



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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AUGUST 22, 2011

(Title Page Reprinted: August 28, 2018)



ANSI/UL 412-2018

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UL 412

Standard for Refrigeration Unit Coolers

First Edition – April, 1979

Second Edition – April, 1980

Third Edition – September, 1993

Fourth Edition – April, 2004

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>.

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Informational

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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 ft² (0.093 m²) 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 m³) 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.

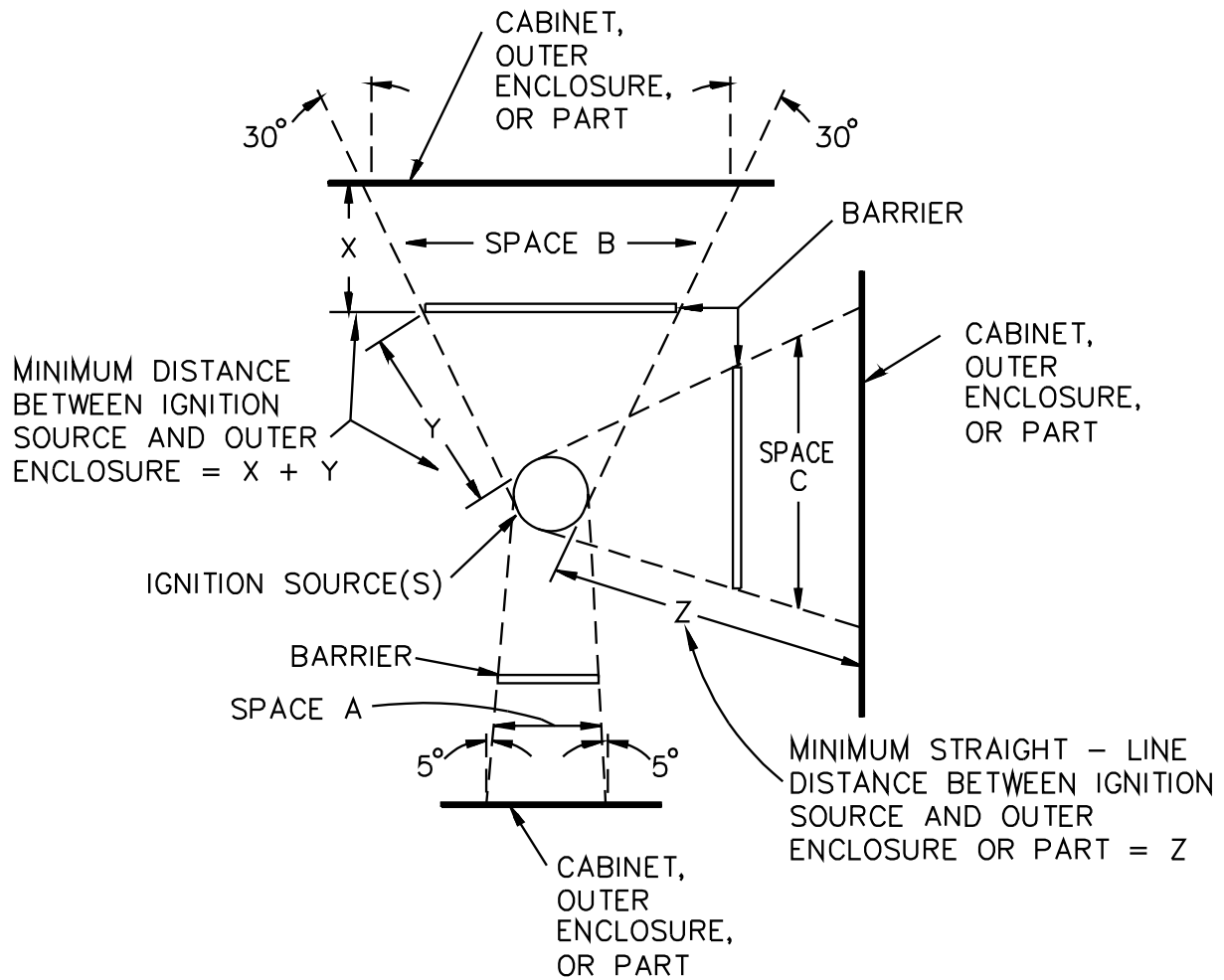
8.3 In reference to 8.2, the assigned flammability rating shall comply with Nonmetallic Material – Ignition Source Separation, Section 9 and Table 48.1.

