



UL 1076

STANDARD FOR SAFETY

Proprietary Burglar Alarm Units and Systems

UL Standard for Safety for Proprietary Burglar Alarm Units and Systems, UL 1076

Sixth Edition, Dated April 6, 2018

Summary of Topics

This revision of ANSI/UL 1076 dated February 16, 2021 includes Expansion of Electronic Media (including websites) for Installation Instructions; [7.4](#), [7.5](#) and Section [8](#).

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 July 3, 2020 and September 23, 2020.

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The Department of Defense (DoD) has adopted UL 1076 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 apply to the construction, performance and operation of equipment intended for use in proprietary burglar alarm units and systems used to protect against burglary. These products are normally intended for indoor use.

1.2 A proprietary burglar alarm system as referred to by these requirements is a system in which alarm initiating circuits and devices are installed at a property and are connected directly or indirectly to constantly monitored receiving equipment at a central supervising station. The central supervising station is located at the protected property and intended for operation by personnel responsible to the owner of the protected property. The protected property may consist of a single property or of noncontiguous properties under a single ownership. The system is arranged so that a predetermined change in the alarm initiating circuits or devices automatically causes transmission of an alarm signal over a supervised signaling channel to the central supervising station.

1.3 These systems normally operate within the limits of Class 2 remote-control and signal circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

1.4 The protection circuit must respond to both an increase and a decrease in the circuit resistance or current within the limits indicated in the appropriate sections of this standard. See [58.3](#), [62.2](#), and [67.6](#).

1.5 A system that provides line security may be classified as either standard line security or encrypted line security. See Standard Line Security Equipment, Section [71](#), and Encrypted Line Security Equipment, Section [72](#).

1.6 Protective devices installed on individual properties are further classified as to extent of protection at each location. Requirements covering installation and classification (of extent) of alarm protective equipment at individual locations are published in the Standard for Installation and Classification of Burglar and Holdup Alarm Systems, UL 681, which is intended to be referenced by burglar-alarm installers.

1.7 Proprietary burglar alarm units and systems are also specially designated as to their intended use on mercantile premises, mercantile safes and vaults, and bank safes and vaults.

1.8 Equipment intended for combination burglar alarm and fire-protective signaling systems shall comply with the requirements in the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

2 Components

2.1 Except as indicated in [2.2](#), 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.

2.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

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

2.4 Specific components are 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.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3.2 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

4 Undated References

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.

5 Terminology

5.1 The term "product" as used in this standard refers to all types of proprietary burglar alarm units and systems.

6 Glossary

6.1 For the purpose of this standard the following definitions apply.

6.2 **ACKNOWLEDGEMENT SIGNAL** – An audible and/or visual signal that is sent to the subscriber by the central station to notify the subscriber that a signal has been received indicating that the protection system has been properly armed. The acknowledgement signal can be sent manually or automatically.

6.3 **CENTRAL SUPERVISORY STATION** – A physically protected building or enclosed area within a building that is constantly manned for the purpose of providing immediate attention to all signals received from the protected areas.

6.4 **CIRCUITS, ELECTRICAL:**

a) **HIGH-VOLTAGE** – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage power-limited circuit.

b) **LOW-VOLTAGE** – A circuit involving a potential of not more than 30 volts alternating current (ac) rms, 42.4 volts direct current (dc) or AC peak.

c) **POWER-LIMITED** – A circuit whose output is limited as described in [Table 6.1](#) and [Table 6.2](#). The power limitation shall be provided by the design of the transformer, a fixed impedance, a noninterchangeable fuse, a nonadjustable manual reset circuit protective device, or a regulating network.

Table 6.1
Power limitations for inherently limited power source (overcurrent protection not required)

Circuit voltage V_{max}^a AC-DC (volts)	Maximum nameplate ratings		Current limitation I_{max}^b (amperes)
	VA (volt-amperes)	Current (amperes)	
0 to 20	$5.0 \times V_{max}^a$	5.0	8.0
Over 20 to 30	100	$100/V_{max}^a$	8.0
Over 30 to 100	100	$100/V_{max}^a$	$150/V_{max}^a$
Over 100 to 250 DC only	$0.030 \times V_{max}^a$	0.030	0.030

NOTE – Reproduced in part from the National Electrical Code (ANSI/NFPA 70-1993 Edition), copyright National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

^a V_{max} : Maximum output voltage regardless of load with rated input applied.

^b I_{max} : Maximum output after 1 minute of operation under any noncapacitive load, including short circuit.

Table 6.2
Power limitations for power sources not inherently limited (overcurrent protection required)

Circuit voltage V_{max}^a AC-DC (volts)	Maximum nameplate ratings		Current limitation I_{max}^b (amperes)	Power limitation $(VA)_{max}^c$ (volt-amperes)	Maximum overcurrent protection (amperes)
	VA (volt-amperes)	Current (amperes)			
0 to 20	$5.0 \times V_{max}^{a,d}$	5.0	$1000/V_{max}^a$	250	5.0
Over 20 to 100	100	$100/V_{max}^a$	$1000/V_{max}^a$	250	$100/V_{max}^a$
Over 100 to 150	100	$100/V_{max}^a$	1.0	NA	1.0

NOTE – Reproduced from the National Electrical Code (ANSI/NFPA 70-1993 Edition), copyright National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

^a V_{max} : Maximum output voltage regardless of load with rated input applied.

^b I_{max} : Maximum output after 1 minute of operation under any noncapacitive load, including short circuit, and with overcurrent protection bypassed.

^c $(VA)_{max}$: Maximum volt-ampere output regardless of load with overcurrent protection bypassed.

^d If the power source is a transformer, $(VA)_{max}$ is 350 or less when V_{max} is 15 or less.

6.5 COMPUTER SYSTEM, FAULT TOLERANT – A computer system containing multiple power supplies, disk drives, processors, and controllers each backing up and checking on the process of others. In the event of a component failure, the other modules take over the function performed by the failed components without affecting the operation of the computer. In addition to the duplicating hardware, a fault-tolerant system includes the necessary software to make the system operational.

