UL 1637

STANDARD FOR SAFETY

Home Health Care Signaling Equipment

UL Standard for Safety for Home Health Care Signaling Equipment, UL 1637

Fifth Edition, Dated September 21, 2017

Summary of Topics

This new edition of the Standard for Safety for Home Health Care Signaling Equipment, ANSI/UL 1637, includes the following changes in requirements:

1. Charging Current Test

2. Cord-Connected Equipment

The revised requirements are substantially in accordance with Proposal(s) on this subject dated March 17, 2017.

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.

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UL 1637

Standard for Home Health Care Signaling Equipment

First Edition – May, 1989
Second Edition – November, 1993
Third Edition – October, 1998
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Fifth Edition

September 21, 2017

This ANSI/UL Standard for Safety consists of the Fifth Edition.

The most recent designation of ANSI/UL 1637 as an American National Standard (ANSI) occurred on September 21, 2017. ANSI approval for a standard does not include the Cover Page, Transmittal Pages and Title Page. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

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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CONTENTS

INTRODUCTION

CONSTRUCTION

ASSEMBLY

FIELD WIRING

INTERNAL WIRING

COMPONENTS

SPACINGS

COMBINATION SYSTEMS

FCC VERIFICATION

PERFORMANCE

ALL UNITS

SIGNAL INITIATING UNITS

MOVEMENT DETECTORS

SHORT RANGE RADIO FREQUENCY DEVICES

MANUFACTURING AND PRODUCTION LINE TESTS

MARKING

SUPPLEMENT SA - INSTRUCTIONS FOR CALCULATING ATTENUATION PARAMETERS AND OPEN AREA TEST DISTANCE (D_{EOAT})

APPENDIX A

INTRODUCTION

1 Scope

1.1 These requirements cover the individual units that comprise a home health care system intended for use in ordinary indoor residential locations.

1.2 These requirements also cover a complete home health care system in which a signal initiating device (both routine monitoring and medical emergency signals) may be connected directly or indirectly to receiving equipment at a residence or to continuously monitored receiving equipment at a central supervising station. The system is arranged so that a predetermined change in the status of the signal initiating circuits or devices automatically causes transmission of a signal over a communication channel to receiving equipment at a residence, to a central supervising station, or to a private telephone number.

1.3 The components of the home health care system may include signal initiating devices, control units, transmitters, and digital communicators, all located at the residence, and the receiving, processing, and displaying equipment located at the central supervising station.

1.4 All field wiring extending to signal initiating units located at the residence is intended to be energized from power limited circuits as defined in 5.3 (c).

1.5 The units covered by these requirements are intended to be installed in accordance with the requirements of:

a) The National Electrical Code, NFPA 70;

b) Other applicable installation codes; and

c) The local inspection authority having jurisdiction.

1.6 Where a unit employs residential fire alarm functions, it shall comply with the Standard for Household Fie Warning System Units, UL 985. Where a unit employs household burglar alarm functions, it shall comply with the Standard for Household Burglar-Alarm System Units, UL 1023. A unit utilizing non-fire and/or non-carbon monoxide emergency and/or non-emergency signaling functions shall meet the requirements of the Standard for General Purpose Signaling Devices and Systems, UL 2017.

2 Components

2.1 Except as indicated in 2.2, a component of a unit 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 units covered by this standard.

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

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

b) Is superseded by a requirement in this standard.

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

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

2.5 If a digital alarm communicator transmitter is used to transmit signals to a remote location and is to be included as a component of the system, it shall comply with the applicable requirements in the Standard for Digital Alarm Communicator System Units, UL 1635. Otherwise the user must be notified that the off-premises transmission method has not been so investigated.

3 Units of measurement

3.1 When a value for measurement is followed by a value in other units in parentheses, the first stated value is the requirement.

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

4 Undated references

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

5 Glossary

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

5.2 CENTRAL STATION RECEIVING UNIT – Equipment located at a central station that receives and displays the information to the operator for action.

5.3 CIRCUITS, ELECTRICAL –

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

b) Low-Voltage – A circuit involving a potential of not more than 30 volts AC rms, 42.4 volts AC peak or DC.

c) Power Limited – A circuit in which the output is limited to 100 volt-amperes, at a maximum of 30 volts AC, 42.4 volts DC. The power limitation is typically provided by a transformer, a fixed impedance, a noninterchangeable fuse, a nonadjustable manual reset circuit protective device, or a regulating network.

5.4 CORD-CONNECTED UNIT – A unit intended for connection to the power source by means of a supply cord.

5.5 MEDICAL EMERGENCY SIGNAL – A signal from an initiating device that requires specific action from the receiver.

5.6 MONITOR SIGNAL – A signal from a monitor-type initiating device that requires no immediate action.

5.7 NORMAL STANDBY CONDITION – The ready-to-operate condition that exists prior to any type of signaling condition.

5.8 PERSONAL CALL UNIT – A device from which the resident may place a call to a central station receiving unit, other receiving unit, or to a private telephone number. This unit may be fixed or portable (carried by the resident). Operation of the unit transmits a medical emergency signal.

5.9 PROGRAM – A set of instructions that is carried out in a sequential and repetitive manner and that determines the system output signal resulting from system input signal.

5.10 RADIO FREQUENCY – Electromagnetic radiation 10 kilohertz or higher.

5.11 RESIDENTIAL CONTROL UNIT – A device that receives input signals from the monitor and personal call units and transmits the information to a central station receiving unit or to a private telephone number. A residential control unit may or may not process the signal.

5.12 SIGNAL INITIATING UNIT – A manually or automatically operated device, in which intended operation results in a signal indication to the residential control unit. The signals may be ″Medical Emergency,″ ″Monitor,″ or ″Trouble.″

5.13 SIGNALING UNIT – All devices and appliances covered by this standard.

5.14 STORED – The action provided by a memory device used for retaining information, instruction, status, and the like. It may be permanent or volatile.

5.15 SUPERVISION – Monitoring of a critical circuit for a fault condition, such as an open, ground, short circuit fault, or loss of transmission capability.

5.16 TROUBLE SIGNAL – A signal that indicates the presence of a fault condition that may impair system operation.

5.17 UNOCCUPIED PERIOD – Period during which the residence is vacant.

5.18 TRAINED INSTALLER – An individual knowledgeable in the product operation and received instruction on installing the product.

6 Installation and Operating Instructions

6.1 A copy or draft of the installation and operating instructions, related schematic wiring diagrams, and installation drawings intended to accompany the equipment are to be furnished with the sample submitted for investigation and are to be used as a guide in the examination and test of the equipment.

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

a) Typical installation drawing layouts and complete representative installation wiring diagram(s) for the signaling unit(s) indicating recommended locations and wiring methods.

b) A concise description of the operation, testing, and maintenance procedures for the signaling unit(s), and recommended testing frequency.

c) Replacement parts, such as lamps or batteries, identified in the instructions by a part number, manufacturer's model number, or the equivalent.

d) A description of the conditions which might be expected to result in unintended signals or impaired operation of the signaling unit(s).

e) A description of any features provided to reduce the risk of fire or electric shock and a warning against bypassing such features.

f) Identification of units that are factory serviceable only. A statement shall be provided indicating that these units should be returned to the manufacturer for service. The manufacturer's name and address shall also be included.

6.3 An installation wiring diagram(s) shall be provided with each signaling unit indicating the field connections to be made. The diagram(s) shall be attached to the residence and receiving units or, if separate, shall be referenced in the marking attached to these units with the diagram number and issue number or date, or both.

6.4 An installation wiring diagram shall show a pictorial view or equivalent of the installation terminals or leads to which field connections are made as they would appear when viewed from the front or normal connecting position. The terminal numbers on the unit shall agree with the numbers on the diagram. An unattached diagram shall be marked with the name or trademark of the manufacturer and an identification number or equivalent.

6.5 If low-voltage, power limited circuit terminal configurations are used that require a special tool for connection, the tool shall be referenced in the instructions.

6.6 The instructions shall be incorporated on the inside of the product, on a separate sheet, or as part of a manual, unless meeting 6.7 or 6.8. If not included directly on the signaling unit product, the instructions or manual shall be referenced in the marking information on the product. See Marking, General, Section 87.

6.7 For products intended only to be installed by a trained installer the installation instructions containing the information required by 6.1 – 6.6 is not prohibited from being made available by one or more of the following means:

a) Electronic instructions within the basic product software;

b) Electronic media such as website, CD-ROM, DVD, etc.; or

c) When the instructions are included as described in (a) or (b), the instructions shall be referenced in the product marking by:

1) Name or trademark of manufacturer,

2) Drawing number, <URL address> (This may be a root or home page and not a specific location), and/or equivalent identification, and

3) Issue date, revision level, and/or release date, or equivalent information such as date of manufacture or firmware level, which correlates the applicable digital manual revision to the product's current hardware/software. (For example, the product is marked with the date of manufacture or firmware level and the digital manual references the date or firmware range to which the manual is applicable).

6.8 Installation Instructions for products that require an Internet connection for initial configuration containing the information required by 6.1 – 6.6 is not prohibited from being made available by the means provided in 6.7 given the requirements of one of the following are met:

a) Where hardcopy installation instructions are not provided, the product annunciates an audible trouble signal when the product is energized until the product; or

b) A constant visual signal visible to the user after the product is installed is permitted to be used in lieu of the audible trouble signal required by 82.1 Exception No. 2 (1) when the following information is provided in hardcopy with the product:

1) Statement the device must be installed and configured before it is to be used,

2) Statement the full manual is to be obtained before installation is started and the website or online location where it is available, and

3) Description of the visual indication given and its meaning.

CONSTRUCTION

ASSEMBLY

7 General

7.1 General

7.1.1 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 need only be evaluated to the following construction requirements: 10.6.1, 10.6.6, 10.6.7, and the following sections: 8.5, Doors and covers, 8.8, Enclosure mounting, 10.5, Leads, 16, Secondary (Standby) Power Supply, 21, Overcurrent Protection, 23, Capacitors, 24, Semiconductors, 25, Storage Batteries, and 28, General.

7.2 Adhesives used to secure conductive parts

7.2.1 An adhesive that is relied upon to reduce a risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.2.2 The requirement in 7.1.1 applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

a) Energize an accessible dead metal part,

b) Make a live part accessible,

c) Reduce spacings below the minimum required values, or

d) Short-circuit live parts.

7.2.3 Whether the conditions specified in 7.2.2 (a) – (d) can occur is to be considered with respect to both:

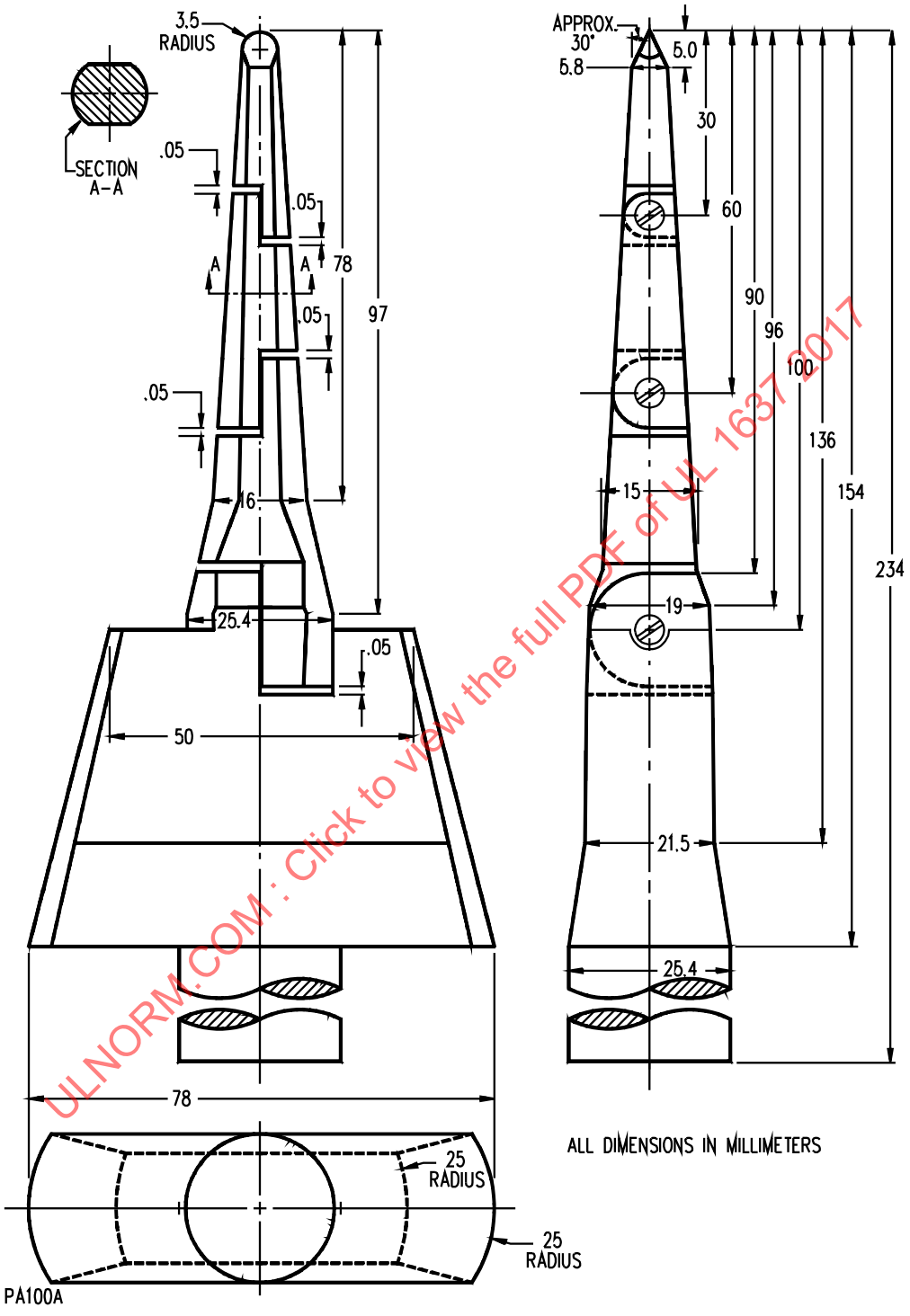
a) A part inside the device and

b) A part on the outside of the device that may affect equipment in which the device is to be installed.

7.3 Accessibility of uninsulated live parts

7.3.1 An opening shall not permit entrance of a 1/2-inch (12.7-mm) diameter rod and shall be sized and arranged so that a nonmetallic probe, as illustrated in Figure 7.1, cannot be made to contact any uninsulated live electrical part (other than a low-voltage part) when inserted through the opening in a straight or articulated position.

Figure 7.1
Articulate probe with web stop



The UL articulate probe without the web stop may be used for openings having a minor dimension less than 3/4 inch (19.1 mm).

7.4 Protection of service personnel

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

7.4.2 During the examination of a signaling unit in connection with the requirements in 7.3.1, a part of the outer enclosure that may be removed without the use of tools, or part of the outer enclosure that may be removed by the user to allow access for making intended operating adjustments, is to be disregarded. It will not be assumed that the part in question affords protection against electric shock.

7.4.3 An electrical component requiring examination, replacement, adjustment, servicing, or maintenance while the signaling unit is energized shall be located and mounted with respect to other components and with respect to grounded metal so that it is accessible for such service without subjecting service personnel to the risk of electric shock from adjacent uninsulated high-voltage live parts.

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

a) Coils of relays and solenoids, and transformer windings, if the coils and windings are provided with insulating overwraps rated for the potentials encountered;

b) Terminals and splices having insulation rated for the potential encountered; and

c) Insulated wire.

7.4.5 If the linear distance from a component requiring servicing to all uninsulated current-carrying parts in excess of 30 volts rms, 42.4 volts peak, 60 volts DC, is less than 6 inches (152 mm), protection shall be provided by insulating tape, barriers, or the equivalent.

Exception: Compliance with this requirement may be achieved by use of:

a) An interlock provided on the cover that de-energizes all live parts in the enclosure when the cover is removed or

b) The following or equivalent permanent and prominent marking provided on the cover front: "CAUTION – Risk of Electrical Shock, De-Energize Unit Prior To Servicing." This marking may be located on a rear panel or at the point of entry if the equipment is factory serviceable only.

8 Enclosures

8.1 General

8.1.1 The frame and enclosure of a signaling unit shall have the strength and rigidity to resist total or partial collapse and the subsequent reduction of spacings, or loosening or displacement of parts. See the Mechanical Strength Tests for Enclosures, Section 53.

8.2 Cast metal

8.2.1 The thickness of a cast metal enclosure shall be as specified in Table 8.1.

Exception: Cast metal of lesser thickness may be employed if, consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength to metal of the thickness specified in the table. See the Mechanical Strength Tests for Enclosures, Section 53.

Table 8.1
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 (115 cm^2) or less and having no dimensions 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) in thickness may be obtained by the provision of reinforcing ribs subdividing a larger area.

8.3 Sheet metal

8.3.1 The thickness of sheet metal for an enclosure shall be not less than that indicated in Table 8.2 or 8.3, whichever applies.

Exception: Sheet metal of lesser thickness may be employed if, consideration being given to the shape, size, and function of the enclosure, it provides equivalent mechanical strength to metal of the thickness specified in the table. See the Mechanical Strength Tests for Enclosures, Section 53.

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

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,		Minimum thickness,	
Maximum width,[b]		Maximum length,[c]		Maximum width,[b]		Maximum length,		Uncoated,		Metal coated,	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)	inch [MSG]	(mm)	inch [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)
35.0	(88.9)	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]	

[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. Construction that is considered to have equivalent reinforcing may be accomplished by constructions that will produce a structure that is as rigid as one built with a frame of angles or channels. Constructions considered to be without supporting frame include:

1) 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, for example, with 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 8.3
Minimum thickness of sheet metal for electrical enclosures – aluminum, copper, or brass

Without supporting frame[a]				With supporting frame or equivalent reinforcing[a]				Minimum thickness,	
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		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 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. Construction that is considered to have equivalent reinforcing may be accomplished by constructions that will produce a structure that is as rigid as one built with a frame of angles or channels. Constructions considered to be without supporting frame include:

1) 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, for example, with 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.

8.3.2 A sheet metal member to which a wiring system is to be connected in the field shall be at least 0.032 inch (0.81 mm) thick if of uncoated steel, 0.034 inch (0.86 mm) thick if of galvanized steel, and 0.045 inch (1.14 mm) thick if of nonferrous metal.

8.4 Nonmetallic

8.4.1 Among the factors to be taken into consideration when determining the acceptability of a nonmetallic enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Flammability and resistance to ignition from electrical sources;

e) Dielectric strength, insulation resistance, and resistance to arc tracking; and

f) Resistance to distortion and creeping at temperatures to which the material may be subjected under any conditions of use.

All these factors are to be considered with respect to aging in accordance with the Polymeric Materials Tests, Section 54. See the Mechanical Strength Tests for Enclosures, Section 53.

8.5 Doors and covers

8.5.1 An enclosure cover shall be hinged, sliding, or similarly attached so it cannot be removed if it gives access to fuses or any other overcurrent protective devices, the intended functioning of which requires renewal; or is necessary to open the cover in connection with the intended operation of the unit.

Exception: If its position is supervised by a tamper contact connected in the closed protective circuit, an enclosure cover need not comply with these requirements.

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

8.6 Enclosure openings

8.6.1 General

8.6.1.1 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.

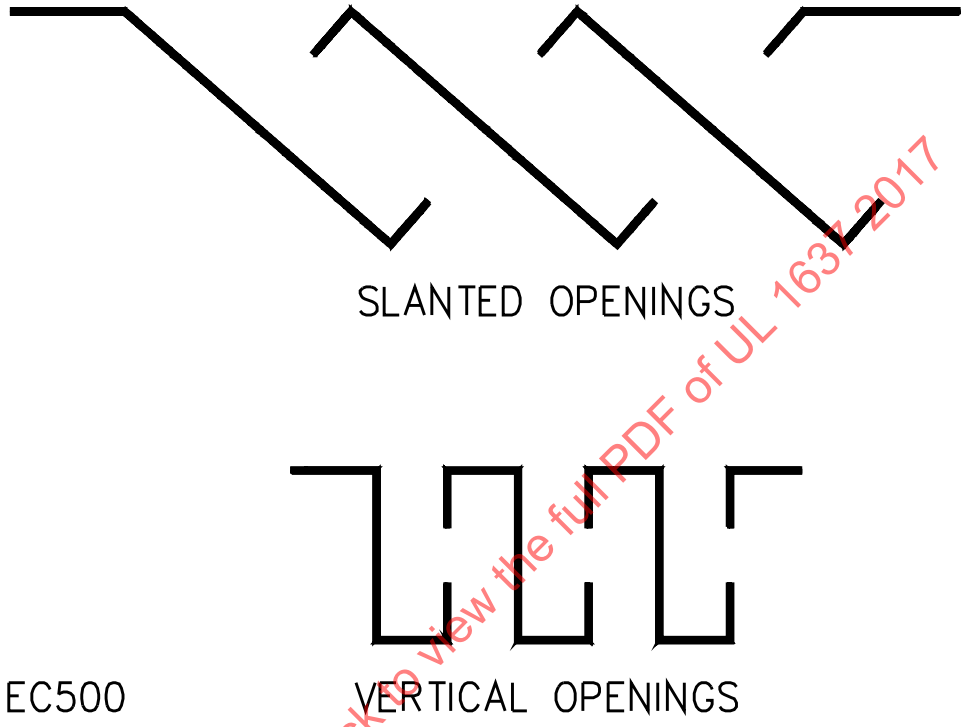
Exception: Products supplied solely from class 2 or 3/power-limited sources and controlling only class 2 or 3/power-limited loads.

8.6.1.2 The requirement in 8.6.1.1 does not apply to an opening for a mounting screw or nail or for a manufacturing operation.

