UL 2017

STANDARD FOR SAFETY

General-Purpose Signaling Devices and Systems

UL Standard for Safety for General-Purpose Signaling Devices and Systems, UL 2017

Second Edition, Dated December 23, 2008

Summary of Topics

This revision of ANSI/UL 2017 dated December 14, 2018 includes the following changes in requirements:

Alternative Means Utilizing Adhesives to Provide Mechanical Securement of Parts

Revision to Require Leakage Current Test Only for Cord-connected Products

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 October 26, 2018.

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UL 2017

Standard for General-Purpose Signaling Devices and Systems

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Second Edition

December 23, 2008

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through December 14, 2018.

The most recent designation of ANSI/UL 2017 as an American National Standard (ANSI) occurred on December 14, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover signaling devices intended for emergency or non-emergency use, used in indoor and/or outdoor locations, and where applicable, installed and used in accordance with the National Electrical Code, NFPA 70.

1.2 Emergency-signaling products covered by these requirements are categorized as indicated below, are associated with property and/or life safety and are of a non-fire/non-security alarm nature. These products are evaluated with regard to product safety and to appropriateness of signaling.

a) Type UM (User-Monitored) devices or systems are intended to be monitored and tested by the user. These devices are intended for household use or are personal signaling devices carried by the user.

b) Type SM (Self-Monitored) devices or systems are intended to be self-monitoring. These devices are intended for, but not restricted to, commercial use.

c) Type AM (Attendant-Monitored) devices or systems are intended to be constantly operated and maintained by competent and experienced personnel, either locally or at a remote station.

d) Residential Water Hazard entrance alarms are devices or systems intended to be installed on gates, doors, or access barriers surrounding residential swimming pools, spas, or hot tubs for the purpose of sounding an audible alarm due to unauthorized entry into these areas.

1.3 Non-emergency-signaling products covered by these requirements are categorized as Type NM (Non-Monitored), are not associated with property and/or life safety, and are only evaluated relative to product safety.

1.4 A product as covered by these requirements consists of a unit assembly of electrical parts having provision for the connection of power supply circuits routed through the equipment by a prescribed scheme of circuiting. Circuits extending from the products connect to separate devices by which the operating part of the product is actuated for signals, and to separate and/or integral devices by which the signals are indicated so as to form a coordinated system combination for definitive signaling services. An installation wiring diagram attached to the product, or referenced in the product marking, indicates the devices and circuits which have been determined to be capable of being used with the product in the field.

1.5 These requirements do not cover the following:

a) Visual signaling appliances as covered by the Standard for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling, UL 1638;

b) Audible signaling devices not provided as part of the product and covered by the Standard for Audible Signal Appliances, UL 464;

c) Equipment intended for use in fire-protective signaling systems used to detect, monitor, signal, or control a fire condition;

d) Equipment intended for use in security alarm systems used to protect against burglary;

e) Home health-care signaling equipment as covered by the Standard for Home Health-Care Signaling Equipment, UL 1637.

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 used in the products covered by this standard.

2.1.2 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.

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

2.1.4 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.

2.2 Units of measurement

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

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

2.3 Undated references

2.3.1 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 ACKNOWLEDGE – To confirm that a message or signal has been received, such as pressing a button or the selection of a software command.

3.3 ACTIVE MULTIPLEX SYSTEM – A system using a signaling method characterized by simultaneous or sequential transmission, or both, and reception of multiple signals, including a means for positively identifying each signal. Uses signaling devices such as transponders to transmit status signals of each initiating device within a prescribed time interval so that lack of receipt of such signal is to be interpreted as a trouble signal.

3.4 ADVERSE CONDITION – Any condition that interferes with the proper transmission or interpretation, or both, of status change signals.

3.5 ALARM SIGNAL – A signal indicating an emergency condition requiring immediate action.

3.6 ANNUNCIATOR – An electrically operated visual indicating device containing identified targets or indicator lamps, alphanumeric displays or other means determined to be the equivalent in which each indication provides status information about a circuit, condition, and/or location.

3.7 CHANNEL – A path for voice or signal transmission utilizing modulation of light or alternating current within a frequency band.

3.8 CIRCUIT CLASSIFICATION:

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

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

c) POWER-LIMITED CIRCUIT – A circuit wherein the power is limited as specified in Tables 42.1 and 42.2.

3.9 COMBINATION SYSTEM – An emergency system whose components might be used, in whole or in part in common with a non-emergency signaling system such as non-critical process monitoring, paging, or building automation.

3.10 CONTIGUOUS PROPERTY – A single owner or single user on a continuous plot of ground, including any buildings thereon, that is not separated by a public thoroughfare, transportation right-of-way, property owned or used by others, or body of water not under the same ownership.

