UL 416

STANDARD FOR SAFETY

Refrigerated Medical Equipment

UL Standard for Safety for Refrigerated Medical Equipment, UL 416

Fourth Edition, Dated August 30, 1993

Summary of Topics

This revision to UL 416 is being issued to remove the reference to the withdrawal date of UL 873 and to address universal upkeep of UL Standards for Safety. These revisions are considered to be non-substantive and not subject to UL's STP process.

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

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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AUGUST 30, 1993
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UL 416

Standard for Refrigerated Medical Equipment

The First and Second editions were titled Standard for Oxygen Therapy Equipment, Refrigerated.

First Edition – August, 1956
Second Edition – May, 1973
Third Edition – July, 1978

Fourth Edition

August 30, 1993

This UL Standard for Safety consists of the Fourth Edition including revisions through September 27, 2013.

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 http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover refrigerated medical equipment such as thermia and oxygen therapy devices for use in hospitals, nursing homes, medical care centers, medical and dental offices, and similar health care facilities in accordance with the National Electric Code, NFPA 70.

1.2 Equipment covered by these requirements employ hermetic refrigerant motor-compressors and air- or water-cooled condensers, designed for use on alternating current circuits rated not more than 600 volts. These requirements take into consideration the hazards resulting from the presence of oxygen and the intended use of oxygen administering equipment but do not cover the canopy (tent), or oxygen storage and distribution systems with which the equipment may be used.

1.3 These requirements do not cover equipment for use in hazardous locations, with respect to flammable anesthetics, as defined in the National Electrical Code, NFPA 70.

1.4 The requirements of this Standard do not consider the complete spectrum of physiological or therapeutic effects, beneficial or otherwise, except where generally accepted limits for potentially hazardous conditions are defined. Devices which necessitate the utilization of conditions exceeding such accepted limits for patient treatment are intended for use by or under the supervision of licensed medical persons. Such equipment shall be provided with warnings prominently displayed on the device.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the standard was developed, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this standard.

2 General

2.1 Components

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

2.1.2 A component need not comply with a specific requirement that:

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

b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

2.2.1 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.

2.3 Terminology

2.3.1 The term ″product″ refers to any equipment covered by the Scope of this standard.

2.4 Undated references

2.4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 For the purpose of this Standard, the following definitions apply.

3.2 ACCESSIBLE PART – A part located so that it can be contacted by a person, either directly or by means of a probe or tool, or that is not recessed the required distance behind an opening. See Assembly.

3.3 ACCESSORY – An optional electrical device or other component, intended for installation in or connection to refrigerated medical equipment for the purpose of modifying or supplementing the functions of the equipment. It may be factory installed or intended for installation by the user or service personnel.

3.4 DOUBLE INSULATION – An insulation system comprised of both functional insulation and supplementary insulation. See 3.7, 3.19, and 3.22.

3.5 ENCLOSURE – An external portion of a product that serves to house and/or support component parts. Enclosures of patient care equipment likely to be contacted by a patient include items such as bedside monitors, bed frames, dental chairs, oxygen therapy equipment, and examination stands.

3.6 FIELD-WIRING TERMINAL – Any terminal to which power supply, control, or equipment grounding connections will be made in the field when the product is installed.

3.7 FUNCTIONAL INSULATION – The insulation necessary for the proper functioning of the product and for basic protection against electric shock.

3.8 INTERLOCK – A device used to de-energize electrical components or stop moving parts that may cause injury to persons that become exposed when an enclosure is opened or when a cover is removed.

3.9 ISOLATING TRANSFORMER – A transformer of which one or more output windings is electrically separated from the input winding and all other output windings by an insulation at least equivalent to double and/or reinforced insulation.

3.10 LEAKAGE CURRENT – Leakage current refers to any current, including capacitively-coupled currents, which may be conveyed from accessible parts of a product to ground or other accessible parts of the product and which is not intended to be applied to a patient.

