

UL 1480

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Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

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UL Standard for Safety for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use,
UL 1480

Fifth Edition, Dated January 31, 2003

Revisions: This Standard contains revisions through and including April 8, 2005.

Summary of Topics

The revision has been issued to update the ANSI information on the title page. No changes in requirements are involved.

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The following table lists the future effective dates with the corresponding item.

Future Effective Date	References
January 31, 2005	Paragraphs 6.2.6, 6.2.7, 21.3, 21.4, Table 21.1, Figures 21.1 – 21.5, 23.1, Section 22 – 25, 29, 31 – 34, 38, 39, 43, 45, 47 – 53

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Page	Date
1	April 8, 2005
2-3	January 7, 2005
4-5	January 31, 2003
6	January 7, 2005
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UL 1480

Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

The first edition was titled Speakers and Amplifiers for Fire Protective Signaling Systems.

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Fifth Edition

January 31, 2003

The most recent designation of ANSI/UL 1480 as an American National Standard (ANSI) occurred on March 25, 2005.

This ANSI/UL Standard for Safety, which consists of the Seventh Edition with revisions through April 8, 2005, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>. UL Santa Clara Standards Department, 1655 Scott Boulevard, Santa Clara, CA 95050.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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INTRODUCTION

1 Scope

1.1 These requirements cover speakers for indoor and/or outdoor use in dry, damp, wet, or underwater locations and are intended for one or more of the following:

- a) Fire alarm systems in accordance with the National Electrical Code, NFPA 70, and the National Fire Alarm Code, NFPA 72, providing emergency voice/alarm occupant notification;
- b) Commercial and professional audio systems providing non-emergency sound reinforcement and reproduction in accordance with NFPA 70 (this includes equipment for institutional, industrial use);
- c) Non-fire emergency voice-warning systems in accordance with NFPA 70; examples of non-fire emergency-warning systems include, but are not limited to:
 - 1) Critical process monitoring (nuclear plant, oil refinery, hazardous chemical processing);
 - 2) Distress alert systems (help for handicapped, for life safety, for rape, for robbery);
 - 3) Crowd control in public places (sporting arena, theater, shopping mall, transportation center); and
 - 4) Non-fire emergency voice-systems covered by the Life Safety Code, NFPA 101.
- d) Underwater speakers in accordance with Article 680 of NFPA 70. An underwater speaker is not to be used in a fire alarm system or as an emergency (non-fire) voice-warning system.

1.2 These requirements do not cover the following:

- a) Speakers intended for use in hazardous locations as defined in the National Electrical Code, NFPA 70; this includes speakers tested with the requirements in the Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment For Use In Hazardous (Classified) Locations, UL 1203;
- b) Speakers intended for personal or private consumer use; this includes speakers for household/domestic use covered by the requirements in the Standard for Audio-Video Products and Accessories, UL 1492 and the Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar General Use, UL 6500;
- c) Speakers which are intended for commercial or professional audio applications and which employ integral active electronics; these products are covered in the Standard for Commercial Audio Equipment, UL 813; the Standard for Professional Video and Audio Equipment, UL 1419; and the commercial audio amplifier applications covered in UL 6500; and
- d) Speakers intended for security applications; these products are covered in the Standard for Local Burglar Alarm Units and Systems, UL 609; and the Standard for Household Burglar-Alarm System Units, UL 1023.

1.3 Speakers intended for use with fire alarm systems and having integral amplifiers must comply with the requirements in this standard in addition to the requirements in the Standard for Amplifiers for Fire Protective Signaling Systems, UL 1711.

1.4 Speakers intended for use with emergency and non-emergency systems and having integral amplifiers must comply with this standard in addition to the requirements in the Standard for General-Purpose Signaling Devices and Systems, UL 2017.

1.5 Speakers intended for use in air-handling spaces in accordance with Installation of Air Conditioning and Ventilating Systems, NFPA 90A, shall comply with the requirements in this standard and 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.

2 General

2.1 Components

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

2.1.2 A component 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 Unless otherwise indicated, all voltage and current values mentioned in this standard are rms.

