UL 985

STANDARD FOR SAFETY

Household Fire Warning System Units

UL Standard for Safety for Household Fire Warning System Units, UL 985

Sixth Edition, Dated May 15, 2015

Summary of Topics

This revision to ANSI/UL 985 dated October 7, 2022 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated August 19, 2022.

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UL 985

Standard for Household Fire Warning System Units

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May 15, 2015

This ANSI/UL Standard for Safety consists of the Sixth edition including revisions through October 7, 2022.

The most recent designation of ANSI/UL 985 as a Reaffirmed American National Standard (ANS) occurred on October 7, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover household fire warning system control units intended to be installed in accordance with the National Fire Alarm Code, ANSI/NFPA 72, and the National Electrical Code, ANSI/NFPA 70.

1.2 A household fire warning system control unit consists of a unit assembly of electrical parts having provision for connection of power supply and initiating device circuits. Provision for connection of a notification appliance circuit is also required unless an alarm sounding device is integral with the control unit. Additional terminals may be provided for the connection of supplementary devices, such as annunciators, remote switches, and the like. A secondary supply, consisting of a rechargeable battery, shall be provided integral with the control unit or provision may be provided for its connection to the control unit.

1.3 Provision for the connection to the control unit of at least one smoke detector is required unless reference is made on the installation diagram for the use of a self-contained smoke detector, such as a single- or multiple-station fire alarm device.

1.4 These requirements also apply to the use of combination systems, such as a combination fire-burglar alarm system control unit, which uses circuit wiring common to both systems. When common wiring is used for combination systems, it shall be connected in such a manner that internal fault conditions (shorts, opens, grounds) in the nonfire alarm (burglary) system circuit wiring, or faults between the fire and nonfire alarm system circuits, will not interfere with the supervision of the fire alarm system or prevent intended alarm signal transmission.

1.5 These requirements do not cover single- or multiple-station fire alarm devices, automatic fire detectors, or alarm notification appliances, such as bells, horns, carbon monoxide alarm devices, emergency initiating devices, non-emergency initiating devices, and the like. They do cover accessories which are external to the control unit and are dependent upon the control unit function, such as end-of-line devices, annunciators, and remote switches.

1.6 If a digital alarm communicator transmitter is used to transmit signals to a remote location and it 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.

1.7 Where a unit employs security functions, it shall comply with the Standard for Household Burglar-Alarm System Units, UL 1023. Units employing medical alert functions shall comply with the Standard for Home-Health Care Signaling Equipment, UL 1637. 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 General

2.1 Components

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

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

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

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

2.3 Undated references

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

3 Glossary

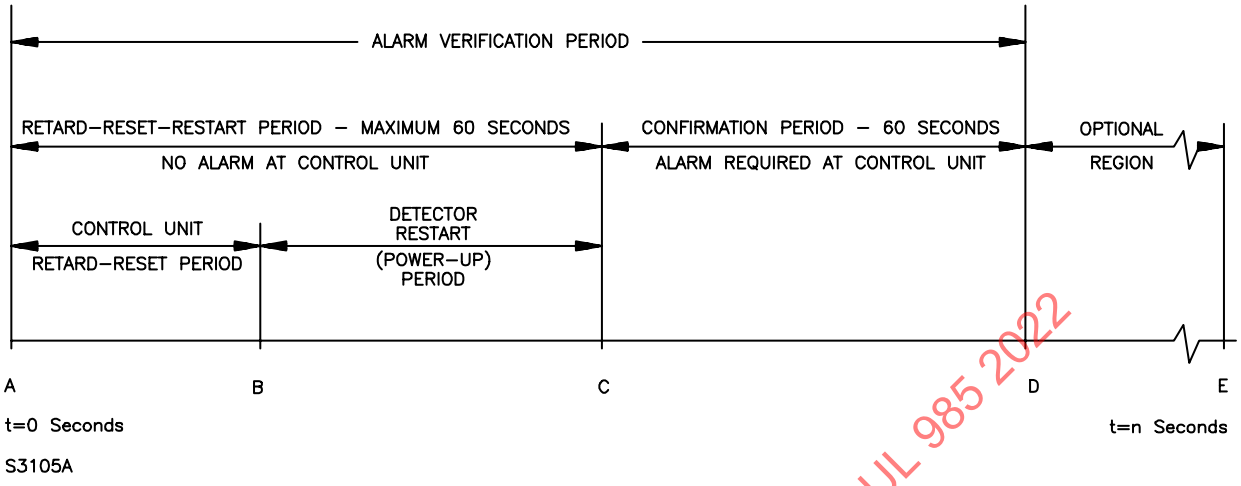
3.1 For the purpose of this standard the following definitions apply.

3.2 ALARM SIGNAL – An audible signal indicating an emergency fire condition requiring immediate action, as an alarm initiated from a manual box, smoke, or heat detector.

3.3 ALARM VERIFICATION – Operation of a control unit in conjunction with a related smoke monitoring head or an initiating device circuit in which an alarm signal from a smoke detector is confirmed one or more times over a predetermined period before the control unit will indicate an alarm. This predetermined period consists of an alarm retard/reset period and an alarm confirmation period. The alarm retard period is the delay time designed in the control unit while the alarm reset period is the power-up time for the detector. See Figure 3.1.

Figure 3.1

Alarm verification – timing diagram



A – Smoke detector goes into alarm.

AB – RETARD-RESET PERIOD (Control Unit) – Control unit senses detector in alarm and retards (delays) alarm signal, usually by de-energizing power to the detector. Length of time varies with design.

BC – RESTART PERIOD (Detector Power-Up Time) – Power to the detector is reapplied and time is allowed for detector to become operational for alarm. Time varies with detector design.

