



UL 2525

STANDARD FOR SAFETY

Two-Way Emergency Communications
Systems for Rescue Assistance

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UL Standard for Safety for Two-Way Emergency Communications Systems for Rescue Assistance, UL 2525

First Edition, Dated June 12, 2020

SUMMARY OF TOPICS

This is the first edition of ANSI/UL 2525, Standard for Two-Way Emergency Communications Systems for Rescue Assistance, and includes approval as an American National Standard.

The new requirements are substantially in accordance with Proposal(s) on this subject dated February 28, 2020 and May 8, 2020.

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UL 2525

Standard for Two-Way Emergency Communications Systems for Rescue

Assistance

First Edition

June 12, 2020

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The most recent designation of ANSI/UL 2525 as an American National Standard (ANSI) occurred on June 10, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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INTRODUCTION

1 Scope

1.1 These requirements cover:

- a) Discrete electrical products for rescue assistance two-way emergency communication systems, e.g. remote communications stations, master control units and accessories.
- b) Electrically- and electronically-operated amplifiers that provide speech communication and distinctive sounds in conjunction with rescue assistance two-way emergency communication systems; and
- c) Commercial stationary and fixed power supplies for rescue assistance two-way emergency communication systems, having input and output ratings of not more than 600 V, direct- and alternating-current, (DC and AC).

1.2 These requirements cover products to be employed in accordance with the following Codes and Standards:

- a) National Electrical Code, NFPA 70;
- b) National Fire Alarm and Signaling Code, NFPA 72;
- c) Life Safety Code, NFPA 101;
- d) International Building Code (IBC)/International Fire Code (IFC);
- e) Building Construction and Safety Code, NFPA 5000;
- f) Fire Code, NFPA 1.

1.3 The products covered by this standard are intended to be used in combination with other devices to form a rescue assistance two-way emergency communication system. These products provide all monitoring, control, and indicating functions of the system. An installation document(s) provided with the product describes the various products needed to form a rescue assistance two-way emergency communication system and their intended use and installation. This standard includes systems used for emergency communication in the following situations:

- a) Exit stairs, stairways, or stair landings (Stairway Communications Systems)
- b) Elevator lobbies and landings (Elevator Landing Communications Systems)
- c) Occupant evacuation elevator lobbies (Occupant Evacuation Elevator Lobby Communications Systems)
- d) Area(s) of Rescue Assistance or Area(s) for Assisted Rescue Communications Systems
- e) Area(s) of Refuge Communications Systems
- f) Other similar two-way emergency communications systems

1.4 These requirements do not cover:

- a) Other initiating devices; nor do they cover notification appliances not provided as part of the product.
- b) Emergency Responder Communications Enhancement Systems, UL 2524,

- c) Communication systems, which are covered by the Standard for Hospital Signaling and Nurse Call Equipment, UL 1069.
- d) Communication systems covered by the Standard for Emergency Call Systems for Assisted Living and Independent Living Facilities, UL 2560.
- e) Fire alarm, emergency voice/alarm communication systems, and two-way in-building wired emergency services communication systems covered by the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864.

1.5 These requirements do not include determination of compliance with regulations of the Federal Communications Commission (FCC). Should products covered by these requirements be required to comply with FCC regulations, a report of verification from the manufacturer is required as evidence of such compliance.

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 Annex 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.

2.3 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 ACCESSORY – A device or appliance externally connected to a master control unit that is employed to assure proper operation of a system or to provide supplementary signaling and/or annunciation. Examples of master control unit accessories are annunciators, end-of-line resistors or diodes, auxiliary relays, remote switches, and the like.

3.2 ACKNOWLEDGE – Action taken to confirm that a message or signal has been received, such as pressing a button.

3.3 ADDRESSABLE – Two-way emergency communication system with discrete identification of interconnected devices and/or appliances that can have their status individually identified or that is used to individually control other functions.

3.4 ADVERSE CONDITION – Any condition occurring in a circuit or communication path that interferes with the proper signaling or interpretation of status-change signals or both. Conditions include radio frequency interference.