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

2.2.3 Wherever the abbreviation "AWG" appears in these requirements, it refers to American Wire Gage.

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 AUDIO CIRCUITS (HIGH-VOLTAGE) – Commercial or professional speakers for connection in accordance with Article 640 of the National Electrical Code, ANSI/NFPA 70, that are used for music or voice communication and are rated more than 120 volts. Fire or emergency warning speakers for connection in accordance with Article 760 of ANSI/NFPA 70, for reproduction of voice and evacuation signals, and are rated more than 30 volts. A combination commercial or professional/fire or emergency-warning system connected in accordance with Article 760 of ANSI/NFPA 70, is considered to be high-voltage when the speaker is rated more than 30 volts.

3.3 AUDIO CIRCUITS (LOW-VOLTAGE) – Commercial or professional speakers for connection in accordance with Article 640 of the National Electrical Code, ANSI/NFPA 70, that are used for music or voice communication and are rated 120 volts or less. Fire or emergency warning speakers for connection in accordance with Article 760 of ANSI/NFPA 70, for reproduction of voice and evacuation signals, and are rated 30 volts or less. A combination commercial or professional/fire or emergency-warning system connected in accordance with Article 760 of ANSI/NFPA 70, is considered to be low-voltage when the speaker is rated 30 volts or less.

3.4 CHEESECLOTH INDICATORS – Cheesecloth used for tests shall be untreated cotton cloth running 14 – 15 square yards per pound (26 – 28 square meters per kilogram) and having what is known in the trade as a "count of 32 by 28".

3.5 CRITICAL COMPONENT – With regard to the risk of fire and electric shock, a critical component is a part that:

- a) Encloses a high-voltage part(s);
- b) Is capable of coming into contact with a source of ignition;
- c) Supports a live part; or
- d) Is capable of coming into contact with a live part.

3.6 ELECTRICAL CIRCUIT (HIGH-VOLTAGE) – A circuit involving a potential of not more than 300 volts and having circuit characteristics in excess of those of a low-voltage circuit.

3.7 ELECTRICAL CIRCUIT (LIVE PART) – A conductive part of a circuit carrying (or having the potential to carry) voltage, power, or current of sufficient magnitude to present a risk of fire or electric shock.

3.8 ELECTRICAL CIRCUIT (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.

3.9 FIELD-WIRING LEADS – Leads to which electrical connections are made in the field.

3.10 FIELD-WIRING TERMINALS – Terminals to which electrical connections are made in the field.

3.11 INSTALLATION LOCATIONS:

- a) Dry – A location with a controlled ambient that is not subject to dampness or wetness.
- b) Damp – A location protected from sun, rain, and water, but subject to moisture (such as basements, barns, cold-storage warehouses, greenhouses, indoor swimming facilities, and similar locations); may also include partially protected locations under canopies, marquees, roofed open porches, and similar spaces.
- c) Wet – A location subject to rain and the spray of non-corrosive and non-flammable liquids that may become saturated with water or that is unprotected from the weather.
- d) Underwater – A location such as a swimming pool or diving tank.

3.12 PINK NOISE – Broadband noise whose energy content is inversely proportional to frequency.

3.13 PRODUCT – Any type of speaker covered by the Scope of these requirements.

3.14 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered 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 30 V AC rms, 42.4 V DC, or 42.4 V peak or less;
- 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) is 5 milliamperes or less; or
- c) The circuit is supplied by a low-voltage source such as the audio circuit described in 3.3.

3.15 RISK OF FIRE – A risk of fire is considered to exist within a circuit that 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 30V AC or 42.4 V peak or more and
- b) The power available to the circuit is 15 watts or greater.

3.16 SPEAKER ASSEMBLY – Includes one or more speaker transducers, a mounting frame or enclosure, a means for field connection, and any electrical components.

3.17 **SPEAKER TRANSDUCER** – The component within in a speaker assembly which converts the electrical signal into an acoustical signal.

3.18 **TISSUE PAPER** – Used as a flame indicator. Undyed, lightweight tissue paper weighing between 12 and 30 g/m².

3.19 **UNDERWATER SPEAKERS:**

a) **Dry-niche** – A dry-niche underwater speaker as covered by these requirements is one intended to be permanently mounted and sealed in the wall of the swimming pool or diving tank. It is equipped with provisions for conduit connection, and is designed to be serviced from the rear in a passageway or tunnel behind the wall of the pool or tank.

b) **No-niche** – A no-niche underwater speaker as covered by these requirements is intended to be securely held or suspended within the pool or diving tank. It is to be provided with a flexible cord of a sufficient length to permit the underwater speaker to be removed and lifted to the deck of the pool or tank for servicing.

c) **Wet-niche** – A wet-niche underwater speaker as covered by these requirements is one intended for installation in or on the wall of a swimming pool or diving tank where the underwater speaker will be surrounded by water. The underwater speaker is supplied by a flexible cord of sufficient length to permit the underwater speaker to be removed from the niche and lifted to the deck of the pool or tank for servicing.