3.11 LIMITED ENERGY CIRCUIT – A limited energy circuit is one in which the product and wiring is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of cotton in an oxygen-enriched atmosphere. Abnormal conditions include unintentional damage to any part of the equipment or wiring, failure of insulation or other failure of electrical components, application of overvoltage, adjustment and maintenance operations, and other similar conditions.

3.12 OPERATING CONTROL – A control, usually a knob, pushbutton, or lever, provided to enable the user to cause the product to perform its intended function, without the use of tools.

3.13 OPERATOR (USER) SERVICING – Any form of servicing that might be performed by personnel other than qualified service personnel. Some examples are:

a) The attachment of accessories by means of attachment plugs and receptacles or by means of other separable connectors.

b) The replacement of recording paper rolls, tapes, and similar items.

c) Resetting of circuit breakers or replacement of tubes, fuses, and lamps that are accessible without the use of tools.

d) Routine operating adjustments necessary to adapt the product for its different intended functions.

e) Routine cleaning, changing of filters and pens, removal of blockages in tubing, and clearing of jams in data-recording media.

3.14 PATIENT-CONNECTED CIRCUITS – All patient connections, such as pads, contacts, probes, sensors, or cuffs applied to the patient and any associated leads, cables, components, or wiring either within or external to the product enclosure. As seen from the patient into the equipment, these circuits extend to the points where the required degree of isolation or protective impedance is reached.

3.15 PATIENT CONNECTIONS –

a) Isolated – A direct or indirect patient contact that is deliberately separated from the supply circuit and ground by virtue of spacings, insulation, protective impedance, or a combination thereof, e.g., electrocardiogram (ECG) leads, intra-aortic pressure monitor.

b) Ordinary – A direct patient contact that does not have the spacings, insulation or protective impedance associated with an isolated patient connection, e.g., blood pressure cuff, thermometers, ultrasonic transducer head.

3.16 PRINTED WIRING – A pattern of conductive material formed in a predetermined design on the surface or surfaces of an insulating base, and intended primarily to provide point-to-point electrical connections, shielding, or to form circuit elements.

3.17 PRINTED WIRING ASSEMBLY – A printed wiring board on which separate components have been added.

3.18 PRINTED WIRING BOARD – The combination of a printed wiring pattern and the insulating base, completely processed as far as the printed portion is concerned.

3.19 REINFORCED INSULATION – Improved functional insulation with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against electric shock as double insulation.

3.20 SAFETY CIRCUIT – Any circuit, either in the primary or secondary, that is relied upon to reduce a risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons, for example, an interlock circuit is considered to be a safety circuit.

3.21 SECONDARY CIRCUITS – Secondary circuits are those circuits supplied from transformer output windings which are electrically separated from the input windings.

3.22 SUPPLEMENTARY (PROTECTIVE) INSULATION – An independent insulation provided in addition to the functional insulation to assure protection against electrical shock in case of failure of the functional insulation.

3.23 SUPPLY CIRCUIT – The branch circuit supplying electrical energy to the product.

3.24 TYPES OF EQUIPMENT – Recognizing the differences in applications to the patient and in the degree of risk posed by electrical equipment in various areas of a health care facility, i.e., professional office, clinic, hospital, or laboratory, refrigerated medical equipment covered by this Standard is treated as follows:

a) Patient Care Equipment – Equipment intended to be used on or with, or likely to be contacted by, a patient in a health care facility in the course of his treatment.

b) Nonpatient Equipment – Equipment for use in a health care facility and for use where contact with a patient is unlikely.

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

4 Installation and Operating Instructions

4.1 The product shall be provided with installation and operating instructions. The instructions shall contain such directions and information as deemed by the manufacturer to be necessary for the proper installation, maintenance, and use of the product. Particular consideration shall be given to directions relating to cleaning and sterilization procedures.

4.2 A copy of the manufacturer's operating and installation instructions, or equivalent information intended to accompany each product 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 product. 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.