6.6 COMPUTER SYSTEM, REDUNDANT – Two computer systems maintained at a central station, either of which can quickly be connected and operational for handling alarm signals in the event that the other computer fails to operate. See [6.5](#) for the definition of a fault-tolerant computer system. A fault-tolerant computer system is considered to be redundant.

6.7 CORD-CONNECTED UNIT – A unit intended for connection to the power source by means of a supply cord. By the nature of its design, such a unit is intended to be moved for reasons of interchange or realignment of the units of a system.

6.8 CRYPTOGRAPHIC AUTHENTICATION – Algorithms intended to ensure the secrecy and/or authenticity of messages.

6.9 DIGITAL ALARM COMMUNICATOR (DAC) – A transmission method as outlined in the Standard for Digital Alarm Communicator System Units, UL 1635, by cellular and/or telephone landline transmission.

6.10 **HARDWIRE KEY DEVICE** – A mechanical or electronic device employed to enable the remote programming mode.

6.11 **HVAC SYSTEM** – Heating, Ventilating, and Air-Conditioning system.

6.12 **LINE-VOLTAGE** – The voltage at any field-connected source of supply, nominally 50 – 60 hertz; 115, 208, or 230 volts.

6.13 **MULTIPLEXING** – A signaling method using wire path, cable carrier, radio, or combinations of these methods characterized by the simultaneous and/or sequential transmission and reception of multiple signals in a communication channel including means for positively identifying each such signal.

6.14 **NORMAL STANDBY CONDITION** – The ready-to-operate condition which exists prior to being tripped or operated by an intrusion.

6.15 **PACKET SWITCHED DATA NETWORK (PSDN)** – A type of data transmission in which data is divided into packets, each of which has a destination address. Each packet is then routed across a computer network. A packet may travel a different route than packets related to it.

6.16 **PRIMARY BATTERY** – Any battery which by design or construction is not intended to be recharged.

6.17 **RADIO FREQUENCY** – Electromagnetic radiation normally 20 kilohertz or higher.

6.18 **"SAFETY" CIRCUIT** – Any circuit that is relied upon to reduce the risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons (an interlock circuit, for example).

6.19 **SECONDARY BATTERY** – Any battery which, by design or construction, is intended to be recharged.

6.20 **SERVICE CENTER** – A location that may be separate from the alarm service company's main business location providing runner, installation, maintenance, and repair service to systems served by the central supervising station. Keys for protected premises are retained at the service center. The service center is to keep maintenance records for the systems that it serves unless the records can be accessed from another location.

6.21 **SERVICE VEHICLE** – A vehicle used to provide runner service, installation, maintenance, and repair service to systems served by the company.

6.22 **SIGNAL TRANSMISSION METHODS** – Any of the following methods: direct wire, multiplex, derived channel, two way radio (RF), DACT/DACR, one way radio (RF), packet switched data network, or code transmitter.

6.23 **SOFTWARE** – Instructions that are temporarily or permanently stored in the computer's memory and used to provide function and control of the computer's components.

6.24 **SYSTEM DATABASE** – Information entered into the computer by authorized personnel including items such as, but not limited to, names, addresses, telephone numbers, security information for system users, graphics and the like.

7 Installation and Operating Instructions

7.1 A copy of the installation and operating instructions intended to accompany the product and related schematic wiring diagrams and installation drawings are to be furnished with the sample submitted for

investigation to be used as a guide in the examination and test of the product, and for this purpose need not be in final printed form.

7.2 The instructions and drawings shall include at least the following:

- a) Typical installation drawing layouts and complete representative installation wiring diagram(s) for the product(s) indicating recommended locations and wiring methods which shall be in accordance with the National Electrical Code, ANSI/NFPA 70-1993.
- b) A concise description of the operation, testing, and maintenance procedures for the product(s), and recommended testing frequency (which shall be at least once per year).
- c) Replacement parts, such as lamps or batteries, shall be identified in the instructions by a part number, manufacturer's model number, or the equivalent.
- d) A description of the conditions which might be expected to result in false alarms or impaired operation of the product(s).
- e) A description of any features provided to reduce the risk of electric shock or fire, and a warning against bypassing such features.

7.3 The instructions may be incorporated on the inside of the product, on a separate sheet, or as part of a manual. If not included directly on the product, the instructions or manual shall be referenced in the marking information on the product. See Markings, General, Section [91](#).

7.4 The installation and operating instructions containing the information required in [7.2](#) shall be made available by one or more of the following means:

- a) Printed hardcopy format;
- b) Installation wiring diagram/instructions attached to the product;
- c) Electronic instructions within the basic product software; or
- d) Electronic media such as CD, DVD, thumb drive, website, or equivalent.

7.5 When the installation and operating instructions are included as described in [7.4](#) (a), (c), or (d), they shall be referenced in the product marking by document number and issue date and/or revision level. Products utilizing electronic media as described in [7.4](#) (c) or (d), shall include information on how to receive a printed copy of the installation and operating instructions.

8 Installation and Operating Instructions Physical Media

8.1 Deleted

8.2 Deleted

8.3 Deleted

CONSTRUCTION

ASSEMBLY

9 General

9.1 Product assembly

9.1.1 The product shall be factory-built as a complete assembly and shall include all the components necessary for its intended function when installed and used as intended. The product may be shipped from the factory as two or more major subassemblies. See [9.1.2](#).

9.1.2 If the product is not assembled by the manufacturer as a complete unit, it shall be arranged in major subassemblies. Each subassembly shall be capable of being incorporated into a final assembly without requiring alteration, cutting, drilling, threading, welding, or similar tasks by the installer. Two or more subassemblies, which shall bear a definite relationship to each other for the intended installation or operation of the product, shall be arranged and constructed to permit them to be incorporated into the complete assembly in only the intended relationship with each other without need for alteration or alignment; otherwise, such subassemblies shall be assembled, tested, and shipped from the factory as one element.