8.6.2 Enclosure top openings

8.6.2.1 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



8.6.3 Enclosure side openings

8.6.3.1 An opening in the side of the enclosure other than a side for product mounting shall:

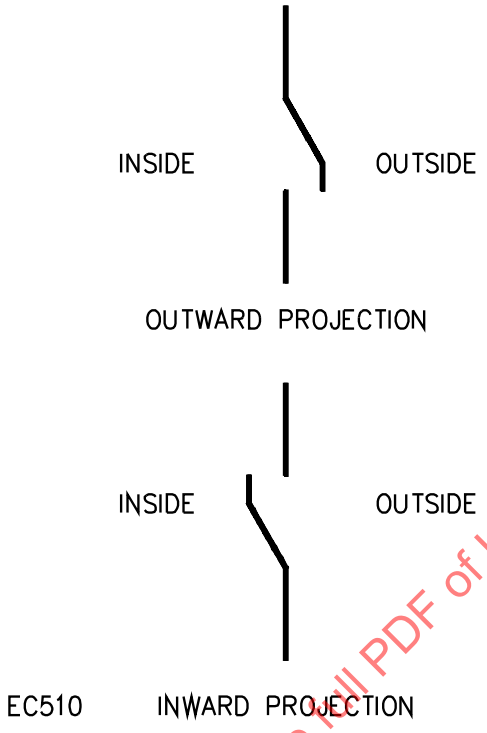
a) Not exceed 0.19 inch (4.8 mm) in any dimension;

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 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 8.3).

8.6.3.2 When a portion of a side panel falls within the area traced out by the 5-degree angle in Figure 8.4, that portion of the side panel shall be investigated as a bottom enclosure in accordance with 8.6.4.1 – 8.6.4.3.

Figure 8.2
Louvers



EC510

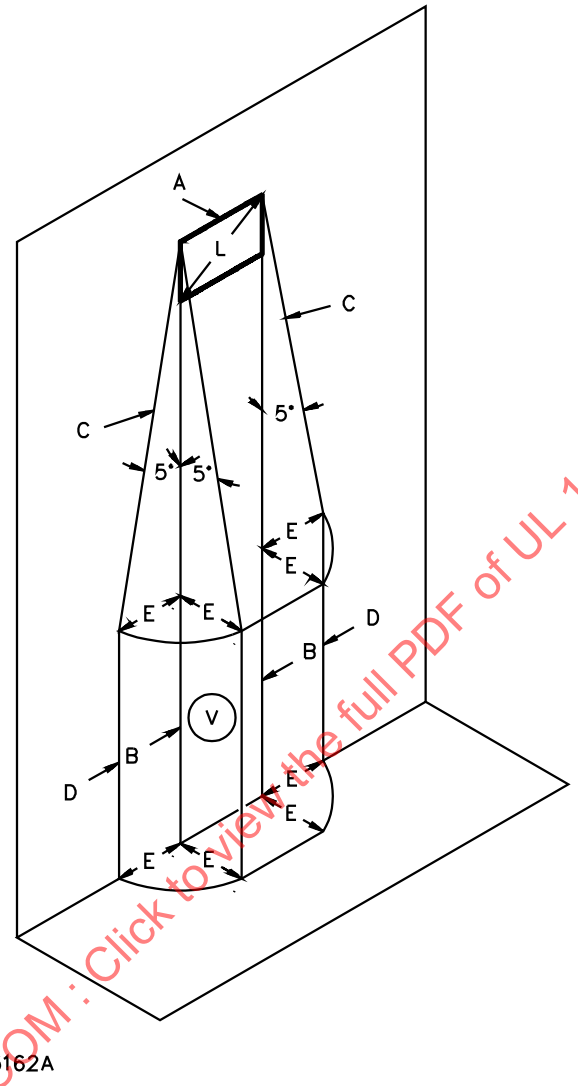
8.6.4 Enclosure bottom openings

8.6.4.1 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 8.4, that complies with the ventilation opening requirements in 8.6.4.2 and 8.6.4.3 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- and thermally-protected motors.

8.6.4.2 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 8.4, 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 56.

Figure 8.3
Example of enclosure side opening



A – Enclosure side opening.

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

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

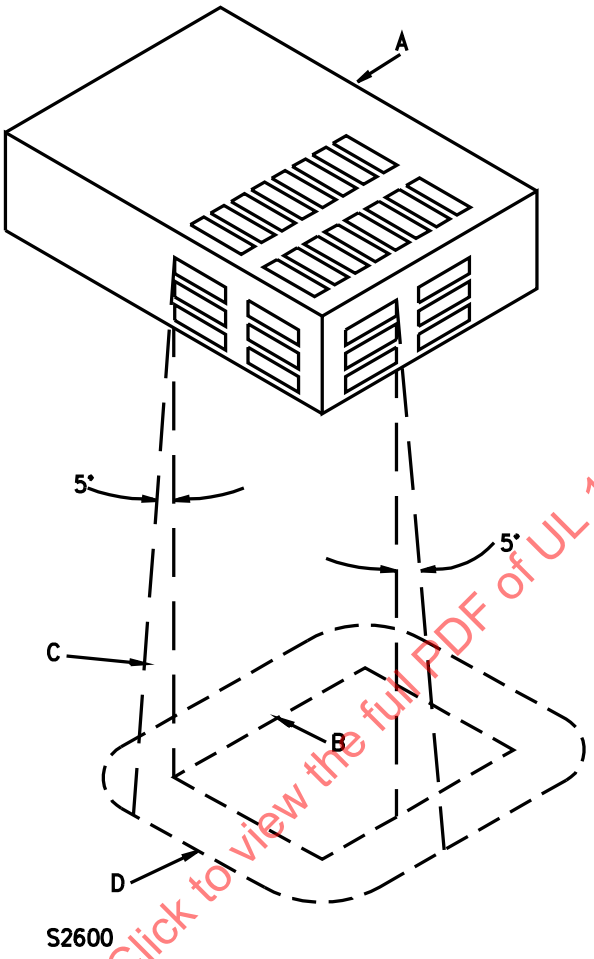
D – Line which is projected straight downward in the same plane as the enclosure side wall.

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.

Figure 8.4
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.

Table 8.4
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	(1.70)
-	-	-	-	[233 holes per inch^2]	([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	(3.18)
-	-	-	-	[72 holes per inch^2]	([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)

8.6.4.3 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).

8.7 Screens and expanded metal

8.7.1 Screens and expanded metal used as a guard, enclosure, or part of an enclosure, shall comply with the requirements in 8.7.2 and 8.7.3 and with the Mechanical Strength Tests for Enclosures, Section 53.

8.7.2 Perforated sheet steel and sheet steel employed for expanded metal mesh shall be not less than 0.042 inch (1.07 mm) thick [0.045 inch (1.14 mm) if zinc coated] if the mesh openings or perforations are 1/2 square inch (323 mm^2) or less in area, and shall be not less than 0.080 inch (2.03 mm) thick [0.084 inch (2.13 mm) if zinc coated] for larger openings. The largest dimension shall not exceed 4 inches (102 mm).

Exception: If the indentation of a guard or the enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to impair performance or reduce spacings below the minimum required values, see Spacings, General, Section 26, 0.020 inch (0.51 mm) expanded steel mesh or perforated sheet steel [0.023 inch (0.58 mm) if zinc coated] may be employed, provided that:

a) The exposed mesh on any one side or surface of the signaling unit protected has an area of not more than 72 square inches (465 cm^2) and has no dimension greater than 12 inches (305 mm) or

b) The width of an opening so protected is not greater than 3-1/2 inches (89 mm).

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

8.8 Enclosure mounting

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

8.9 Battery compartment (unsealed batteries)

8.9.1 A compartment for storage batteries shall have a total volume not less than twice the volume occupied by the batteries. Ventilating openings shall be provided and located so 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.

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

9 Corrosion Protection

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

9.2 The requirement in 9.1 applies to all enclosures of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend.

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

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

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

Exception: If galvanic action does not result in impaired operation of the signaling unit, risk of fire, electric shock, or unintentional contact with moving parts that may cause injury to persons, this requirement does not apply.

9.4 Hinges and other attachments shall be resistant to corrosion.

9.5 Cabinets and enclosures of corrosion-resistant material may be employed without special corrosion protection.

FIELD WIRING

10 Power Supply

10.1 General

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

10.2 Field wiring compartment

10.2.1 The supply cord or supply leads shall not be capable of being pushed into the unit through the cord-entry hole if such displacement is likely to subject the cord or supply leads to mechanical damage or to exposure to a temperature higher than that for which the cord or supply leads are intended, to reduce spacings (such as to a metal strain-relief clamp) below the minimum required values, or to damage internal connections or components.

10.2.2 The field wiring compartment in which connections are to be made shall be of the size necessary for completing all wiring connections as specified by the installation wiring diagram.

10.2.3 Internal components in the wiring area and wire insulation shall be protected from sharp edges by insulating or metal barriers having smooth, rounded edges or shall be marked in accordance with 87.13.

10.2.4 The wiring terminals of a signaling unit intended for mounting in an outlet box shall be located or protected so that, upon installation, the wiring in the outlet box is not forced against the terminals so as to damage the conductor insulation.

10.3 Terminals (general application)

10.3.1 A field-wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces. This may be accomplished by means such as two screws or rivets; by square shoulders or mortices; by a dowel pin, lug, or offset; or by a connecting strap or clip fitted into an adjacent part.

10.3.2 For 8 AWG (8.4 mm^2) and larger conductors, pressure wire connectors shall be used. For 10 AWG (5.3 mm^2) and smaller conductors, the parts to which wiring connections are made shall consist of clamps, or wire binding screws with cupped washers, terminal plates, studs and nuts with cupped washers, or the equivalent to hold the wire in position.

10.3.3 A wire binding screw at a field-wiring terminal shall be not smaller than No. 8 (4.2 mm diameter), except that a No. 6 (3.5 mm diameter) screw may be used for the connection of one 14, 16, or 18 AWG (2.1, 1.3, or 0.82 mm^2) conductor.

10.3.4 A terminal plate for a wire binding screw shall be of a nonferrous metal not less than 0.030 inch (0.76 mm) thick for a 14 AWG (2.1 mm^2) or smaller wire and not less than 0.050 inch (1.27 mm) thick for a wire larger than 14 AWG, and in either case there shall be not less than two full threads in the metal. A terminal plate formed from stock having the minimum required thickness may have the metal extruded at the tapped hole for the binding screw to provide two full threads.

Exception: Two full threads are not required if a lesser number of threads results in a connection in which the threads will not strip with intended tightening torque in accordance with the values indicated in the Standard for Wire Connectors, UL 486A-486B as applicable.

10.3.5 An upturned lug or a cupped washer shall be capable of retaining a conductor under the head of the screw or the washer.

10.3.6 A wire binding screw shall thread into metal.

Exception: Other constructions may be employed if they provide equivalent thread security of the wire binding screw.

10.3.7 If two or more conductors are intended to be connected by wrapping under the same screw, a nonferrous intervening metal washer shall be employed to separate each conductor. A separate washer is not required if two conductors are separated and intended to be secured under a common clamping plate. If the wires protrude above terminal barriers, the nonferrous clamping plate shall include means, such as upturned tabs or sides, to retain the wire.

10.4 Terminals (qualified application)

10.4.1 Any of the following terminal configurations may be employed for connection of field wiring provided that they comply with the requirements in 10.4.2. See the Special Terminal Assemblies Tests, Section 55.

a) Telephone Type Terminals – Nonferrous terminal plates employing a narrow V-shaped slot for securing of a conductor in a special post construction. Requires special tool for wire connection.

b) Solderless Wrapped Terminals – Solderless wrapped nonferrous terminals that require a special tool and terminal post construction.

c) Quick-Connect Terminals – Nonferrous quick-connect (push type) terminals consisting of male posts permanently secured to the device and provided with compatible female connectors for connection to field wiring. Requires special tool for crimping of field wires. Mating terminals shall be shipped with the signaling unit with instructions for their installation.

d) Push-In Terminals – Nonferrous (screwless) push-in terminals of the type employed on some switches and receptacles. 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. Push-in terminals are not considered acceptable for use with aluminum conductors. See 87.12.

e) Solder Terminals – Conventional nonferrous solder terminals.

f) Other Terminals – Other terminal connections may be employed if found to be equivalent to items (a) – (e) in this paragraph and limited to the same restrictions.

10.4.2 Any of the terminal configurations listed in 10.4.1 may be employed for connection of field wiring if the construction complies with all of the following:

a) If a special tool is required for connection, its use shall be indicated on the installation wiring diagram by name of manufacturer and model number or equivalent, along with information as to where the tool may be obtained.

b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum wire size employed shall be 22 AWG (0.32 mm^2).

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

d) If a lead is to be disconnected for testing or routine servicing it shall comply with the requirements in 55.2.1.

10.5 Leads

10.5.1 Leads provided in lieu of wiring terminals for connection to a low voltage circuit shall have a free lead length of not less than 6 inches (152 mm), and shall not be smaller than 22 AWG (0.32 mm^2).

Exception No. 1: The lead may be less than 6 inches long if it is evident that the use of a longer lead may result in damage to the lead insulation.

Exception No. 2: Copper leads as small as 26 AWG (0.13 mm^2) may be used if:

a) The current does not exceed 1 ampere for lengths up to 2 feet (61 cm) and the current does not exceed 0.4 amperes for lengths up to 10 feet (3.05 m);

b) There are two or more conductors and they are covered by a common jacket or the equivalent;

c) The assembled conductors comply with the requirements of 51.3 for strain relief; and

d) The installation instructions shall indicate that the lead shall not be spliced to a conductor larger than 18 AWG (0.82 mm^2).

10.5.2 Leads provided in lieu of wiring terminals for connection to a line-voltage source shall not be smaller than 18 AWG (0.82 mm^2), shall not have less than a 0.030 inch (0.76 mm) minimum average and 0.027 inch (0.69 mm) minimum at any point wall of insulation, and shall be of copper.

10.6 Cord connected equipment

10.6.1 A cord connected signaling unit that is intended to be connected to a high-voltage supply circuit shall be provided with a flexible power supply cord no less than 6 feet (1.8 m) long connected to a two or three prong attachment plug of acceptable type and rated for connection to the supply circuit.

Exception: The cord may be less than 6 feet long if it is evident that the use of the longer cord may result in damage to the cord or signaling unit, or result in a risk of fire, electric shock, or injury to persons, or is not required for the intended operation of the signaling unit.

10.6.2 A flexible power supply cord may be used with a signaling unit that is not intended for frequent movement from one location to another.

10.6.3 A flexible power supply cord shall be of Type SJ, SJT, or equivalent, minimum 18 AWG (0.82 mm^2). It shall be rated for use at the voltage and ampacity rating of the signaling unit.

10.6.4 A smoothly rounded restraining means shall be provided for securing the attachment plug to the receptacle.

Exception: Products utilizing a secondary power source meeting the requirements of Section 40, Charging Current Test, and where loss of the AC primary power source results in annunciation of an audible trouble signal.

10.6.5 Leads intended for connection to an external circuit shall be provided with a strain relief means if stress on the lead may be transmitted to terminals, splices, or internal wiring. See Strain Relief Test, Section 51.

10.6.6 The power supply cord shall be provided with strain relief means so that a stress on the cord will not be transmitted to terminals, splices, or internal wiring.

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

10.6.8 Clamps of any material (metal or otherwise) are acceptable for use on cords and supply leads without varnished-cloth insulating tubing or the equivalent under the clamp unless the tubing or the equivalent is necessary to reduce the risk of damaging the cord or supply leads.

10.7 Permanently connected equipment

10.7.1 A fixed signaling unit shall have provision for connection of one of the wiring systems that, in accordance with the National Electrical Code, ANSI/NFPA 70, would be acceptable for it.

10.7.2 A knockout provided for connection of a field-wiring system to a field-wiring compartment shall accommodate conduit of the trade size as indicated in Table 10.1.

Table 10.1
Trade size of conduit in inches (mm OD)

Wire size,		Number of wires[a]									
AWG	(mm^2)	2		3		4		5		6	
14	(2.1)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)
12	(3.3)	1/2	(21.3)	1/2	(21.3)	1/2	(21.3)	3/4	(26.7)	3/4	(26.7)

NOTE – Trade size per Specification for Zinc Coated Rigid Steel Conduit, ANSI C80.1.

[a] This table is based on the assumption that all conductors will be of the same size and there will be not more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

10.7.3 The location of a terminal box or compartment in which power supply connections are to be made shall be such that the connections are to be accessible without removing parts other than a service cover or panel and the cover of the outlet box or compartment in which the connections are made.

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

10.7.5 The signaling unit shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than that required by the signaling unit.

10.8 Grounding

10.8.1 A grounding means shall be provided for all equipment containing parts that require grounding. See Bonding for Grounding, Section 15.

10.8.2 The following are considered to constitute means for grounding:

a) In a signaling unit intended to be permanently connected by a metal enclosed wiring system, a knockout or equivalent opening in the metal enclosure of the signaling unit.

b) In a signaling unit intended to be permanently connected by a nonmetallic enclosed wiring system, such as nonmetallic-sheathed cable, an equipment grounding terminal or lead.

c) In a cord-connected signaling unit, an equipment grounding conductor in the cord.

10.8.3 On a permanently connected signaling unit, a terminal intended solely for the connection of an equipment grounding conductor shall be capable of securing a conductor of the size acceptable for the particular application in accordance with the National Electrical Code, ANSI/NFPA 70.

10.8.4 A soldering lug, a push-in, a screwless connector, or a quick-connect or similar friction fit connector shall not be used for the grounding terminal intended for the connection of field supply connections or for the grounding wire in a supply cord.

10.8.5 On a permanently connected signaling unit, 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 identified such as by being marked ″G,″ ″GR,″ ″GND,″ or ⏚, or the like, or by a marking on a wiring diagram provided on the signaling unit. See also 10.8.7.

10.8.6 The wire binding screw or pressure wire connector intended for connection of an equipment grounding conductor shall be secured to the frame or enclosure of the signaling unit and shall be located so that it is unlikely to be removed during service operations such as replacing fuses, resetting manual-reset devices, or the like.

10.8.7 If a pressure wire connector intended for grounding is located where it could be mistaken for a neutral conductor of a grounded supply, it shall be identified by a marking ″EQUIPMENT GROUND,″ with a green color identification, or both, or ⏚ .

10.8.8 On a permanently connected signaling unit, the surface of an insulated lead intended solely for the connection of an equipment grounding conductor shall be finished in a continuous green color or a continuous green color with one or more yellow stripes, and no other lead shall be so identified.

10.8.9 On a cord connected signaling unit, the grounding conductor of the flexible cord shall be finished with a continuous green color or with a continuous green color with one or more yellow stripes, and no other conductor shall be so identified. The grounding conductor shall be secured to the frame or enclosure of the signaling unit by a positive means, see Bonding for Grounding, Section 15, that is not likely to be removed during any servicing operation not involving the power supply cord. The grounding conductor shall be connected to the grounding blade of the attachment plug.

11 Polarity Identification

11.1 In a signaling unit intended to be connected to a grounded circuit, one terminal or lead shall be identified for the connection of the grounded conductor. The identified terminal or lead shall be the one connected to the screw shells of lampholders, and to which no primary overcurrent-protective devices of the single-pole type are connected.

11.2 A terminal intended for the connection of a grounded supply conductor shall be composed of or plated with metal that is substantially white in color and shall be distinguishable from the other terminals, or identification of the terminal shall be clearly shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or natural gray color and shall be distinguishable from the other leads.

INTERNAL WIRING

12 General

12.1 Internal wiring shall have thermoplastic or rubber insulation not less than 1/64 inch (0.4 mm) thick for 0 – 300 volt applications if power is less than 375 volt-amperes, current is less than 5 amperes, and the wiring is not subject to flexing or mechanical abuse. Otherwise, thermoplastic or rubber insulation not less than 0.030 inch (0.76 mm) minimum average and 0.027 inch (0.69 mm) minimum at any point and rated 600 volts shall be used. Other insulating material of lesser thickness may be used if it is equivalent.

12.2 The length of leads or a cable assembly connected to parts mounted on a hinged cover shall be such that the cover can be opened fully without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged so that abrasion of insulation and jamming between parts of the enclosure does not occur.

12.3 Insulation, such as coated fabric and extruded tubing, shall be rated for the temperature and other environmental conditions to which it may be subjected in intended use.

12.4 Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, and the like, that may cause abrasion of the conductor insulation. Holes in sheet metal walls through which insulated wires pass shall be provided with a bushing if the wall is 0.042 inch (1.07 mm) or less in thickness. Holes in walls thicker than 0.042 inch shall have smooth, rounded edges.

13 Wiring Methods

13.1 All splices and connections shall be mechanically secure and bonded electrically.

13.2 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or equivalently arranged.

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

13.4 A printed-wiring assembly employing insulating coatings or encapsulation shall be tested for dielectric voltage withstand before and after being treated. If it is impractical to use untreated samples, finished samples shall be subjected to the Dielectric Voltage-Withstand Test, Section 49, after they are subjected to the Humidity Test, Section 43; Temperature Test, Section 37; and other applicable tests described in this standard.

14 Separation of Circuits

14.1 Internal wiring of circuits that operate at different potentials shall be separated by barriers, clamps, routing, or other equivalent means, unless all conductors are provided with insulation rated for the highest potential involved.

14.2 If a barrier is used to provide separation between the wiring of different circuits, it shall be of metal or of insulating material. A barrier of insulating material shall be not less than 0.028 inch (0.71 mm) thick. Any clearance between the edge of a barrier and a compartment wall shall be not more than 1/16 inch (1.6 mm).