3.11 DERIVED CHANNEL – A circuit that uses the local leg of the public switched network as an active multiplex channel while simultaneously allowing that leg's use for normal telephone communications.

3.12 DIGITAL-ALARM COMMUNICATOR RECEIVER (DACR) – A system component that receives and displays signals from digital-alarm communicator transmitters (DACT's) sent over the public switched telephone network.

3.13 DIGITAL-ALARM COMMUNICATOR SYSTEM (DACS) – A system in which signals are transmitted from a digital-alarm communicator transmitter (DACT), located remote from the supervising station, through the public switched telephone network to a digital-alarm communicator receiver (DACR).

3.14 DIGITAL-ALARM COMMUNICATOR TRANSMITTER (DACT) – A system component to which initiating devices or groups of devices are connected. The DACT seizes the connected telephone line, dials a preselected number to connect to a digital-alarm communicator receiver (DACR), and transmits signals indicating a status change.

3.15 DIGITAL-ALARM RADIO RECEIVER (DARR) – A system component that receives and decodes radio signals.

3.16 DIGITAL-ALARM RADIO SYSTEM (DARS) – A system in which signals are transmitted from a digital-alarm radio transmitter (DART) located remote from the supervising station through a radio channel to a digital-alarm radio receiver (DARR).

3.17 DIGITAL-ALARM RADIO TRANSMITTER (DART) – A system component to which initiating devices or a group of devices are connected.

3.18 EMERGENCY – Associated with property and/or life safety and are of a non-fire/non-security alarm nature.

3.19 EMERGENCY VOICE/ALARM COMMUNICATIONS – Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as evacuation signals pertaining to an emergency, to the occupants of a building.

3.20 END-OF-LINE DEVICE – A device installed at the end of a circuit for the purpose of monitoring the circuit for fault conditions.

3.21 EVACUATION – The withdrawal of occupants from a building.

3.22 FAULT – An open or ground condition singularly applied on any line extending from a product.

3.23 FIXED EQUIPMENT – Any equipment or product that is intended to be permanently connected electrically to the wiring system.

3.24 HOUSEHOLD – The family living unit in single-family detached dwelling, single-family attached dwellings, multi-family buildings, and mobile homes.

3.25 INITIATING CIRCUIT – Circuit to which automatic or manual initiating devices are connected.

3.26 INITIATING DEVICE – A manually or automatically operated device, the normal intended operation of which results in signal indication from the product/system.

3.27 INTERCOM – Two-way voice communication equipment intended for emergency use.

3.28 KEYPAD – A means of manually controlling the product. Provided with a visual indicating device containing identified targets or indicator lamps, alpha-numeric displays, or other means determined to be the equivalent in which each indication provides status information about a circuit, condition, and/or location.

3.29 LEG FACILITY – That part of a communication channel that connects not more than one remote unit to a primary or secondary trunk facility.

3.30 LOCAL MONITORING UNIT – A product located at the protected property which connects to initiating and indicating devices for alerting occupants at the premises or transmits signals to a constantly attended supervising station.

3.31 NON-EMERGENCY FUNCTION – Not associated with property and/or life safety.

3.32 NOTIFICATION APPLIANCE – A component that provides audible, tactile, or visible outputs, or any combination thereof.

3.33 NOTIFICATION APPLIANCE CIRCUIT – A circuit or path directly connected to a notification appliance.

3.34 NOTIFICATION ZONE – An area covered by notification appliances that are activated simultaneously.

3.35 OFF-HOOK – To make connection with the public switched telephone network in preparing to dial a telephone number.

3.36 ON-HOOK – To disconnect from the public switched telephone network.

3.37 OPERATING PROGRAM – The basic operating software that is alterable only to the equipment manufacturer. This software is sometimes referred to as firmware, BIOS, or executive program.

3.38 PATH – Any conductor, optic fiber, radio carrier, or other means for transmitting information between two or more units and/or locations.

3.39 PORTABLE EQUIPMENT – Any conductor, optic fiber, radio carrier, or other means for transmitting information between two or more units and/or locations.

3.40 POWER SUPPLY – A source of electrical operating power including the circuits and terminations connecting it to the dependant product/system components.

3.41 PRE-RECORDED MESSAGE DEVICE – An automatically- or manually-actuated device intended to translate a prerecorded message stored on a tape or other medium into an electronic signal that, when amplified and introduced into speakers, produces vocal or tonal information.

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

3.43 PRIMARY OPERATOR INTERFACE – Intended to be the main means of interfacing the controls for manually operating the product/system.

3.44 PRIMARY TONE GENERATOR – A device intended to generate an electronic signal that, when amplified and introduced into speakers, produces a non-prerecorded, nonvocal audible signal recognizable as indicating an evacuation condition.