9.2 Electrical protection

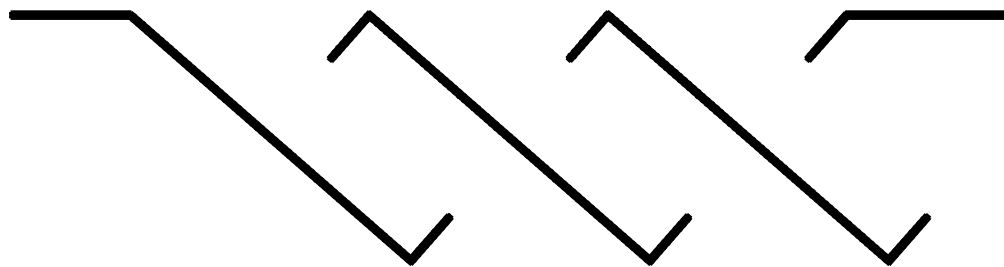
9.2.1 Louvers and other openings in the enclosure shall be constructed and located to prevent unintentional contact with uninsulated high-voltage live parts. In determining compliance with this requirement, parts such as covers, panels and grilles used as part of the enclosure are to be removed unless tools are required for their removal or an interlock is provided.

9.2.2 Uninsulated high-voltage live parts shall be located, guarded, or enclosed as indicated in [9.2.3](#) – [9.2.5](#).

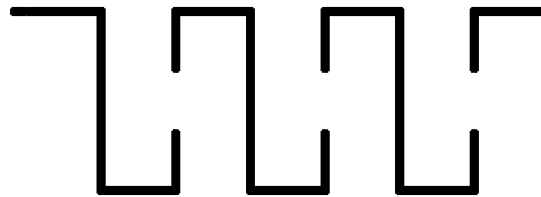
9.2.3 Openings directly over uninsulated high-voltage live parts shall not exceed 0.187 inch (4.75 mm) in any dimension unless the configuration is such to reduce the risk of direct entry to uninsulated high-voltage live parts. See [Figure 9.1](#) for examples of top cover constructions that are considered to reduce the risk of direct entry.

Figure 9.1

Cross-sections of top cover constructions



SLANTED OPENINGS

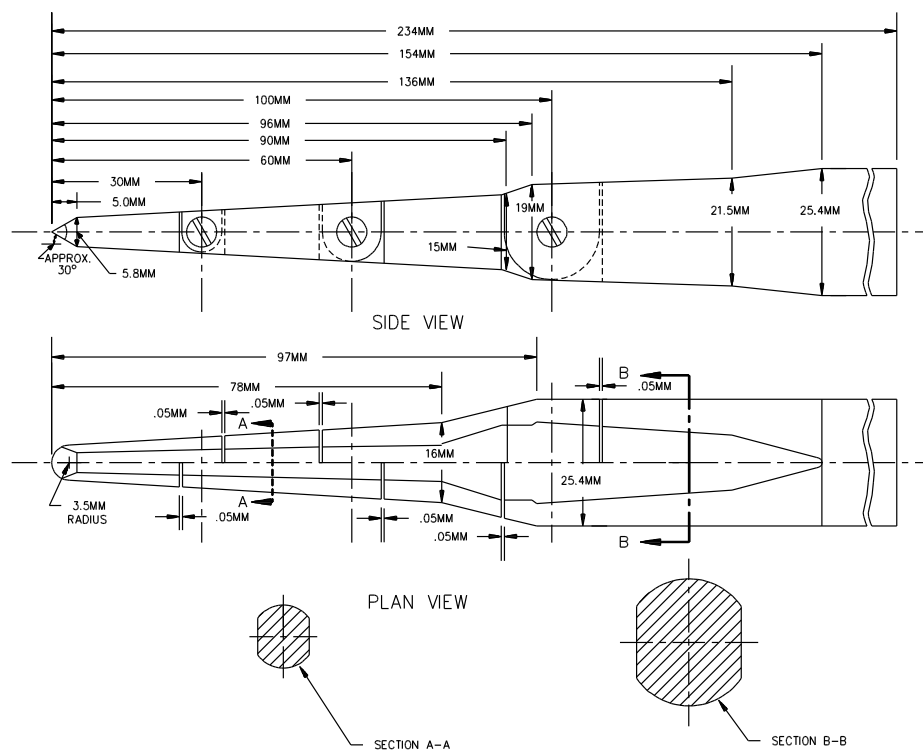


EC500

VERTICAL OPENINGS

9.2.4 An opening in an electrical enclosure shall not permit entrance of a 1-inch (25.4-mm) diameter rod and shall be sized and so arranged that a probe, as illustrated in [Figure 9.2](#), cannot be made to contact any uninsulated live electrical part (other than low-voltage) when inserted through the opening in a straight or articulated position.