3.5 AIR-HANDLING SPACE – Space used for environmental air-handling purposes other than ducts or plenums. The space over a hung ceiling used for environmental air-handling is an example.

3.6 ANNUNCIATOR – A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means in which each indication provides status information about a circuit, condition, or location.

3.7 ATTENDANT NOTIFICATION APPLIANCE – A notification appliance intended to get the attention of the master control unit operator to indicate an emergency signal, or trouble condition.

3.8 ATTENDANT NOTIFICATION APPLIANCE CIRCUIT – A circuit or path directly connected to an attendant notification appliance.

3.9 AVERAGE VALUE – The sum of all instantaneous values of current (or voltage), averaged over one-half of an alternating cycle.

3.10 BATTERY CHARGER – A product intended to deliver sufficient current to maintain storage batteries in their fully-charged condition while the batteries are not connected to a load. The storage batteries are intended to provide a secondary source of operating power in response to failure of the primary source of operating power.

3.11 REMOTE COMMUNICATIONS STATION – A manually-operated device, the normal intended operation of which results in an emergency signal indication at the master control unit.

3.12 CIRCUIT CLASSIFICATIONS:

a) High-Voltage Circuit – A circuit involving a potential of not more than 600 V nominal 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 V alternating current (AC) rms, 42.4 V direct current (DC) or peak.

c) Power-Limited Circuit – A circuit wherein the power is limited as specified in [Table 43.1](#) and [Table 43.2](#).

3.13 COMBINATION SYSTEM – A two-way emergency communication system whose components might be used, in whole or in part, in common with non-emergency or other emergency signaling systems.

3.14 COMMUNICATION (S) CIRCUIT – Communications circuit between master control units and remote communications stations and networked master control units that carries voice, audio, data, and other signals.

3.15 DISPLAY – The visual representation of output data or status information, other than printed copy.

- 3.16 **DISTINCTIVE SIGNALS** – Signals obtained from different sounding appliances (such as bells, horns, sirens, and buzzers) or from a single appliance (such as an electronic horn) where a continuous signal is obtained under one condition and a pulsing signal under another.
- 3.17 **EMERGENCY SIGNAL** – A signal indicating an emergency condition requiring immediate action such as a signal indicative of a need for rescue assistance.
- 3.18 **END-OF-LINE DEVICE** – A device installed at the end of a circuit for the purpose of monitoring the circuit for fault conditions.
- 3.19 **EVACUATION** – The withdrawal of occupants from a building.
- 3.20 **EXTERNAL CIRCUITS** – Circuits or wiring leaving the product.
- 3.21 **FAULT** – An open, ground, or short-circuit condition on any line extending from a product.
- 3.22 **FIELD WIRING** – Conductors to be installed by others to connect a product to source(s) of supply, devices, other products, and loads.
- 3.23 **FIXED EQUIPMENT** – Any equipment product that is intended to be permanently connected electrically to the wiring system.
- 3.24 **GAGES** – Wherever they appear in this standard, the abbreviations MSG, GSG, and AWG mean, respectively, Manufacturers' Standard Gage for Steel Sheets, Galvanized Sheet Gage, and American Wire Gage. Reference to sheet metal by gage number is intended only as auxiliary information. Sheet metal of the indicated gage number may not be used if the forming processes have reduced the thickness of the sheet to a point below the specified minimum thickness.
- 3.25 **GROUNDING CONDUCTOR** – A conductor employed to connect the intentionally grounded circuit of a wiring system to a grounding electrode.
- 3.26 **GROUND FAULT** – A circuit impedance to ground sufficient to result in the annunciation of a trouble condition.
- 3.27 **GROUNDING CONDUCTOR** – A conductor employed to connect non-current-carrying parts of equipment, raceways, and enclosure to a grounding electrode at the service which is, in turn, connected to earth ground or to some conducting body which serves in place of earth ground.
- 3.28 **INSTALLATION LOCATIONS: Dry** – A location with a controlled ambient that is not subject to dampness or wetness.
- 3.29 **LIFE SAFETY NETWORK** – A combination system that carries other signals in addition to fire alarm or mass notification signals and is connected to a fire alarm or mass notification system.
- 3.30 **MASTER CONTROL UNIT** – The principal on-premise attended location where the status of the two-way emergency communication system is displayed and from which the system can be manually controlled.
- 3.31 **MESSAGE(S)** – Communicated data that contains specific information relating to the status of the product and is transmitted via a wired or wireless pathway from an origin to a destination.
- 3.32 **NON-VOLATILE MEMORY** – A storage device not alterable by the interruption of the power to the memory; for example, ROM, FLASH, PROM, EPROM, and EEPROM.