14.3 When Class 2, Class 3, and power-limited fire alarm circuit conductors occupy the same enclosure as electric light, power, Class 1, or nonpower-limited fire alarm circuit conductors, both of the following conditions shall be met:

a) The enclosure shall provide a minimum of two conductor entry openings so that the Class 2, Class 3, power-limited fire alarm circuit conductors may be segregated from electric light, power, Class 1, and nonpower-limited fire alarm circuit conductors. The installation document shall completely detail the entry routing of all conductors into the enclosure.

b) The enclosure shall be constructed so that, with all field-installed wiring connected to the product, a minimum of 1/4 inch (6.4 mm) spacing is provided between all Class 2, Class 3, and power-limited fire alarm circuit conductors and all electric light, power, Class 1, and nonpower-limited fire alarm circuit conductors. Compliance with this requirement may be achieved by specific wire routing configurations that are detailed in the installation document. If a wire routing scheme will not maintain a separation of 1/4 inch (6.4 mm), barriers shall be used to provide separation.

Exception: This requirement need not apply when all circuit conductors operate at 150 volts or less to ground, and:

a) The Class 2, Class 3, and power-limited fire alarm circuits are installed using CL3, CL3R, or CL3P, or substitute cable permitted by the National Electrical Code, NFPA 70, and the Class 2, Class 3, and power-limited fire alarm circuit conductors extending beyond the cable jacket are separated a minimum of 1/4 inch or by nonconductive tubing or by a nonconductive barrier from all other conductors; or

b) The Class 2, Class 3, and power-limited fire alarm circuit conductors are installed as a Class 1 or higher circuit.

15 Bonding for Grounding

15.1 In a high-voltage signaling unit, provision shall be made for the grounding of all exposed or accessible noncurrent-carrying metal parts that are likely to become energized and that may be contacted by the operator or by service personnel during service operations likely to be performed while the signaling unit is energized.

15.2 Uninsulated metal parts, such as cabinets, electrical enclosures, capacitors and other electrical components, shall be bonded for grounding if they may be contacted by the operator or service personnel, except as indicated in 15.3.

15.3 Metal parts described as follows need not be grounded:

a) Adhesive-attached metal-foil markings, screws, handles, and the like, located on the outside of enclosures or cabinets and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized.

b) Isolated metal parts, such as small assembly screws, that are positively separated from wiring and uninsulated live parts.

c) Cabinets, panels, and covers that do not enclose uninsulated live parts if wiring is separated from the cabinet, panel, or cover so that it is not likely to become energized.

d) Panels and covers that are insulated from electrical components and wiring by an insulating barrier that is secured in place and is of vulcanized fiber, varnished cloth, phenolic composition, or similar materials not less than 0.028 inch (0.71 mm) thick. If material having a lesser thickness is used, consideration is to be given to such factors as its electrical, mechanical, and flammability properties when compared with materials in the specified thicknesses.

15.4 The metal enclosure of a signaling unit having a slide-out chassis is considered to be grounded if the resistance between the point of connection of the equipment grounding means and enclosure does not exceed 0.1 ohm. Unless a separate grounding conductor is used, all nonconductive coatings between the enclosure and equipment grounding means shall be penetrated when the chassis is inserted in the enclosure. In such cases, metal-to-metal contact shall be maintained at any point of insertion or withdrawal of the chassis.

15.5 Metal-to-metal hinge bearing members on a door or cover are considered to be a means for bonding a door or cover for grounding if a minimum of two pin-type hinges with a minimum of three knuckles each are employed.

15.6 A separate component bonding conductor shall be of copper, a copper alloy, or other material acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by metallic or nonmetallic coatings, such as enameling, galvanizing, or plating. A separate bonding conductor or strap shall:

a) Be protected from mechanical damage or be located within the confines of the outer enclosure or frame and

b) Not be secured by a removable fastener used for any purpose other than bonding for grounding unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener.

15.7 The bonding shall be by a positive means, such as clamping, riveting, bolted or screw connection, welding, or soldering and brazing materials having a softening or melting point greater than 445°C (833°F). The bonding connection shall penetrate nonconductive coatings such as paint or vitreous enamel. Bonding around a resilient mount shall not depend on the clamping action of rubber or other nonmetallic material.

Exception: A connection that depends upon the clamping action exerted by rubber or other nonmetallic material is acceptable if it complies with the requirement in 15.10.

15.8 With reference to 15.7, a bolt or screw connection that incorporates a star washer under the screwhead or a serrated screwhead is acceptable for penetrating nonconductive coatings. If the bonding means depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

15.9 An internal connection for bonding internal parts to the enclosure for grounding, but not for a field installed grounding conductor or for the grounding wire in a supply cord, may employ a quick-connect terminal if:

a) The terminal is not likely to be displaced,

b) The component is limited to use on a circuit having a branch circuit protective device rated 20 amperes or less, and

c) The terminal dimensions are 0.020 by 0.187 by 0.250 inch (0.51 by 4.75 by 6.4 mm), 0.032 by 0.187 by 0.250 inch (0.81 by 4.75 by 6.4 mm), or 0.032 by 0.205 by 0.250 inch (0.81 by 5.2 by 6.4 mm).

15.10 On a cord connected signaling unit, a bonding conductor or strap shall have a cross-sectional area not less than that of the grounding conductor of the supply cord.

Exception: A bonding conductor may have a cross-sectional area less than that of the supply cord grounding conductor as described in 15.13.

15.11 On a permanently connected signaling unit, the size of a conductor employed to bond an electrical enclosure shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. The size of the conductor or strap shall be in accordance with Table 15.1.

Table 15.1
Bonding wire conductor size

Rating of overcurrent device, amperes	Copper wire,		Aluminum wire,	
	AWG	(mm^2)[a]	AWG	(mm^2)[a]
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)

[a] Equivalent cross-sectional area.

15.12 A conductor, such as a clamp or strap, used in place of a separate wire conductor as indicated in 15.11, is acceptable if the minimum cross-sectional conducting area is equivalent to the wire sizes indicated in Table 15.1.

15.13 A bonding conductor to an electrical component need not be larger than the size of the conductors supplying the component.

15.14 Splices shall not be employed in wire conductors used to bond electrical enclosures or electrical components.

15.15 If more than one size branch circuit overcurrent protection device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, if a component is individually protected by a branch circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding conductor for that component is to be sized on the basis of the overcurrent device intended for ground-fault protection of the component.

15.16 The continuity of the grounding system of the signaling unit shall not rely on the dimensional integrity of nonmetallic material.

16 Secondary (Standby) Power Supply

16.1 A central station receiving unit shall be equipped with standby power, or terminals or leads for the connection of standby power.

16.2 The use of a standby power source for an AC-operated signal initiating device or residential home health care control unit is optional.

16.3 If a battery is employed as a standby power supply, it shall be a rechargeable type of sufficient capacity to comply with the requirements of the Power Supply Supervision Test, Section 33.

Exception: A primary (nonrechargeable) type of battery may be employed if the battery voltage is monitored so that a trouble indication, as described in 33.1.1, is obtained when the battery reaches 85 percent of nominal rated battery voltage.

COMPONENTS

17 General

17.1 Mounting of components

17.1.1 A switch, lampholder, attachment plug, connector base, or similar electrical component shall be secured in position and, except as noted in 17.1.2 – 17.1.9, shall be prevented from turning.

17.1.2 In the mounting or supporting of small, fragile insulating parts, screws or other fastenings shall not be tight enough to cause cracking or breaking of those parts with expansion and contraction.

17.1.3 The requirement that a switch be prevented from turning may be waived if the construction complies with all of the following:

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

b) The means for mounting the switch makes it unlikely that operation of the switch will loosen it.

c) Spacings are not reduced below the minimum required values if the switch rotates.

d) The operation of the switch is by mechanical means rather than by direct contact by persons.

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

17.1.5 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position, if such motion may result in a reduction of spacings below the minimum required values. The securing of contact assemblies shall provide for the continued alignment of contacts.

17.1.6 The means for preventing turning is to consist of more than friction between surfaces.

17.1.7 A lock washer that provides both spring takeup and an interference lock may be used as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

17.1.8 A flush plate for outlet-box mounting shall be 0.030 inch (0.76 mm) or thicker ferrous metal, 0.040 inch (1.02 mm) or thicker nonferrous metal, or 0.100 inch (2.54 mm) or thicker nonconductive material.

17.1.9 A yoke or strap or the mounting ears of a part intended to be mounted on a standard outlet box or similar back box shall be 0.040 inch (1.02 mm) or thicker steel. If a nonferrous metal is used, it shall be of a thickness that provides mechanical strength and rigidity not less than that of 0.040 inch thick steel.

17.2 Current-carrying parts

17.2.1 All current-carrying parts shall be of silver, copper, a copper alloy, or other material acceptable for use as an electrical conductor.

Exception: Multimetallic thermal elements and heater elements of a thermal protector need not comply with this requirement.

17.2.2 Bearings, hinges, and the like shall not be used as current-carrying parts.

17.3 Insulating materials

17.3.1 Insulating materials used for a base for the support of live parts shall be porcelain, phenolic or cold-molded composition, or the equivalent.

17.3.2 A base mounted on a metal surface shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base that are not staked, upset, sealed, or equivalently secured so that such parts and the ends of replaceable terminal screws do not come in contact with the supporting surface.

17.3.3 Ordinary vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not for the sole support of live parts where shrinkage, current leakage, or warping of the fiber may introduce a risk of fire or electric shock.

17.3.4 A countersunk sealed live part shall be covered with a waterproof insulating compound that will not melt at a temperature 15°C (27°F) higher than the maximum intended operating temperature of the assembly, and at not less than 65°C (149°F) in any case. The depth or thickness of sealing compound shall not be less than 1/8 inch (3.2 mm).

17.3.5 The thickness of a flat sheet of insulating material, such as phenolic composition or the equivalent, used for panel-mounting of parts shall be not less than that indicated in Table 17.1.

Table 17.1
Thickness of flat sheets of insulating material

Maximum dimensions				Minimum thickness,[a]	
Length or width,		Area,			
inches	(cm)	inches^2	(cm^2)	inch	(mm)
24	(60.9)	360	(2322)	3/8	(9.5)
48	(122)	1152	(7432)	1/2	(12.7)
48	(122)	1728	(11,148)	5/8	(15.9)
Over 48	(122)	Over 1728	(11,148)	3/4	(19.1)

[a] Material less than 3/8 inch but not less than 1/8 inch (3.2 mm) in thickness may be used for a panel if the panel is supported or reinforced to provide rigidity not less than that of a 3/8 inch thick sheet. Material less than 1/8 inch thick may be used for subassemblies, such as supports for terminals for internal wiring, resistors, and other components.

17.4 Fuseholders

17.4.1 A fuseholder shall be installed or protected so that adjacent uninsulated high-voltage live parts – other than the screw shell of a plug fuseholder, cartridge fuse clips, or wiring terminals to the fuseholder – will not be exposed to contact by persons removing or replacing fuses. A separation of less than 4 inches (102 mm) is considered to be adjacent.

17.5 Operating mechanisms

17.5.1 Operating parts, such as unenclosed switches, relays, and similar devices shall be protected by individual dust covers or equivalent or by dust-tight cabinets against malfunction as the result of dust or other material. The use of individual dust covers over operating mechanisms or a gasket between the enclosure and cover complies with this requirement.

17.5.2 Moving parts shall have sufficient play at bearing surfaces so that binding will not occur.

17.5.3 Provision shall be made such that adjusting screws and similar adjustable parts do not loosen under the conditions of use.

17.5.4 Manually operated parts shall withstand the stresses to which they will be subjected in operation.

18 Bushings

18.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall comply with the requirements in 12.4.

18.2 If the cord hole is in phenolic composition or other nonconducting material, a smooth, rounded surface is considered to be the equivalent of a bushing.

18.3 Ceramic materials and some molded compositions may be used for insulating bushings.

18.4 Fiber may be used where it will not be subjected to a temperature higher than 90°C (194°F) under intended operating conditions if the bushing is not less than 3/64 inch (1.2 mm) thick and if it will not be exposed to moisture.

18.5 A soft rubber bushing may be provided in the frame of a motor if the bushing is not less than 3/64 inch (1.2 mm) thick and if the bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substance that may have a deleterious effect on rubber. If a soft rubber bushing is provided in a hole in metal, the hole shall be free from sharp edges, burrs, projections, and the like, that could cut into the rubber.

18.6 An insulating metal grommet may be considered to be acceptable in lieu of an insulating bushing if the insulating material used is not less than 1/32 inch (0.8 mm) thick and completely fills the space between the grommet and the metal in which it is mounted.

19 Transformers, Coils, and Relays

19.1 A line voltage power transformer shall be of the two-coil or insulated type.

Exception: An autotransformer may be used if the terminal or lead common to both input and output circuits is identified, and the output circuits are located only within the enclosure containing the autotransformer. See 11.1.

19.2 A coil shall be treated with an insulating varnish, and baked or otherwise impregnated to exclude moisture.

19.3 Enameled or equivalently coated wire is not required to be given additional treatment to exclude moisture.

20 Switches

20.1 A switch provided as part of the signaling unit shall have a current and voltage rating not less than that of the circuit it controls when the signaling unit is operated under any condition of intended service. If the circuit controlled has a power factor less than 75 percent, the switch shall have a horsepower rating (judged on the basis of the ampere equivalent) or a rating of not less than 200 percent of the maximum load current.

21 Overcurrent Protection

21.1 Fuseholders, fuses, and circuit breakers provided on a unit shall be rated for the application. A protective device, other than a fuse, employed to limit the output circuit of the main power supply providing energy to the equipment to be used by the resident, shall be a manual or automatic resettable type. The maximum current rating of the noninterchangeable overcurrent protection employed with a transformer providing energy to a low-voltage power limited circuit shall be 100 volt-amperes divided by the open circuit voltage of the circuit, but shall not exceed 5 amperes:

$$100\ VA/V_{maximum} \leq 5\ Amperes$$

in which $V_{maximum}$ is the maximum rms circuit voltage.

22 Printed Wiring Boards

22.1 Printed-wiring boards shall comply with the Standard for Printed Wiring Boards, UL 796, and shall have a minimum flame class rating of V-2. The spacings between circuits shall comply with the spacing requirements of this standard. The board shall be mounted so that deflection of the board during servicing will not result in damage to the board or in a risk of fire or electric shock.

23 Capacitors

23.1 A capacitor shall be rated for the voltage and temperature to which it may be subjected under the most severe conditions of intended use. A paper capacitor shall be impregnated or otherwise enclosed to exclude moisture.

23.2 A capacitor employing a liquid dielectric medium more combustible than askarel shall be protected against expulsion of the dielectric medium when tested in accordance with the applicable performance requirements of this standard.

24 Semiconductors

24.1 Semiconductors shall be rated for the intended application under all environmental conditions to which they will be exposed in service.

25 Storage Batteries

25.1 A storage battery shall have sealed cells, or cells with spray-trap vents, and shall be charged by a rectifier, which may be a part of the signaling unit assembly.

25.2 Batteries shall be located and mounted so that terminals of cells will not come in contact with terminals of adjacent cells or with metal parts of the battery enclosure as a result of shifting of the batteries. The mounting arrangement shall permit access to the cells of unsealed batteries for checking the electrolyte.

25.3 A conditioning charge shall be limited so that, with the maximum rate of charge that can be obtained, the battery gases will not impair the operation of any part of the signaling unit. The trickle and fast charge rates of a battery shall not exceed the battery manufacturer's recommended rates.

SPACINGS

26 General

26.1 A signaling unit shall be constructed to maintain spacings between uninsulated live parts and dead metal parts and between uninsulated live parts of opposite polarity. The spacings shall be not less than those indicated in Table 26.1.

Table 26.1
Minimum spacings

Point of application	Voltage range [d]	Minimum spacings [a, b]			
		Through-air		Over-surface	
	volts	inches	(mm)	inches	(mm)
To walls of enclosure					
Cast metal enclosures					
Power limited and non-power limited	0 – 300	1/4	(6.4)	1/4	(6.4)
Sheet metal enclosures					
Power limited and non-power limited	0 – 50	1/4	(6.4)	1/4	(6.4)
Power limited	51 – 150	1/4	(6.4)	1/4	(6.4)
Non-power limited	51 – 300	1/2	(12.7)	1/2	(12.7)
Installation wiring terminals:					
With barriers	0 – 30	1/8	(3.2)	3/16	(4.8)
	31 – 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)
Without barriers	0 – 30	3/16	(4.8)	3/16	(4.8)
	31 – 150	1/4	(6.4)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)
Rigidly clamped assemblies [c] :					
Power-limited	0 – 30	–	–	–	–
Non power-limited	0 – 30	3/64	(1.2)	3/64	(1.2)
	31 – 150	1/16	(1.6)	1/16	(1.6)
	151 – 300	3/32	(2.4)	3/32	(2.4)
Other parts	0 – 30	1/16	(1.6)	1/8	(3.2)
	31 – 150	1/8	(3.2)	1/4	(6.4)
	151 – 300	1/4	(6.4)	3/8	(9.5)

[a] An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material used where spacings would otherwise be insufficient, shall not be less than 0.028 inch (0.71 mm) thick; except that a liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through-air spacing required. The liner shall be located so that it will not be affected adversely by arcing. Insulating material having a thickness less than that specified may be used if it is suitable for the particular application.

[b] Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. The wire shall not be smaller than 18 AWG (0.82 mm^2)

[c] Rigidly clamped assemblies include such parts as contact springs on relays or cam switches, printed wiring boards, and the like.

[d] These are rms values. Equivalent direct current or peak voltages 42.4 volts for 30 volts rms, 212 volts for 150 volts rms, and 424 volts for 300 volts rms.

26.2 The spacing between an uninsulated live part and a wall or cover of a metal enclosure, a fitting for conduit or metal-clad cable, and any dead metal part shall be not less than that indicated in Table 26.1.

26.3 The To-Walls-of-Enclosure spacings indicated in Table 26.1 are not to be applied to an individual enclosure of a component part within an outer enclosure.

26.4 An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition, or similar material provided where spacings would otherwise not comply with these requirements, shall not be less than 0.028 inch (0.71 mm) thick; except that a liner or barrier not less than 0.013 inch (0.33 mm) thick may be used in conjunction with an air spacing of not less than one-half of the through air spacing required. The liner shall be located so that it will not be affected by arcing.

26.5 Film-coated wire is considered to be a bare current-carrying part in determining compliance of a signaling unit with the spacing requirements, but the coating is acceptable as turn-to-turn insulation in coils.

27 Components

27.1 The through air and over surface spacings at an individual component part are to be judged on the basis of the volt-amperes used and controlled by the individual component. However, the spacing from one component to another, and from any component to the enclosure or to other uninsulated dead metal parts excluding the component mounting surface, shall be judged on the basis of the maximum voltage and total volt-ampere rating of all components in the enclosure.

27.2 The spacing requirements in Table 26.1 do not apply to the inherent spacings inside motors, except at wiring terminals, or to the inherent spacings of a component provided as part of the signaling unit. Such spacings are to be judged on the basis of the requirements for the component. The electrical clearances resulting from the assembly of a component into the complete device, including clearances to dead metal or enclosures, shall be those indicated in Table 26.1.

27.3 Minimum values of spacings are not specified for sockets and similar related component parts, such as vacuum tubes, potentiometers, and the like, used in electronic circuits. However, if the spacings in such components do not comply with the requirements of Table 26.1, the circuit shall comply with the Dielectric Voltage-Withstand Test, Section 49.

27.4 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 are not required to be evaluated to the following tests: Section 34, Electrical Measurements Test, Section 35, Volt-Ampere Capacity Test, Low-Voltage Power-Limited Circuits, Section 44, Leakage Current Test, Section 49, Abnormal Operation Test, Section 50, Dielectric Voltage-Withstand Test, Section 53, Mechanical Strength Tests for Enclosures, Section 54, Polymeric Materials Tests, Section 55, Special Terminal Assemblies Test, Section 85, Production-Line Dielectric Voltage-Withstand Test and Section 86, Production-Line Grounding Continuity Test.

COMBINATION SYSTEMS

28 General

28.1 General

28.1.1 A home health care system that includes provisions for transmission of fire alarm signals, burglar alarm signals, or both, shall comply with the appropriate standards and codes for the intended service. In all cases the priority of signaling shall be in accordance with 28.2.2(b).

28.2 Carbon monoxide signaling systems

28.2.1 Carbon monoxide detectors shall meet the requirements of the Standard for Gas and Vapor Detectors and Sensors, UL 2075, and carbon monoxide alarms shall meet the requirements of the Standard for Single and Multiple Station Carbon Monoxide Alarms, UL 2034.

28.2.2 The following operation shall be obtained in a combination control unit such as a combination employing household burglar alarm control unit, household fire alarm functions, and carbon monoxide monitoring functions:

a) Distinctive alarm signals shall be obtained between carbon monoxide alarms and other functions, such as burglar alarm. The use of a common sounding appliance for carbon monoxide and burglar alarm complies with this requirement if distinctive signals are obtained.

Exception: The audible emergency evacuation signal shall be permitted to be used for other devices as long as the desired response is immediate evacuation.

b) The following priority of signaling shall be maintained:

1) Fire alarms;

2) Carbon monoxide alarms and medical (home health care) alarms;

3) Sprinkler supervisory;

4) Security alarms;

5) Fire and carbon monoxide trouble signals; and

6) Other signals.

28.2.3 Short circuit, open circuit, or ground single faults in the non-carbon monoxide and non-fire monitoring equipment or in the wiring between the non-carbon monoxide and non-fire monitoring equipment and the carbon monoxide monitoring alarm system shall not impede or impair the monitoring for integrity of the carbon monoxide monitoring alarm system, nor impede or impair any carbon monoxide monitoring alarm signal transmissions or operations.

28.2.4 The required operation of the carbon monoxide alarm equipment shall not be impaired by any failure of the non-carbon monoxide and non-fire alarm equipment hardware, software or circuits, or by any maintenance procedure, including removal or replacement of defective equipment or powering down of the non-carbon monoxide and non-fire equipment.