Figure 9.2
Probe

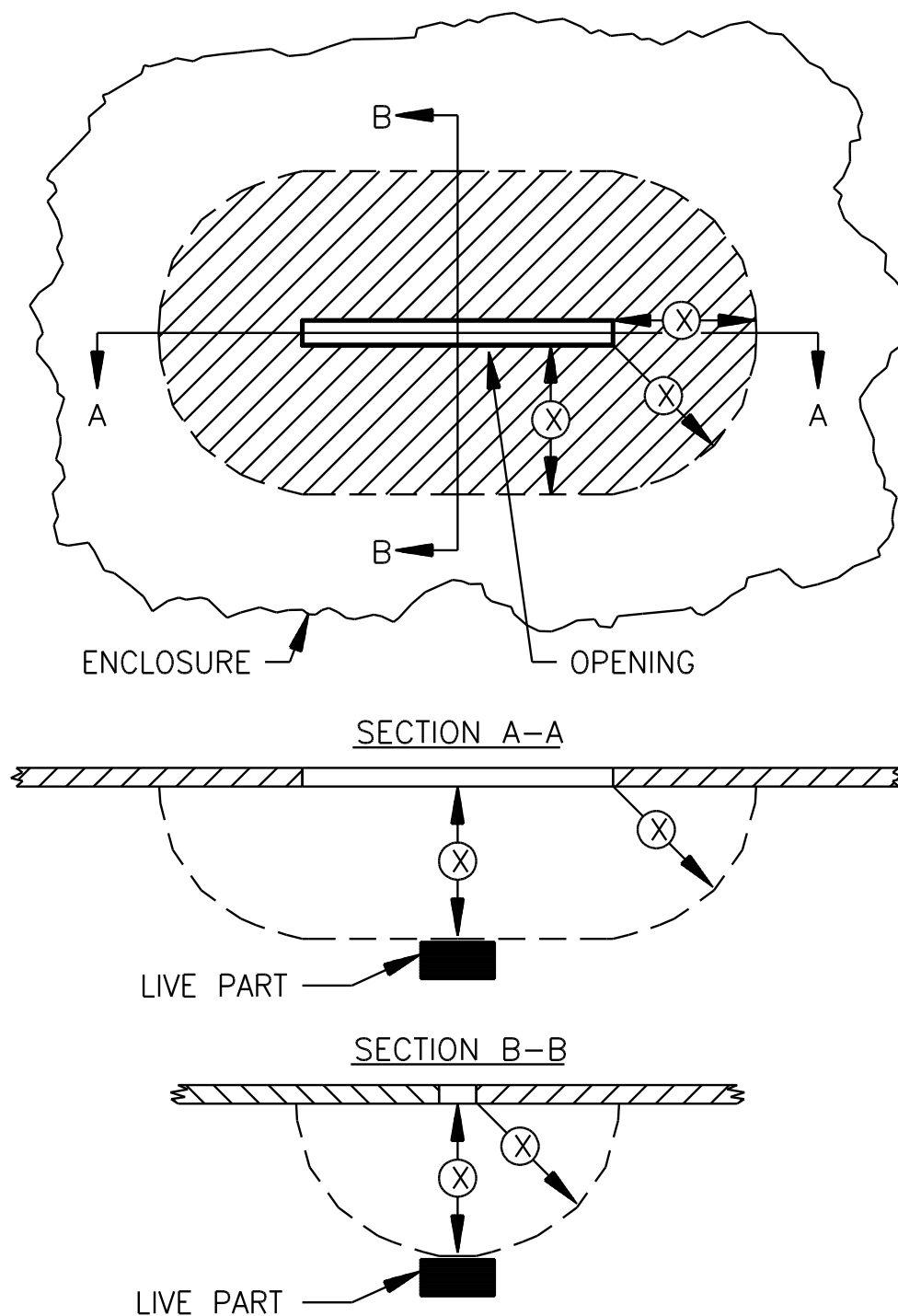


PA100

NOTE – High-impact polystyrene probe available from Underwriters Laboratories Inc.

9.2.5 An opening that permits entrance of a 1-inch (25.4-mm) diameter rod may be used under the conditions described in [Figure 9.3](#).

Figure 9.3
Opening in enclosure



EC100A

The opening may be used if, within the enclosure, 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 that can be inserted through the opening, but not less than 6-1/16 inches (154 mm).

10 Protection of Service Personnel

10.1 An uninsulated live part of a high-voltage circuit within the enclosure shall be located, guarded, or enclosed so as to reduce the risk of accidental contact by persons performing service functions while the equipment is energized.

10.2 During the examination of a product in connection with the requirements in [10.1](#), a part of the outer enclosure which may be removed without the use of tools, or part of the outer enclosure which may be removed by the user to allow access for making normal operating adjustments, is to be disregarded; that is, it is to be assumed that the part in question does not afford protection against electric shock.

10.3 An electrical component which may require examination, replacement, adjustment, servicing, or maintenance with the product energized shall be located and mounted with regard to other components and with regard to grounded metal so that it is accessible for such service without subjecting service personnel to the risk of electric shock from adjacent uninsulated high-voltage live parts.

10.4 The following are not considered to be uninsulated live parts:

- a) Coils of relays and solenoids, and transformer windings, if the coils and windings are provided with insulating overwraps rated for the potentials encountered;
- b) Terminals and splices with insulation rated for the potential encountered; and
- c) Insulated wire.

11 Enclosures

11.1 General

11.1.1 The frame and enclosure of a product shall have the strength and rigidity to resist total or partial collapse and the attendant reduction of spacings, loosening or displacement of parts, or other defects. See the Mechanical Strength Tests for Enclosures, Section [55](#).

