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.