- 3.33 NORMAL CONDITION – System, circuits, and components are operating as intended and no abnormal condition exists.
- 3.34 OFF-SITE COMMUNICATIONS LINKS – Physical media or wireless methodology for providing two-way voice, audio, data, and other signals between a two-way emergency communication system within a building and an off-site constantly attended monitoring location on contiguous or non-contiguous property.
- 3.35 OPEN FAULT – A circuit impedance increase sufficient to prevent normal operation.
- 3.36 OPERATOR – Individual(s) responsible to access and operate the product and/or system, but does not have access to portions of the product required for servicing and maintenance.
- 3.37 OPERATOR INTERFACE – Providing controls for manually operating the product/system.
- 3.38 PATH (PATHWAY) – Any conductor, optic fiber, radio carrier, or other means for transmitting information between two or more units and/or locations.
- 3.39 POWER SUPPLY – A source of electrical operating power including the circuits and terminations connecting it to the dependent product/system components.
- 3.40 POWER SUPPLY-BATTERY CHARGER – A power supply that serves the dual function of providing operating power and charging storage batteries. The power supply is usually permanently connected to storage batteries, and the power supply-battery combination is intended to provide all of the electrical operating power required by the equipment to which the combination is connected, when the equipment is operating in its intended manner.
- 3.41 PRIMARY BATTERY – Any battery which by design or construction is not intended to be recharged.
- 3.42 RESCUE ASSISTANCE – Building occupants that need assistance during an emergency can request assistance by using a remote communications station that signals a master control unit.
- 3.43 RESET – A control function that attempts to return a system or device to its normal condition state.
- 3.44 RISK OF ELECTRIC SHOCK – A risk of electric shock is determined to exist at any part if:
- a) The potential between the part and earth ground or any other accessible part is more than 42.4 V peak, and
 - b) The continuous current flow through a 1500 Ω resistor connected across the potential exceeds 0.5 mA.
- 3.45 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:
- a) The open circuit voltage is more than 42.4 V peak and the energy available to the circuit under any condition of load including short circuit, results in a current of 8 A or more after 1 min of operation; or
 - b) A power of more than 15 W can be delivered into an external resistor connected between the two points.
- 3.46 SHORT-RANGE RADIO-FREQUENCY DEVICES – Any device that communicates with control/receiving equipment by low-power radio signals in accordance with the Code of Federal Regulations (CFR) 47.

3.47 SOFTWARE – Programs, instructions, procedures, data, and the like that are executed by a central processing unit of a product and which influences the functional performance of that product. For the purpose of this standard, software is one of two types:

a) Executive Software – Control and supervisory program which manages the execution of all other programs and directly or indirectly causes the required functions of the product to be performed.

b) Site-Specific Software – Program that is separate from, but controlled by, the executive software which allows inputs, outputs, and system configuration to be selectively defined to meet the needs of a specific installation.

3.48 STANDBY POWER SOURCE – Provides power when the primary power source fails.

3.49 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.

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

3.51 SUPERVISORY CIRCUIT – A circuit or path that monitors the status of other systems which must be maintained to prevent affecting normal system operation.