3.45 PRIVATE RADIO FREQUENCY SYSTEM – A radio system under the control of the supervising station or other company where only private access to the system is permitted.

3.46 PROGRAM-CONTROLLED UNIT – A unit for which the intended operation is controlled or influenced by a stored program. The word ″program,″ as used here, refers to a set of instructions that is carried out in a sequential and repetitive manner and that determines the system output signal resulting from a specific system input signal. The word ″stored″ refers to the action provided by memory devices in which the memory is either transient or permanent and that are used for retaining information, instruction, status, and similar information.

3.47 REMOTE MONITORING UNIT – A unit that monitors inputs and controls outputs through various types of circuits and that serves a local location.

3.48 REPEATER – Equipment used to relay signals between a remote unit, initiating device or similar device and the receiving unit.

3.49 RESIDENTIAL WATER HAZARD ENTRANCE ALARM – A product intended to monitor moveable accesses (doors, screens, or similar structures) that give direct access to residential aquatic areas such as swimming pools, spas or hot tubs.

3.50 RISK OF ELECTRICAL SHOCK – A risk of electrical shock is determined to exist within a circuit unless that circuit meets one of the following criteria:

a) The circuit is supplied by an isolating source such that the maximum open circuit voltage potential available to the circuit is not more than 30 V AC rms, 42.4 V DC, or 42.4 V peak or

b) The circuit is supplied by an isolating source such that the current available through a 1500-ohm resistor connected across any potential in the circuit (including to ground) does not exceed 5 mA.

3.51 RISK OF FIRE – A risk of fire is determined to exist within a circuit unless that circuit meets both of the following criteria:

a) The circuit is supplied by a power source such that the maximum open-circuit voltage potential available to the circuit is not more than 30 V AC or 42.4 V peak and

b) The circuit in which the power available to the circuit is limited to a value less than 15 watts.

3.52 SIGNALING CIRCUIT – A circuit over which signals are transmitted between separately enclosed equipment.

3.53 SITE-SPECIFIC SOFTWARE – Software that defines the specific operation and configuration of a particular system. Typically it defines the type and quantity of hardware modules, customized labels, and specific operating features of a system.

3.54 STANDBY POWER SOURCE – Provides power when the primary power source fails. An alternative is another electrical power source, a rechargeable battery, or a non-rechargeable battery.

3.55 STATIONARY EQUIPMENT – Any product that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

3.56 STORAGE BATTERY – Any battery which, by design or construction, is intended to be recharged.

3.57 SUPERVISING STATION – The operator interface of a Type AM system to which alarm and trouble signals are directly monitored or are received from remote monitoring units. Intended to be constantly attended and maintained by competent and experienced personnel.

3.58 SUPPLEMENTARY – Refers to equipment or operations not required by this standard.

3.59 SUPPLEMENTARY DEVICE – A device intended to be connected to a supplementary-device circuit.

3.60 SUPPLEMENTARY-DEVICE CIRCUIT – A circuit provided by the product for controlling a device, the operation of which is supplementary to the primary initiating alarm and alerting devices of the product.

3.61 SWITCHED TELEPHONE NETWORK – An assembly of communication facilities and central office equipment operated jointly by authorized service providers that provides the general public with the ability to establish transmission channels via discrete dialing.

3.62 TRANSMISSION FAULT – A condition which interrupts communication on a signaling circuit.

3.63 TRANSMITTER – A system component that provides an interface between signaling circuits, initiating circuits/devices, or other units and the transmission channel.

3.64 TRANSPONDER – A multiplex alarm transmission system functional assembly located remote from the supervising station.

3.65 TROUBLE SIGNAL – A signal indicating a fault condition of any nature, such as a circuit break or ground or other trouble condition occurring in the device or wiring associated with the product.

3.66 TRUNK FACILITY – That part of the communication channel that connects two or more leg facilities to a supervising station.

a) PRIMARY TRUNK FACILITY – That part of a communication channel that connects all leg facilities to a supervising station.

b) SECONDARY TRUNK FACILITY – That part of a communication channel that connects all leg facilities to a supervising station.

3.67 WIRE-TO-WIRE FAULT – A wire-to-wire (short-circuit) fault is determined to be a resistance of 0.1 ohm or less across the circuit.

4 Equipment Types

4.1 Signaling systems and devices covered by this standard are categorized by the following types to facilitate determining the applicable requirements. See Table 4.1 for references to the sections applicable to each type.

Table 4.1
Sections of standard applicable to equipment types

Equipment types	Construction requirements, sections	Performance requirements, sections
NM	5 – 33	34 – 56, 62, 64 – 66, 81 – 84
UM, SM, AM	5 – 33	34 – 76, 81 – 84
Residential water hazard entrance alarm	5 – 33	34 – 84

5 Installation and Operating Instructions

5.1 A copy of the installation and operating instructions and related schematic wiring diagrams and installation drawings shall be used as a guide in the examination and test of the product. For this purpose, a printed edition is not required.