28.2.5 Where the combination system activates audible carbon monoxide alarm signals, the system shall be capable of signaling the following patterns:

a) A single and tone pattern consisting of four cycles of 100 ms plus or minus 10 percent ″on″ and 100 ms plus or minus 10 percent ″off,″ followed by 5 seconds plus or minus 10 percent ″off.″

b) After the initial 4 min. of alarm, the five-second ″off″ time shall be permitted to be changed to 60 seconds plus or minus 10 percent.

c) The carbon monoxide alarm signal shall be repeated in compliance with (a) and (b) until the alarm is reset or the alarm signal is manually silenced.

28.2.6 The operator interface for the system shall distinctly annunciate carbon monoxide alarm and trouble condition(s).

28.2.7 Wired circuits and pathways to carbon monoxide initiating devices and notification appliances shall be monitored for integrity as follows:

a) The initiating device (detector) circuit and indicating circuit of a carbon monoxide alarm unit shall be monitored for integrity so that within 200 seconds a distinctive audible trouble signal will indicate the occurrence of a single break (open) or single ground fault in the interconnections, which would prevent the intended operation of the interconnected devices. Prior to the application of a fault the control unit shall be energized in the intended standby condition while connected to a rated source of voltage and frequency.

Exception: Supervision is not required for an initiating device circuit extending not more than 3 feet (0.91 m) from the control unit or not more than 3 feet from a device (transmitter) that provides the required supervised transmission of an alarm at the control unit provided that a test feature or procedure is incorporated to test the operability of the circuit and the 3-foot distance does not include an intervening barrier such as a wall or ceiling.

b) An open or ground fault in any circuit extending from a household control unit, other than the carbon monoxide initiating device circuit, shall not affect the operation of the control unit for carbon monoxide signaling, except for the loss of the function extending from that circuit.

c) A single break or single ground fault in any initiating device or notification appliance circuit or any circuit extending from the control unit shall not cause a carbon monoxide alarm signal.

28.2.8 The following requirements cover the operation of carbon monoxide products and systems that utilize initiating, annunciating, and remote control devices that provide carbon monoxide signaling by means of low-power radio-frequency (RF):

a) Additional assurance of successful transmission capability shall be provided by one of the following methods:

1) Transmitting the normal supervisory status transmission at a reduced power level of at least 3 decibels;

2) Increasing the minimum signal strength levels used in the product-specific field test procedure by at least 3 decibels;

3) By another equivalent means.

b) The transmitter/receiver combination shall be arranged so that the occurrence of an alarm or emergency condition at any transmitter will be immediately communicated and annunciated at the receiver/control unit. When unusual or abnormal operating conditions (such as clash or interference) require the signal to be delayed, it shall not be delayed for a period of more than 10 seconds.

c) Receiver/control unit until manually reset, and shall identify the particular RF initiating device in alarm.

d) To provide higher priority to carbon monoxide alarm and supervisory signals than to other signals, carbon monoxide alarm and sprinkler supervisory signals shall be periodically repeated at intervals not exceeding 60 seconds until the initiating device is returned to its non-alarm condition. Receiver/control units activating RF appliances shall automatically repeat alarm and supervisory signal transmissions at intervals not exceeding 60 seconds or until confirmation that the output appliance received the signal. The duty cycle of the transmission shall be not more than 15 percent measured over a one-minute interval.

Exception: If the transmitter is manually activated, the 15 percent duty cycle limitation is not applicable.

e) The maximum allowable response delay from activation of a carbon monoxide initiating device to wireless activation of required carbon monoxide alarm functions shall be 10 seconds.

f) When a receiver/control unit activates carbon monoxide signals via RF appliance(s) such as relays or notification appliances, the activated appliance shall remain locked-in until manually reset at the receiver/control unit.

g) A low-power radio-frequency system combination intended to provide carbon monoxide supervisory service shall be arranged so that the occurrence of an off-normal condition of the supervisory device shall be annunciated by a supervisory signal and identify the affected device. The supervisory signal shall latch at the receiver/control unit until either manually reset or the restoration signal is processed as indicated in 28.2.8(i).

h) Restoration from off-normal to the normal carbon monoxide supervisory condition of the supervisory device shall result in the receiver/control unit either canceling the previously annunciated supervisory signal or annunciating the status change audibly and visibly identifying the affected device.

i) When required to increase the probability of a carbon monoxide alarm signal reaching the receiver, an individual transmitter shall remain in the transmit mode for an interval in excess of that used for status reporting. When specified, the transmission shall be repeated periodically until the alarm or emergency condition is terminated if a maximum duty cycle of 15 percent averaged over a 1-minute interval is maintained.

j) Monitoring for integrity shall comply with all the following:

1) Each low-power transmitter/transceiver shall transmit check-in signals at intervals not exceeding 80 minutes.

2) Any transmission interruption between a low-power radio transmitter/transceiver and the receiver/fire alarm control unit exceeding 4 hours shall cause a latching trouble signal at the household fire alarm control unit/operator interface.

3) Low-power transmitters/transceivers shall be limited to serving a single initiating device.

4) Where retransmission devices (repeaters and/or transceivers) are provided, disconnecting or failure of any single retransmission device (repeater and/or transceivers) does not interrupt communications between any low-power transmitter/transceiver and the receiver/fire alarm control unit.

Exception: A receiver/control unit which reports and identifies an inoperative transmitter in the system within 200 seconds.

k) Reception of any unwanted (interfering) transmission by a retransmission device (repeater), or by the receiver/control unit for a continuous period of 20 seconds or more, that would inhibit any status change signaling within the system, shall result in an audible and visual trouble signal indication at the receiver/control unit. This indication shall identify the specific trouble condition (interfering signal) as well as the device(s) affected (repeater and/or receiver/control unit).

l) A transmitter shall supervise the capacity of the battery. The battery shall be monitored while loaded by transmission of the transmitter, or a load equivalent to the load imposed by transmission.

m) A battery trouble status signal shall be transmitted to the receiver before the battery capacity of the transmitter has depleted to a level sufficient to power the unit for a minimum of 7 days. The trouble signal shall be transmitted at intervals not exceeding 4 hours until the battery is replaced.

n) The battery of the transmitter shall be capable of operating the transmitter, including the initiating device if powered by the same battery, for not less than 1 year of normal signaling service before the battery depletion threshold specified in 28.2.8(n) is reached.

o) The battery trouble status signal is not required to be transmitted at a time other than the normal report time of the transmitter. The audible annunciation of a battery trouble signal at the receiver/control unit is permitted to be delayed for a maximum period of 12 hours.

p) The audible signal of the receiver may be silenceable if provided with an automatic feature to resound the signal at intervals not exceeding 4 hours.

q) The trouble status signal shall persist at the receiver/control unit until the depleted battery has been replaced.

r) Any mode of failure of a primary battery in an initiating device transmitter or repeater shall not affect any other initiating device transmitter.

28.2.9 Where the system has provision for signaling off premise, the signaling of carbon monoxide alarms shall meet the following requirements:

a) Supplementary functions, including the extension of an alarm beyond the residential occupancy, shall not interfere with the operation and monitoring for integrity requirements of 28.2.

b) Digital Alarm Communicator Transmitters (DACTs) serving the protected premises shall comply with the requirements of the Standard for Digital Alarm Communicator System Units, UL 1635, with the following exceptions:

Exception No. 1: Shall only require a single telephone line;

Exception No. 2: Shall only require a call to a single digital alarm communicator receiver (DACR) number;

Exception No. 3: Test signals shall be transmitted at least monthly; and

Exception No. 4: The DACT signal shall be permitted to be transmitted over a dedicated cellular telephone connection.

c) Communications path(s) such as internet signaling shall comply with the following:

1) Any failure of the communications path shall be annunciated at the supervising station within 7 days of a fault that affects the communication between the transmitter at the protected premise and the receiver at the supervising station.

2) Failure to complete a signal transmission from the transmitter at the protected premise to the receiver at the supervising station shall result in a trouble annunciation at the user interface at the protected premise.

3) Alarm, trouble, and supervisory signals, and their restoration to normal, shall be received, displayed, and recorded at the supervising station in not greater than 90 seconds from the time they are transmitted from the protected premises.

4) Where a transmitter shares a transmission or communications channel with other transmitters, each transmitter shall have a unique identifier.

5) Communication of alarm, supervisory, and trouble signals shall prevent degradation of the signal in transit by means of one of the following:

i) Signal repetition: Multiple transmissions repeating the same signal;

ii) Parity check: A mathematical check sum algorithm of a digital message that verifies correlation between transmitted and received message; or

iii) A means that provides a certainty of 99.99 percent that the received message is identical to the transmitted message.

d) The installation instructions for the transmitter shall alert the user that all equipment necessary for the transmission of alarm, trouble, supervisory and other signals located at the residence shall have a secondary power capacity of 24 hours.

e) The time period for the minimum required test signals shall be the default programming setting for the transmitter.

28.2.10 Carbon monoxide alarms interconnected to the household fire warning system equipment shall meet the requirements of 28.2.

Exception No. 1: Carbon monoxide alarms interconnected to home health care system equipment when all the following conditions are met:

a) Alarm signals are solely annunciated within the premises and are not signaled off-premise;

b) An open, ground fault, or short circuit faults on the wired interconnections do not prevent the operation of each individual smoke alarm or the remaining operation of the household fire warning system;

c) Radio frequency jamming signals on wireless pathways do not prevent the operation of each individual smoke alarm or the remaining operation of the household fire warning system;

d) Priority of signaling is maintained as described in 28.2.2(b);

e) The control unit shall remain in alarm as long as the originating transmitter remains in alarm;

f) Receipt and alarm/display by the control unit is within a maximum of 20 seconds; and

g) The transmitter and receiver shall be capable of communicating at an equivalent open area test distance D_{EOAT} during and/or following the performance based tests in Sections 44, 45, 48, 51, 52, 53, and 54, as applicable. D_{EOAT} is a "line of sight" distance equivalent to 30.5 m (100 ft) indoors as defined by the following equations.

$$D_{EOAT} = 30.5(10L^{b}/40)$$

Where L_b is the building attenuation factor, a value dependent on the frequency of the wireless transmission. The building attenuation factor, L_b, represents the maximum attenuation value of typical floors and walls within a majority of structures. L_b shall assume four walls and two floors and be calculated as follows:

$$L_b = 4(L_w) + 2(L_f)$$

Where:

L_w = attenuation value of a wall = $2L_1 + L_2$

L_f = attenuation value of a floor = $L_1 + L_2 + L_3 + L_4$ and

L_1 = Frequency dependent attenuation value for 13 mm drywall[1]

L_2 = Frequency dependent attenuation value for 38 mm structural lumber (dry)[1]

L_3 = Frequency dependent attenuation value for 19 mm plywood (dry)[1]

L_4 = Frequency dependent attenuation value for 13 mm glass/tile floor[1]

NOTE: The losses are in dB and the distances are in meters.

Exception No. 2: Following initial verification of D_{EOAT}, an alternative to conducting all of the performance based tests at D_{EOAT}, it is acceptable that the testing be conducted with the transmitter and receiver in close proximity to one another provided the transmitter signal strength is equal to or less than the signal strength value at D_{EOAT}.

[1] Stone, W. ″Electromagnetic Attenuation in Construction Materials″, National Institute of Standards and Technology, NISTIR 6055, 1997.

FCC VERIFICATION

29 General

29.1 A signaling unit radiating or utilizing radio frequency energy is subject to the safety requirements and regulations of the Federal Communications Commission (FCC). Verification of the compliance of such equipment with the regulatory agency involved is required prior to or may be obtained concurrently with the establishment of compliance with the requirements of this standard.

PERFORMANCE

ALL UNITS

30 General

30.1 Test units and data

30.1.1 Home health care system units that are fully representative of production units are to be used for each of the following tests unless otherwise specified.

30.1.2 The units employed for testing are to be those specified by the wiring diagram of the signaling unit, except that substitute devices may be used if they produce functions and load conditions equivalent to those obtained with the devices intended to be used with the signaling unit in service.

30.1.3 If a signaling unit is to be mounted in a definite position in order to function as intended, as detailed by the installation instructions or marking on the unit, it shall be tested in that position.

30.1.4 If a signaling unit or device is intended to be employed with a specific power supply to obtain intended operation, it shall be connected to that power supply during each of the Performance tests described in this standard.

30.2 Test voltages

30.2.1 Unless specifically noted otherwise, the test voltage for each test of a signaling unit shall be as indicated in Table 30.1, and at rated frequency for alternating current circuits.

Table 30.1
Voltages for tests

Nameplate voltage rating	Test voltage
110 to 120	120
220 to 240	240
Other	Marked nameplate rating
Battery circuit	Nominal battery voltage

31 Normal Operation Test

31.1 Home health care equipment shall operate as intended when tested, at the voltage given by Table 30.1, in conjunction with related signal initiating and indicating devices to form a system of the type indicated by the installation wiring diagram and any supplementary information provided.

31.2 A signaling system unit shall be in the standby condition and prepared for signaling operation when it is connected to related devices and circuits.

31.3 The operation of a signaling unit shall result in the operation of related devices so as to produce a signal that will not be confused with background noise and that is the type of signal for which the combination is designed.

31.4 Operation of a personal call unit shall result in an audible alarm indication at both the residential control unit and receiver as well as a visual indication at the receiver unit. The visual indication shall identify the source of the signal. The visual signal shall be maintained continuously, locked in by either the unit from which the signal originated or by the unit receiving the signal, until a manual reset is performed.

Exception: The visual signal need not be continuously maintained if a printed record is also generated.

31.5 The transmission of a medical emergency signal to the central station receiving unit may be delayed for not more than 3 minutes. A ″call cancel″ switch may be provided at the residential control unit to cancel unintended medical emergency signals during the delay feature.

31.6 Silencing of an audible signal of one circuit of a central station receiving unit common to several circuits shall result in reenergization of the audible signal upon receipt of a subsequent signal from another circuit.

31.7 The signal indication resulting from the operation of a central station receiving unit shall include a permanent record of all signals. Audible indication shall be given of all medical emergency signals.

31.8 There shall be distinction among trouble, medical emergency, and monitor signals for residential and central station receiving equipment. This shall be accomplished by means of a sounding appliance common to two or more signals coupled with a distinguishing visual indication of the signal received, or by other equivalent means.

31.9 A visual indication is required in a central station receiving control unit to identify a medical emergency signal and the location from which the signal originated. Any one of the following or equivalent means shall be used:

a) One lamp coupled with a lamp test switch, in which operation of the lamp test switch indicates a lamp that has burned out, or an equivalent means to readily identify a burned out lamp. A common lamp test switch may be common to all lamps or a particular group of lamps.

b) A reliable lamp, such as a light emitting diode or an incandescent lamp that complies with a 150,000-cycle endurance test. See Table 47.1.

c) One lamp coupled with a printed record.

31.10 The operation of a control unit from a standby power source shall produce the same medical emergency, monitor, and trouble signals, under normal and emergency conditions, that are produced with the unit connected to its main power source.

Exception No. 1: The trouble signal that is obtained upon loss of main power is not required for a residential control unit operating from standby power.

Exception No. 2: Response at a central receiving unit operating from standby power shall include an audible trouble signal and either a visual signal or printed record, or both.

31.11 The operation of a signaling unit shall not depend upon any ground connection.

31.12 The residential control unit may incorporate a feature whereby the central receiving unit can be alerted to intentionally unoccupied periods.

31.13 It shall be possible to maintain operation of the residential control unit during unoccupied periods such that a medical emergency signal is capable of being transmitted to the central receiving station. Other signals such as monitor signals may be halted during unoccupied periods.

31.14 The representative system combination is to be investigated in the ″occupied″ and ″unoccupied″ conditions throughout the test program.

31.15 The health care system control unit(s) shall be in the normal standby condition and prepared for the intended signaling operation when it is connected to related devices and circuits as specified on the installation wiring diagram provided by the manufacturer (see Installation and Operating Instructions, Section 6).

31.16 In accordance with the marking requirements in 87.1(h) regarding testing the system weekly on standby power, the system shall provide one of the following or equivalent methods:

a) Disconnecting ac power and verify that system can operate for emergency signaling. The instructions shall indicate to reconnect the restraining means.

b) A manual test feature which disconnects the ac power and tests the system for emergency signaling.

c) An automatic test feature that tests the battery under a load representative of emergency signaling. Where the battery does not have sufficient capacity, the system shall provide an audible and visual low battery trouble annunciation at an operator interface on the premise.

d) An automatic battery test under sufficient load to determine if the battery has sufficient capacity to operate the system for emergency signaling. Where the automatic test determines that the battery does not have this capacity, the condition of the battery shall be transmitted to a central supervising station.

32 Electrical Supervision Test

32.1 The circuits between the signal initiating unit and the residential control unit, over which medical emergency signals are to be transmitted, shall be supervised so that an audible trouble signal is obtained for a single open, single ground, or short-circuit fault. The trouble signal is to be indicated at the residential control unit.

Exception: Supervision does not apply to a portable transmitter that is intended to be carried or worn on a person, such as a pendant, wrist instrument, or equivalent.

32.1.1 The audible trouble signal shall be distinctive from all alarm signals. Where an intermittent signal is used, it shall sound at least once every ten seconds with minimum on-time duration of one-half second. When a common audible signal (distinct from alarm) is to be employed for trouble annunciation for both medical and non-medical related signals, distinction shall be achieved visually.

32.2 An initiating device circuit of a control unit employing radio frequency (RF) transmission shall be supervised in accordance with 76.1.

Exception: Supervision is not required for an initiating device circuit extending not more than 3 feet (0.91 m) from the control unit or not more than 3 feet from a device (transmitter) that provides the required supervised transmission of an alarm at the control unit, provided that a test feature or procedure is incorporated to test the operability of the circuit and the 3-foot distance does not include an intervening barrier such as a wall or ceiling. See 87.1(h).

32.3 If radio frequency transmission is employed between a fixed initiating device and a residential control unit, failure of the transmission capability shall be indicated by an audible trouble signal either at the residential control unit or at the off premises central station receiving unit within 24 hours after the failure occurs.

32.4 Opening or shorting of capacitors, shall either have no effect on intended operation or be indicated by a trouble or alarm signal.

Exception: A manual test method provided as a part of the operation of the system that effectively tests the capability of critical components may be used in lieu of electrical supervision. A critical component is a component whose malfunction will impair the operation of the unit (such as by preventing the receipt of signals by the operator) or will create a risk of fire or electric shock.

32.4.1 Where it is not practical to have a component failure indicated, a reliable component shall be used. The reliability of the component may be based on de-rating or on reliability data recorded for the particular component. Suitable sources are:

a) The capacitor derating parameters specified in Table 32.1;

b) The Military Handbook Electronic Reliability Design Handbook, MIL-HDBK-338, RIAC 217+, or equivalent, such that the failure rate is equal to or less than 0.5 failures per million hours of operation; and

c) Component reliability data based on actual performance in a similar application, such that the failure rate is equal to or less than 0.5 failures per million hours of operation.

d) The maximum temperature rise is 40 C in a maximum 25 C ambient.

Table 32.1
Capacitor derating parameters

Type	Derating parameter	Derating level[a]
Mica, film, glass	Normal operating voltage Temperature from maximum limit	60 percent 10°C
Ceramic	Normal operating voltage Temperature from maximum limit	60 percent 10°C
Electrolytic aluminum	Normal operating voltage Temperature from maximum limit	80 percent 20°C
Electrolytic tantalum	Normal operating voltage Temperature from maximum limit	60 percent 20°C
Solid tantalum	Normal operating voltage Maximum operating temperature	60 percent 85°C

[a] Percent of derated value to the rated normal operating temperature.

32.5 Malfunction or breakdown of a cooling fan motor that would result in temperatures exceeding those specified in Table 39.1 shall be indicated by an audible trouble signal.

32.6 The fuses of a central station receiving unit shall be electrically supervised to indicate opening of the fuse by an audible trouble signal if the fault impairs the operation of the unit. (See 32.10 for the opening of AC power line fuses.)

32.7 A multiple ground fault or short circuit fault on conductors extending from power limited circuits that would impair the intended operation of the unit shall result in an audible trouble or alarm signal.

32.8 To determine compliance with the requirements in 32.1 – 32.7, a representative system combination in the normal standby condition indicated in 31.15 is to be assembled, and the type of fault to be detected is to be introduced separately in each circuit conductor.

32.9 The operation of any manual-switching part of a signaling unit to other than its normal position, while the unit is in the supervisory condition, shall be indicated by an audible trouble signal or by a lamp or other visual annunciator, if the off-normal position of the switch impairs the intended operation of the signaling unit.

32.10 To determine compliance with the requirements in 32.9, with the representative system combination in the normal supervisory condition indicated in 31.15, the unit signal operation is to be determined with the manual-switching part in each position.

32.11 A trouble signal shall be distinctive from a medical emergency signal and shall be indicated at the receiver unit by the continuous operation of an audible device that may be common to several supervised circuits. A switch to silence the audible device may be provided only if the switch transfers the trouble indication to a lamp or other visual indicator. The visual indicator shall continue to indicate until the silencing switch is restored to its normal position, unless an audible trouble signal is obtained when a fault occurs without restoring the switch to normal or unless the audible trouble signal is again energized upon correction of the fault.

32.12 The visible indicator referred to in 32.11 shall be located and identified so that the user will recognize the signal as soon as it is activated.

32.13 The lines extending from remote (but not supplementary) annunciators employed in central station receiving equipment indicating lamps and sounding appliances, shall be either supervised, or installed in conduit, provided that the control unit is located in the same room (including closets) as the annunciator.