CONSTRUCTION

5 General

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

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

5.2 A product shall be constructed so that it can be cleaned or sterilized in accordance with the manufacturer's instructions, see Installation and Operating Instructions, without affecting the application, operation, and performance of the product. One sample of the product, or appropriate portion of the sample if it is intended to be only partially cleaned or sterilized, shall be subjected to the Cleaning and Sterilization Test if it is not obvious that the product complies with this requirement.

5.3 Carrying handles or grips furnished on a portable product shall withstand loading as described in 44.1. The handles shall not break loose from the product and there shall be no permanent distortion, cracking, or other evidence of failure.

5.4 Mounting brackets on a product intended to be wall or ceiling mounted shall withstand loading as described in 44.2 without evidence of damage to the brackets or mounting surface.

5.5 Unless an investigation shows the circuits to be energy limited as defined in 3.11, all electrical components shall be separated from oxygen-enriched atmospheres. An oxygen-enriched atmosphere is considered to exist if the oxygen concentration exceeds 21 percent by volume.

5.6 In applying 5.5 to products such as oxygen-therapy equipment, it will be necessary to provide barriers between the oxygen-enriched atmosphere and those areas containing electrical components. Small neoprene or asbestos gaskets and grommets are considered acceptable on a motor mounting plate and shaft and may be employed in conjunction with thermal-sensing devices extending into the oxygen-enriched atmosphere provided there is ventilation of outside air into the electrical compartment to limit the oxygen concentration. See 18.14.

5.6 revised June 24, 1997

5.7 Components requiring oiling shall not be located in areas in which oxygen is discharged.

6 Assembly

6.1 General

6.1.1 A product incorporating a condensing unit of the pull-out type shall be constructed so that the condensing unit can be pulled out without kinking or otherwise damaging the refrigerant tubing and without pinching, abrading, or stressing wires and cords.

6.2 Mechanical protection

6.2.1 Louvers and other openings in the enclosure shall be constructed and located to prevent unintentional contact with hazardous moving parts and with hot surfaces. See 6.2.5 and 6.2.6. Parts such as covers, panels, or grilles used as part of the enclosure are to be removed unless tools are required for their removal.

6.2.2 Hazardous moving parts, such as fan blades, blower wheels, or belts, shall be guarded or enclosed so that the minor dimension of any opening shall not exceed the values indicated in 6.2.3.

6.2.3 The distance from an opening to the moving part shall be in accordance with Table 6.1, but the minor dimension of the opening shall not, in any case, exceed 1 inch (25.4 mm). For an opening having a minor dimension intermediate between two of the values included in the table, the distance from the opening to the moving part shall be not 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 5 pounds (22.3 N).

Table 6.1
Dimensions of openings

Minor dimensions of opening[a]		Minimum distance from opening to moving part	
inches	(mm)	inches	(mm)
1/4	(6.4)	1/2	(12.7)
3/8	(9.5)	1-1/2	(38.1)
1/2	(12.7)	2-1/2	(63.5)
3/4	(19.1)	4-1/2	(114.0)
1	(25.4)	6-1/2	(165.0)

[a] Openings less than 1/4 inch (6.4 mm) are not to be considered.

6.2.4 A moving part is not to be considered when judging compliance with 6.2.2 and 6.2.3 if:

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

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

6.2.5 When tested in accordance with the Temperature and Pressure Test and the Heating Test, surfaces which exceed the temperature rise of (d) (2) or (d) (3) of Table 36.1 shall be guarded in accordance with 6.2.2 – 6.2.3.

6.2.6 The sheath of a heater element, as installed in the complete product, shall be protected against mechanical damage. In addition, if the temperature of a heater exceeds the limits permitted by (d)(2) or (d)(3) of Table 36.1, whichever is appropriate, it shall be guarded in accordance with 6.2.2 - 6.2.3 to protect persons from coming in contact with it.

6.3 Electrical protection

6.3.1 Louvers and other openings in the enclosure shall be constructed and located to prevent unintentional contact with uninsulated live parts. Parts such as covers, panels, or grilles used as part of the enclosure are to be removed unless tools are required for their removal or an interlock is provided. See 8.2.1.