3.52 SUPERVISORY CONDITION – An abnormal condition related to the monitoring of other systems and/or equipment.

3.53 SUPERVISORY SIGNAL – A signal indicating the need of action in connection with the monitoring of other systems or equipment.

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

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

3.56 SUPPLEMENTARY-DEVICE CIRCUIT – A circuit provided by a product for controlling a device, the operation of which is supplementary to the primary functionality of the emergency communication system.

3.57 TRAINED SERVICE PERSONNEL – service personnel that are trained and have knowledge and experience of the maintenance for the equipment being serviced or maintained.

3.58 TROUBLE SIGNAL – A visual or audible 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 a two-way emergency communications system.

3.59 USER – An individual who operates or services the product.

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

4 Information Required for Assessment

4.1 The following documentation may be required to determine compliance:

a) Schematic diagrams of all circuits.

b) Where the product uses software, evidence of software integrity as described in [38.3.1](#) – [38.3.4](#).

- c) Marking to be applied to the product as required in Markings, Section [67](#).
- d) Installation wiring diagram/instructions as required in Installation Wiring Diagram/Instructions, Section [68](#).
- e) Operating instructions as required in Operating Instructions, Section [69](#).

CONSTRUCTION

5 General

5.1 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.

5.2 Metals, when required to meet the requirements of this standard, shall not be used in such combination as to cause galvanic action that will increase 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.

5.3 Where breakage or deterioration of a part such as an enclosure, a frame, a guard, or the like can result in a risk of injury to persons, the part shall be constructed to meet the demand or expected loading conditions.

5.4 The requirement in [5.3](#) applies also to those positions of a part adjacent to a moving part identified to involve a risk of injury to persons.

5.5 Electrical equipment with nonmetallic enclosures and other non-metallic discrete objects, intended to be installed in air-handling spaces shall additionally comply with the requirements in the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces, UL 2043.

5.6 Products that currently meet all the requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1 or the Standard for Audio, Video, and Similar Electronic Apparatus-Safety Requirements, UL 60065 or the Standard for Audio/Video, Information and Communication Technology Equipment – Safety Requirements – Part 1, UL 62368 need only be evaluated to the following sections with respect to the construction requirements: [6.1.1](#), [9.5](#), [11.1.1](#), [11.2](#), [12.1](#) – [12.3](#), [12.6](#), [14.4](#), [19](#), [23.1](#), [25.3](#), and [27](#).

6 Enclosures

6.1 General

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

6.2 Metallic material

6.2.1 An enclosure of metal shall have a minimum thickness as specified in [Table 6.1](#), [Table 6.2](#), or [Table 6.3](#), or shall comply with the test requirements in Mechanical Strength Tests for Metal Enclosures and Guards, Section [57](#).

Table 6.1
Cast-metal electrical enclosures

Use, or dimensions of area involved ^a	Minimum thickness			
	Die-cast metal,		Cast metal other than die-cast,	
	in	(mm)	in	(mm)
Area of 24 in ² (155 cm ²) or less and having no dimension greater than 6 in (152 mm)	1/16	(1.6)	1/8	(3.2)
Area greater than 24 in ² (155 cm ²) or having any dimension greater than 6 in (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 in (1.6 mm) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

Table 6.2
Minimum thickness of sheet metal for electrical enclosures of carbon 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, ^c		Uncoated,	Metal coated,
in	(cm)	in	(cm)	in	(cm)	in	(cm)	in (mm)	in (mm)
								[MSG]	[GSG]
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 6.2 Continued on Next Page

Table 6.2 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness	
Maximum width, ^b in (cm)	Maximum length, ^c in (cm)	Maximum width, ^b in (cm)	Maximum length, in (cm)	Uncoated, in (mm)	
				[MSG]	[GSG]
<p>^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:</p> <ol style="list-style-type: none"> 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. <p>^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.</p> <p>^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 in (12.7 mm) wide.</p>					