33 Power Supply Supervision Test

33.1 Battery powered units

33.1.1 A signal initiating device using a primary battery as the source of supply shall be capable of initiating an emergency or monitor signal at the voltage at which a low battery audible trouble signal is first obtained. The low battery trouble signal shall be distinctive from the emergency or monitoring signal, and shall be at the signal initiating device, at the residential control unit, or at the control station receiving unit. If the trouble signal is the battery operated signal initiating device, the trouble signal shall be energized at least once per minute for a minimum of 7 days.

Exception: A "power-on" indicator is not required if a signal indicating loss of AC power is transmitted to the central station receiving unit.

33.2 Residential control unit

33.2.1 Loss of power to an AC operated residential home health care control unit shall be indicated by de-energization of a "power on" light, or energization of an audible or visual trouble signal.

33.2.2 The capacity of the standby power for a residential control unit shall be sufficient to operate the unit for 24 hours while in the standby mode of operation that consumes maximum power, and immediately thereafter be capable of operating for at least 5 minutes upon initiation of any signaling unit.

Exception: Standby capacity of 4 to 24 hours is acceptable if the unit is not intended for carbon monoxide signaling and the unit is prominently marked on its enclosure with the following or equivalent wording: "Battery capacity for emergency standby at least ____ hours."

33.2.3 If the residential control unit is equipped with terminals or leads for the connection of standby power, the terminals shall be marked with the voltage, current, and minimum capacity of the batteries in ampere-hours, and the number and type of batteries to be used. See 87.1(d)(2).

33.2.4 With standby power connected, neither loss nor restoration of a line voltage source shall cause a medical emergency or monitor signal.

33.2.5 To determine compliance with the requirements of 33.2.4, the signaling unit is to be energized in the normal standby condition and the supply circuit interrupted for 1 minute and restored for 1 minute for a total of 10 cycles of interruption and restoration.

33.2.6 Following restoration of power after an extended power failure of 24 hours or more, a rechargeable battery shall recharge within 48 hours to provide the standby power as required in 33.2.1. See the Charging Current Test, Section 40.

33.3 Central station receiving units

33.3.1 A central station receiving unit shall be electrically supervised so that loss of AC power will result in an audible trouble signal.

Exception: For a constantly attended receiving unit, de-energization of a normally energized display is acceptable in lieu of an audible trouble signal.

33.3.2 The capacity of the standby power shall be sufficient to operate the unit for 24 hours under the following conditions: The receiving unit shall first be operated for 24 hours in the standby mode of operation that consumes maximum power. At the end of the 24 hours of standby operation, the receiving unit shall be capable of receiving medical emergency signals from 10 percent (minimum of two) of the signaling circuits. The signals shall be initiated one at a time and acknowledged and the audible signal silenced before the next signal is initiated. The required capacity of the standby power can be accomplished by means of an engine-driven generator and storage batteries with at least a 4-hour capacity.

33.3.3 If receiving units are equipped with terminals for the connection of standby power, the terminals shall be marked with the voltage, current, and minimum capacity of batteries in ampere-hours and the number and type of batteries to be used. See 87.1(d)(2).

33.3.4 With standby power connected, neither loss nor restoration of the primary voltage source shall cause a medical emergency or monitor signal.

33.3.5 To determine compliance with the requirement of 33.3.4, the receiving unit is to be energized in the normal standby condition and the supply circuit interrupted for 1 minute and restored for 1 minute for a total of 10 cycles of interruption and restoration.

33.3.6 Following an extended power failure of 24 hours or more and subsequent restoration of power, the receiving unit shall, within 48 hours, recharge sufficiently to provide the required standby power in accordance with 33.3.2.

33.3.7 Momentary power failures and subsequent power restorations shall not render the equipment inoperative for any of its functions unless a trouble signal, as described in 33.3.1, is obtained.

34 Electrical Measurements Test

34.1 Input circuit

34.1.1 The input to a signaling unit shall not exceed 110 percent of the marked input rating while connected to an input voltage source in accordance with Table 30.1, and while delivering maximum rated output voltage and current.

34.2 Output circuit

34.2.1 With the input voltage adjusted to 110 percent of rated value, the output voltage shall not exceed 110 percent of rated value with no load (or minimum load specified by the manufacturer) connected to the output circuit. The input voltage is then to be reduced to the test value determined by Table 30.1, and rated load is to be connected to the output circuit. The input voltage is then to be reduced to 85 percent of rated test value, and the output voltage, measured at the terminals of the power supply, shall not be less than 85 percent of rated voltage.

34.2.2 With reference to the requirements of 34.2.1, rated load is that value of output current delivered by the power supply with the input voltage adjusted to the value determined by Table 30.1 and with the output connected to the maximum load specified by the installation wiring diagram.

34.3 Battery circuit

34.3.1 A home health care unit intended to be employed with a floating battery shall have sufficient capacity to maintain the battery fully charged under all conditions of intended operation and with sufficient capacity to operate the system under signaling conditions with the battery disconnected. The same regulation shall be provided with the battery disconnected.

34.3.2 With reference to the requirements of 34.3.1, a fully charged battery is defined as a battery having sufficient capacity to maintain the signaling unit in the standby operating condition for 24 hours or for the period marked in accordance with the exception to 33.2.2. Additionally the battery shall be capable of generating a complete medical emergency transmission, and at least 5 minutes of audible signal at the residence. In the normal standby condition, with the system input voltage at 85 percent of rated value, the battery charger shall maintain the battery in the fully charged condition.

34.4 Circuits connected to specific equipment

34.4.1 If a signaling unit output circuit is intended to be connected to a specific device, it need not comply with the requirements of 34.2.1 – 34.3.2 if it complies with all other requirements in this standard while connected to the device.

35 Volt-Ampere Capacity Test, Low-Voltage Power-Limited Circuits

35.1 A signaling circuit of home health care equipment intended to be installed in residences shall be of a low-voltage, power-limited type and shall be obtained, either directly or indirectly, from the output of an isolating step-down transformer or, if provided, a standby battery. For this purpose, there are two types of power limited circuits: those inherently limited by a reliable fixed impedance or reliable electronic circuitry requiring no overcurrent protection and those having power limited by a combination of a transformer or standby battery and overcurrent protection.

a) Power limitations shall be obtained by the use of any one of the following configurations:

1) Energy-limiting transformers [see (b)(1), (2), and (3)].

2) Nonenergy-limiting transformer, standby battery, or both, coupled with a noninterchangeable overcurrent protective device in the output circuit [see (b)(1), (2), and (4)].

3) Combination transformer, standby battery, or both, and reliable fixed impedance [see (b)(1), (2), and (3)].

4) Combination transformer, standby battery, or both, and reliable electronic circuit [see (b)(1), (2), and (3)].

5) Arrangement equivalent to any of the above.

b) The capacity of a low-voltage, power-limiting circuit of home health care equipment shall not be greater than the following values:

1) 100 volt-amperes, 5 amperes maximum at the maximum rated voltage and frequency.

2) 30 volts, 60 hertz (42.4 volts peak), 42.4 volts peak for nonsinusoidal AC, or 42.4 volts continuous DC.

3) For a circuit whose power is limited internally by a reliable fixed impedance or reliable electronic circuit, 8 amperes short circuit current, measured after 1 minute.

4) For a circuit whose power is limited by a combination of a nonenergy-limiting transformer, standby battery, or both, and noninterchangeable overcurrent-protective device, 250 volt-amperes under any condition of loading. If the maximum voltage from the circuit is 15 volts, 60 hertz, or less, then the maximum volt-amperes shall not be greater than 350 volt-amperes.

c) Components, circuits, or both, may be determined to be reliable by any one of the following methods:

1) The component has been previously investigated and determined to be acceptable for the application.

2) The opening or short-circuiting (singly) of any unreliable component (electrolytic capacitor, transistor junction, diode, vacuum tube, and the like) in the circuit in question does not cause the limits in 34.1.1 to be exceeded.

3) The individual component or each component of the circuit has a predicted failure rate of 2.5 or fewer failures per million hours as determined for a ″Ground Fixed″ (GF) environment by MIL-HDBK 217B, or equivalent.

35.2 To determine if the capacity of a low-voltage power-limited circuit complies with the requirements of 35.1, the output circuit is to be connected to a variable resistance load. With the unit connected to a rated source of supply voltage and frequency, the load resistor is to be varied from open circuit to short circuit conditions in such a manner that the elapsed time is between 1-1/2 and 2-1/2 minutes. Voltage and current measurements are to be recorded for each value and the maximum volt-amperes (volts times amperes) capacity is to be calculated. The short circuit current, open circuit voltage, and the current at the rated voltage value of the circuit are to be included in the measurements. The overcurrent protective device is to be shunted out during the test.

35.3 The output circuit of a power supply supplying a low-voltage, power-limited circuit, and complying with the limits of 35.1 shall not be interconnected with the output circuit of another power supply, either in series or parallel, unless the voltage and current measurements (volt-amperes) at the output terminals of the interconnected combination also comply with the requirements in 35.1. The presence of a fault condition in the interconnecting wiring is not to be considered in determining the energy capability of two or more power supplies in combination.

Exception: Two or more separate power supplies supplying low-voltage, power-limited circuits are to be treated as two separate circuits, each having its own separate output connections, and the output at each circuit shall be marked to warn that the separation shall be maintained.

35.4 For a unit provided with a standby battery, the volt-ampere capacity test is to be conducted with the unit connected to:

a) Both a rated AC supply source and a fully charged battery.

b) A rated AC supply source (battery disconnected).

c) A fully charged battery (AC power source disconnected).

CAUTION – To prevent possible shorting of the battery circuit and the resultant risk of explosion, precautions must be taken to provide acceptable overcurrent as well as physical protection during this test.

35.5 For this test, a volt-ampere load curve (from open circuit to the maximum volt-amperes that can be obtained from the battery) is required.

36 Undervoltage Operation Test

36.1 A home health care system unit shall operate for its intended signaling performance while energized at 85 percent of its rated primary and secondary supply voltages and with the appropriate value of maximum load connected to the circuit.

36.2 A product that uses batteries for standby power shall comply with the requirements of the Charging Current Test, Section 40.

37 Overvoltage Operation Test

37.1 A home health care system unit shall withstand 110 percent of its rated supply voltage continuously without damage during the standby condition and shall operate as intended at the increased voltage.

37.2 The signaling unit is to be subjected to the increased voltage in the standby condition until constant temperatures are attained, and then tested for its intended signaling operation. For this test, zero ohms line impedance is to be employed in the initiating circuit.

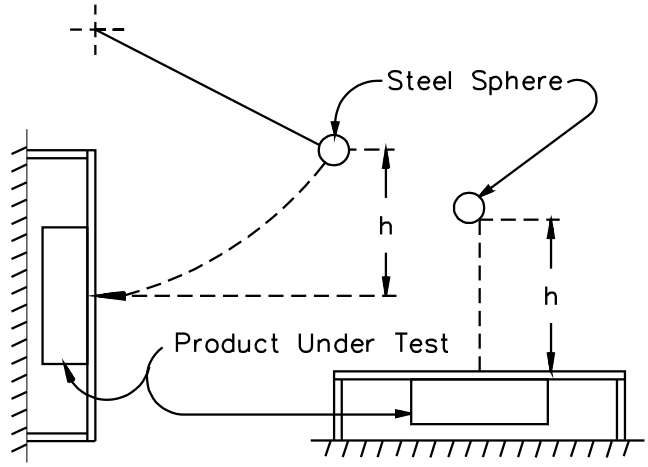
38 Jarring Test

38.1 A signaling unit shall withstand jarring resulting from impact and vibration such as might be experienced in service, without causing signaling operation of any part and without impairing its subsequent operation.

38.2 The device is to be mounted in a position of intended use to the center of a 6- by 4-foot (1.8- by 1.2-m), 3/4 inch (19.1 mm) thick plywood board secured in place at four corners. An impact of 3 foot-pounds (4.2 J) is to be applied to the center of the reverse side of this board by means of a 1.18 pound (0.54 kg), 2 inch (50.8 mm) diameter steel sphere. For this impact, the sphere is to be swung through a pendulum arc from a height (h) of 2.54 feet (0.77 m) or dropped from a height (h) of 2.54 feet, depending upon the mounting of the equipment. See Figure 38.1.

38.3 For this test the unit is to be energized in the standby condition and connected to a rated source of supply. Following the jarring, the unit is to be tested for the intended signaling operation.

Figure 38.1
Jarring test



IP110

39 Component Temperature Test

39.1 A product, when operated under any normal condition of intended use and at maximum rated load, shall not reach a temperature at any point high enough to:

a) Result in a risk of fire or electric shock;

b) Adversely affect any materials in the product; or

c) Exceed the temperature rises at specific points as specified in Tables 39.1 and 39.2.

Exception: A component with a temperature exceeding that indicated in Table 39.1 may be used when reliability data at the higher temperature is provided by the manufacturer to justify its use. See note c to Table 39.1.

Table 39.1
Maximum temperature rises for electronic components

Component or device	Normal standby (i.e. any long term fire or security condition of operation or any non-fire or non-emergency operating condition)		Alarm condition (i.e. short term operating condition of fire, security, or emergency signaling)	
	°F	(°C)	°F	(°C)
A. COMPONENTS				
1. Capacitors [a]	45	(25)	72	(40)
2. Resistors [b]				
Carbon	45	(25)	90	(50)
Wire-wound	90	(50)	225	(125)
Other	45	(25)	90	(50)
B. SOLID-STATE DEVICES	See note (c)			

[a] In lieu of complying with these temperature limits, a component shall meet the derating parameters specified in Table 30.1 or the component reliability assessment specified in 32.4.1.

[b] In lieu of complying with these temperature limits, a resistor shall not dissipate more than one-half of its maximum power rating under the test conditions specified.

[c] The temperature of a solid-state device (such as a transistor, SCR, or integrated circuit) shall comply with one of the following:

1) Not exceed the temperature limits specified in both (a) and (b):

a) 50 percent of its rated junction temperature, or storage temperature when not rated for junction temperature, during the normal standby condition and during any non-fire or emergency signaling condition.

b) 75 percent of its rated junction temperature, or storage temperature when not rated for junction temperature, under the alarm condition or any other short term condition of operation which produces the maximum temperature dissipation of the component.

For reference purposes, 32°F (0°C) shall be determined as 0 percent. For integrated circuits, the loading factor shall not exceed 50 percent of its rating under the normal standby condition and 75 percent under any condition of operation.

2) Not exceed 100 percent of its rating under any condition of normal use and the component is subjected to one of the following:

a) For integrated circuits the component complies with the requirements of MIL-STD 883H, For all other solid state devices (such as diodes, transistors, SCR's, LEDs) the component complies with the requirements of MIL-STD-750F.

b) A quality control program established by the manufacturer consisting of inspection and testing of all pertinent parameters of 100 percent of components either on an individual basis, as part of an assembly, or the equivalent.

c) Each assembled production unit is subjected to a burn-in test under the condition which results in the maximum temperatures for 24 hours, while connected to a source of rated voltage and frequency in an ambient of at least 120°F (49°C), followed by an operation test for normal signaling performances.

d) Component reliability data based on actual performance in a similar application, or the Military Handbook Electronic Reliability Design Handbook, MIL-HDBK-338, or equivalent, such that the failure rate is equal to or less than 0.5 failures per million hours of operation.

Table 39.2
Maximum temperature rises for materials and component parts

Materials and component parts	°F	(°C)
1. Varnished cloth insulation	108	(60)
2. Fuses:		
a) Glass G, J, L, and CC:		
Tube	180	(100)
Ferrule or blade	153	(85)
b) Others	117	(65)
3. Fiber used as electrical insulation	117	(65)
4. Wood and similar combustible material	117	(65)
5. Any point on or within a terminal box on a permanently wired unit	117	(65)
6. A surface upon which a permanently wired unit is mounted in service, and surfaces that are adjacent to the unit when it is so mounted	117	(65)
7. Enclosure surfaces:		
a) Surfaces subject to contact during intended use or maintenance:		
Metallic	63	(35)
Nonmetallic	108	(60)
b) Other surfaces:		
Metallic	81	(45)
Nonmetallic	126	(70)
8. Class 105 (formerly Class A) insulation systems on windings of relays, solenoids, magnets, transformers and similar parts:		
Thermocouple method	117	(65)
Resistance method	153	(85)
9. Class 130 (formerly Class B) insulation systems on windings of relays, solenoids, magnets, transformers and similar parts:		
Thermocouple method	153	(85)
Resistance method	189	(105)
10. Class 155 insulation systems on windings of relays, solenoids, magnets, transformers and similar parts:		
Thermocouple method	198	(110)
Resistance method	216	(120)
11. Class 180 insulation systems on windings of relays, solenoids, magnets, transformers and similar parts:		
Thermocouple method	225	(125)
Resistance method	243	(135)
12. Phenolic composition used as electrical insulation or as a part whose malfunction is capable of resulting in a risk of fire, electric shock, injury to persons or risk from electrical-energy/high-current levels.[a]	225	(125)
13. Insulated conductors, appliance wiring material	see note [b]	
14. Sealing compound	72°F (22°C) less than melting point	
15. Printed-wiring board	see note [c]	

[a] The limitations on phenolic composition and on rubber and thermoplastic insulation do not apply to compounds that have been investigated and determined to meet the requirements for use at higher temperatures.

[b] 77°F (25°C) less than the established temperature rating of the wire.

Table 39.2 Continued on Next Page

Table 39.2 Continued

Materials and component parts	°F	(°C)
[c] Temperatures on the surface of any printed-wiring board shall not exceed the temperature limits of the board.		

39.2 All values for temperature rise apply to equipment intended for use with ambient temperatures normally prevailing in occupiable spaces which usually are not higher than 77°F (25°C). When equipment is intended specifically for use with a prevailing ambient temperature constantly more than 77°F (25°C), the test of the equipment is to be made with the higher ambient temperature, and the allowable temperature rises specified in Tables 39.1 and 39.2 are to be reduced by the amount of the difference between that higher ambient temperature and 77°F.

39.3 Temperature measurements on equipment intended for recessed mounting are to be made with the unit installed in the intended manner on or against the black painted surface of an enclosure of 3/4 inch (19.1 mm) wood such that the walls of the enclosure make a close fit with the product and extending approximately 2 inches (50.8 mm) on the top, sides and rear, and the front extended to be flush with the product cover.

39.4 A product shall be connected to a supply circuit of rated voltage. A product having a single frequency rating is to be tested at that frequency. A product rated AC/DC or DC - 60 hertz is to be tested at both direct current and 60-hertz alternating current. A product rated 25 - 60 hertz or 50 - 60 hertz is to be tested on 50-hertz alternating current.

39.5 A product that is rated for use at more than one voltage or for a range of voltages shall be evaluated at the rated voltages.

39.6 A product that is rated for use at more than one voltage, or a range of voltages, and contains a tapped transformer or other means of being adapted to different supply voltages shall be tested at the most unfavorable combination of supply voltage and voltage adjustment.

39.7 For the purpose of prescreening, thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2), and an infrared temperature probe or the equivalent, are not prohibited from being employed to identify those components and/or materials in which compliance with 49.1 is questionable and, therefore, requiring the measurements indicated in 39.8.

39.8 Temperatures are to be measured by thermocouples except the change-of-resistance method shall be used for coil and winding temperatures where the coil is inaccessible for mounting of thermocouples (for example, a coil immersed in sealing compound) or where the coil wrap includes thermal insulation or more than two layers [1/32 inch (0.8 mm) maximum in total thickness] of cotton, paper, rayon, or the like.

39.9 Whenever temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wire and a potentiometer-type instrument are to be used. The thermocouple wire is to conform to the requirements in the Initial Calibration Tolerances for Thermocouples table in Standard Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M.

39.10 The temperature of a copper coil winding is determined by the change-in-resistance method, wherein the resistance of the winding at the temperature to be determined is compared with the resistance at a known temperature by means of the formula:

$$T = \frac{R}{r}(234.5 + t) - 234.5$$

in which:

T is the temperature to be determined in degrees C,

R is the resistance in ohms at the temperature to be determined,

r is the resistance in ohms at the known temperature, and

t is the known temperature in degrees C.

39.11 As it is generally necessary to de-energize the winding before measuring R, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to give the value of R at shutdown.

39.12 The circuit of a current-regulating resistor or reactor provided as part of a product is to be adjusted for the maximum resistance or reactance at rated load.

39.13 The durations of the tests are to be not less than:

a) Sixteen hours, for the normal standby condition of any signaling unit.

b) One hour for the normal signaling condition of a signaling unit intended to be actuated by automatic or manual devices.

c) Until constant temperatures are attained for a rectifier operating at its maximum rated output.

39.14 If the signaling unit has a power supply-battery charger combination, the test sequence is to be as follows:

a) The power supply section is to be delivering maximum rated output power and the battery charger section is to be connected to a discharged battery, see 39.13, of the maximum capacity prescribed by the manufacturer. The terminal voltage of the discharged battery shall be measured prior to the beginning of this test, before input or output connections are made.

b) After operation for 1 hour, the temperature rises shall not exceed the values shown in the second column (″Signaling Condition - Short Term Operation″) of Table 39.1.

c) The signaling unit is to be operated for a total of 48 hours of continuous operation (normal standby), while delivering maximum standby load.

d) At the conclusion of the 48 hour period, the product is to be subjected to the Charging Current Test, Section 40.

39.15 With reference to 39.14, a discharged battery is one that has been:

a) Fully charged, in a new condition, according to the manufacturer's instructions, then:

b) Delivering normal standby load for 24 hours or for a period marked in accordance with the Exception to 33.2.2 with primary power disconnected.

39.16 A temperature is determined to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5-minute intervals, indicate no change.

39.17 If, during the temperature test, the temperature on a lead intended to be field installed or on a surface of the wiring compartment which the lead might contact is more than 60°C (140°F), the signaling unit shall be marked as described in 87.11.

40 Charging Current Test

40.1 The Charging Current Test is to be conducted in conjunction with the Temperature Test, Section 37, on products provided with standby batteries.