5.2 The instructions and drawings shall include directions and information for proper and safe installation, testing, maintenance, operation, and use of the product.

6 Compatibility

6.1 The interconnection of the product with other products shall be evaluated for the purpose of operating as a coordinated system relative to the intended emergency signaling and without risk of fire, shock, or injury to persons.

6.2 The requirements of 6.1 apply to:

a) Separate products connected to any circuit and by which the operating parts of the product are actuated for signaling and/or action and

b) Separate or incorporated appliances or units by which signals are indicated or actions carried out.

6.3 Power circuits interconnecting products shall have compatible voltage and current ratings.

6.4 All equipment directly connected to the product shall be evaluated for the application.

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7 General

7.1 A product shall use materials that have been determined to comply with the requirements for the particular use, as indicated by the performance requirements of this standard.

7.2 Metals, when required to meet the requirements of this standard, shall not be used in such combination as to cause galvanic action that increases the risk of fire, electric shock, injury to persons, or impair the operation of a product associated with the safety of life and/or property protection.

7.3 When breakage or deterioration of a part such as an enclosure, a frame, a guard results in a risk of injury to persons, then the part shall be constructed to meet the demand or expected loading conditions.

7.4 The requirement in 7.3 applies also to those positions of a part adjacent to a moving part identified to involve a risk of injury to persons.

8 Enclosure

8.1 General

8.1.1 All electrical parts of a product shall be enclosed to provide protection of internal components and prevent contact with uninsulated live parts.

8.1.2 Enclosures shall have the strength and rigidity to resist the abuses to which the product is likely to be subjected during intended use without increasing the risk of fire, electrical shock, or injury to persons

8.1.3 Enclosure parts fastened with adhesive meeting 11.5 – 11.8 shall comply with the test requirements in Mechanical Strength Tests for Metal Enclosures and Guards and Enclosure Parts Fastened with Adhesive, Section 48.

8.2 Metallic material

8.2.1 An enclosure of metal shall have a minimum thickness as specified in Tables 8.1, 8.2, or 8.3 or shall comply with the test requirements in Mechanical Strength Tests for Metal Enclosures and Guards, and Enclosure Parts Fastened with Adhesive Section 48.

Table 8.1
Cast-metal electrical enclosures

Use, or dimensions of area involved[a]	Minimum thickness			
	Die-cast metal,		Cast metal other than die-cast,	
	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.

Table 8.2
Minimum thickness of sheet metal for electrical enclosures of carbon steel or stainless steel

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness			
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Uncoated,		Metal coated,	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inches [MSG]	(mm)	inches [GSG]	(mm)
4.0	10.2	Not limited		6.25	15.9	Not limited		0.020	(0.51)	0.023	(0.58)
4.75	12.1	5.75	14.6	6.75	17.1	8.25	21.0	[24]	[24]		
6.0	15.2	Not limited		9.5	24.1	Not limited		0.026	(0.66)	0.029	(0.74)
7.0	17.8	8.75	22.2	10.0	25.4	12.5	31.8	[22]	[22]		
8.0	20.3	Not limited		12.0	30.5	Not limited		0.032	(0.81)	0.034	(0.86)
9.0	22.9	11.5	29.2	13.0	33.0	16.0	40.6	[20]	[20]		
12.5	31.8	Not limited		19.5	49.5	Not limited		0.042	(1.07)	0.045	(1.14)
14.0	35.6	18.0	45.7	21.0	53.3	25.0	63.5	[18]	[18]		
18.0	45.7	Not limited		27.0	68.6	Not limited		0.053	(1.35)	0.056	(1.42)
20.0	50.8	25.0	63.5	29.0	73.7	36.0	91.4	[16]	[16]		
22.0	55.9	Not limited		33.0	83.8	Not limited		0.060	(1.52)	0.063	(1.60)
25.0	63.5	31.0	78.7	35.0	88.9	43.0	109.2	[15]	[15]		
25.0	63.5	Not limited		39.0	99.1	Not limited		0.067	(1.70)	0.070	(1.78)
29.0	73.7	36.0	91.4	41.0	104.1	51.0	129.5	[14]	[14]		
33.0	83.8	Not limited		51.0	129.5	Not limited		0.080	(2.03)	0.084	(2.13)
38.0	96.5	47.0	119.4	54.0	137.2	66.0	167.6	[13]	[13]		
42.0	106.7	Not limited		64.0	162.6	Not limited		0.093	(2.36)	0.097	(2.46)
47.0	119.4	59.0	149.9	68.0	172.7	84.0	213.4	[12]	[12]		
52.0	132.1	Not limited		80.0	203.2	Not limited		0.108	(2.74)	0.111	(2.82)
60.0	152.4	74.0	188.0	84.0	213.4	103.0	261.6	[11]	[11]		
63.0	160.0	Not limited		97.0	246.4	Not limited		0.123	(3.12)	0.126	(3.20)
73.0	185.4	90.0	228.6	103.0	261.6	127.0	322.6	[10]	[10]		