3.20 **VANDAL-RESISTANT** – A speaker enclosure constructed so that the sounder cannot be compromised. See 6.2.7.

4 Instructions and Drawings

4.1 Each product shall be provided with installation instructions and drawings that shall include the following information:

a) Typical representative installation wiring diagram for the product indicating recommended wiring methods. The recommended methods shall be in accordance with the applicable section of the National Electrical Code, ANSI/NFPA 70, and/or the National Fire Alarm Code, ANSI/NFPA 72, as applicable. The wiring method and compartment shall be such as not to interfere with the operation of the speaker.

b) Identification of replacement parts (such as fuses) by a part number, manufacturer's model number, ratings, or the equivalent.

4.2 The instructions are not prohibited from being incorporated on a visible interior or exterior surface of the product, on a separate sheet, or as part of a manual. When not included directly on the product, the instructions or manual shall be referenced in the marking information on the product, which shall include an issue date, number, or the equivalent.

CONSTRUCTION

ASSEMBLY

5 General

5.1 The construction of a speaker for fire alarm, emergency, commercial, or professional use shall comply with the construction requirements contained in Sections 5 – 20 unless, where permitted by test, the construction is determined to be equivalent. A means of determining construction equivalence shall comply with the requirements in Recommended Loudspeaker Safety Practices, ANSI/EIA 636.

5.2 Unless specifically indicated otherwise, the construction requirements specified for a product also apply to any remote accessories with which it is to be employed.

5.3 If provision is made for testing the operability of a product, the means provided shall not involve a risk of electric shock or injury to persons.

5.4 A test means shall be constructed and located so as to reduce the risk of tampering by unauthorized personnel.

6 Enclosures

6.1 General

6.1.1 The frame and enclosure of a product shall have the strength and rigidity to resist total or partial collapse with attendant reduction of spacings, loosening or displacement of parts, and development of other conditions that could impair operation of the product and result in a risk of fire, electric shock, or injury to persons.

6.1.2 Uninsulated high-voltage electrical parts or hazardous moving parts of a product shall be located or enclosed to provide protection from unintentional contact by persons.

6.1.3 The mounting means of an enclosure 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.

6.1.4 An attachment point provided for mounting of the speaker system shall be of sufficient strength for mounting as outlined in the installation instructions. See the mounting/handle securement test in Mechanical Strength Tests, Section 31.

6.1.5 An enclosure intended for outdoor use, or for use in wet locations, shall be provided with external means for mounting.

Exception: Internal means for mounting are not prohibited from being used when constructed to prevent water from entering the enclosure.

6.1.6 When knockouts or unthreaded holes are provided for use with conduit, there shall be provision for drainage of the enclosure when the hole is located above the lowest terminal lug or live part within the enclosure, unless:

- a) The installation instructions specify the use of watertight cable, conduit, or EMT fittings for installation in outdoor or wet locations and
- b) The unused knockouts and/or unthreaded holes are sealed to resist the entrance of water.

6.1.7 A gasket used as an environmental seal shall consist of material that is suitable for its application (see Gasket Testing, Section 43). A gasket that will be disturbed during routine servicing as described in the installation instructions shall be cemented, pinned, or otherwise secured to one of the contacting surfaces.

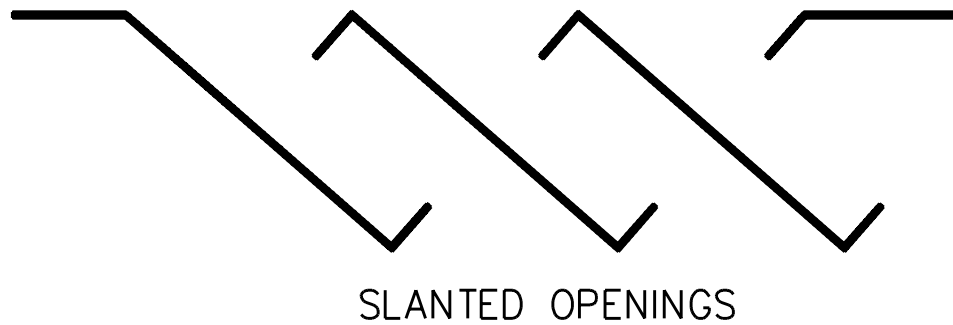
6.1.8 An underwater speaker shall be mounted in a metal forming shell. The shell shall have a metal screen or grill that is electrically bonded to the forming shell by a positive locking device that requires a tool for removal.