**Table 6.3
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, in (mm)
Maximum width, ^b in (cm)	Maximum length, ^c in (cm)	Maximum width, ^b in (cm)	Maximum length, in (cm)	
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	0.023 (0.58)
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.5 (24.1)	
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	0.029 (0.74)
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)	
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	0.036 (0.91)
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)	
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	0.045 (1.14)
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)	
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	0.058 (1.47)
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)	
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	0.075 (1.91)
20.0 (50.8)	25.0 (63.5)	45.0 (114.3)	55.0 (139.7)	
25.0 (63.5)	Not limited	60.0 (152.4)	Not limited	0.095 (2.41)
29.0 (73.7)	36.0 (91.4)	64.0 (162.6)	78.0 (198.1)	
37.0 (94.0)	Not limited	87.0 (221.0)	Not limited	0.122 (3.10)
42.0 (106.7)	53.0 (134.6)	93.0 (236.2)	114.0 (289.6)	
52.0 (132.1)	Not limited	123.0 (312.4)	Not limited	0.153 (3.89)
60.0 (152.4)	74.0 (188.0)	130.0 (330.2)	160.0 (406.4)	

^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

Table 6.3 Continued on Next Page

Table 6.3 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, in (mm)
Maximum width, ^b in (cm)	Maximum length, ^c in (cm)	Maximum width, ^b in (cm)	Maximum length, in (cm)	
<p>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:</p> <ol style="list-style-type: none"> 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. <p>^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.</p> <p>^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 in (12.7 mm) wide.</p>				

6.2.2 Where threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or where a construction that is determined to be 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 can be attached.

6.2.3 Where 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, and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

6.2.4 At any point where conduit or metal-clad cable is to be attached to the enclosure, sheet metal shall be of such thickness or shall be so formed or reinforced that it will have stiffness at least equivalent to that of an uncoated flat sheet of steel having a minimum thickness of 0.032 in (0.81 mm).

6.3 Polymeric materials

6.3.1 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.

6.3.2 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 6.4](#).

Table 6.4
Flammability characteristics of polymeric material

Polymeric material area/dimensions	Flammability rating
0.24 in ³ (4 cm ³) maximum and 2.4 in (61 mm) maximum length	None
Greater than 0.24 in ³ (4 cm ³) and less than 2 ft ² (0.19 m ²), 6 ft (1.83 m) maximum length	HB, V-2, V-1, V-0, or 5V

Table 6.4 Continued on Next Page

Table 6.4 Continued

Polymeric material area/dimensions	Flammability rating
Greater than 2 ft ² (0.19 m ²) and less than 10 ft ² (0.93 m ²), 6 ft (1.83 m) maximum length	V-1, V-0, or 5V
Greater than 10 ft ² (0.93 m ²), or longer than 6 ft (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

6.3.3 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.

6.3.4 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, Non-Environmental Considerations, UL 50.

6.3.5 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, Non-Environmental Considerations, UL 50.

6.4 Covers

6.4.1 An enclosure cover shall be hinged, sliding, pivoted or similarly attached to provide access to fuses or any other over current-protective device, the intended protective functioning of which requires renewal or resetting, or 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 emergency signal. This applies only when the cover provides access to overcurrent devices such as fuses or circuit breakers or other indicators that are not used on a continuing basis.

6.4.2 Normal operation referenced in [6.4.1](#) is determined to be operation of a switch for testing or for silencing an audible signal or operation of any other component of a unit which requires such action in connection with its intended performance.

6.4.3 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."

6.4.4 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 6.5](#).

Table 6.5
Thickness of glass covers

Maximum size of opening				Minimum thickness,	
Length or width,		Area,			
in	(mm)	in ²	(cm ²)	in	(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 in (3.2 mm) or more, depending upon the size, shape, and mounting of the glass panel.

6.4.5 A glass panel for an opening having an area of more than 144 in² (929 cm²), or having any dimension greater than 12 in (305 mm), shall be supported by a continuous groove not less than 3/16 in (4.8 mm) deep along all four edges of the panel, or other means that have been determined to be an equivalent arrangement.

