance of 12 ohms being used. Sheathed heating elements in which a metal sheath is bonded in accordance with 18.1 shall be electrically disconnected during this test. For appliances having surge arresters incorporating spark gaps, the test shall be repeated at a level that is 95 percent of the flashover voltage. If a feedback system depends on inputs related to a disconnected heating element, an artificial network may be needed.

70A.3.7 Injected currents shall be applied in accordance with IEC 61000-4-6, Standard for Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields, test level 3 being applicable. During the test, all frequencies between 0.15 MHz to 80 MHz shall be covered. The dwell time for each frequency shall be sufficient to observe a possible malfunction of the protective electronic circuit.

70A.3.8 Voltage dips and interruptions specified as test level Class 3 shall be applied in accordance with:

a) IEC 61000-4-11, Standard for Electromagnetic Compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests, for appliances having a rated current not exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-11 shall be applied at zero crossing of the supply voltage; or,

b) IEC 61000-4-34, Standard for Electromagnetic Compatibility (EMC) – Part 4-34: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Mains Current More Than 16 A Per Phase for appliances having a rated current exceeding 16 A. The values specified in Table 1 and Table 2 of IEC 61000-4-34 shall be applied at zero crossing of the supply voltage.

70A.3.9 Supply source (mains) signals shall be tested in accordance with IEC 61000-4-13, Standard for Electromagnetic Compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signalling at a.c. Power Port, Low Frequency Immunity Tests. Table 11 with test level Class 2 using the frequency steps according to Table 10 of IEC 61000-4-13 shall be applied.

70A.4 Programmable Component Reduced Supply Voltage Test

70A.4.1 In accordance with 25.21(f), the following test is applicable to an appliance provided with a protective electronic circuit intended to comply with 24.2.3(c) or 25.10(h) and having a programmable component for one or more of its safety functions.

70A.4.2 Following the voltage changes specified in 70A.4.3, an appliance shall continue to either operate normally from the same point in its operating cycle at which the voltage decrease occurred or a manual operation shall be required to restart the appliance. In addition, there shall be no risk of fire, electric shock or injury to persons. Electrical live parts or moving parts shall not be exposed. The appliance shall comply with the Dielectric Voltage-Withstand Test in Section 52.

70A.4.3 The appliance shall be operated at rated voltage and at conditions specified in the Temperature Test – Cooling Mode, Section 50 with the room ambient maintained at 21.1 – 26.7°C (70 – 80°F) until thermal equilibrium occurs. The power supply voltage shall then be changed, by approximately 10 V/s until the voltage reductions or increases specified in (a) – (d) are attained. The power supply voltage shall then be maintained at each voltage condition for not less than 60 s as follows:

a) Voltage shall be reduced until the appliance ceases to respond to user inputs or parts controlled by the programmable component cease to operate, whichever occurs first. This value of supply voltage shall be recorded.

b) Voltage shall be increased to rated voltage so that the appliance operates as intended;