6.2 Openings

6.2.1 Openings in enclosures intended for outdoor use, or for use in damp or wet environments, are only permitted when the internal components are protected from the accumulation of moisture that may degrade the integrity or protection of the enclosure.

6.2.2 An opening in the top of the enclosure shall be constructed and sized to reduce the risk of entry of a foreign object and contact by persons with uninsulated high-voltage live or moving parts. An opening directly over an uninsulated live part shall be less than 0.187 inches (4.75 mm) in any dimension unless the configuration of the opening prevents direct entry to uninsulated high-voltage live parts. To determine accessibility of parts, the probe illustrated in Figure 6.1 shall be used. See Figure 6.2 for examples of acceptable top cover openings.

Figure 6.2
Cross-sections of top cover openings



EC500

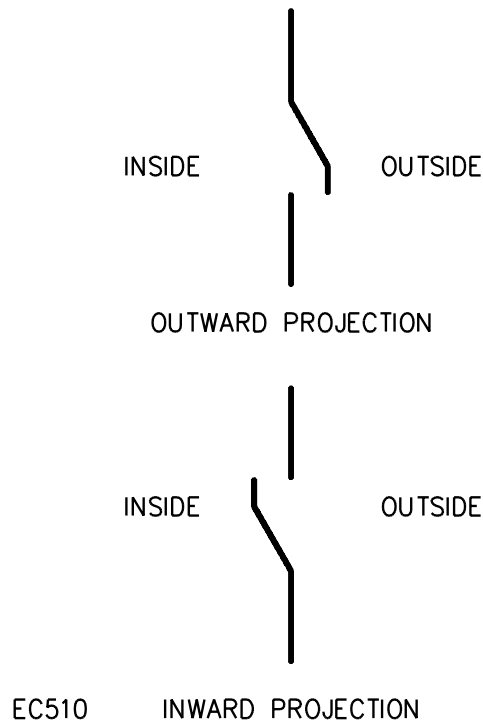
6.2.3 An opening in the side of the enclosure shall be located and sized to reduce the risk of entry of a foreign object and contact by persons with internal parts. A louver is not prohibited from being used when shaped to deflect external falling objects outward. See Figure 6.3 for examples of acceptable louver constructions.

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Figure 6.3
Cross-sections of side louvers



6.2.4 An opening in the enclosure of a fire or emergency warning speaker shall prevent access to a relay, terminal, control, or related component that is capable of affecting the performance or safety of the product.

6.2.5 A speaker assembly intended for mounting through a wall surface into a concealed space of a building structure such as a hollow space in the wall shall have no openings that vent into the concealed space when the product is mounted as intended. The speaker assembly is permitted to be mounted in an enclosure to prevent venting into the concealed space. The front panel mounting surface is required to be gasketed to insure that venting has been prevented only when the front panel mounting surface is irregular.

Exception: This requirement does not apply to the following:

- a) Openings which must be used for product mounting or for manufacturing operations (such as paint drainage or bend relief);*
- b) Openings which are effectively sealed unless used (such as knock-outs and flashed-over molded holes in plastic assemblies); and*
- c) Openings which may be used for product mounting or other purposes (such as cable entry) which do not exceed the area limitations of Table 6.1.*

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Table 6.1
Speaker assembly or enclosure openings

Maximum linear dimension of enclosure,		Area of largest surface of enclosure,		Maximum number of openings	Maximum total area of openings,	
inches	(cm)	square inches	(cm ²)		square inches	(cm ²)
7	17.8	32	206	4	1.2	7.7
18	45.7	135	870	6	1.2	7.7
40	102.0	1000	2540	6	1.5	9.7
Over 40	102.0+	Over 1000	2540+	8	2.0	12.9

6.2.6 An acoustical opening for a speaker intended for fire or emergency warning use shall restrict direct access to the sound producing element by a rigid rod 3.2 mm (0.125 inch) in diameter. The grill covering the acoustical opening shall withstand the force indicated in the speaker grill test. See 31.4.

