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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UL 412

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.

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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

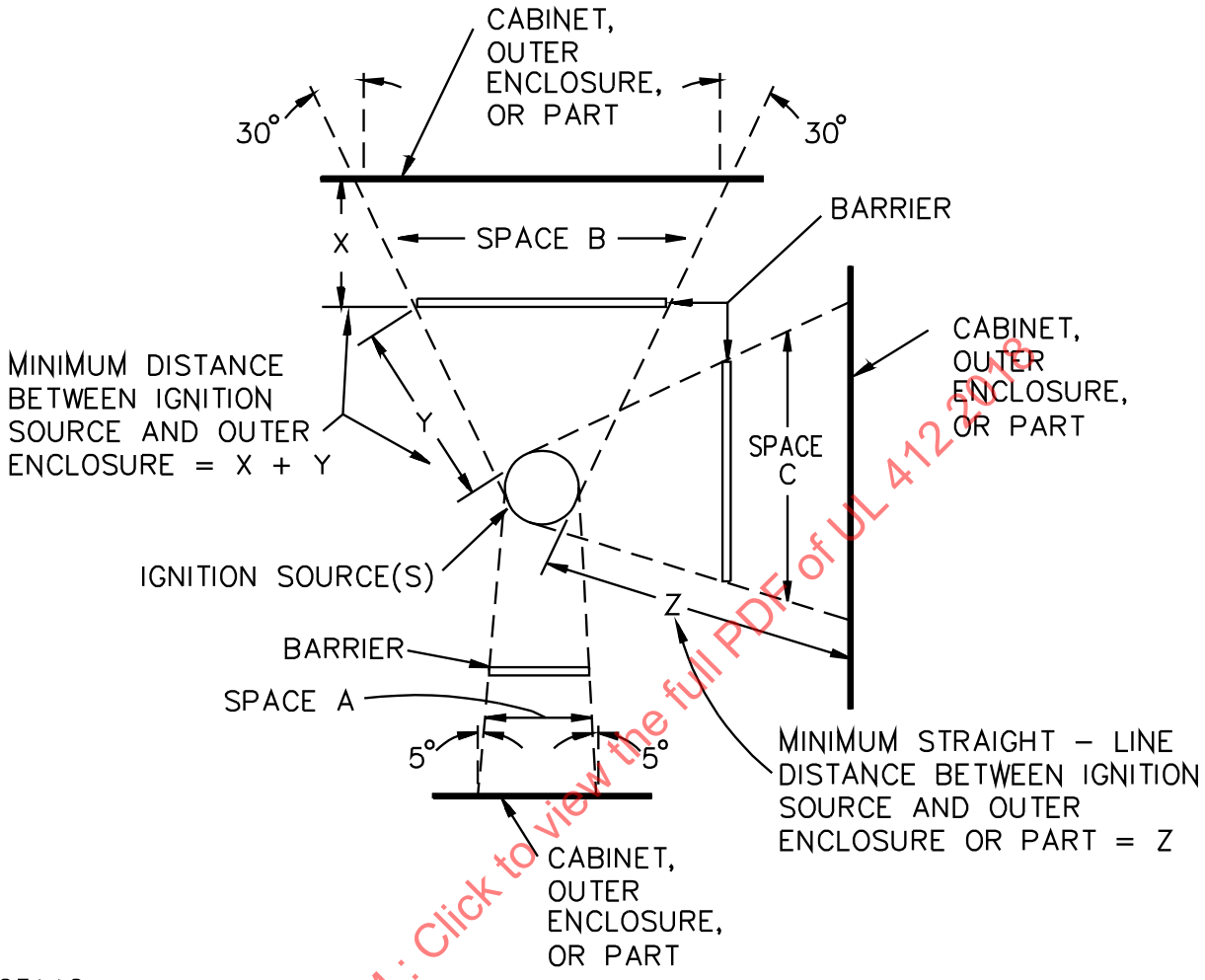
9.1 Parts formed from nonmetallic materials that are rated HB or HBF and positioned as shown in Figure 9.1 shall be separated from ignition sources by means of a barrier, extending at least to the boundary surface of the space whenever such parts are located:

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



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.