40.2 At the conclusion of the 48-hour charging period [see 39.14(c)] during which the signaling unit is operating continuously with maximum standby load connected and with the AC input to the signaling unit reconnected, the battery terminal voltage shall not be less than 95 percent of the value measured after the initial battery-charging period.

40.3 With the AC source disconnected, normal standby load is to remain connected to the output for the 24 hour period (or for a period marked in accordance with the Exception to 33.2.2) specified.

40.4 After maximum standby load has been applied at the residential control unit for 5 minutes, battery terminal voltage shall be not less than 85 percent of the marked ratings of the output circuits.

Exception: Where a combination system includes carbon monoxide signaling, after the 5 minutes of home health care or carbon monoxide alarm, the maximum carbon monoxide alarm load shall continue to be applied for a period of not be less than 12 hours. The 5-second "off" time of the carbon monoxide alarm signal shall be permitted to be changed to 60 seconds plus or minus 10 percent.

41 Battery Charger Tests

41.1 A nonfloat-type battery charger employed in a home health care unit shall isolate the battery from external loads until an AC power loss occurs, at which time a transfer mechanism shall connect the battery to the unit.

41.2 A home health care unit employing battery charger circuitry shall comply with the requirements of the Charging Current Test, Section 40, except that during the recharge cycle, only the discharged battery is to be connected to the charger, and any external loading contemplated for the system is to be connected to the home health care unit.

42 Variable Ambient Temperature Test

42.1 A home health care unit shall comply with the requirements of the Normal Operation Test, Section 31, in an ambient temperature of 120°F (49°C) and also in an ambient temperature of 32°F (0°C).

42.2 The unit is to be energized in the normal standby condition using the supply specified in 30.2.1. The unit is to be maintained at each test temperature for at least 3 hours or until thermal equilibrium is attained. The unit is then to be tested for operation.

43 Humidity Test

43.1 A home health care unit shall comply with the requirements of the Normal Operation Test, Section 31, while energized from a rated source of voltage and frequency after having been exposed for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (86 ±3°F). The performance shall be determined with the unit in the humid ambient. See also 44.2.

44 Leakage Current Test

44.1 The leakage current of a residential home health care unit, other than one operating from a primary battery and directly powered from a source less than 42.4 volts peak, shall not exceed the following values and those specified in 44.2 when measured under all of the following conditions immediately after being subjected to the Humidity Test, Section 43. All grounding connections to the unit are to be disconnected prior to making the measurement. See Figure 44.1.

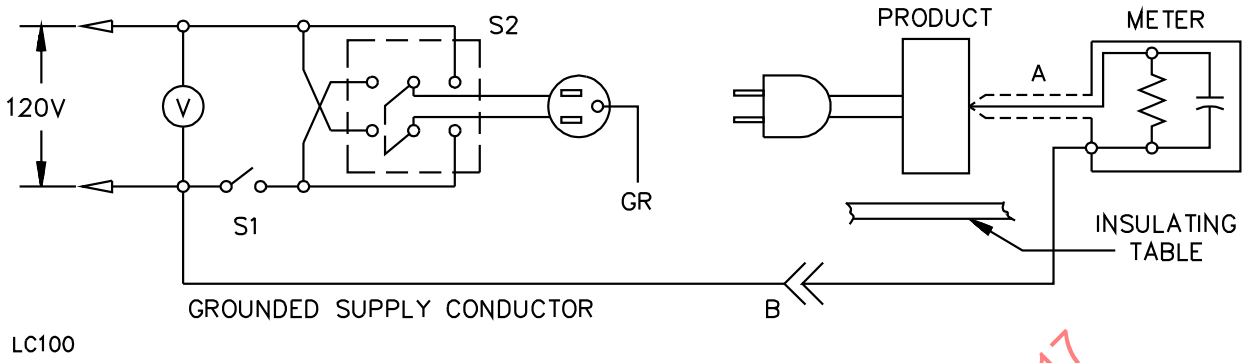
a) Between any exposed surface of permanently installed equipment and earth ground: 500 microamperes AC or DC.

b) Between any exposed surface of any cord-connected equipment and earth ground: 500 microamperes AC or DC.

c) Between any exposed surface of any cord-connected equipment that may be contacted by a resident simultaneously with earth ground: 100 microamperes AC or DC.

d) Between any current-carrying part of a remote control device, such as a pendant control assembly, and earth ground: 100 microamperes AC or DC.

Figure 44.1
Leakage current measurement circuit



44.2 While in the humidity environment the leakage current measurement is to be made in the standby and signaling conditions. The leakage current values in 44.1 are rms values for essentially DC (nonfiltered rectified AC) and sinusoidal waveforms up to 1 kilohertz. For frequencies above 1 kilohertz the leakage current limit is the value given in 44.1 multiplied by the frequency in kilohertz up to a maximum multiplier of 100.

44.3 For AC measurements, the test meter employed to measure the leakage current is to be an average responding AC ammeter that indicates the rms value of a pure sine wave, having an error of not greater than 5 percent, and a maximum input impedance of 1000 ohms. For DC measurements, a DC ammeter, having a maximum impedance of 1000 ohms, is to be employed.

44.4 If a surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using metal foil with an area of 100 by 200 mm (3.9 by 7.8 inches) placed in contact with the surface. Where the surface is less than 100 by 200 mm, the metal foil is to be the same size as the surface. The metal foil is not to be pressed into openings and is not to remain in place long enough to affect the temperature of the sample.

45 Overload Test

45.1 A home health care unit shall comply with the requirements of the Normal Operation Test, Section 31, after being subjected to 50 cycles of signal operation at a rate of not more than 15 cycles per minute with the supply circuit at 115 percent of rated voltage at rated frequency, and with rated loads applied to the output circuits that receive energy from the unit power supply. Each cycle is to start with the unit energized in the normal standby condition, followed by an actuation for medical emergency, and then a return to normal standby condition. There shall be no electrical or mechanical malfunction of any of the components in the unit. The fuse described in 45.5 shall not open.

45.2 Rated test loads are to be connected to those output circuits of the unit that are energized from the unit power supply. The test loads are to be those devices, or the equivalent, intended for connection in service. If an equivalent load is employed for a device consisting of an inductive load, a power factor of 60 percent is to be employed. The rated loads are to be established with the control unit connected to rated supply voltage and frequency.

45.3 For direct current signaling circuits an equivalent inductive test load is to have the required direct current resistance for the test current and the inductance (calibrated) to obtain a power factor of 60 percent when connected to a 60 hertz rms potential equal to the rated direct current test voltage. When the inductive load has both the required direct current resistance and the required inductance, the current measured with the load connected to an alternating current source is to be equal to 0.6 times the current measured with the load connected to a direct current source of the voltage.

45.4 Unless the device controlling a motor circuit has a horsepower rating, it is to be tested with the motor stalled.

45.5 A home health care unit for use with a grounded supply circuit is to be tested with the enclosure and all other normally grounded parts connected through a 15-ampere fuse to the grounded conductor of the supply circuit.

46 Overload Test – Separately Energized Units

46.1 A home health care unit shall comply with the requirements of the Normal Operation Test, Section 31, after being subjected to 50 cycles of signal operation at a rate of not more than 15 cycles per minute with the unit connected to a source of rated voltage and frequency and 150 percent rated loads applied to the output circuits that do not receive energy from the unit. There shall be no electrical or mechanical malfunction of any of the components of the unit.

46.2 The test loads shall be set at 150 percent of rated current while connected to a separate power source of rated voltage and frequency at 0.6 power factor.

46.3 A home health care unit employing a power-supply battery charger or a battery charger with a transfer mechanism is to be subjected to the greater of the two following currents: a current of 150 percent of the maximum rated load current or a current equivalent to the maximum inrush current entering a discharged battery connected to the charging circuit.

47 Endurance Test

47.1 A home health care unit shall comply with the requirements of the Normal Operation Test, Section 31, after being subjected to the number of test cycles indicated in Table 47.1. The individual devices shall be operated by an automatic switching device at a rate of not less than 6 cycles per minute while connected to rated test voltage and frequency and maximum normal load. (See 45.2.) There shall be no electrical or mechanical malfunction of the components.

Exception: The test rate may be more than 6 cycles per minute, but shall not exceed 30 cycles per minute, if agreeable to all concerned.

Table 47.1
Endurance test cycles

Type of equipment	Number of signaling performance
Receiving	150,000
Residential control	30,000
Residential transmitting	30,000
Residential digital communicators	30,000
Personal call	6,000
Monitor signal	100,000

47.2 An operating device, such as a switch, relay, and the like, supplied as a part of a unit, shall perform as intended after being operated for the number of cycles indicated in Table 47.1. If an electrical load is involved, the contacts of the device shall be caused to make and break the rated current at the rated voltage. The load shall represent that which the device is intended to control. The endurance tests of these devices may be conducted in conjunction with the endurance test on a signaling unit. There shall be no electrical or mechanical malfunction of the device.

47.3 A home health care unit shall operate as intended following 6000 cycles of operation as described in 47.4.

47.4 With the input connected to a voltage source in accordance with Table 30.1, maximum rated load is to be alternately applied, then removed (or reduced to the manufacturer's specified minimum value) at a rate of not more than 15 cycles per minute. Each cycle is to consist of the load application followed by an equal time of the load removal (or reduction).

48 Electrical Transient Tests

48.1 General

48.1.1 A home health care system unit shall not generate unintentional medical emergency or monitor signals and shall operate as intended after being subjected to 500 externally induced and 500 internally induced transients while energized from a source of supply in accordance with 30.1.1, connected to the devices normally used with the unit, and operating in the supervisory condition. Following each test, the product shall comply with the requirements of the Normal Operation Test, Section 31.

48.2 Externally induced high-voltage (ring wave surge voltage) transients

48.2.1 A product intended to be powered from commercial AC power shall be subject to supply line transients induced directly between the power supply circuit conductors of the product under test.

48.2.2 For this test, the product is to be connected to a transient generator capable of producing the Location Category A, 100 kHz Ring Wave transients as defined in IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits, IEEE C62.41.

48.2.3 Each product is to be subjected to 500 oscillatory transient pulses induced at an average rate of 3 pulses every minute. Each transient pulse is to be induced 90 degrees into the positive half of the 60 hertz cycle, with reference to earth ground. A total of 250 pulses are to be applied so that the polarity of the transients is positive with reference to earth ground, and the remaining 250 pulses are to be negative with respect to earth ground.

48.3 Internally induced transients

48.3.1 The unit is to be energized in the standby condition while connected to a source of supply in accordance with Table 30.1. The supply source is to be alternately de-energized for approximately 1 second, then energized for approximately 9 seconds by an automatic switching device cycling at a rate of not more than 6 cycles per minute for a total of 500 cycles. Standby power shall be connected during this test.

48.4 Input/output (low-voltage) field-wiring transients

48.4.1 A product shall not generate a false signal and shall operate as intended when subjected to the extraneous transients described in 48.4.2.

48.4.2 The product is to be energized in the normal standby condition while connected to a source of supply in accordance with 30.2. All field-wiring circuits are to be tested as specified in 48.4.3 and 48.4.4.

Exception: This test is not required when manufacturer's installation instructions indicate that it is not permitted to connect cables greater than 98.5 feet (30 m) long.

48.4.3 For this test, each output circuit is to be subjected to the transient waveforms specified in Table 48.1, as delivered into a 200-ohm load. The transient pulses are to be coupled directly onto the output circuit conductors of the equipment under test. See Table 48.1 and Figures 48.1 – 48.4.

Table 48.1
Transient waveforms

Peak voltage level, V	Minimum energy level, J	Minimum pulse duration, µs	Figure No.
2400	1.0	80	46.1
1000[a]	0.31	150	46.2
500[a]	0.10	250	46.3
100	0.011	1120	46.4

[a] Other applied transients having peak voltages representative of the entire range of 100 - 2400 volts shall be used in lieu of these values when the output circuit is only designed specifically to protect against these predetermined values. The transients shall meet or exceed the specified minimum pulse duration (Figure 48.5) and minimum energy level (Figure 48.6) parameters, and shall have an equal or faster minimum transient pulse rise time than that specified in Figure 48.7.

Figure 48.1
Signal line transients – 2400V curve
(Note: the x axis is to be 10 microseconds/div)