Table 8.2 Continued on Next Page

Table 8.2 Continued

Without supporting frame[a]		With supporting frame or equivalent reinforcing[a]		Minimum thickness	
Maximum width,[b] inches (cm)	Maximum length,[c] inches (cm)	Maximum width,[b] inches (cm)	Maximum length, inches (cm)	Uncoated, inches (mm) [MSG]	Metal coated, inches (mm) [GSG]

[a] A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that 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 that 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.

Table 8.3
Minimum thickness of sheet metal for electrical enclosures of aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length, inches	(cm)	inches	(mm)
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

Table 8.3 Continued on Next Page

Table 8.3 Continued

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
Maximum width,[b] inches	(cm)	Maximum length,[c] inches	(cm)	Maximum width,[b] inches	(cm)	Maximum length, inches	(cm)	inches	(mm)

[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.

8.2.2 When threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or when a construction that is determined to be the equivalent is used, there shall not be less than 3-1/2 nor more than 5 threads in the metal, and the construction shall be such that a standard conduit bushing is capable of being attached.

8.2.3 When threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall not be less than five full threads in the metal. There shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors determined to be the equivalent to that provided by a standard conduit bushing.

8.2.4 At any point where conduit or metal-clad cable shall be attached to the enclosure, sheet metal shall be minimum 0.032 inch (0.81 mm) thick or shall be formed or reinforced so that it shall have the stiffness minimum to an uncoated flat sheet of steel.

8.3 Polymeric materials

8.3.1 Polymeric materials used as an enclosure shall comply with the applicable portion of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and also with the additional requirements specified in this Standard.

8.3.2 Polymeric material that is not used as an enclosure, but that is attached to or exposed on the outside of a product such as a viewing window, shall have flammability characteristics as shown in Table 8.4.

Table 8.4
Flammability characteristics of polymeric material

Polymeric material area/dimensions	Flammability rating
0.24 inches^3 (4 cm^3) maximum and 2.4 inches (61 mm) maximum length	None
Greater than 0.24 inches^3 (4 cm^3) and less than 2 square feet (0.19 m^2), 6 feet (1.83 m) maximum length	HB, V-2, V-1, V-0, or 5V
Greater than 2 square feet (0.19 m^2) and less than 10 square feet (0.93 m^2), 6 feet (1.83 m) maximum length	V-1, V-0, or 5V
Greater than 10 square feet (0.93 m^2), or longer than 6 feet (1.83 m)	Maximum flame spread rating of 200 as specified in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or radiant panel as specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94

8.3.3 Conductive coatings applied to nonmetallic surfaces such as the inside surface of an enclosure, shall comply with the appropriate requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, unless flaking or peeling of the coating cannot result in the reduction of spacings or the bridging of live parts.

8.3.4 A polymeric enclosure intended for connection to a rigid metallic conduit system shall comply with the requirements for polymeric enclosure rigid metallic conduit connections in the Standard for Enclosures for Electrical Equipment, UL 50.

8.3.5 The continuity of a conduit system shall be provided by metal-to-metal contact and not rely on a polymeric material and shall comply with the requirements for polymeric enclosure bonding in the Standard for Enclosures for Electrical Equipment, UL 50.

8.4 Covers

8.4.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached to provide access:

a) To fuses or any other over current-protective device, the intended protective functioning of which requires renewal or

b) When it is necessary to open the cover in connection with the normal operation of the unit.

Exception: In lieu of providing a hinged, sliding, or pivoted cover, supervision of the enclosure cover by means of a tamper feature is suitable when its operation results in either a trouble or alarm signal. This applies only to over current devices such as fuses or circuit breakers or other indicators that are not used on a continuing basis.

8.4.2 Normal operation, referenced in 8.4.1, is determined to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit which requires such action in connection with its intended performance.

8.4.3 A hinged cover is not required when the only fuse(s) enclosed is intended to provide protection to portions of internal circuits used on a separate printed-wiring board or circuit subassembly, to prevent circuit damage resulting from a fault. The use of such a fuse(s) is suitable when the following (or other wording that has been determined to be equivalent) is indicated as a marking on the outside of the cover: ″Circuit Fuse(s) Inside – Disconnect Power Prior To Servicing.″

8.4.4 Glass covering an observation opening shall be tempered and secured in place so that it cannot be displaced and shall provide mechanical protection for the enclosed parts. The thickness of a glass cover shall not be less than that indicated in Table 8.5.