6.3.2 Uninsulated live parts of the product shall be located, guarded, or enclosed as indicated in 6.3.3 - 6.3.16. These requirements apply only to parts of high-voltage circuits.

6.3.3 If an opening in the enclosure will not permit the entrance of a 3/4 inch (19.1 mm) diameter rod, the probe illustrated in Figure 6.1 shall not touch any uninsulated live parts and the probe illustrated in Figure 6.2 shall not touch any enamel insulated wire when inserted through the opening. The probe shall not pass through grilles, screens, louvers, or the like when a force of 5 pounds (22.3 N) is applied.

Figure 6.1
Probe

Figure 6.1 revised November 24, 1998

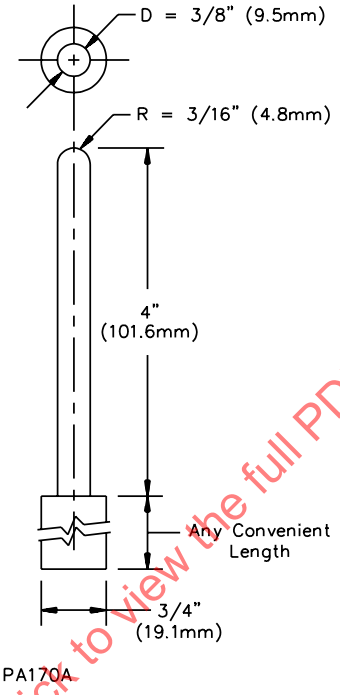
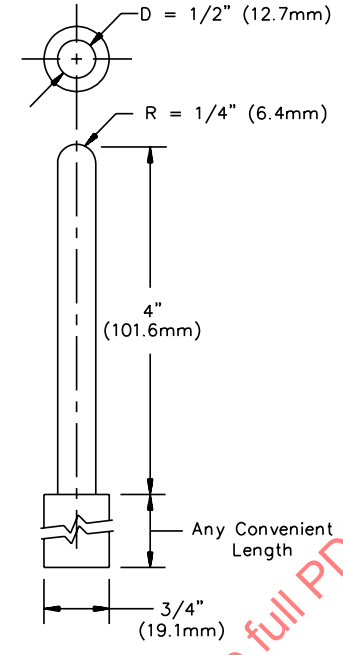


Figure 6.2
Probe

Figure 6.2 revised November 24, 1998



6.3.4 If an opening in the enclosure permits the entrance of a 3/4 inch (19.1 mm) diameter rod, the conditions described in Figure 6.3 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.