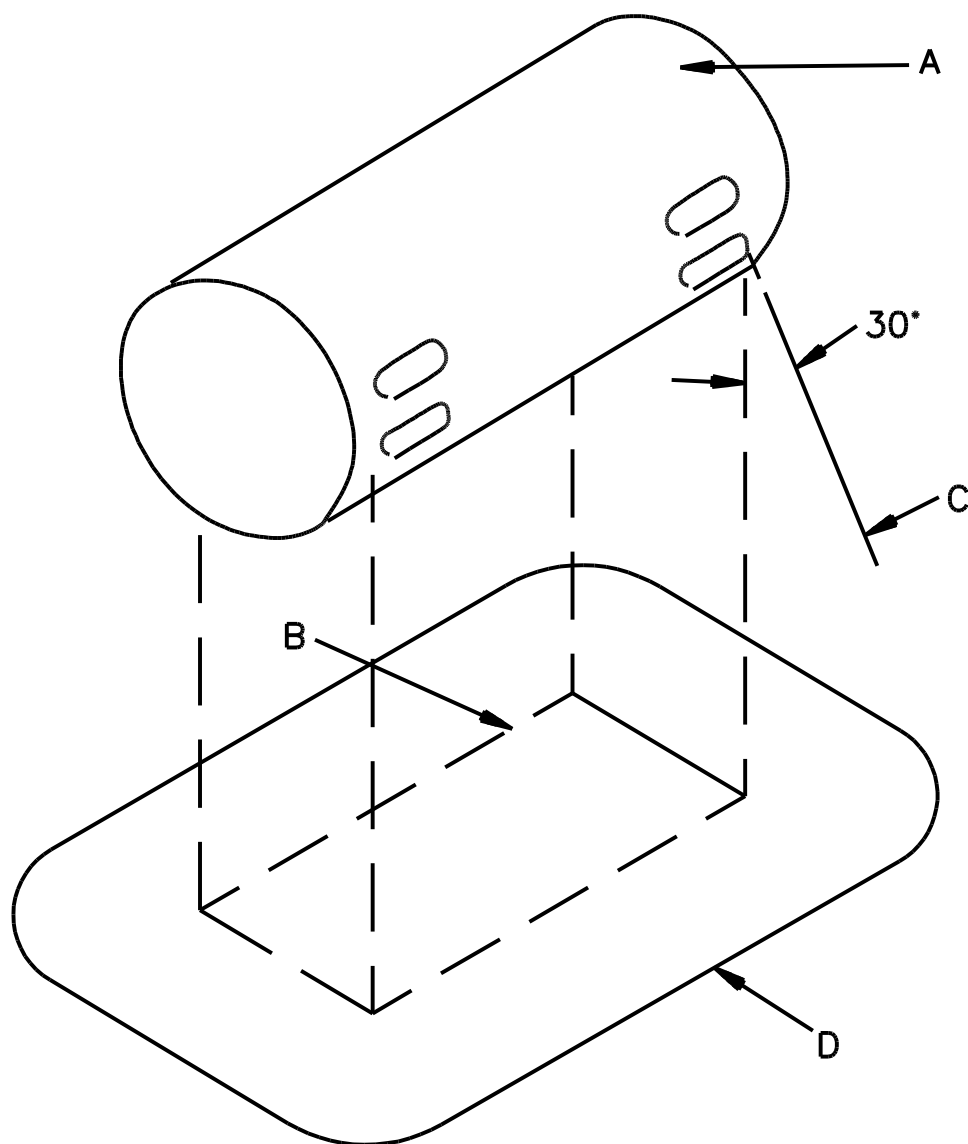
11.1.2 Operating parts, such as gear mechanisms, light-duty relays, and similar devices, shall be enclosed to reduce the risk of malfunction from dust or from other material which may impair their intended operation.

11.1.3 An enclosure containing other than power-limited circuits shall be constructed to reduce the risk of emission of flame, molten metal, flaming or glowing particles, or flaming drops. See the Ignition Through Bottom-Panel Openings Tests, Section [54](#).

11.1.4 The requirement in [11.1.3](#) requires either a nonflammable bottom in accordance with [11.3.2](#), or a protective barrier as described in [Figure 11.1](#) under all areas containing combustible materials.

Exception: Openings not larger than 1/16 square inch (40.3 mm²) may be provided for the bottom of the enclosure under areas containing only materials classified as V-1 or less flammable. See [11.3.3](#).

Figure 11.1
Protective pan



EB110

A – The entire component under which a barrier (flat or dished with or without a lip or other raised edge) of noncombustible material is to be provided. The sketch above is of a metal enclosed component with ventilating openings to show that the protective barrier is required only for those openings from which flaming parts might come. If the component or assembly does not have its own noncombustible enclosure, the area to be protected would be the entire area occupied by the component or assembly.

B – Projection of the outline of the area of (A) which needs a bottom barrier vertically downward onto the horizontal plane of the lowest point on the outer edge (D) of the barrier.

C – Inclined line that traces out an area (D) on the horizontal plane of the barrier. Moving around the perimeter of the area (B) which needs a bottom barrier, this line projects at a 30-degree angle from the line extending vertically at every point around the perimeter of (A) and oriented to trace out the largest area, except that the angle may be less than 30 degrees if the barrier or portion of the bottom cover contacts a vertical barrier or side panel of noncombustible material, or if the horizontal extension of the barrier (B) to (D) would exceed 6 inches (152 mm).

D – Minimum outline of the barrier, except that the extension B-D need not exceed 6 inches (152 mm) (flat or dished with or without lip or other raised edge). The bottom of the barrier may be flat or formed in any manner provided that every point of area (D) is at or below the lowest point on the outer edge of the barrier.

11.1.5 A construction using individual barriers under components, groups of components, or assemblies, as specified in [Figure 11.1](#) is to be considered as complying with the requirement in [11.1.3](#).

11.2 Doors and covers

11.2.1 An enclosure cover shall be hinged, sliding, or similarly attached so as to reduce the risk of its being removed if it:

- a) Gives access to fuses or any other overcurrent protective device, the intended functioning of which requires renewal or
- b) Is necessary to open the cover in connection with the intended operation of the unit.

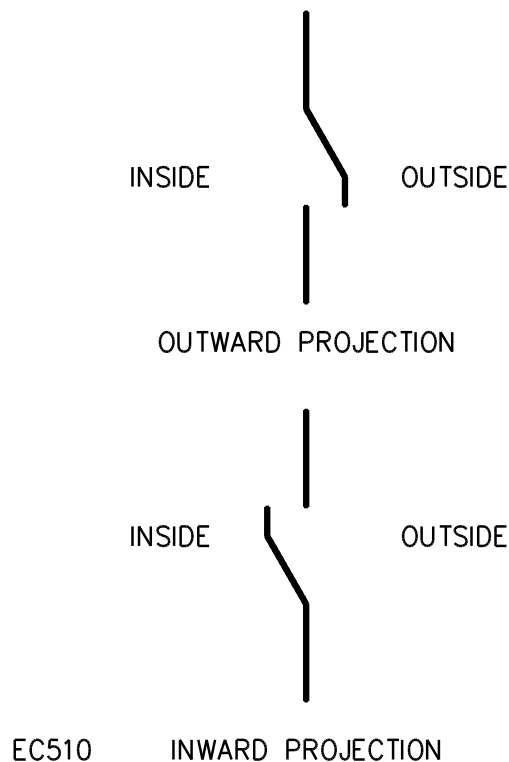
Exception: If its position is supervised by a tamper contact which is connected in the closed protective circuit, an enclosure need not comply with these requirements. See also [35.5](#).

11.2.2 Fasteners requiring the use of a tool or key shall be used for all enclosures if access is not required for operation of the product.