Table 8.5
Thickness of glass covers

Maximum size of opening				Minimum thickness,	
Length or width,		Area,			
inches	(mm)	inches^2	(cm^2)	inch	(mm)
4	102	16	103	1/16	1.6
12	305	144	929	1/8	3.2
over 12	over 305	over 144	over 929	see note a	

[a] 1/8 inch (3.2 mm) or more, depending upon the size, shape, and mounting of the glass panel.

8.4.5 A glass panel for an opening having an area of more than 144 square inches (929 cm^2), or having any dimension greater than 12 inches (305 mm), shall be supported by a continuous groove not less than 3/16 inch (4.8 mm) deep along all four edges of the panel, or other means that have been determined to be an equivalent arrangement.

8.4.6 A transparent material other than glass used for the cover of an observation opening shall not introduce a risk of fire, distort, nor become less transparent at the temperature to which it is intended to be subjected under either normal or abnormal service conditions. See 8.3.2.

8.5 Battery compartments

8.5.1 A compartment for vented storage batteries shall have a total volume at least twice the volume occupied by the batteries. Ventilating openings shall be provided and so located as to permit circulation of air for dispersion of gas while the battery is being charged at the highest rate permitted by the means incorporated in the control unit.

8.5.2 The interior of a storage battery compartment shall be protected so that it will be resistant to detrimental action by the electrolyte.

8.6 Enclosure openings – general

8.6.1 An enclosure intended for recessed mounting and whose front panel is to be flush with the surface of the wall shall have no openings that vent into concealed spaces of a building structure, such as into hollow spaces in the wall, when the product is mounted as intended.

8.6.2 The requirement in 8.6.1 does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) when:

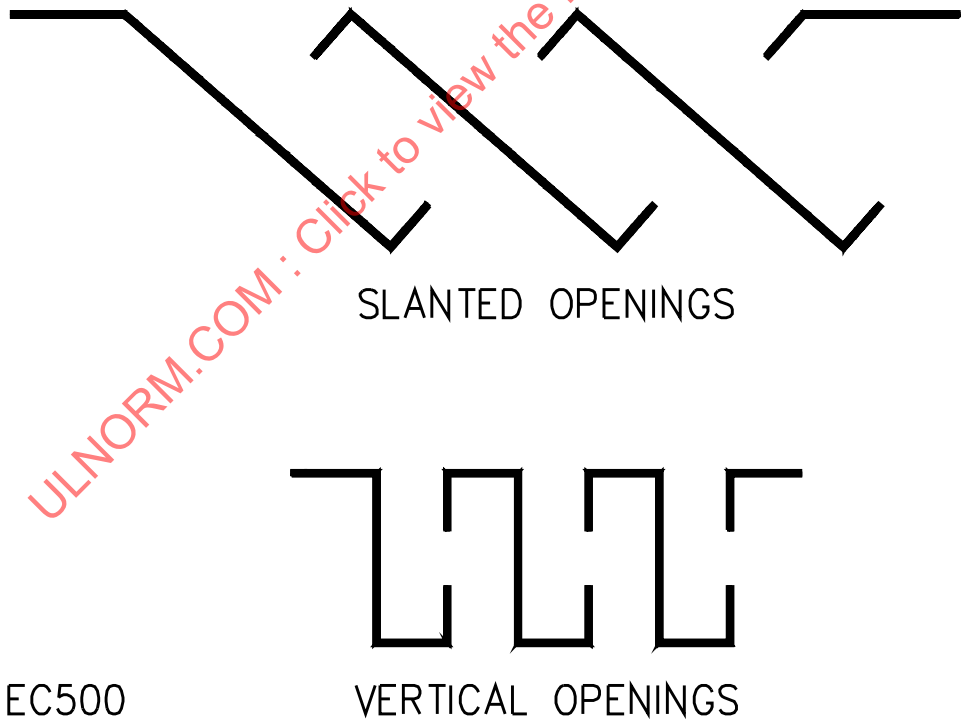
a) The opening does not have a dimension greater than 17/64 inch (6.75 mm) or an area greater than 0.055 square inch (35.5 mm^2) and

b) There are no more mounting screw holes than are needed to mount the product.

8.7 Enclosure top openings

8.7.1 An opening directly over an uninsulated live part involving a risk of fire, electric shock, or electrical-energy/high-current levels, shall not exceed 0.20 inch (5.0 mm) in any dimension unless the configuration is such that a vertically falling object cannot fall into the unit and contact an uninsulated live part. See Figure 8.1 for examples of top-cover designs complying with the intent of the requirement.