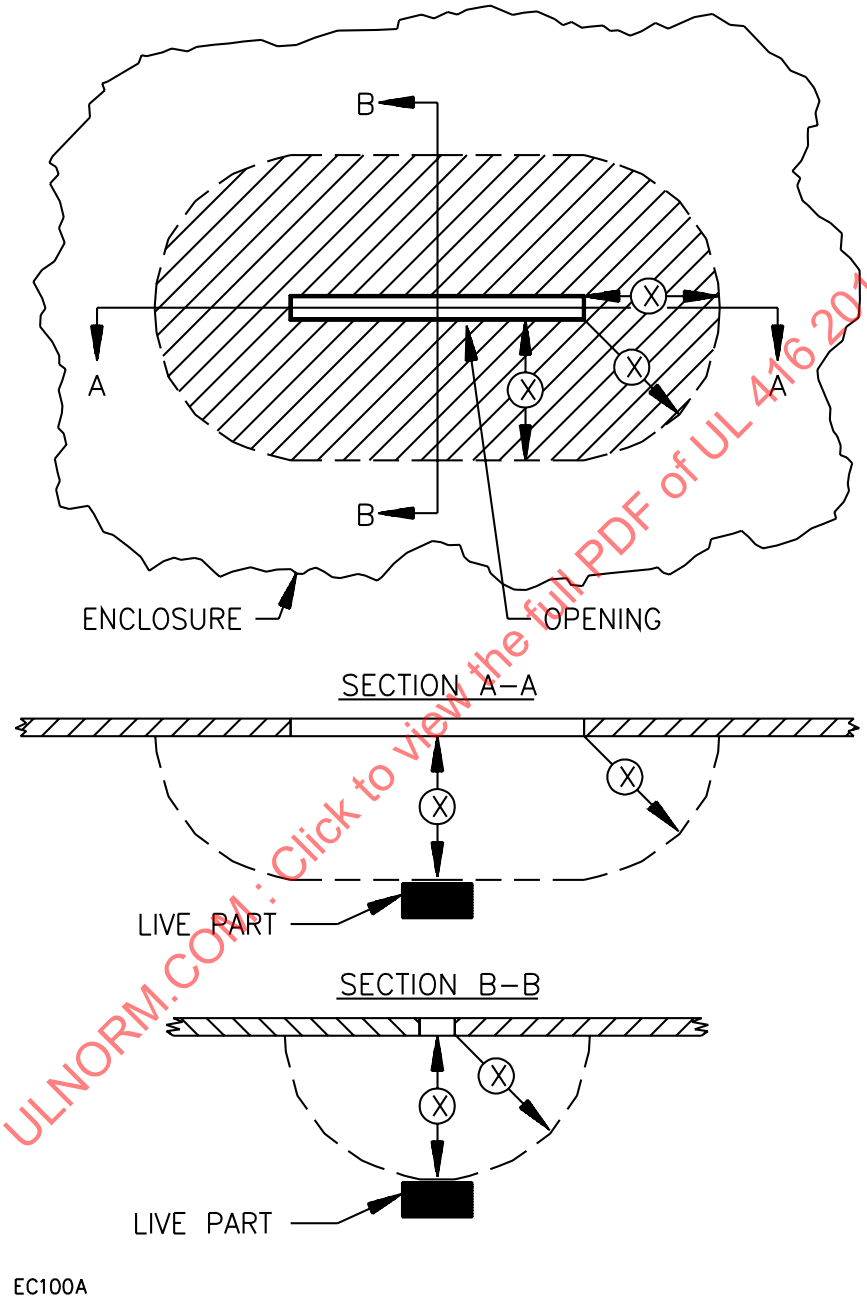
6.3.5 In addition to the requirements of 6.3.2 – 6.3.4, uninsulated live parts inside the enclosure which are likely to be contacted by persons performing operations such as refilling, relamping, replacing fuses, resetting manual-reset devices, oiling motors, or other such normal service operations shall be located, guarded, or enclosed to prevent accidental contact unless tools are required to expose the live part. See 66.2.1.

6.3.6 A fuseholder shall be constructed, installed, or protected so that adjacent uninsulated high-voltage live parts, other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder, will not be exposed to contact by persons removing or replacing 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) is considered to be adjacent.

6.3.7 Electrical components shall be located or enclosed so that live parts will not be wetted by liquids due to accumulation, overflow, splashing, leakage, cleaning, or defrost.

Figure 6.3
Opening in enclosure

Figure 6.3 revised November 24, 1998



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The opening is acceptable if, within the enclosure, there is no uninsulated live part or enamel-insulated wire:

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

b) Within the volume generated by projecting the perimeter X inches (mm) normal to its plane. X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 4 inches (102 mm).

6.3.8 Fluid reservoirs, condensate parts or receptacles and the like shall be constructed and located so that overflow will not wet live parts or enamel insulated wire.

6.3.9 An overflow spout, drain hole, cutout, or the like in the condensate pan may be acceptable for preventing dripping of water on electrical parts. An Overflow Test, Section 41, is to be conducted if it is not evident that the product complies with 6.3.8.

6.3.10 A switch, lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be secured in position and, except as noted in 6.3.11 and 6.3.12, shall be prevented from turning. See 6.3.13.

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

a) The switch is to be of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during the operation of the switch,

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

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

d) Operation of the switch is to be by mechanical means rather than direct contact by persons.