11.3 Enclosure openings

11.3.1 Openings in the enclosure shall be so constructed and of such size to reduce the risk of direct entry of foreign objects. See also [9.2.3](#). See [Figure 9.1](#) for examples of top cover constructions that may be used to reduce the risk of direct entry. See also [Figure 11.2](#) for examples of side opening constructions which may be used.

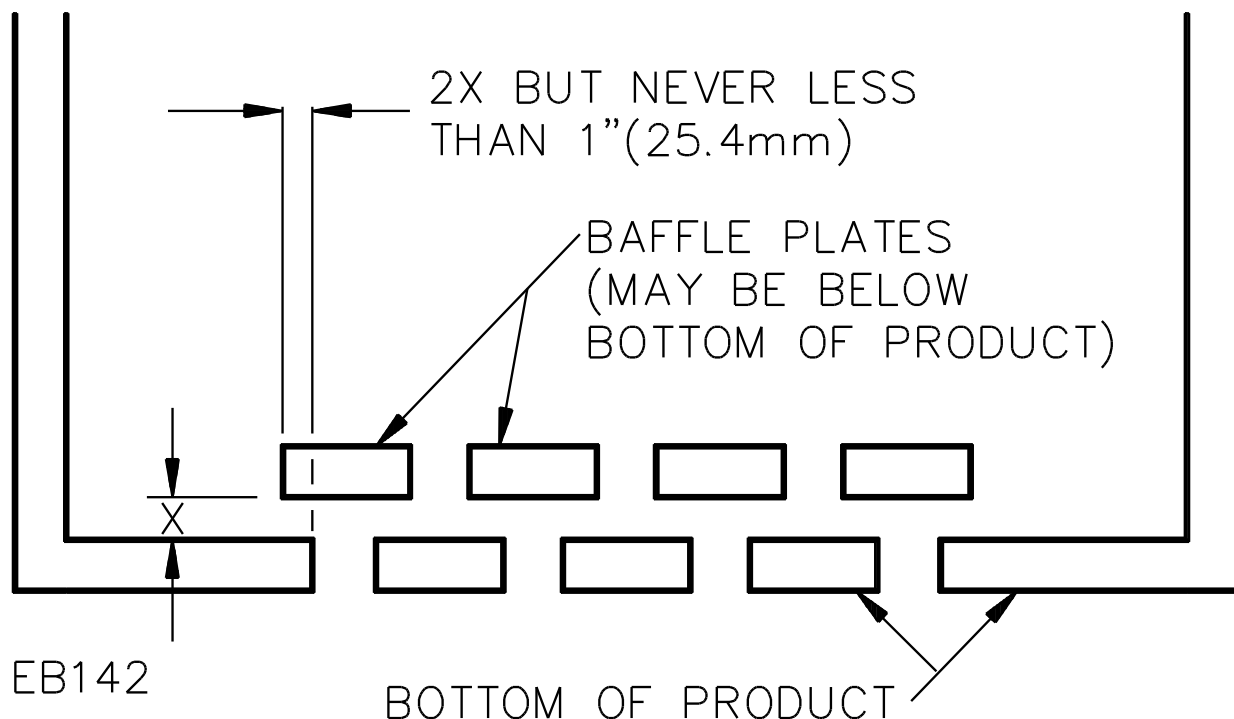
Figure 11.2
Cross-sections of side louvers



11.3.2 Openings may be provided in the bottom panels or protective pans under areas containing materials not classified as V-1, in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, if constructed in a manner that reduces the risk of materials from falling directly from the interior of the product onto the supporting surface or any other location under the product. [Figure 11.3](#) illustrates a type of baffle that meets this requirement. A second construction that meets this requirement is a 0.040 inch (1.02 mm) sheet-steel bottom panel in which 5/64 inch (2.0 mm) maximum, round holes are spaced not closer together than 1/8 inch (3.2 mm) center-to-center. Constructions other than these two may be used if they comply with the Ignition Through Bottom-Panel Openings Tests, Section [54](#).

Figure 11.3

Baffle



11.3.3 The bottom of the enclosure under areas containing only materials classified as V-1 or better, may have openings not larger than 1/16 square inch (40.3 mm²).

11.3.4 Openings may be used, without limitation of the size or number of openings, in areas containing only PVC, TFE, CTFE, FEP, and neoprene insulated wire or cable, in areas containing plugs and receptacles, and in areas underneath impedance protected or thermally protected motors.

11.3.5 Openings in the enclosure shall not give access to any relays, terminals, controls, or related components that might be subject to tampering by hand or with tools.

11.4 Screens and expanded metal

11.4.1 Screens and expanded metal used as a guard, enclosure, or part of an enclosure, shall comply with the requirements in [11.4.2](#) and [11.4.3](#) and with the Mechanical Strength Tests for Enclosures, Section [55](#).

11.4.2 Perforated sheet steel and sheet steel used for expanded metal mesh shall not be less than 0.042 inch (1.07 mm) thick [0.045 inch (1.17 mm) if zinc coated] if the mesh openings or perforations are 1/2 square inch (323 mm²) or less in area, and shall not be less than 0.080 inch (2.03 mm) thick [0.84 inch (2.13 mm) if zinc coated] for larger openings. The largest dimension shall not exceed 4 inches (102 mm).

Exception: If the indentation of a guard or the enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to impair performance or reduce spacings below the minimum required values (see Spacings, General, Section 27) 0.020 inch (0.53 mm) expanded steel mesh or perforated sheet steel [0.023 inch (0.58 mm) if zinc coated] may be used, if:

- a) The exposed mesh on any one side or surface of the product that is protected has an area of not more than 72 square inches (464 cm²) and has no dimension greater than 12 inches (305 mm) or*
- b) The width of an opening so protected is not greater than 3-1/2 inches (89 mm).*

11.4.3 The wires of a screen shall not be less than 16 AWG (1.3 mm diameter) steel if the screen openings are 1/2 square inch (323 mm²) or less in area, and shall not be less than 12 AWG (2.1 mm diameter) steel for larger screen openings.