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 in² (645.2 mm²), 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.

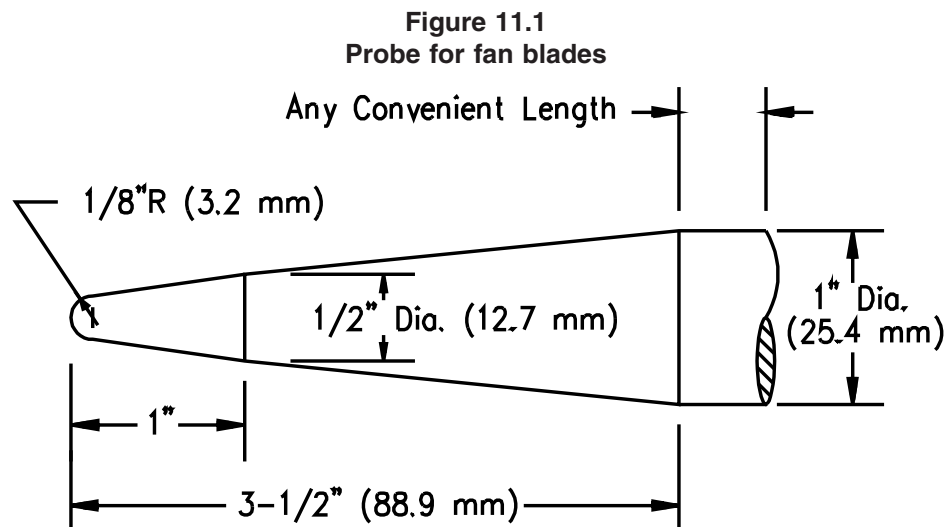
11.1.5 The rotor of a motor, a pulley, a gear, a belt, a fan blade, or other moving part shall be guarded or enclosed so that the minor dimension of any opening does not exceed the values indicated in 11.1.6 or 11.1.7.

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.



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

^a Openings less than 1/4 inch (6.4 mm) are not to be considered.
^b But not more than 3 inches (76.2 mm). See 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:

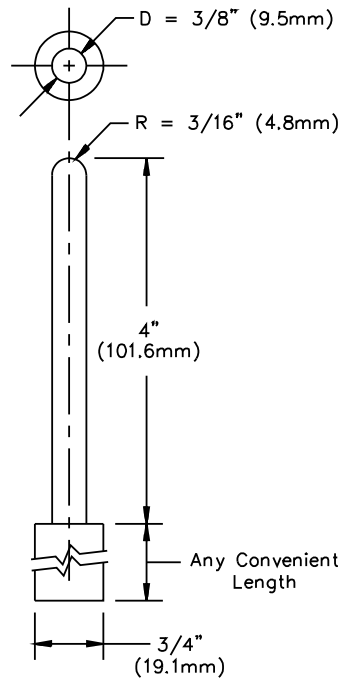
- a) The unit cooler is intended for installation such that the lowest part of the exposed defrost heater is 7 feet (2.1 m) or more above floor level and is marked in accordance with 76.5 and 76.7, or*
- b) The unit cooler is for use with a walk-in cooler or refrigerated warehouse and is marked in accordance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



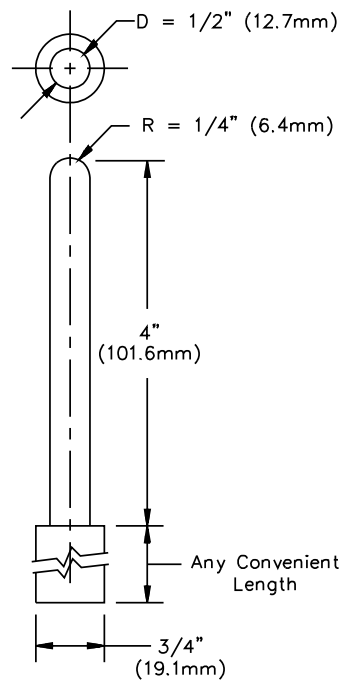
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11.2 Protection from live parts

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.