6.3.12 A lampholder of a type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values. See Spacings, Section 25.

6.3.13 The means for preventing rotation mentioned in 6.3.10 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.

6.3.14 An uninsulated current carrying part and a part that supports a live part shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum acceptable values. See Section 25, Spacings. Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part, but a lock washer as described in 6.3.13 is acceptable.

6.3.14 revised June 24, 1997

6.3.15 Flammable or electrically conductive thermal or acoustical insulation shall not contact uninsulated live parts. See 50.2.1.

6.3.16 Materials used for acoustical or thermal insulation in oxygen-administering equipment shall be classified Type 5V in accordance with the requirements for flammability of plastic materials for use in devices and appliances, UL 94.

6.3.16 revised November 24, 1998

7 Accessories

7.1 A product 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.

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

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

7.4 With reference 7.3, 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 electrical enclosures and in other areas where such operations may damage electrical or refrigeration components and wiring within the enclosure.

7.5 Strain-relief means shall be provided for the wiring in the accessory if there is a possibility of transmitting strain to the terminal connections during installation.

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

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7.7 Except where it is obvious, the mounting location of the accessory shall be indicated on the product. If the mounting location is obvious due to the function of the accessory and arrangement of the product, and instructions are provided covering the installation and location for the accessory, the mounting location of the accessory need not be indicated on the product.

7.8 As part of the investigation, accessories are to be trial installed to determine that their installation is feasible, and that the instructions provided are detailed and correct.

8 Enclosures

8.1 General

8.1.1 Enclosures shall be formed and assembled so that they will have the strength and rigidity necessary to resist the abuses to which they may be subjected without increasing the risk of fire or unintentional contact with hazardous moving parts due to total or partial collapse with the resulting reduction of spacings, loosening or displacement of parts, or other serious defects. Enclosures for individual electrical components, outer enclosures, and combinations of the two are considered in determining compliance with this requirement.

8.1.2 A risk of fire is considered to exist at a component part or assembly if an investigation shows that the supply for such part or assembly is capable of delivering a power of more than 15 watts into an external resistor connected between the point in question and any return to the power supply.

8.1.3 An electrical shock is considered to exist at any accessible conductive part of a product if the available current through an appropriate impedance connected between the part and other accessible conductive parts or between the part and ground, is more than the values specified in 33.4.1 and 33.7.1.1, as determined by the type of equipment involved. See 3.24.

8.1.4 For unreinforced flat surfaces, cast metal shall be not less than 1/8 inch (3.2 mm) in thickness, except malleable iron shall be not less than 3/32 inch (2.4 mm) in thickness and die-cast metal shall be not less than 5/64 inch (2.0 mm) in thickness. Corresponding thicknesses of not less than 3/32, 1/16, and 3/64 inch (2.4, 1.6, and 1.2 mm) may be used if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape and/or size of the surface is such that adequate physical strength is provided.

8.1.5 Unless investigated and found acceptable for the application, the thickness of a sheet-metal enclosure shall be not less than the value indicated in Table 8.1. See 8.2.3 with reference to the minimum thickness at a point where conduit or metal-clad cable is to be connected.

8.1.6 Among the factors which are taken into consideration when evaluating an enclosure are:

a) Mechanical strength,

b) Resistance to impact,

c) Moisture-absorptive properties,

d) Flammability,

e) Resistance to distortion at temperatures to which the material may be subjected under conditions of use, and

f) Resistance to corrosion. For a nonmetallic enclosure or part of an enclosure, all of these factors are considered with respect to aging.