11.5 Cast metal

11.5.1 The thickness of cast metal for an enclosure shall be as indicated in [Table 11.1](#).

Exception: Cast metal of lesser thickness may be used if, with consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See the Mechanical Strength Tests for Enclosures, Section 55.

Table 11.1
Cast-metal enclosures

Use, or dimensions of area involved ^a	Minimum thickness			
	Die-cast metal,		Cast metal of other than the die-cast type,	
	inch	(mm)	inch	(mm)
Area of 24 square inches (155 cm ²) or less and having no dimension greater than 6 inches (152 mm)	1/16	(1.6)	1/8	(3.2)
Area greater than 24 square inches (155 cm ²) or having any dimension greater than 6 inches (152 mm)	3/32	(2.4)	1/8	(3.2)
At a threaded conduit hole	1/4	(6.4)	1/4	(6.4)
At an unthreaded conduit hole	1/8	(3.2)	1/8	(3.2)
^a The area limitation for metal 1/16 inch (1.6 mm) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.				

11.6 Sheet metal

11.6.1 The thickness of sheet metal for an enclosure shall not be less than that indicated in [Table 11.2](#) or [Table 11.3](#), whichever applies.

Exception: Sheet metal of lesser thickness may be used if, with consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength. See the Mechanical Strength Tests for Enclosures, Section 55.

Table 11.2
Minimum thickness of sheet metal for electrical enclosures carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness uncoated,		Minimum thickness metal coated,	
Maximum width, ^b	Maximum length, ^c	Maximum width, ^b	Maximum length, ^c	inch	(mm)	inch	(mm)
inches	(cm)	inches	(cm)	[MSG]		[GSG]	
4.0	(10.2)	Not limited	6.25	0.020	(0.51)	0.023	(0.58)
4.75	(12.1)	5.75	6.75	[24]		[24]	
6.0	(15.2)	Not limited	9.5	0.026	(0.66)	0.029	(0.74)
7.0	(17.8)	8.75	10.0	[22]		[22]	
8.0	(20.3)	Not limited	12.0	0.032	(0.81)	0.034	(0.86)
9.0	(22.9)	11.5	13.0	[20]		[20]	
12.5	(31.8)	Not limited	19.5	0.042	(1.07)	0.045	(1.14)
14.0	(35.6)	18.0	21.0	[18]		[18]	
18.0	(45.7)	Not limited	27.0	0.053	(1.35)	0.056	(1.42)
20.0	(50.8)	25.0	29.0	[16]		[16]	
22.0	(55.9)	Not limited	33.0	0.060	(1.52)	0.063	(1.60)
25.0	(63.5)	31.0	35.0	[15]		[15]	
25.0	(63.5)	Not limited	39.0	0.067	(1.70)	0.070	1.78
29.0	(73.7)	36.0	41.0	[14]		[14]	
33.0	(83.8)	Not limited	51.0	0.080	(2.03)	0.084	(2.13)
38.0	(96.5)	47.0	54.0	[13]		[13]	
42.0	(106.7)	Not limited	64.0	0.093	(2.36)	0.097	(2.46)
47.0	(119.4)	59.0	68.0	[12]		[12]	
52.0	(132.1)	Not limited	80.0	0.108	(2.74)	0.111	(2.82)
60.0	(152.4)	74.0	84.0	[11]		[11]	
63.0	(160.0)	Not limited	97.0	0.123	(3.12)	0.126	(3.20)
73.0	(185.4)	90.0	103.0	[10]		[10]	

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- 1) Single sheet with single formed flanges (formed edges),
- 2) A single sheet which is corrugated or ribbed, and
- 3) An enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

Table 11.3
Minimum thickness of sheet metal for electrical enclosures aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, inch (mm)
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, inches (cm)	
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.5 (24.1)	0.023 (0.58)
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)	0.029 (0.74)
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)	0.036 (0.91)
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)	0.045 (1.14)
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)	0.058 (1.47)
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	
20.0 (50.8)	25.0 (63.5)	45.0 (114.3)	55.0 (139.7)	0.075 (1.91)
25.0 (63.5)	Not limited	60.0 (152.4)	Not limited	
29.0 (73.7)	36.0 (91.4)	64.0 (162.6)	78.0 (198.1)	0.095 (2.41)
37.0 (94.0)	Not limited	87.0 (221.0)	Not limited	
42.0 (106.7)	53.0 (134.6)	93.0 (236.2)	114.0 (289.6)	0.122 (3.10)
52.0 (132.1)	Not limited	123.0 (312.4)	Not limited	
60.0 (152.4)	74.0 (188.0)	130.0 (330.2)	160.0 (406.4)	0.153 (3.89)

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal which is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and which has sufficient torsional rigidity to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure which is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- 1) A single sheet with single formed flanges (formed edges),
- 2) A single sheet which is corrugated or ribbed, and
- 3) An enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece which is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels which are not supported along one side, for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified unless the side in question is provided with a flange at least 1/2 inch (12.7 mm) wide.

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

11.7 Product enclosure mounting

11.7.1 An enclosure shall have means for mounting that shall be accessible without disassembly of any operating part of the product. Removal of a completely assembled panel to mount the enclosure is not considered to be disassembly of an operating part.

11.8 Polymeric materials

11.8.1 Among the factors taken into consideration when evaluating the acceptability of a nonmetallic enclosure are:

- a) The mechanical strength;
- b) Resistance to impact;
- c) Moisture-absorptive properties;
- d) Flammability and resistance to ignition from electrical sources;
- e) Dielectric strength, insulation resistance, and resistance to arc tracking; and
- f) Resistance to distortion and creeping at temperatures to which the material may be subjected under any conditions of use.

All these factors are considered with regard to aging in accordance with the Polymeric Materials Test, Section [51](#), and the Mechanical Strength Tests for Enclosures, Section [55](#).

12 Electric Shock

12.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See the Electric Shock Current Test, Section [40](#).

12.2 Each terminal provided for the connection of an external antenna shall be conductively connected to the supply circuit grounded conductor. The conductive connection shall have a maximum resistance of 5.2 megohms, a minimum wattage rating of 1/2 watt, and shall be effective with the power switch in either the on or off position.