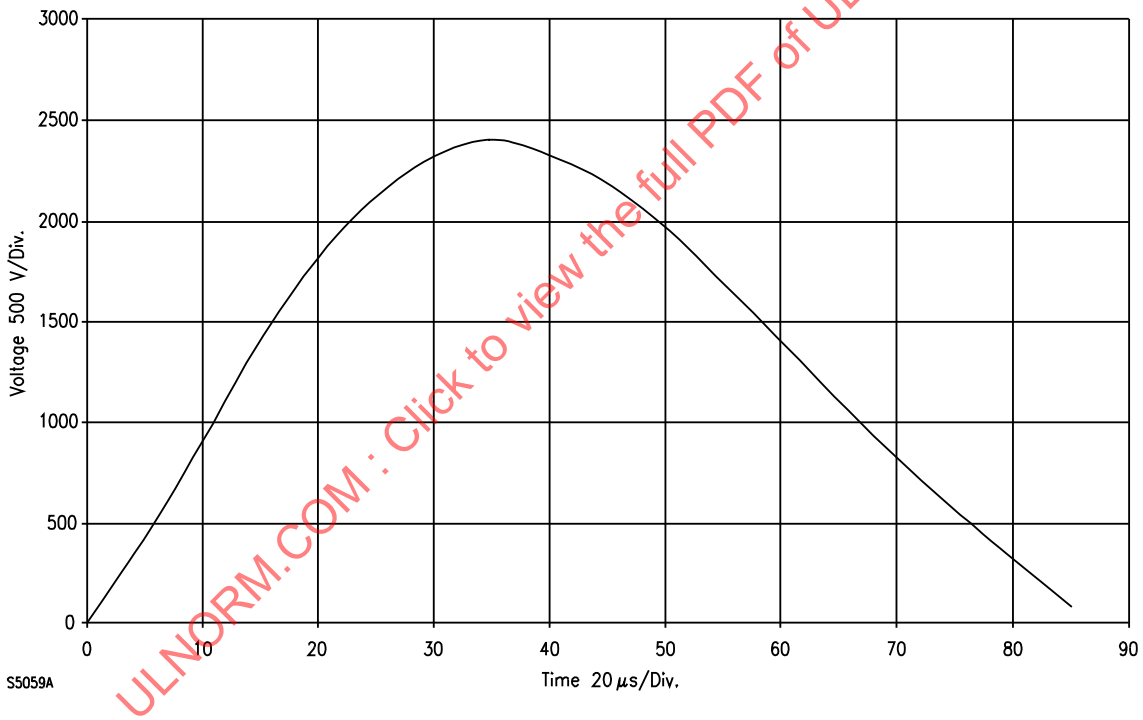


Figure 48.2
Signal line transients – 1000V curve

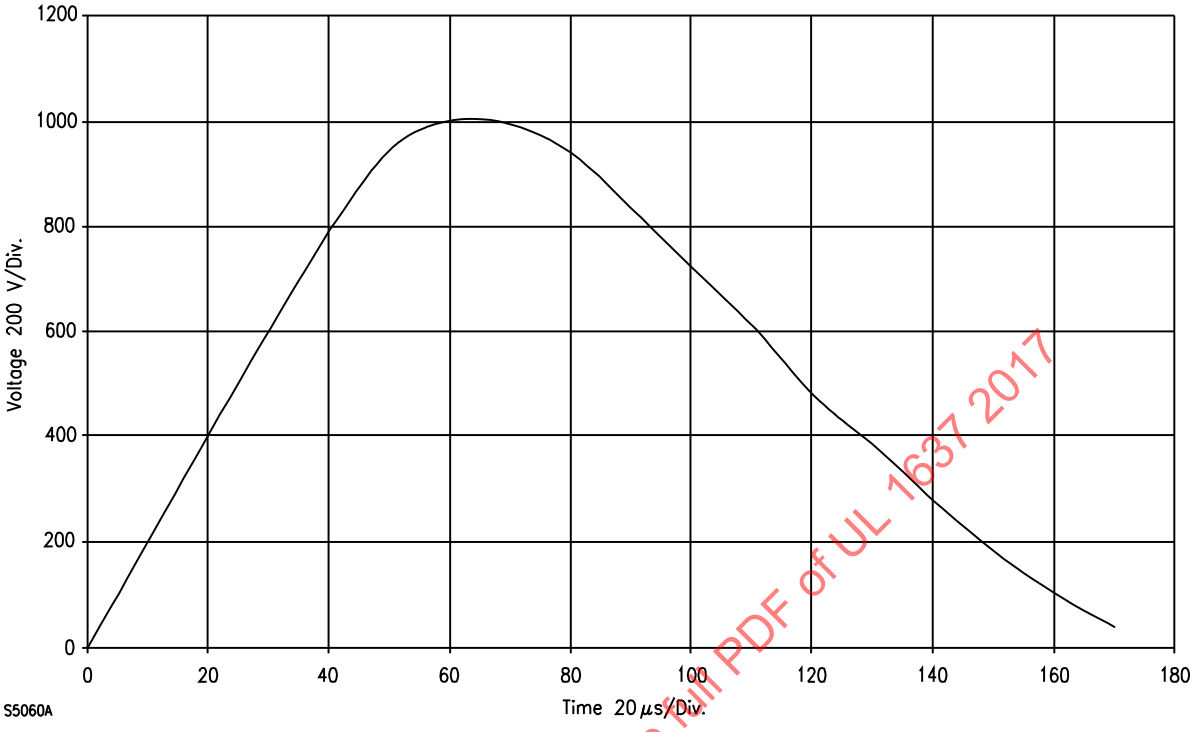


Figure 48.3
Signal line transients – 500V curve

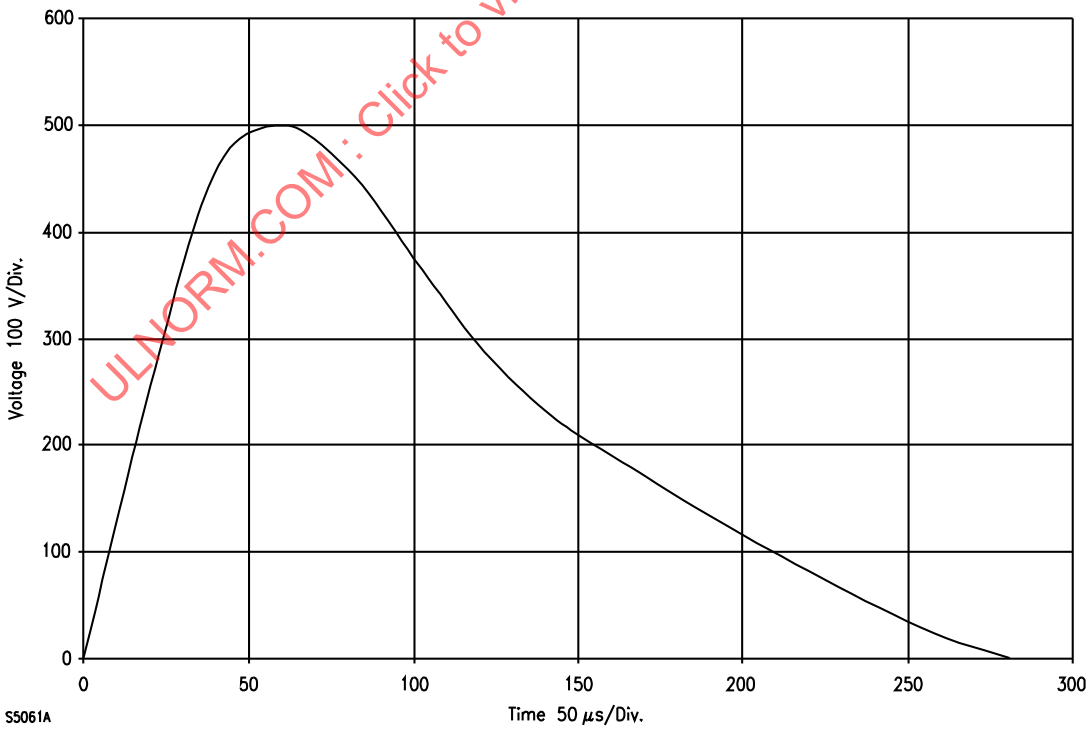


Figure 48.4
Signal line transients – 100V curve

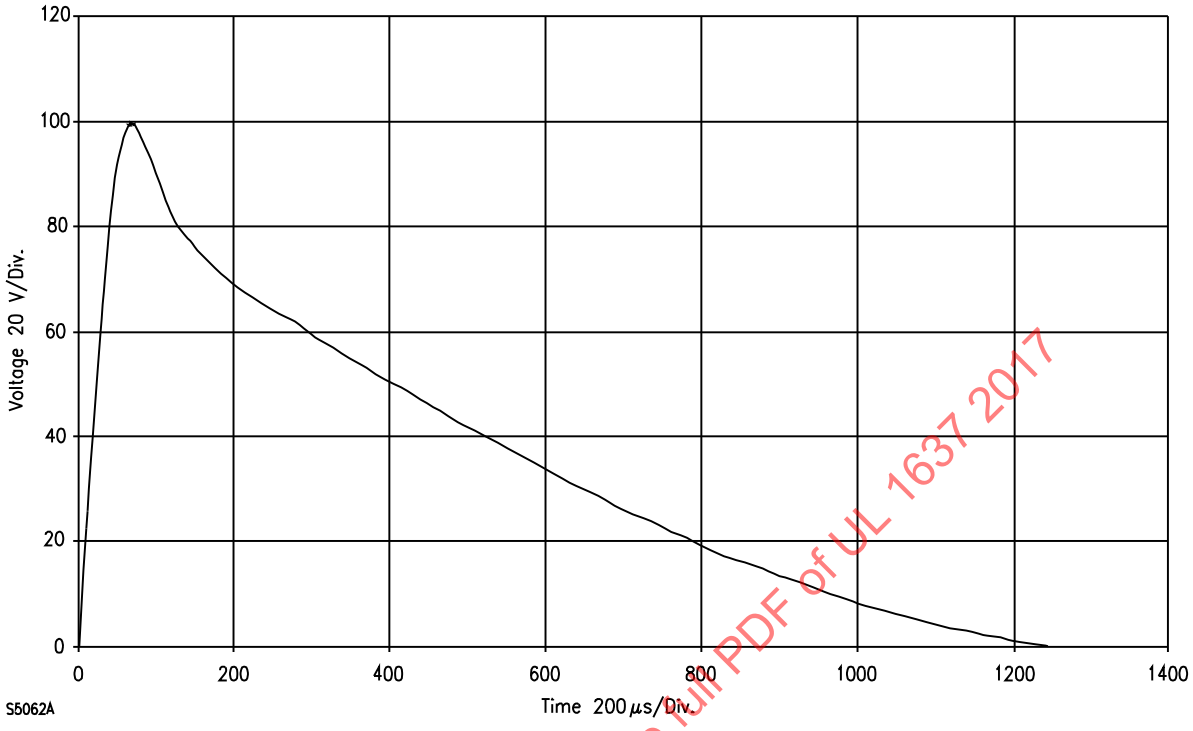


Figure 48.5
Minimum transient pulse duration vs. transient peak voltage

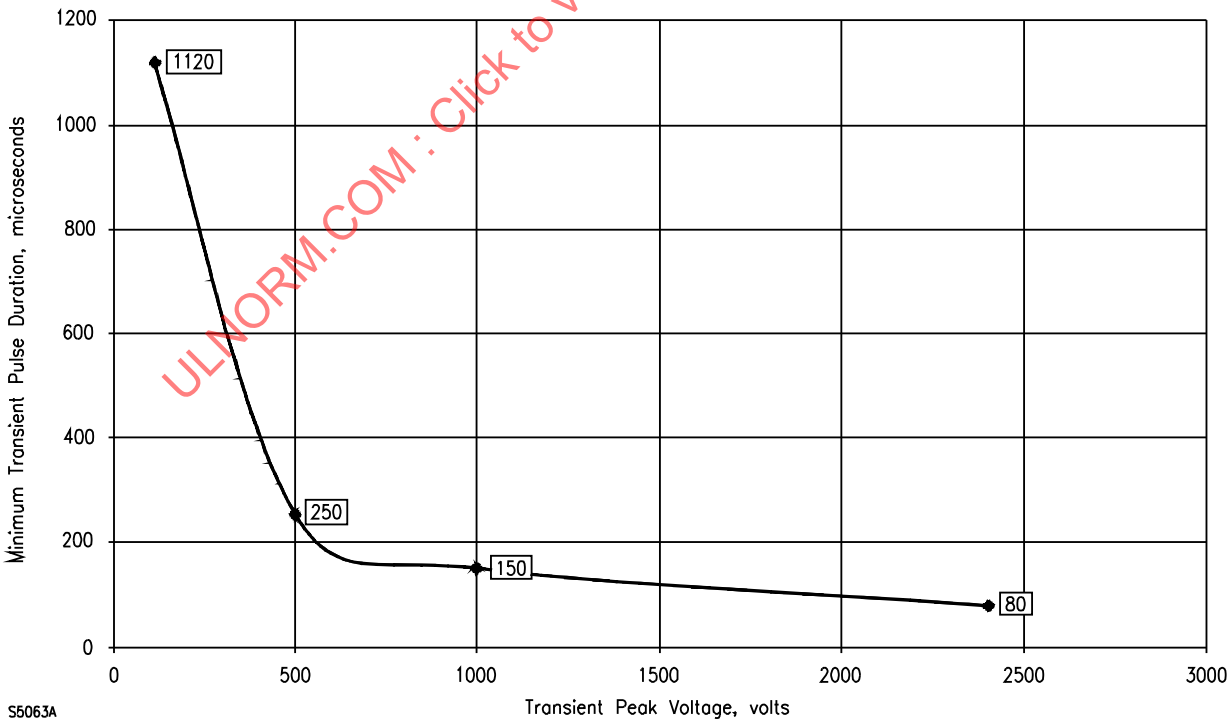


Figure 48.6
Minimum transient energy level vs. transient peak voltage

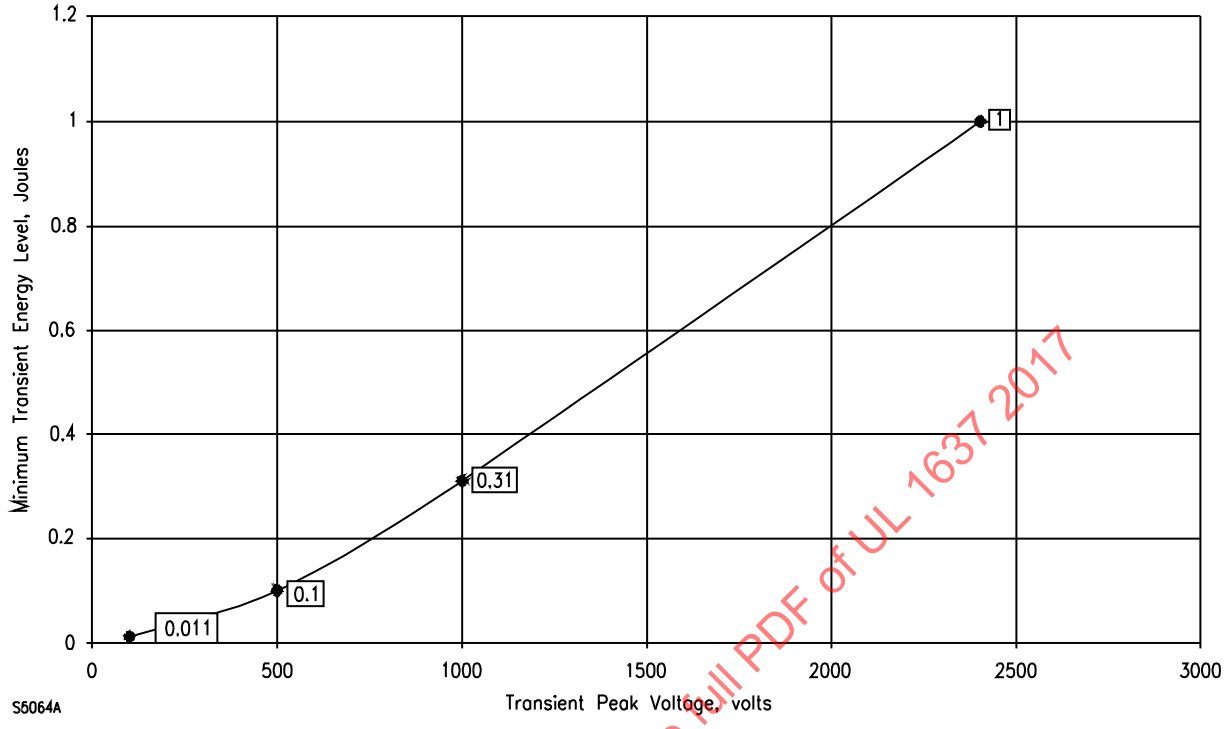


Figure 48.7
Minimum transient energy level vs. transient peak voltage

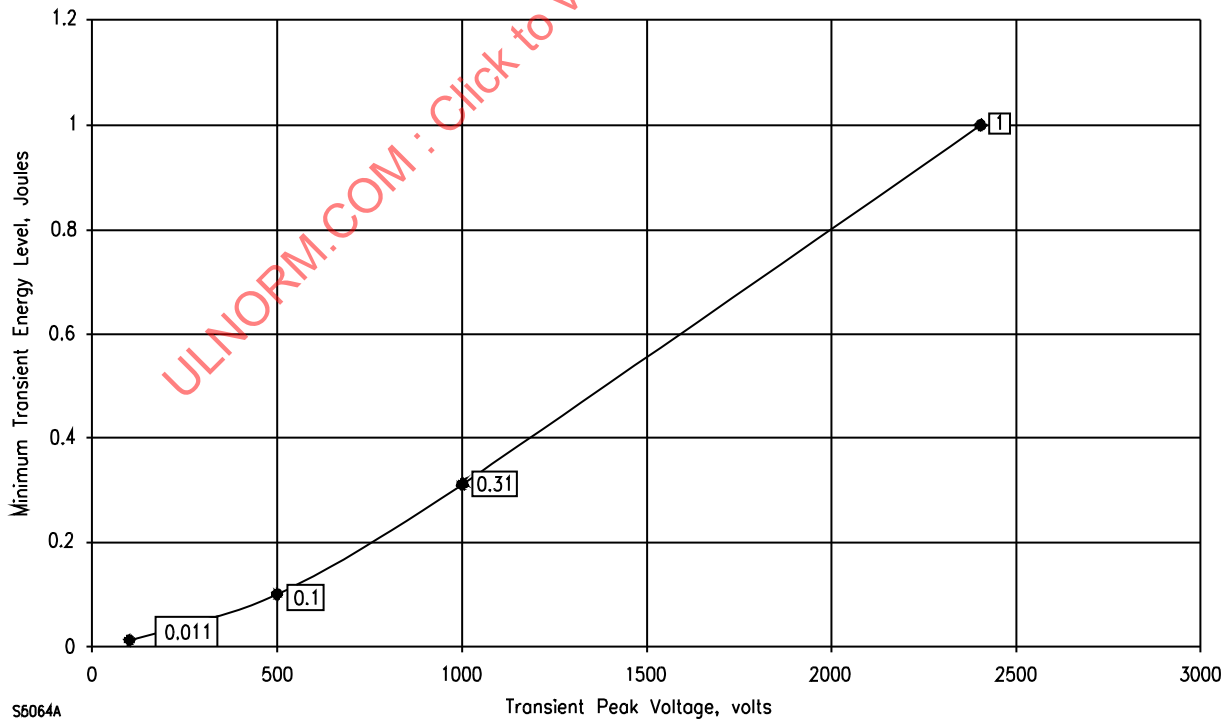
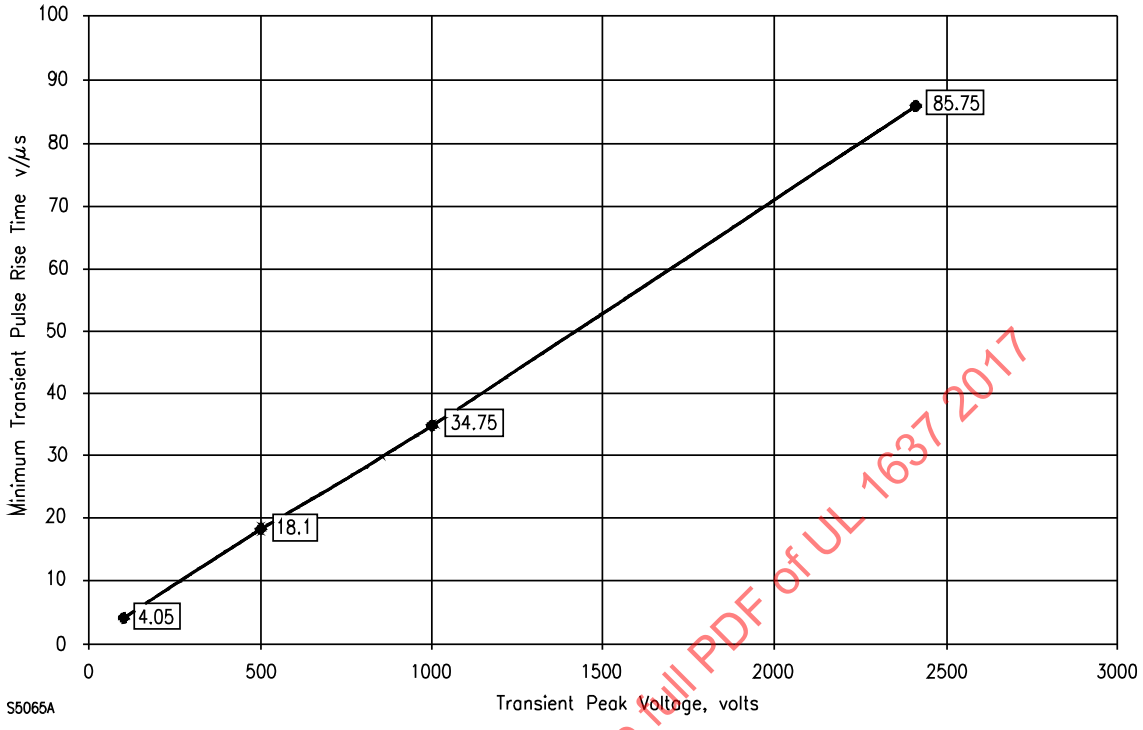


Figure 48.8
Minimum transient pulse rise time vs. transient peak voltage



48.4.4 Each conductor of a circuit is to be subjected to 60 transient pulses induced at the rate of six pulses per minute as follows:

a) Twenty pulses (four at the 2400 peak voltage level and two at each of the other transient voltage levels specified in 48.4.3) between each lead or terminal and earth ground, consisting of ten pulses of one polarity, and ten of the opposite polarity and

b) Twenty pulses (four at the 2400 peak voltage level and two at each of the other transient voltage levels specified in 48.4.3) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten pulses of the opposite polarity.

49 Dielectric Voltage-Withstand Test

49.1 A home health care unit shall withstand for 1 minute, without breakdown, the application of an essentially sinusoidal AC potential of a frequency within the range of 40 – 70 hertz, or a DC potential, between live parts and the enclosure, between live parts and exposed dead metal parts, and between live parts of circuits operating at different potentials or frequencies. See 49.2. The test potential is to be:

a) For a unit rated 30 volts AC rms (42.4 volts DC or AC peak), or less – 500 volts (707 volts, if a DC potential is used).

b) For a unit rated between 31 and 250 volts AC rms – 1000 volts (1414 volts, if a DC potential is used).

c) For a unit rated more than 250 volts AC rms – 1000 volts plus twice the rated voltage (1414 volts plus 2.828 times the rated AC rms voltage, if a DC potential is used).

49.2 For the application of a potential between live parts of circuits operating at different potentials or frequencies, the voltage is to be the applicable value specified in 49.1 (a), (b), or (c) based on the highest voltage of the circuits under test instead of the rated voltage of the unit. Electrical connections between the circuits are to be disconnected before the test potential is applied.

49.3 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an AC test potential in accordance with 49.1(c) is to be applied directly to all wiring involving more than 250 volts.

49.4 If the charging current through a capacitor or capacitor type filter connected across the line, or from line to earth ground, is sufficient to prevent maintaining the specified AC test potential, the capacitor or filter is to be tested using a DC test potential in accordance with 49.1.

49.5 The test potential may be obtained from any convenient source having sufficient capacity to maintain the specified voltage. The output voltage of the test apparatus is to be monitored. Starting at zero, the potential is to be increased at a rate of approximately 200 volts per minute until the required test value is reached and is to be held at that value for 1 minute.

49.6 A printed wiring assembly or other electronic circuit component that would be damaged by the application of, or would short-circuit, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. A representative subassembly may be tested instead of an entire unit. Rectifier diodes in the power supply may be individually shunted before the test to avoid destroying them in the case of a malfunction elsewhere in the secondary circuits.

50 Abnormal Operation Test

50.1 General

50.1.1 A home health care system unit operating in any condition of intended application shall not increase the risk of fire or electric shock when fault conditions are introduced.

50.1.2 To determine compliance with the requirement of 50.1.1, the unit is to be connected to a source of supply in accordance with Table 30.1 and operated under the most severe circuit fault conditions likely to be encountered in service. Shorting of the secondary of the power supply transformer and shorting of an electrolytic capacitor represent typical fault conditions. Prior to being energized, the signaling unit is to be wrapped in a single layer of bleached cheesecloth having an area of 14 – 15 square yards to the pound (25.8 – 27.7 m^2/kg) and a thread count of 32 by 28. There shall be no emission of flame or molten metal, or any other manifestation of a risk of fire, see 50.2.1. Following this test, the unit shall comply with the requirements in the Dielectric Voltage-Withstand Test, Section 49.

50.1.3 The fault condition is to be maintained continuously until constant temperatures are attained or until burnout occurs, if the fault does not result in the operation of an overload protective device.

50.2 Variable autotransformer

50.2.1 A variable autotransformer used as a means of output-voltage adjustment is to be adjusted to a position corresponding to 50 percent of its maximum mechanical adjustment range. A load then is to be connected to the output or outputs of the power supply sufficient to draw either 125 percent of rated output current or the maximum current that the power supply delivers in the application, whichever is lower. The input of the power supply is to be connected to a voltage source in accordance with Table 30.1. The test is to be continued until burnout or temperature stabilization occurs.

50.3 Overvoltage

50.3.1 Where a product has provisions for connection to a telephone, telegraph, or outside wiring as covered by Article 800 of the National Electrical Code, ANSI/NFPA 70, the product shall comply with the requirements for protection against overvoltage from power line crosses described in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

51 Strain Relief Test

51.1 Flexible cord

51.1.1 When tested in accordance with 51.1.2, the strain relief means provided on a flexible cord shall withstand for 1 minute without displacement a pull of 35 pounds-force (156 N) applied to the cord with the connections within the signaling unit disconnected.

51.1.2 A 35 pound (15.88 kg) weight is to be secured to the cord and supported by the signaling unit so that the strain relief means will be stressed from any angle permitted by the construction of the signaling unit. There shall be no movement of the cord sufficient to indicate that stress would have been transmitted to the internal connections.

51.2 Plug restraining

51.2.1 A plug restraining means shall withstand for 1 minute a pull of 5 pounds force (22.25 N) while installed as intended in service without any evidence of damage to the connection.

51.3 Field-wiring leads

51.3.1 Each lead employed for field connections shall withstand for 1 minute a pull of 10 pounds-force (44.5 N) without evidence of damage or of transmittal of stress to the internal connections.

52 Drop Test

52.1 The enclosure of a device intended to be hand held, such as a pendant control or switch, shall withstand being dropped without inducing a risk of fire, electric shock, or injury to persons, and the device shall operate as intended following the test. Cracking of the enclosure without exposing live internal parts is acceptable.

52.2 Each of three samples is to be dropped 25 times from a height of 5 feet (1.52 mm) onto an asbestos tiled concrete surface. The distance of the drop is to be measured from the asbestos tiled concrete surface to the bottom-most part of the device. Each sample of the device is to be positioned to impact on the weakest point that can be contacted in the drop.

53 Mechanical Strength Tests for Enclosures

53.1 These tests apply only to nonmetallic enclosures or to metallic enclosures that do not comply with the thickness requirements described in Table 8.3 and the requirements in 8.2.1 – 8.5.1.

53.2 The external enclosure of a signaling unit containing high-voltage circuits or other than power limited circuits shall withstand a force of 25 pounds (111 N) for 1 minute without:

a) Permanent distortion to the extent that spacings are reduced below the values specified in 26.2 – 26.5,

b) Transient distortion that results in contact with or damage to live parts that would affect operation, and

c) Causing openings that expose uninsulated high- or low-voltage live parts.

The force is to be applied by means of a 1/2 inch (12.7 mm) diameter steel hemisphere. Any openings that occur during application of the force are to be judged under the requirements in 7.3.1.

53.3 The external enclosure of a signaling unit containing only low-voltage power limited circuits shall be subjected to the test of 53.2, except that the applied force is to be 10 pounds (44 N).

53.4 The external enclosure of a signaling unit containing high-voltage circuits or other than power limited circuits shall withstand an impact of 5 foot-pounds (6.78 J) without:

a) Permanent distortion to the extent that spacings are reduced below the values specified in 26.2 – 26.5, or

b) Transient distortion that results in contact with or damage to live parts that would affect operation, and

c) Causing openings that expose uninsulated high- or low-voltage live parts.

The impact is to be applied by means of a solid, smooth, steel sphere 2 inches (50.8 mm) in diameter and weighing approximately 1.18 pounds (0.54 kg). The sphere is to fall freely from rest through a vertical distance of 51 inches (1.31 m). Any openings resulting from the impact are to be judged under the requirements in 7.3.1.

53.5 The external enclosure of a signaling unit containing only low-voltage power limited circuits shall be subjected to the test of 53.4, except that the impact shall be 2 foot-pounds (2.7 J), and the sphere is to fall through a vertical distance of 20-13/32 inches (0.51 m).

54 Polymeric Materials Tests

54.1 General

54.1.1 Thermoplastic materials included for the sole support of current-carrying parts or as an enclosure of a unit are to be subjected to the following tests. The complete unit is to be used, if possible.

54.2 Temperature test

54.2.1 There shall be no excessive warping or exposure of high-voltage uninsulated current-carrying parts so as to impair operation of the unit when representative samples of a plastic material are aged for 7 days in an air circulating oven maintained at 70°C (158°F).

54.2.2 For this test at least three representative samples are to be placed in the oven. Following the aging period of 7 days, the samples are to be removed, permitted to cool to room temperature, and then examined for distortion.

54.3 Flame test

54.3.1 When tested in accordance with 54.3.2 – 54.3.6, a polymeric material employed for the sole support of current-carrying parts or as an enclosure shall not continue to burn for more than 1 minute after the fifth 5-second application of a test flame, with an interval of 5 seconds between applications of the flame. There shall be no dripping of particles or complete consumption of the sample during the test, and the material shall not be destroyed in the area of the test flame to the extent that the integrity of the enclosure is affected. Three samples of the material or three test specimens consisting of a part or section of the polymeric enclosure are to be subjected to this test. If the sample size permits, the test may be conducted on one sample with the flame applied at three different locations. Consideration may be given to leaving in place components and other parts that may influence the test performance.