Exception: A speaker whose sound producing element and grill are one in the same, and which complies with the acoustical opening requirements in 31.4 and the impact test in 31.2, is not required to comply with the requirements in 6.2.6.

Revised 6.2.6 effective January 31, 2005

6.2.7 A vandal resistant speaker shall restrict direct access to the sound producing element by a rigid rod 0.8 mm (0.031 inch) in diameter. The grill covering the acoustical opening shall withstand the force indicated in the speaker grill test, 31.4. All exterior exposed covers and grills shall be secured with tamper resistant hardware that prevents removal by common tools such as a screwdriver, pliers, or an Allen wrench.

Revised 6.2.7 effective January 31, 2005

6.3 Cast metal

6.3.1 The thickness of cast metal for an enclosure shall be at least the applicable value specified in Table 6.2.

Table 6.2
Cast-metal electrical 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 or having any dimension greater than 6 inches	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) in thickness may be obtained by the provision of reinforcing ribs subdividing a larger area.				

6.3.2 When threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, there shall be not less than 3-1/2 nor more than five threads in the metal, and the construction shall permit a standard conduit bushing to be attached as intended.

6.3.3 When threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall be not less than 3-1/2 full threads in the metal, and there shall be a smooth, rounded inlet hole that affords protection to the conductors equivalent to that provided by a standard conduit bushing.

6.3.4 A product intended to be supported by rigid conduit shall be provided with conduit hubs, or the equivalent, having not less than five full threads.

6.4 Sheet metal

6.4.1 The thickness of sheet metal employed for the enclosure of a product shall be at least the minimum applicable value specified in Table 6.3 or 6.4.

Exception: Sheet metal of lesser thickness is not prohibited from being employed when, considering the shape, size, and function of the enclosure, it provides equivalent mechanical strength to an enclosure of the applicable thickness specified in the tables.

Table 6.3
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			
Maximum width, ^b inches (cm)		Maximum length, ^c inches (cm)		Maximum width, ^b inches (cm)		Maximum length, ^c inches (cm)		Uncoated, inch (mm)		Metal coated, inch (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				
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				
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				
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				
18.0	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				
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				
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				
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				
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				
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				
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				

Table 6.3 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, ^c inches (cm)	Uncoated, inch (mm)	Metal coated, inch (mm)
^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 that may be applied via the enclosure surface when it is deflected. A structure that is as rigid as one built with a frame of angles or channels is considered to have equivalent reinforcing. Constructions considered to be without supporting frames include: 1) A single sheet with single formed flanges (formed edges), 2) A single sheet that is corrugated or ribbed, and 3) An enclosure surface loosely attached to a frame, such as by spring clips. ^b The width is the smaller dimension of a rectangular sheet metal piece that 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 that 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 continuous flange at least 1/2 inch (12.7 mm) wide.					

Table 6.4

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, inches (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	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	42.0 106.7	Not limited	0.058 1.47
14.0 35.6	16.0 40.6	45.0 114.3	55.0 139.7	
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 See note a in Table 6.3.

Table 6.4 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, inches (mm)
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, inches (cm)	
^b See note b in Table 6.3.				
^c See note c in Table 6.3.				

6.4.2 A hole larger than 1-3/8 inch (34.9 mm) diameter shall have a closure of thickness at least equal to that required for the enclosure of the product or shall have a standard knockout seal. Such plates or plugs shall be securely mounted.

6.4.3 A knockout in a sheet metal enclosure shall be reliably secured, but the removal of the knockout shall not result in undue deformation of the enclosure.

6.4.4 A knockout shall be provided with a surrounding surface area of sufficient size to permit seating of a conduit bushing, and shall be located so that a bushing employed at any knockout likely to be used during installation will not reduce spacings between uninsulated live parts and the bushing to values less than those specified in Spacings, Section 19.

6.4.5 A sheet metal member to which a metal-enclosed wiring system is to be connected in the field shall not be less than:

- a) 0.032 inch (0.81 mm) thick when of steel and
- b) 0.045 inch (1.14 mm) thick when of nonferrous metal.