6.4.6 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 [6.3.2](#).

6.5 Battery compartments

6.5.1 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.

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

6.6 Enclosure openings – general

6.6.1 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.

Exception: Products supplied solely from power-limited sources and controlling only power-limited loads.

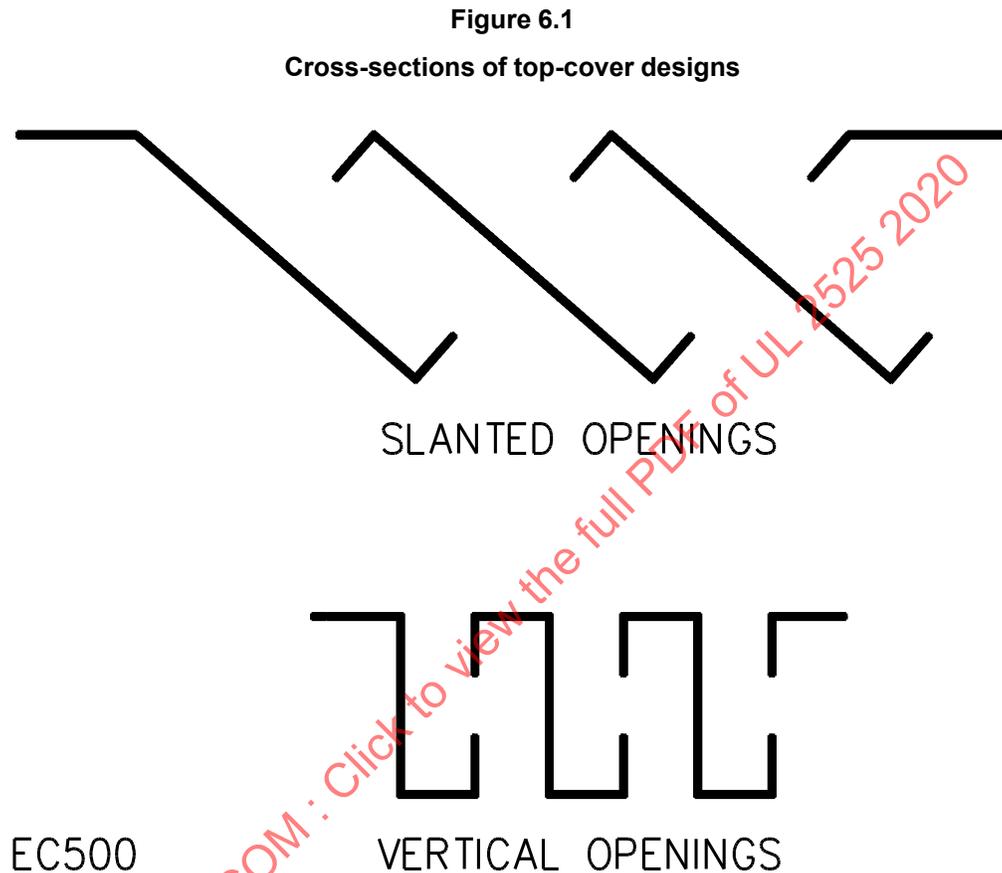
6.6.2 The requirement in [6.6.1](#) does not apply to an opening for a mounting screw or nail or for a manufacturing operation (such as paint drainage) when:

- a) An opening for non-mounting purposes does not have a dimension greater than 17/64 in (6.75 mm) or an area greater than 0.055 ft² (35.5 mm²); and
- b) An opening for mounting does not have a dimension greater than 0.75 in (19.05 mm) or an area greater than 0.7 in² (430 mm²) and there are no more holes than are needed to mount the product.

6.6.3 Acoustical openings for both the speaker and microphone shall be vandal-resistant by not providing direct access to any sound producing element, for example, a cone or diaphragm, by a rigid rod 0.8 mm (0.03 in) in diameter.

6.7 Enclosure top openings

6.7.1 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 in (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 6.1](#) for examples of top-cover designs complying with the intent of the requirement.