54.3.2 Two of the three test samples shall show acceptable performance. If one sample does not comply with the requirements, the test shall be repeated on a second sample with the flame applied under the same conditions as for the noncomplying sample. If the second specimen does not comply with the requirements, the material is not acceptable.

54.3.3 The following test equipment is to be employed:

a) Test Chamber – The test chamber is to consist of a sheet metal cell 2 by 1 by 1 foot (0.6 by 0.3 by 0.3 m), open at the top and on one long side. The chamber is to be located so that an ample supply of air is provided, but the sample is not subjected to drafts. The chamber may be placed in a hood, provided that the fan is turned off during the test and is operated only between tests to remove fumes.

b) A ring stand with a clamp is to be used for supporting the samples.

c) Burner and Mounting Block – The test flame is to be obtained by means of a Tirrill burner having a nominal bore of 3/8 inch (9.5 mm). The tube length above the primary air inlets is to be approximately 4 inches (102 mm). The burner is to be adjusted so that, while the burner is in a vertical position, the overall height of the flame is 5 inches (127 mm) and the height of the inner blue cone is 1-1/2 inches (38.1 mm). A mounting block is to be provided so that the burner may be positioned at an angle of 20 degrees from the vertical.

d) A stopwatch or clock.

e) Circulating-air oven.

54.3.4 The samples are to be conditioned. Prior to the flame test, the samples are to be returned to room temperature.

54.3.5 The test sample is to be mounted as intended in service in the test chamber. The test flame is to be applied at an angle of 20 degrees from the vertical to any portion of the interior of the enclosure judged as likely to be ignited by proximity to live or arcing parts, coils, wiring, and the like. The test flame is to be applied to a different location on each of the three samples tested.

54.3.6 The test flame is to be applied for 5 seconds and removed for 5 seconds. The operation is to be repeated until the specimen has been subjected to a total of five applications of the test flame.

55 Special Terminal Assemblies Test

55.1 General

55.1.1 To determine compliance of a field wiring connection with the requirements in 10.4.1 and 10.4.2, representative samples of the terminal assembly shall comply with all of the following tests.

55.2 Disconnection and reconnection

55.2.1 If a wire is to be disconnected for testing or routine servicing and then reconnected, each terminal is to be subjected to 20 disconnections and 20 reconnections prior to being subjected to the tests described in 55.3.1 – 55.6.2.

55.3 Mechanical secureness

55.3.1 A terminal connection shall withstand the application of a straight pull of 5 pounds (2.5 kg), applied for 1 minute to the wire in the direction that would most likely result in pullout, without separating from the wire.

55.3.2 Six samples of the terminal are to be connected to wire of the sizes with which they are intended to be connected in accordance with the manufacturer's instructions. If a special tool is required to assemble the connection it is to be employed. Each sample is to be subjected to a gradually increasing pull on the wire until the test pull of 5 pounds (2.5 kg) is attained.

55.4 Flexing test

55.4.1 The wire attached to a terminal shall withstand an average of five right angle bend cycles without breaking.

55.4.2 Six terminal assemblies employing the maximum wire size and six with the minimum wire size are to be subjected to this test. The terminal is to be rigidly secured so that movement will not occur. With the wire in 3-pound (1.5 kg) tension and held at a point 3 inches (76.2 mm) from the terminal-to-wire juncture the wire is to be bent at a right angle from the nominal wire position and then returned to its normal wire position. This cycle is to be repeated five times. The wires are to be assembled to the terminals using any special tool required by the manufacturer's instructions.

55.5 Millivolt drop test

55.5.1 The millivolt drop across any terminal connection using the maximum and minimum wire sizes intended to be employed and with the terminals connected in series, shall not be greater than 300 millivolts with the maximum current of the circuit flowing through the terminal connections at the rated voltage of the circuit.

55.5.2 Six terminal assemblies employing the maximum wire sizes and six assemblies employing the minimum sizes are to be subjected to this test. The wires are to be assembled to the terminals, using any special tool required by the manufacturer's instructions. The millivolt drop is then to be measured using a high impedance millivoltmeter while the maximum current is flowing through the connection.

55.6 Temperature test

55.6.1 The maximum temperature rise on any terminal connection using the maximum and minimum wire sizes intended to be employed and with the terminals connected in series, shall not be greater than 30°C (86°F) based on an ambient temperature of 25°C (77°F).

55.6.2 Six terminal assemblies employing the maximum wire size and six employing the minimum size are to be subjected to this test. The wire is to be assembled to the terminals using any special tool required by the manufacturer's instructions. The maximum current then is to be passed through the terminal and wire. After temperatures have stabilized, the maximum temperature rise is then to be measured by the thermocouple method.

56 Ignition Test Through Bottom-Panel Openings

56.1 The bottom-panel constructions described in 8.6.1 – 8.6.4 are permitted without testing. Other constructions can be used when they comply with the test described in 56.2 – 56.5.

56.2 Openings in a bottom panel shall be arranged and sufficiently small in size and few in number so that hot flaming No. 2 furnace oil poured three times onto the openings from a position above the panel is extinguished as it passes through the openings.

56.3 3 A sample of the complete, finished bottom panel is to be supported in a horizontal position a short distance above a horizontal surface under a hood or in another area that is ventilated but free from drafts. Bleached cheesecloth running 14 – 15 yd^2/lb mass (26 - 28 m^2/kg mass) and having what is known to the trade as ″a count of 32 by 28″ (a square 1 inch on a side has 32 threads in one direction and 28 in the other or square 1 centimeter on a side has 13 threads in one direction and 11 in the other), is to be draped in one layer over a shallow flat-bottomed pan that is of a size and shape to cover completely the pattern of openings in the panel but is not sufficiently large to catch any of the oil that runs over the edge of the panel or otherwise does not pass through the openings. The pan is to be centered under the center of the pattern of openings in the panel. The center of the cheesecloth is to be 2 inches (50 mm) below the openings. Use of metal screen or wire-glass enclosure surrounding the test area is recommended to keep splattering oil from causing injury to persons.

56.4 A small metal ladle not more than 2-1/2 inches (65 mm) in diameter, with a pouring lip and a long handle whose longitudinal axis remains horizontal during pouring, is to be partially filled with 0.34 ounces (10 cm^3 or 10 ml) of No. 2 fuel oil, which is a medium-volatile distillate having a minimum API gravity of 30 degrees, a flash point of 110 – 190°F (43.3 – 87.7°C), and an average calorific value of 136,900 Btu/gal (38.2 MJ/L); see the Standard Specification for Fuel Oils, ASTM D396. The ladle containing the oil is to be heated and the oil is to be ignited. The oil is to flame for 1 minute and then is to be poured at the approximate rate of, but not less than 0.034 ounces (1 cm^3/s or 1 mL/s) in a steady stream onto the center of the pattern of openings from a position 4 inches (100 mm) above the openings. It is to be observed whether the oil ignites the cheesecloth.

56.5 Five minutes after completion of the pouring of the oil, the cheesecloth is to be replaced with a clean piece and a second 0.34-ounce (10-cm^3 or 10-mL) ladle of hot flaming oil is to be poured onto the openings, again to be observed whether the cheesecloth is ignited. Five minutes later, a third identical pouring is to be made. The openings do not comply with the requirement in 56.1 if the cheesecloth is ignited during any of the three pourings.

SIGNAL INITIATING UNITS

57 General

57.1 For the tests described in Sections 58 – 68, a signal initiating unit is to be installed in accordance with the instructions provided unless otherwise indicated. A test need not be conducted on a particular unit if the principle of operation is such that the test would have no possible affect.

58 Vibration Test

58.1 A signal initiating unit shall withstand vibration without breakage or damage to parts and without a shift of its alignment. Following the vibration the product shall operate for its intended signaling operation.

58.2 To determine compliance with 58.1, sensitivity, range, or both shall be measured following vibration, and shall be within ±25 percent of the value recorded in the Sensitivity and Range Tests, Section 63.

58.3 A sample is to be energized and secured in its intended mounting position on a mounting board and the board, in turn, securely fastened to a variable speed vibration machine vibrating at an amplitude of 0.01 inch (0.25 mm). The frequency of vibration is to be varied from 10 to 35 hertz in increments of 5 hertz until a resonant frequency is obtained. The samples are then to be vibrated at the maximum resonant frequency for a period of 1/4 hour. If no resonant frequency is obtained, the samples are to be vibrated at 35 hertz for a period of 4 hours.

58.4 For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from a position of rest or one-half of the total table displacement. Resonance is defined as the maximum magnification of the applied vibration.

59 Static Discharge Test

59.1 The components of a signal initiating unit shall be shielded so that their operation is not impaired, or a false signal obtained, when subjected to static electric discharges.

CAUTION: Potentially lethal voltages are used in this test. Precautions should be taken to avoid risk of electric shock.

59.2 Each of two signaling initiating units are to be mounted in the intended mounting position on a 3/4 inch (19 mm) thick unpainted exterior grade plywood surface, and connected to a source of supply in accordance with Table 30.1. If a unit is intended to be installed on a metal electrical junction box, the box is to be connected to earth ground. A series combination of a 250-picofarad low leakage capacitor, rated at 20,000 volts DC and a 1500 ohm (10,000 volt) resistor(s), is to be connected to two high-voltage insulated leads 3 feet (0.9 m) long. The end of each lead is to terminate in a 1/2 inch (12.7 mm) diameter metal test probe with a spherical end mounted on an insulating rod. The capacitor is to be charged from a source of 10,000 volts DC for at least 2 seconds for each discharge.

59.3 Ten discharges are to be applied to different points on the exposed surface of each signal initiating unit, recharging the capacitor for each discharge. Five discharges are to be made with one lead connected to earth ground and the other lead probed on the unit surface, followed by five discharges with the polarity reversed.

59.4 Following the discharges, the unit is to be tested for sensitivity and/or range, and shall be within ±25 percent of the values recorded in the Sensitivity and Range Tests, Section 63.

60 Stability Test

60.1 The response of a signal initiating unit after being operated as described in 60.2 shall not vary more than ±25 percent from the value obtained prior to the test. The response is to be determined as described in the Sensitivity and Range Tests, Section 63.

60.2 A signal initiating unit set at the maximum rated sensitivity or range setting specified by the manufacturer, mounted in a position of intended use, and energized from a source of supply in accordance with Table 30.1 is to be operated within the area being covered for at least 30 days in an ambient room temperature of 25 ±5°C (77 ±9°F) 50 ±20 percent relative humidity, having an air movement of 10 ±10 feet per minute (0.05 ±0.05 m/s).

60.3 If an unexplained signal occurs during the 30 days, the test is to be extended an additional 30 days during which no unexplained signals shall occur, starting from the time that the first unintended signal occurred.

61 Battery Replacement Test

61.1 The battery connections of a signal initiating unit shall withstand 50 cycles of removal and replacement from the battery terminals. The unit shall then comply with the requirements of the Normal Operation Test, Section 31.

61.2 For this test, a unit is to be installed as intended in service and the battery connections removed and replaced as recommended by the manufacturer.

62 Polarity Reversal Test

62.1 A signal initiating unit intended to be connected to a specific polarity shall not be affected when connected to the incorrect polarity and then shall operate as intended after being reconnected to the correct polarity of a supply source. This includes high-voltage cord connected, fixed wiring (splice lead), and battery operated (main or standby) type of units. The incorrect polarity is to be applied for at least 1 hour on the unit unless a trouble signal or medical emergency signal is obtained. For battery operated units intended to be connected by a polarized clip assembly, the reverse polarity is to be applied for a minimum of 1 second. A trouble or medical emergency signal is acceptable under any incorrect polarity applied. A maximum 1-second unintended medical emergency or monitoring signal is permitted when the correct polarity is applied.

62.2 Two samples are to be subjected to this test. The unit shall then comply with the requirements of the Normal Operation Test, Section 31.

63 Sensitivity and Range Tests

63.1 A signal initiating unit shall comply with the sensitivity and range requirements specified by the manufacturer. Each unit shall be tested before and after being subjected to the requirements of the Jarring Test, Section 38; the Variable Ambient Temperature Test, Section 42; and the Humidity Test, Section 43. The tests are to be conducted consecutively on a single sample, or simultaneously on several samples if a sufficient number has been submitted.

64 Photoelectric

64.1 Foreign light

64.1.1 The photoelectric receiver unit shall not alarm by extraneous light or heat striking the receiver at an angle of 15 degrees or more from the axis of the light beam with which the receiver is intended to operate.

64.1.2 To determine compliance with the requirement in 64.1.1, a 150 watt incandescent light bulb, energized from a 120 volt, 60 hertz source, is to be used. The bulb is to be positioned in a plane perpendicular to the intended beam axis and 5 feet (1.5 m) from the front of the receiver.

64.1.3 The conditions of 64.1.2 shall be repeated using a fluorescent fixture with four 40 watt ″daylight″ type tubes.

64.2 Operating speed

64.2.1 A photoelectric system shall operate as intended when a cylindrical object 8 inches (203 mm) in diameter, with its axis and direction of motion perpendicular to the beam axis, passes through the beam at a speed of 8.8 feet per second (2.7 m/s).

64.3 Beam cutoff

64.3.1 At the maximum operating range, a 75 percent reduction in the light received shall not produce a signal.

64.4 Range

64.4.1 The maximum effective range of a photoelectric unit shall be determined for an unreflected beam by the method described in 64.3.1, or the manufacturer may specify a shorter distance.

MOVEMENT DETECTORS

65 Microwave

65.1 General

65.1.1 A microwave type movement detector is a unit that produces radio frequency radiation. This unit shall be used to cover a specific area and detect movement therein.

65.2 Sensitivity

65.2.1 Provision shall be made for adjusting the sensitivity or range, or both, to cover areas of various sizes and configurations.

65.2.2 At normal sensitivity or range, or both, the unit shall either:

a) Not be affected by air turbulence of 300 feet per minute (1.52 m/s) caused by an 8 inch (203 mm) diameter portable fan with a metal blade having a metal shroud, placed 3 feet (0.9 m) below the detector, aimed across the face of the detector transmitter or receiver, or both, and cycled 5 minutes on and 5 minutes off for 1 hour or

b) If unintended signals result from (a), markings on the unit or in the installation instructions shall warn against use in turbulent air.

65.2.3 At normal sensitivity or range, or both, the unit shall either:

a) Not be affected by air turbulence caused by an electric heating coil rated 3 kilowatts placed approximately 3 feet (0.9 m) below the face of the detector transmitter or receiver, or both, and energized for 5 minutes, then de-energized for 25 minutes for a total of 3 hours or

b) If unintended signals result for (a), markings on the unit or in the installation instructions are to warn against use in turbulent air. Ceiling units are to be tested with and without deflectors, if provided.

65.2.4 At normal sensitivity or range, or both, the unit shall not be affected by fluorescent lamps when operated according to the manufacturer's installation instructions, or at a distance of 1 foot (0.91 m) from a fluorescent fixture with four unshielded 40 watt tubes.

65.3 Range

65.3.1 The maximum effective range of a microwave unit shall be specified by the manufacturer.

65.4 Maximum power density

65.4.1 The maximum power density of microwave radiation emitted by a movement detector shall not exceed 5 milliwatts per square centimeter at a distance of 5 centimeters.

65.4.2 To determine compliance with the requirement in 65.4.1, measurements[a] of microwave radiation emission are to be made at points approximately 5 centimeters away from the external surface of the movement detector, and the measurements are to be averaged over a 6-minute period.

[a] Meter employed to measure radiation is NARAD Microwave Corp., Model 8611, Broad Bond Isotropic Radiation Monitor.

66 Sonic and Ultrasonic

66.1 General

66.1.1 A sonic or ultrasonic type movement detector is a unit that shall produce inaudible radiation of sound waves which may be used to cover a specific area and detect movement therein or to create channels of radiation and detect movement through the channel.

66.2 Sensitivity

66.2.1 Provision shall be made for adjusting the sensitivity or range, or both, to cover areas of various sizes and configurations.

66.2.2 At normal sensitivity or range, or both, the system shall either:

a) Not be affected by air turbulence of 300 feet per minute (1.52 m/s) caused by an 8 inch (203 mm) diameter portable fan with a metal blade having a metal shroud, placed 3 feet (0.9 m) below the detector, aimed across the face of the detector transmitter or receiver, or both, and cycled 5 minutes on and 5 minutes off for 1 hour or

b) If unintended signals result from (a), markings on the unit or in the installation instructions shall warn against use in turbulent air.

66.2.3 At normal sensitivity or range, or both, the unit shall either:

a) Not be affected by air turbulence caused by an electric heating coil rated 3 kilowatts placed approximately 3 feet (0.9 m) below the face of the detector transmitter or receiver, or both, and energized for 5 minutes, then de-energized for 25 minutes for a total of 3 hours or

b) If unintended signals result from (a), markings on the unit or in the installation instructions shall warn against use in turbulent air.

Ceiling units are to be tested with and without deflectors, if provided.

66.3 Range

66.3.1 The maximum effective range of the intrusion detection unit shall be specified by the manufacturer.

67 Passive Infrared

67.1 General

67.1.1 A passive infrared type movement detector is a unit that shall detect invisible radiation emitted by a human body moving in the specified area.

67.2 Sensitivity

67.2.1 The sensitivity or range, or both, of the unit shall be sufficient to cover the areas of various sizes and configurations specified by the manufacturer.

67.3 Stability

67.3.1 The unit shall demonstrate a high degree of stability in the test area with the sensitivity or range, or both, equal to or better than that specified by the manufacturer. See 60.1 and 60.2.

67.3.2 At normal sensitivity or range, or both, the unit shall either:

a) Not be affected by air turbulence caused by an electric heating coil rated 3 kilowatts placed approximately 3 feet (0.9 m) below the face of the detector transmitter or receiver, or both, and energized for 5 minutes, then de-energized for 25 minutes for a total of 3 hours or

b) If unintended signals result from (a), markings on the unit or the installation instructions shall warn against use in turbulent air.

Ceiling units shall be tested with and without deflectors, if provided.

67.3.3 At normal sensitivity or range, or both, and installed in accordance with the installation instructions, the unit shall not be affected when energized and exposed to reflected sunlight indoors.

67.4 Range

67.4.1 The maximum effective range of a passive infrared unit shall be specified by the manufacturer.

68 Multiplex Systems

68.1 General

68.1.1 Multiplex equipment shall comply with all other requirements of this standard. In the event of conflict, the equipment shall comply with the requirements in 68.1.3 – 68.3.9.

68.1.2 With regard to the requirement in 68.1.1, multiplexing is a method of signaling characterized by the simultaneous or sequential transmission or both and reception of multiple signals over a communication channel with means for positively identifying each signal.

68.1.3 Multiplexing may be accomplished over a wire path, leased communication channels, radio or microwave carrier, or combinations of these.

68.2 Operation

68.2.1 Any change in the status of the circuit that is initiated at the residence shall be indicated at the central station receiving unit by audible and visual means and shall result in an automatic recording that shows the identification of the residence, the new status, the time and date.

Exception No. 1: This operation does not apply to monitor signals, unless a predetermined level of inactivity is exceeded.

Exception No. 2: An automatic printout is not required if each individual circuit supervised by the multiplex system is provided with an individual display. A change in status shall be indicated by the individual display affected.

Exception No. 3: The year is not required to be automatically recorded, but may be manually recorded.

68.2.2 The act of recording such a signal shall not prevent the system from continuing to automatically check the condition of the other circuits.

68.2.3 If one recorded signal identifies the nature of the signal, no recorded repetition of the signal is required. The operator shall acknowledge receipt of the signal in order to silence the audible signal.

Exception: An acknowledgment signal is not required for a status change initiated at the central station receiving unit.

68.2.4 Acknowledgment of a status change signal or initiating a status change at the central station receiving unit shall result in a visual display or a recording of the condition of the system, or both.

68.2.5 If a constant visual display is not provided to indicate the condition of each circuit, there shall be means whereby the operator can determine the condition of any circuit at any time.

68.2.6 There shall be no loss or confusion of signals due to temporary outage of the receiving equipment or outage of the connecting link between the central station receiving equipment and the residential circuits. The system, or an intermediate station, shall store information concerning any status change occurring during such an outage.

68.2.7 The occurrence of a single break, a single ground, a wire-to-wire short, a loss of signal, or any combination of these that would prevent the receipt of a medical emergency signal from that portion of the system affected by the fault, shall be automatically recorded. The recording shall identify each circuit affected, so that knowledge of the routing of the connecting links between the circuit and the central station receiving equipment will enable operating personnel to determine the approximate location of the fault. Any changes in the status of the affected circuits shall be recorded when the fault is cleared.

68.3 Private radio facilities

68.3.1 The central station receiving equipment shall be provided with dual transmitting and receiving equipment.

Exception: Remotely located equipment need not be duplicated unless six or more systems are dependent on it.

68.3.2 Switchover from the operating transmitter to the standby transmitter shall be accomplished in 30 seconds or less. The transfer shall be automatic, except that manual transfer is acceptable if the transmitters are located where operating personnel are always on duty.

68.3.3 Operating personnel shall be able to independently deactivate either transmitter.

68.3.4 The dual receivers shall be energized at all times with provisions for selecting a usable output from one of the two.

68.3.5 If the unit is located where no personnel are on duty, the circuit extending between the central station receiving equipment and the radio equipment shall be supervised so that a fault will be indicated to the operating personnel.

68.3.6 Each receiver in a dual receiver system shall be operated for a total of not less than 3 hours within each 8-hour period.

68.3.7 Each transmitter and each receiver shall have its own antenna.

68.3.8 Any malfunction that would prevent the operation of either unit shall be annunciated at the central station receiving unit and a visual indication shall always be present at the central station to indicate their condition.

68.3.9 The following conditions shall be supervised at the central station receiving unit:

a) Transmitter in use (radiating).

b) Failure of AC power supplying the radio equipment.

c) Receiver malfunction.

d) Indication of automatic switchover.