Exception: The conductive connection need not be provided if:

- a) Such a connection is established in the event of electrical breakdown of the antenna isolating means;*
- b) The breakdown does not result in a risk of electric shock; and*
- c) In a construction using an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 megohms.*

12.3 The maximum value of 5.2 megohms mentioned in [12.2](#) is to include the maximum tolerance of the resistor value used; for example, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance may be used. A component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors may be rated a minimum of 1/4 watt.

12.4 The replacement of any component used in the product shall not result in a risk of electric shock.

13 Corrosion Protection

13.1 Iron and steel parts, other than bearings, and the like, where such protection is impracticable, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other means determined to be equivalent. Bearing surfaces shall be of such materials and design as to resist binding due to corrosion.

13.2 The requirement in [13.1](#) applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

Exception No. 1: This requirement does not apply to parts, such as washers, screws, bolts, and the like, if corrosion of such unprotected parts would not be likely to result in a risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons or to impair the operation of the unit.

Exception No. 2: Parts made of stainless steel, polished or treated, if necessary, do not require additional protection against corrosion.

13.3 Metals used in cabinets and enclosures shall be galvanically compatible.

Exception: This requirement does not apply if galvanic action does not result in malfunction of the product; or result in a risk of fire, electric shock, or unintentional contact with moving parts that can cause injury to persons.

13.4 Hinges and other attachments shall be resistant to corrosion.

FIELD WIRING CONNECTIONS

14 General

14.1 Wiring terminals or leads shall be provided for connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70-1993.

15 Cord-Connected Products

15.1 A portable product that is intended to be connected to high-voltage or line voltage shall be provided with not less than 6 feet (1.8 m) of flexible cord and a two- or three-prong attachment plug of a type rated for connection to the supply circuit.

Exception: A cord may be less than 6 feet (1.8 m) long if it is evident that the use of a longer cord may result in damage to the cord or product; may in a risk of fire, electric shock, or injury to persons, or is not required for the intended operation of the product.

15.2 A flexible cord may be used with a stationary product.

15.3 A flexible cord shall be of Type SJ, SJT, or equivalent, and shall not be smaller than 18 AWG (0.82 mm²). It shall be rated for use at the voltage and current rating of the product.

15.4 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring. See the Strain Relief Test, Section [53](#).

15.5 If a knot in a flexible cord serves as strain relief, a surface against which the knot may bear or with which it may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, which may cause abrasion of the insulation on the conductors.

15.6 Clamps of any material (metal or otherwise) may be used on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp unless the tubing or the equivalent is necessary to prevent the clamp from damaging the cord or supply leads.

15.7 The supply cord or supply leads shall be prevented from being pushed into the unit through the cord-entry hole if such displacement is likely to:

- a) Subject the cord or supply leads to mechanical damage or to exposure to a temperature higher than that for which the cord or supply leads are rated,
- b) Reduce spacings (such as to a metal strain-relief clamp) below the minimum required values, or
- c) Damage internal connections or components.

16 Permanently-Connected Products

16.1 General

16.1.1 A permanently-connected product shall have provision for connection of one of the applicable wiring systems in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

16.1.2 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size determined by applying [Table 16.1](#).

Table 16.1
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)	1	(33.4)	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)
NOTE – This table is based on the assumption that all conductors will be of the same size and there will not be 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.											

16.1.3 The location of a terminal box or compartment in which power supply connections are to be made shall be such that 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.

16.1.4 A terminal compartment intended for the connection of a supply raceway shall be secured in position and shall be prevented from turning.

16.1.5 The product shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than that required by the product. It is to be assumed that branch circuit conductors rated 60°C (140°F) will be used.

16.2 Field-wiring terminals

16.2.1 General

16.2.1.1 As used in these requirements, field-wiring terminals are those terminals to which power supply (including equipment grounding) or control connections will be made in the field when the product is installed.

16.2.1.2 A field-wiring terminal shall comply with:

- a) [16.2.1.4](#) – [16.2.1.7](#);
- b) The field-wiring requirements in the Standard for Electrical Quick-Connect Terminals, UL 310;
- c) The requirements in the Standard for Wire Connectors, UL 486A-486B;
- d) The Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E; or
- e) The Standard for Terminal Blocks, UL 1059, rated for field-wiring (FW) Code 2 applications and also suitable for the voltage, current, wire range, and wire type of the intended application.

The current-carrying parts shall be silver, copper, a copper alloy, or a similar nonferrous conductive material. Securing screws and the like may be plated steel. Equipment provided with quick-connect terminals intended for field termination of electrical conductors to the equipment and complying with UL 310 shall be provided with strain relief, and the installation instructions shall include instructions for effecting the strain relief and include reference to the specific connectors to be used.

16.2.1.3 A field-wiring terminal shall be prevented from turning or shifting in position. This may be accomplished by means such as two screws or rivets; by square shoulders or mortises; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part. Friction between surfaces shall not be used for preventing movement of the terminals.

16.2.1.4 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for 8 AWG (8.4 mm²) and larger wires. If the connectors or lugs are secured to a plate, the plate thickness shall not be less than 0.050 inch (1.3 mm). Securing screws may be plated steel.

16.2.1.5 A wire binding screw used at a wiring terminal shall not be smaller than No. 8 (4.2 mm diameter). Plated screws are not prohibited.

Exception: A No. 6 (3.5 mm diameter) screw may be used for the connection of one 14 AWG (2.1 mm²) and a No. 4 (2.8 mm diameter) screw may be used for the connection of a 9 AWG (0.65 mm²) or smaller conductor.

16.2.1.6 Terminal plates tapped for wire binding screws shall:

- a) Not have less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or that which has been determined to be the equivalent, to hold the wires in position. Other constructions may be used if they provide equivalent thread security of the wire binding screw.
- b) Be of a nonferrous metal not less than 0.050 inch (1.3 mm) thick for a No. 8 (4.2 mm diameter) or larger screw, and not less than 0.030 inch (0.76 mm) thick for a No. 6 (3.5 mm diameter) or smaller screw.