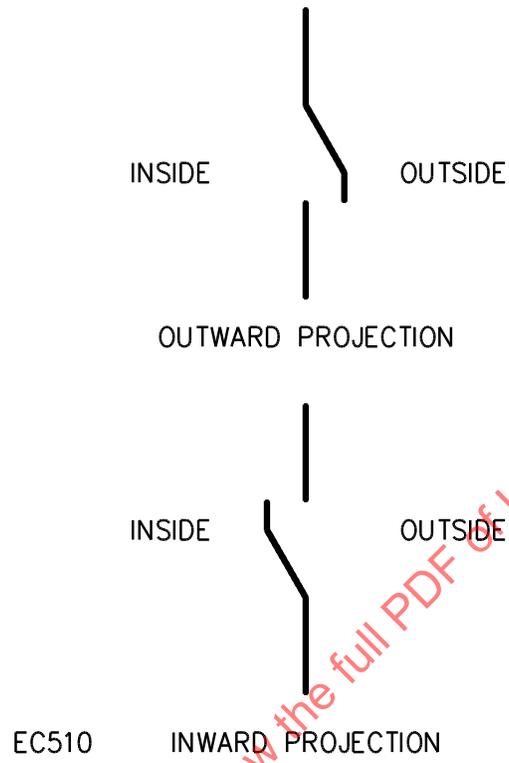
6.8 Enclosure side openings

6.8.1 An opening in the side of the enclosure shall:

- a) Not exceed 0.19 in (4.8 mm) in any dimension;
- b) Be provided with louvers shaped to deflect an external falling object outward (see [Figure 6.2](#) for examples of louver designs complying with the requirement); or
- c) Be located and sized so that objects which are present cannot drop into the unit and fall (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 (see [Figure 6.3](#)).

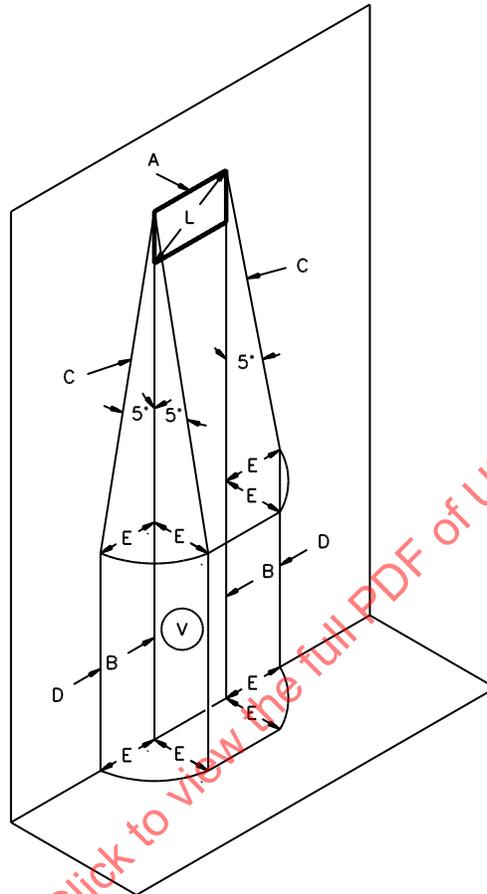
6.8.2 When a portion of a side panel falls within the area traced out by the 5° angle in [Figure 6.4](#), that portion of the side panel shall be investigated as a bottom enclosure in accordance with [6.9.1](#) – [6.9.3](#).

Figure 6.2
Louvers



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Figure 6.3
Example of enclosure side opening



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A – Enclosure side opening.

B – Vertical projection of the outer edges of the side opening.

C – Inclined lines that project at a 5° angle from the edges of the side opening to point located E distance from B.

D – Line which is projected straight downward in the same plane as the enclosure side wall.

E – Projection of the opening (not to be greater than L).

L – Maximum dimension of the enclosure side opening.

V – Volume in which bare parts at uninsulated live parts are not located.