Table 8.1
Thickness of sheet metal

Table 8.1 revised June 24, 1997

Maximum dimensions of enclosure				Minimum thickness of sheet metal in inches											
				Steel[a]								Copper, brass, or aluminum[a]			
				Without supporting member				With reinforcing support[c]							
Length or width,		Area in,		Zinc coated,		Uncoated,		Zinc coated,		Uncoated,		Without supporting member,		With reinforcing support[c],	
inch	mm	inch^2	cm^2	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
3	76.4	6[b]	38.7	0.023 (24)	0.584	0.020 (24)	0.508	0.023 (24)	0.584	0.020 (24)	0.508	0.023 (22)	0.584	0.023 (22)	0.584
8	203.2	36	232.3	0.029 (22)	0.740	0.026 (22)	0.660	0.023 (24)	0.584	0.020 (24)	0.508	0.036 (18)	0.910	0.029 (20)	0.740
12	304.8	90	580.7	0.034 (20)	0.864	0.032 (20)	0.813	0.023 (24)	0.584	0.020 (24)	0.508	0.045 (16)	1.143	0.029 (20)	0.740
18	457.2	135	871.0	0.045 (18)	1.143	0.042 (18)	1.067	0.034 (20)	0.864	0.032 (20)	0.813	0.058 (14)	1.473	0.045 (16)	1.143
24	609.6	360	2322.1	0.056 (16)	1.422	0.053 (16)	1.346	0.045 (18)	1.143	0.042 (18)	1.067	0.075 (12)	1.905	0.058 (14)	1.473
48	1219.2	1200	7742.0	0.070 (14)	1.778	0.067 (14)	1.702	0.056 (16)	1.422	0.053 (16)	1.346	0.095 (10)	2.413	0.075 (12)	1.905
60	1524.0	1500	9678.0	0.097 (12)	2.464	0.093 (12)	2.362	0.056 (16)	1.422	0.053 (16)	1.346	0.122 (8)	3.099	0.075 (12)	1.905
Over 60	1524.0	Over 1500	9678.0	0.126 (10)	3.200	0.123 (10)	3.124	0.056 (16)	1.422	0.053 (16)	1.346	0.153 (6)	3.886	0.075 (12)	1.905

[a] The figures in parentheses are the Manufacturer's Standard Gage numbers (for uncoated steel), the Galvanized Sheet Gage numbers (for zinc-coated steel) and the American Wire Gage (B&S) numbers (for copper, brass, or aluminum) which provide the specified minimum thickness of metal.

[b] Volume of enclosure not more than 12 cubic inches (196.7 cm^3).

[c] Any subdivided area not provided with a reinforcing support is considered to be without support in determining minimum thicknesses.

8.1.7 The enclosure(s) of a product shall prevent mechanical damage to wiring, electrical components, and refrigerant tubing.

8.1.8 The enclosure shall prevent the emission of molten metal, burning insulation, flaming particles, or the like through openings onto flammable material, including the surface upon which the product is mounted.

8.1.9 Unless it can be determined that failure of an electrical component will not result in a risk of fire, components, such as controls, solenoids, starting relays, and switches, shall be individually enclosed except at terminals. See Burnout Tests – Components.

8.1.10 The requirement in 8.1.8 necessitates the use of a metal barrier or a barrier of material classified as Type 5V when tested in accordance with the requirements for flammability of plastic material for parts in devices and appliances, UL 94:

a) Under a motor unless:

1) The structural parts of the motor or of the product provide the equivalent of such a barrier.

2) The overload (overcurrent) protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the product when the motor is energized under each of the following fault conditions:

i) Open main winding,

ii) Open start winding,

iii) Starting switch short-circuited, and

iv) Capacitor of a permanent-split-capacitor motor short-circuited, or

3) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current) so that the temperature of the motor windings will not exceed 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and will not exceed 150°C (302°F) with the rotor of the motor locked.

b) Under wire unless it is of the flame-retardant type, e.g., polyvinyl chloride- or neoprene-insulated.

8.1.10 revised November 24, 1998

8.1.11 The barrier mentioned in 8.1.10 shall be horizontal or constructed to provide equivalent protection, shall be located as indicated in Figure 9.1, and shall not be smaller in area than indicated in Figure 9.1. Openings for drainage, ventilation, or the like, may be employed in the barrier if the openings are protected by a baffle, screen, or the like so that molten metal, burning insulation, and the like cannot fall outside the enclosure.

8.1.12 Sheet metal to which 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 metal.