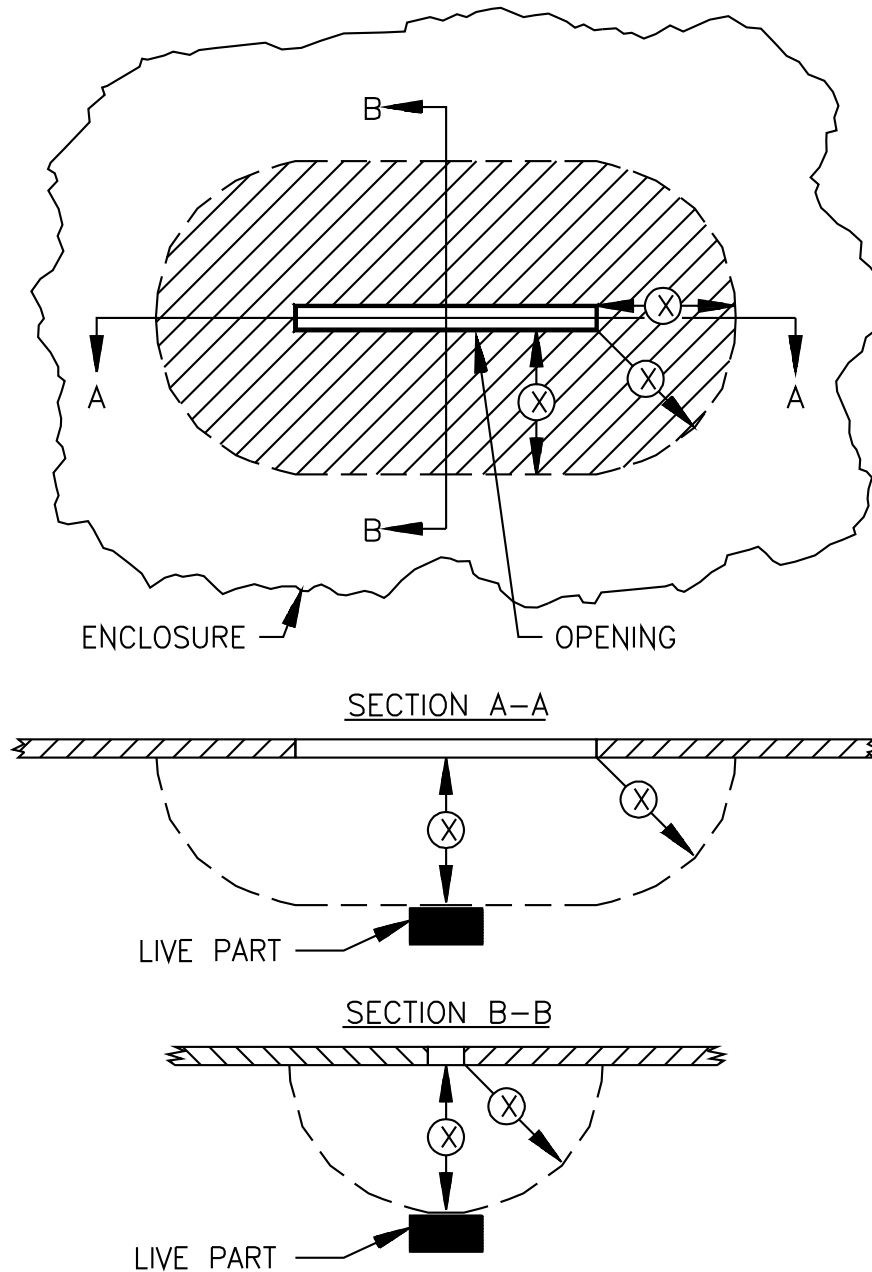
Figure 11.3
Probe



PA170B

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



EC100A

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

- Less than X inches (mm) from the perimeter of the opening, as well as
- 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 Inches	Conduit Size, O.D. Inches (mm)		Knockout or hole diameter Inches (mm)		Bushing dimensions			
					Overall diameter Inches (mm)		Height 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 (mm ²)	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 mm²) and larger conductors, pressure wire connectors shall be used. For field-wiring terminals intended for 10 AWG (5.3 mm²) 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 mm²) 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 mm²), 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 mm²) 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 mm²) 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.

15.4.2 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		Ampacity, A
AWG	(mm ²)	
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	(mm ²)	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 mm²) or larger,
 - 2) Not more than 4 feet (1.2 m) in length, and