Figure 8.1
Cross-sections of top-cover designs



8.8 Enclosure side openings

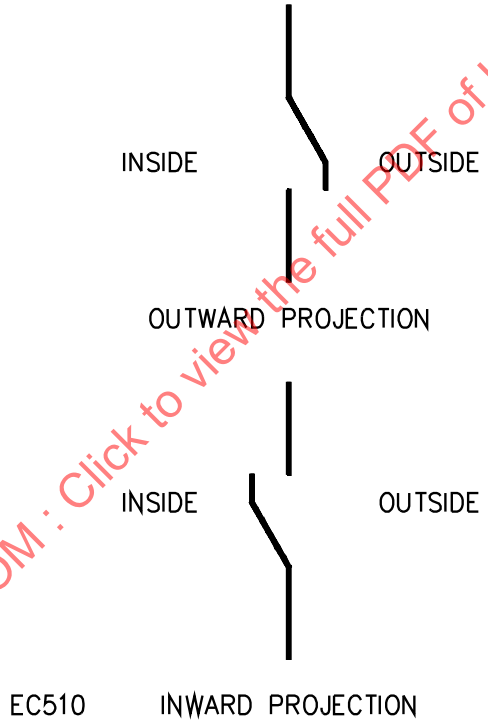
8.8.1 An opening in the side of the enclosure shall:

a) Not exceed 0.19 inch (4.8 mm) in any dimension;

b) Be provided with louvers shaped to deflect an external falling object outward. See Figure 8.2 for examples of louver designs complying with the requirement; or

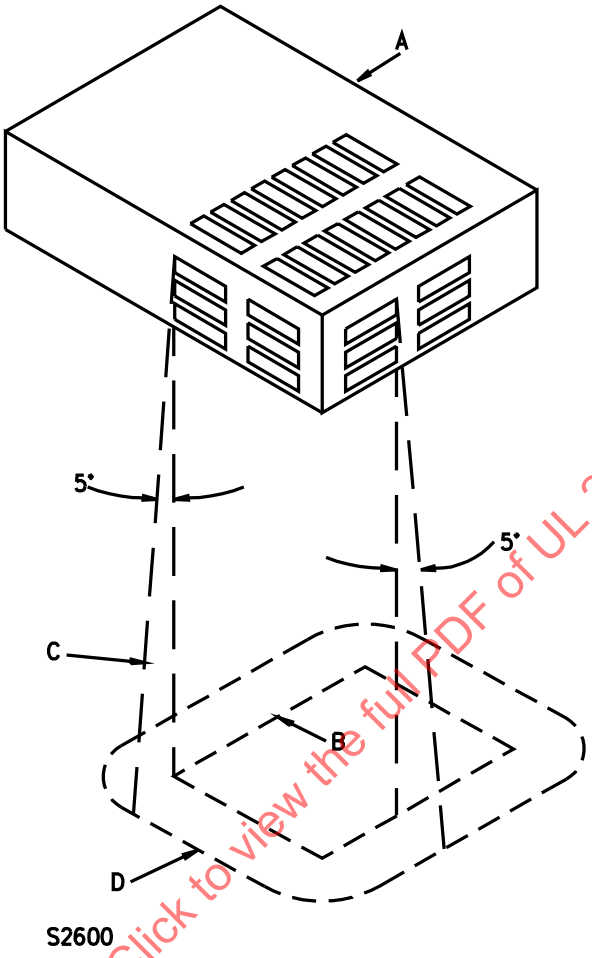
c) Be located and of such size so that objects which are to be present cannot fall into the unit and drop (with no horizontal velocity) onto uninsulated live parts involving a risk of fire, electric shock, or electrical-energy/high-current levels, or parts involving injury to persons.

Figure 8.2
Louvers



8.8.2 When a portion of a side panel falls within the area traced out by the 5 degree angle in Figure 8.3, that portion of the side panel shall be investigated as a bottom enclosure in accordance with 8.9.1 – 8.9.3.

Figure 8.3
Enclosure bottom



A – The entire component under which an enclosure (flat or dished with or without a lip or other raised edge) of noncombustible material is to be provided. The sketch is of an enclosed component with ventilation openings showing that the enclosure is required only for those openings through which flaming parts are to be emitted. When the component or assembly does not have its own noncombustible enclosure, the area to be protected is the entire area occupied by the component or assembly.

B – Projection of the outline of the area of A that requires a bottom enclosure vertically downward onto the horizontal plane of the lowest point on the outer edge D of the enclosure.

C – Inclined line that traces out an area D on the horizontal plane of the enclosure. Moving around the perimeter of the area B that requires a bottom enclosure, this line projects at a 5 degree angle from the line extending vertically at every point around the perimeter of A and is oriented to trace out the largest area; except that the angle shall be less than 5 degrees when the enclosure bottom contacts a vertical enclosure or side panel, or when the horizontal extension of the enclosure B to D exceeds 6 inches (152 mm).