6.5 Nonmetallic

6.5.1 An enclosure or part of an enclosure of nonmetallic material shall have sufficient mechanical strength and durability and shall be formed so that operating parts will be protected against damage. The mechanical strength of the enclosure shall be at least equivalent to a sheet metal enclosure of the minimum thickness specified in Table 6.2.

6.5.2 Among the factors to be taken into consideration when evaluating the acceptability of a nonmetallic enclosure or part are:

- a) Flammability;
- b) Mechanical strength;
- c) Resistance to impact;
- d) Dielectric strength and insulation resistance; and
- e) Resistance to distortion at temperatures to which the material will be subjected under conditions of anticipated use.

All these factors are considered with regard to aging. See Polymeric Materials, Section 18.

6.5.3 A wooden enclosure shall be solid or laminated wood at least 3/8 inch (9.5 mm) thick and be spaced at least 1/2 inch (12.7 mm) from live or arcing parts and potential sources of ignition.

7 Protection Against Corrosion

7.1 A product shall be protected against corrosion in accordance with the Corrosion Tests, Section 40.

Exception No. 1: This requirement does not apply where such protection is impractical, such as on a bearing or similar part.

Exception No. 2: This requirement does not apply to a part such as a washer, screw, bolt, or similar parts, when corrosion of the unprotected part is not likely to result in a risk of fire or electric shock.

7.2 The requirement in 7.1 applies to an enclosure and mounting hardware of a product upon which intended mechanical operation may depend.

7.3 Bearing surfaces shall be of materials and construction that resist binding due to corrosion.

7.4 Metals shall be used in combinations that are galvanically compatible.

FIELD WIRING CONNECTIONS

8 General

8.1 A product shall be provided with wiring terminals or leads for connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70, or the National Fire Alarm Code, ANSI/NFPA 72, corresponding to the electrical rating of the product.

8.2 A product intended for fire or emergency warning shall be provided with duplicate terminals or leads or an equivalent means to achieve electrical supervision. The means for supervision shall be provided for each incoming and each outgoing circuit connection. A common terminal may be used for connection of both incoming and outgoing wires, provided that the design and construction of the terminal does not permit an uninsulated section of a single conductor to be looped around the terminal and serve as two separate connections, thereby precluding supervision of the connection in the event that the wire becomes dislodged from under the terminal. A notched clamping plate under a single securing screw is not prohibited from being employed when separate conductors are intended to be inserted in each notch but this arrangement shall be supplemented by additional marking in the wiring area or on the installation wiring diagram specifying the intended connections to the terminals.

9 Field-Wiring Compartments

9.1 A field-wiring compartment to which connections are to be made shall be of sufficient size for completing all wiring connections specified by the installation wiring diagram.

9.2 The wiring of a product intended for mounting in or on an outlet box shall be located or protected so that, upon installation, the wiring in the outlet box is not forced against the terminals or other sharp edges that can damage the conductor insulation.

9.3 An outlet box or compartment of a fire or emergency warning speaker in which field-wiring connections are to be made shall be located such that the connections may be inspected after the product is installed as intended. The removal of mounting screws, or equivalent arrangement, to view the field-wiring connections is acceptable.

9.4 A forming shell for an underwater speaker shall be provided with the means of connection to rigid metal conduit, intermediate metal conduit or rigid nonmetallic conduit. Where rigid nonmetallic conduit is used, the installation instructions shall instruct that an 8 AWG insulated copper conductor shall be installed in the conduit with provisions for termination in the forming shell and the outlet box.

10 Field-Wiring Terminals and Connectors

10.1 A field-wiring terminal shall be constructed to prevent the turning or shifting of connections. Friction between surfaces is not to be used to prevent movement of the terminal.

10.2 A field-wiring terminal shall be of sufficient size for completing all field-wiring connections as specified in the installation instructions. The terminal construction shall bind the field wiring to prevent reduction of spacings.

10.3 A wire-binding screw intended for field-wiring connections shall be a No. 8 (ASTM) or M4 (metric) or larger. The screw is not prohibited from being of plated steel.

Exception: A No. 6 or M3.5 screw is not prohibited from being used for the connection of one 14 AWG (2.1 mm²) or smaller conductor, and a No. 4 or M3 screw is not prohibited from being used for the connection of an 18 AWG (0.65 mm²) or smaller conductor.