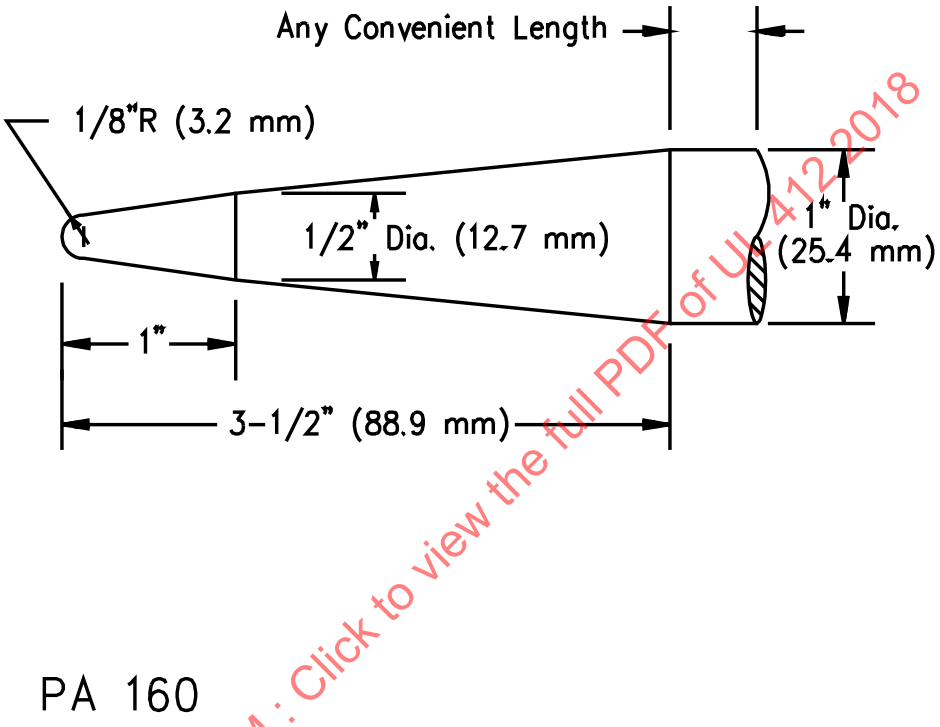
11.1.6 A fan blade employing a guard with openings having a minor dimension less than 1 inch (25.4 mm) shall be guarded such that the probe illustrated in Figure 11.1 cannot contact any part of the fan blade when inserted through openings in the guard with a force of 2.5 pounds (11.1 N).

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



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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.

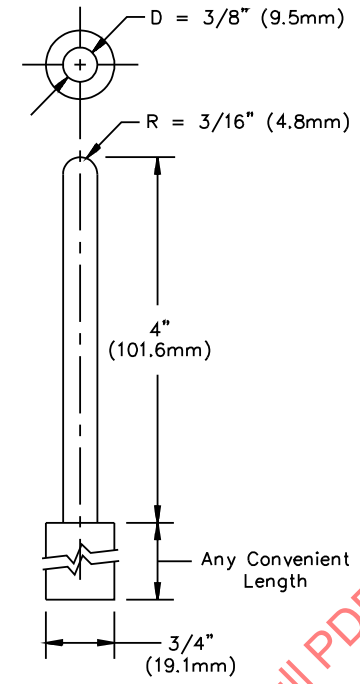
11.1.10 A heater element, as installed in the complete unit cooler, shall be protected against mechanical damage. A copper or steel sheath that:

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

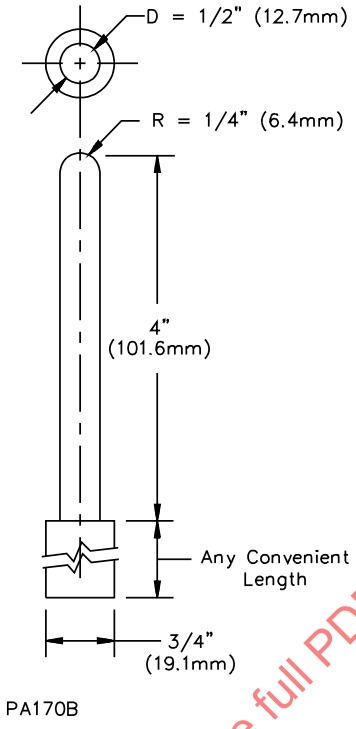


11.2 Protection from live parts

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.