D – Minimum outline of the enclosure, except that the extension B to D is not required to exceed 6 inches (152 mm), flat or dished with or without a tip or other raised edge. The bottom shall either be flat or formed in any manner when every point of area D is at or below the lowest point on the outer edge of the enclosure.

8.9 Enclosure bottom openings

8.9.1 The bottom of an enclosure shall consist of a complete or partial bottom enclosure under a component, groups of components, or assemblies, as shown in Figure 8.3, that complies with the ventilation opening requirements in 8.9.2 and 8.9.3 unless a test demonstrates that the bottom enclosure provided contains flames, glowing particles or similar burning debris when all combustible material in the interior is ignited.

Exception: Openings without limitation on their size and number are permitted in areas that contain only wires, cables, plugs, receptacles, and impedance-protected and thermally protected motors.

8.9.2 Ventilation openings provided in the bottom of an enclosure under materials that are not rated V-1 or less flammable meet the intent of the requirements when the openings are constructed so that materials do not fall directly from the interior of the unit. Other bottom-opening constructions that comply with the intent of the requirements are those that incorporate a perforated metal plate as described in Table 8.6, or a galvanized or stainless-steel screen having a 14 by 14 mesh per 1 inch (25.4 mm) constructed of wire with a minimum diameter of 1/64 inch (0.4 mm). Other constructions are to be used only when they comply with the Ignition Test Through Bottom-Panel Openings, Section 50.

Table 8.6
Perforated metal plates

Minimum thickness,		Maximum diameter of holes,		Minimum spacing of holes center-to-center,	
inch	(mm)	inch	(mm)	inch	(mm)
0.026	0.66	0.045	1.14	0.67 [233 holes per inch^2]	1.70 [36 holes per cm^2]
0.026	0.66	0.047	1.19	0.093	2.36
0.032	0.81	0.075	1.91	0.125 [72 holes per inch^2]	3.18 [11 holes per cm^2]
0.036	0.91	0.063	1.60	0.109	2.77
0.036	0.91	0.078	1.98	0.125	3.18

8.9.3 The bottom of the enclosure under areas containing only materials rated V-1 or less flammable shall have openings no larger than 1/16 inch^2 (40 mm^2).

8.10 Gaskets

8.10.1 A gasket shall be of a material suitable for the temperature and use to which it will be subjected. The gasket material shall be resistant to aging. A gasket that will be disturbed during routine servicing, such as during battery replacement, shall be formed of resilient material such as neoprene or silicone rubber.

8.10.2 A gasket of neoprene, rubber, neoprene composition, or rubber composition used to prevent the entry of water into a fixture shall be subjected to the Gasket Accelerated Aging Test, Section 54, and when intended for outdoor use, Gasket Low Temperature Test – Outdoor Use, Section 55.

8.10.3 A gasket material other than those specified in 8.10.2 meets the intent of the requirements when the characteristics are determined to be the equivalent, including resistance to aging. Such material is determined resistant to aging when there is no visible evidence of deterioration (such as cracking after flexing, softening, or hardening) after these characteristics are investigated.

9 Internal Materials

9.1 Polymeric materials used within an enclosure shall be evaluated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: Unrated resistors, capacitors, semiconductors, integrated circuit packages, optical isolators, and similar electrical components meet the intent of the requirement when they are mounted on a material with a minimum flammability rating of V-1.

9.2 All combustible material used within an enclosure shall be V-2, HF-2, or better.

Exception: Motors, relays, capacitors, semiconductors, transformers, switches, insulating tubing or tape, and other electrical elements are exempt from the above requirement when they comply with the flame test applicable to the component. Meter faces and cases (when determined capable for mounting live parts) and indicator lamps or jewels, or both, are exempt from flammability requirements. The following requirements apply to parts that are isolated either by at least 0.5 inch (12.5 mm) of air, or a solid barrier of V-1 or less-flammable material from uninsulated electrical parts that involve a risk from electrical energy - high current levels:

a) Gears, cams, belts, bearings, strain-relief bushings applied over PVC-jacketed cords, and other small parts that contribute negligible fuel to a fire is not required to be investigated.

b) Tubing for air or fluid systems, and foamed plastics, shall not be more flammable than HB. Foamed plastics classed HBF in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, are determined as complying with this requirement.

10 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

10.1 To reduce the risk of unintentional contact and a risk of electric shock from an uninsulated live part or film-coated wire and injury to persons from a moving part, an opening in an enclosure shall have a minor dimension less than 1 inch (25.4 mm), and such a part or wire shall not be contacted by the probe illustrated in Figure 10.1.