10.4 A terminal plate tapped for wire-binding screws shall:

a) Have at least 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 the equivalent to hold the wires in position. Other constructions are not prohibited from being used when they provide equivalent security of the wire-binding screw threads.

b) Be of a nonferrous metal not less than 0.050 inch (1.3 mm) thick for a No. 8 or M4 or larger screw, and not less than 0.030 inch (0.76 mm) thick for a No. 6 or M3.5 screw.

10.5 The following terminal configurations that comply with 10.4 are not prohibited from being employed on all circuits to which field-wiring connections are to be made:

a) Quick-Connect Terminals – Nonferrous (push-type) quick-connect terminals consisting of male posts permanently secured to the product and provided with compatible female connectors for connection to field wiring. Such terminals require a specific tool for crimping of field wires.

Mating terminals shall be shipped with the product with instructions for their installation. Electrical supervision of the field wiring shall include the mating of the connector on a speaker intended for fire- or emergency-warning systems.

b) Push-In Terminals – Nonferrous push-in terminals (screwless) of the type employed on some switches and receptacles, wherein solid conductors are pushed into slots containing spring-type contacts. The leads can be removed by means of a tool inserted to relieve the spring tension on the conductor.

c) Other Terminals – Other terminal connections and materials are not prohibited from being used when determined to be equivalent to those specified in (a) or (b) and limited to the same restrictions.

10.6 A product employing a terminal of any of the configurations described in 10.5 shall comply with all of the following:

a) When a tool for a specific purpose is required for connection, its use shall be indicated on the installation wiring diagram by name of manufacturer and model number or equivalent.

b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size shall be as indicated in the applicable section of the National Electrical Code, ANSI/NFPA 70, or the National Fire Alarm Code, ANSI/NFPA 72.

c) The wire size to be employed shall be acceptable for the current-carrying capacity of the circuit application.

11 Leads

11.1 A lead provided for field connection of a high-voltage speaker shall be at least 6 inches (152 mm) long, provided with strain relief, and 18 AWG (0.82 mm²) or larger with insulation not less than 1/32 inches (0.8 mm) thick. A lead provided for field connection of a low-voltage speaker shall be at least 6 inches (152 mm) long, provided with strain relief, and no smaller than 22 AWG (0.32 mm²) with insulation not less than 1/64 inches (0.4 mm) thick.

Exception: A lead is not prohibited from being less than 6 inches (152 mm) long when it is evident that the use of a longer lead is capable of resulting in damage to the insulation.

12 Grounding

12.1 For a product intended to be connected to a grounded circuit, one terminal or lead shall be identified for the connection of the grounded conductor.

12.2 A terminal intended for the connection of a grounding conductor shall be identified on the product and in the installation wiring diagram. A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green colored head that is hexagonal, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly marked "G", "GR", "GROUND", "GROUNDING", or equivalent marking, or by a marking on a wiring diagram provided on the product. The wire-binding screw or pressure wire connector shall be secured to the frame of the product and located so that it is unlikely to be removed during servicing of the product.

12.3 Acceptable means for equipment-grounding include the following:

- a) For a product intended to be permanently connected by a metal-enclosed wiring system, a knockout (or equivalent opening) in the metal enclosure.
- b) For a product intended to be connected by a nonmetal-enclosed wiring system (such as nonmetallic-sheathed cable or multiple-conductor cord), an equipment-grounding terminal or lead.

12.4 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green, with or without one or more yellow stripes. No other lead shall be so identified.

INTERNAL WIRING AND ASSEMBLY

13 General

13.1 Internal wiring shall have insulation rated for the potential temperature and environmental conditions to which it may be subjected during intended use of the product.

13.2 A lead or a cable assembly connected to a part mounted on a hinged cover shall be of sufficient length to permit the full opening of the cover without the lead or cable being pulled taught and applying stress to the lead or the connections. The lead shall be secured or equivalently arranged to reduce the risk of abrasion of the insulation and jamming of the leads between parts of the enclosure.

13.3 A wireway shall be smooth and free from sharp edges, burrs, fins, moving parts, and similar defects that may cause abrasion of conductor insulation.

13.4 A splice or connection shall have mechanical and electrical integrity.

13.5 A stranded conductor clamped under a wire-binding screw (or similar part) shall have the individual strands soldered together or equivalently arranged.

13.6 A splice shall be provided with insulation equivalent to that of the wires involved.

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