AC – RETARD-RESET-RESTART PERIOD – No alarm obtained from control unit. Maximum period of time is 60 seconds.

CD – CONFIRMATION PERIOD – Detector is operational for alarm at point C. If detector is still in alarm at point C, control unit will alarm. If detector is not in alarm, system returns to standby. If the detector realarms at any time during the confirmation period the control unit will alarm.

DE – OPTIONAL REGION – Either an alarm can occur at control unit or restart of the alarm verification cycle can occur.

AD – ALARM VERIFICATION PERIOD – Consists of the retard-reset-restart and confirmation periods.

3.4 ANNUNCIATOR – An externally-connected electrically-operated visual indicating device containing two or more identified targets or indicator lamps in which each target or lamp indicates the circuit condition and/or location.

3.5 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 DC or AC peak.

c) Power-Limited – A circuit wherein the power and current are limited as specified in Table 48.1 and Table 48.2.

3.6 CONTROL UNIT ACCESSORY – A device or appliance externally connected to a control unit which is used to ensure the intended operation of a system or to provide supplementary signaling and/or annunciation. Examples of control unit accessories are annunciators, end-of-line resistors or diodes, auxiliary relays, and remote switches.

3.7 DISTINCTIVE SIGNALS – Signals obtained from different sounding appliances, such as bells, horns, sirens, and buzzers, or from a single appliance, such as an electronic horn, where a continuous signal is obtained under one condition and a pulsing signal under another.

3.8 END-OF-LINE RESISTOR – A resistor installed at the end of an initiating or indicating device circuit to limit the amount of supervisory current.

3.9 FAULT – An open or ground condition on any line extending from a control unit.

3.10 INDICATING DEVICE – Any audible signal used to indicate a fire, supervisory, or trouble condition. Examples of audible signal appliances are bells, horns, sirens, electronic horns, buzzers, and chimes.

3.11 INDICATING DEVICE CIRCUIT – Circuit to which indicating devices are connected.

3.12 INITIATING DEVICE – A manually- or automatically-operated device whose operation results in a fire alarm indication from the control unit. Examples of alarm signal initiating devices are thermostats, manual boxes, and smoke detectors.

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

3.14 MESSAGE – Communicated data that contains specific information relating to the status of the product and is transmitted via a wired or wireless pathway from an origin to a destination.

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

3.16 TROUBLE SIGNAL – A visual or audible signal indicating a fault condition of any nature, such as an open or ground or other trouble condition, occurring in the device or connected wiring.

4 Instructions and Drawings

4.1 A copy or draft of the operating and installation instructions and related schematic wiring diagrams and installation drawings intended to be furnished with each product are to be used as a basis for the examination and testing of the control unit.

4.2 The instructions and drawings shall include such directions and information as deemed by the organization responsible for the product to be adequate for attaining the intended and safe installation, maintenance, and operation of the control unit. See Installation Drawing, General, Section 79, and Instructions, General, Section 80.

4.3 In addition to the information given in 4.1 and 4.2, the manufacturer shall provide an evacuation plan as specified in 80.2.

5 Compatibility Information

5.1 General

5.1.1 Compatibility between a two-wire smoke detector that receives its power from the initiating device circuit of a fire alarm control unit is dependent upon the interaction between the circuit parameters, such as voltage, current, frequency, and impedance, of the detector and the initiating device circuit.

5.1.2 A detector that does not receive its power from the initiating device circuit of a control unit (conventionally a detector having four or more wires for field connection) may be used with any electrically compatible fire alarm system control unit without the need for compatibility consideration, as its connection does not impose any load on the initiating circuit. Under an alarm condition, the four-wire detector acts as a switch (similar to a manual station or heat detector) to place the system in alarm.

5.1.3 As a two-wire detector obtains its power from the initiating device circuit of a system control unit, its operation is dependent on the characteristics of the circuit to which it is connected, as the detector imposes a resistive and capacitive load on the circuit. Similarly, the load imposed upon the initiating device circuit by a connected detector shall not prevent alarm response by a control unit to a detector in alarm, nor prevent a trouble response to an open circuit after the last detector.

5.1.4 The connection of a two-wire smoke detector shall be restricted to the specific control units or initiating device circuits with which a compatibility evaluation has been made.

5.1.5 A supplementary signaling device [such as an audible appliance, relay, or annunciator lamp (LED-type)] that is integral with a two-wire smoke detector, and that is also powered from an initiating device circuit of a fire alarm system control unit, may be used if its operation, including level of audibility and light output, is not inhibited under the maximum normal standby and alarm loading conditions specified in the detector and control unit installation wiring diagrams.

5.2 Method of evaluation

5.2.1 In accordance with 5.1.1 – 5.1.5, to determine whether any combination of control unit and smoke detector or detectors is compatible, and whether the detectors are the same model or a mixture of one or more models or types, the tests indicated in (a) – (h) are to be conducted:

a) Operating voltage determination, as described in 43.1.1 – 43.1.3.

b) Alarm threshold impedance, as described in 43.2.1 – 43.2.3.

c) Maximum current limitation, as described in 43.3.1 and 43.3.2.

d) Multiple detector alarm capacity, as described in 43.4.1.

e) Detectors with optional components, as described in 43.5.1 and 43.5.2.

f) Dynamic load immunity, as described in 43.6.1 and 43.6.2.

g) Electrical supervision, as described in 43.7.1 and 43.7.2.

h) Detector reset, as described in 43.9.1 and 43.9.2.

5.3 Changes affecting compatibility

5.3.1 If the compatibility integrity of a previously installed compatible combination may be affected by replacement detectors or a modification of either the detectors or the control unit, the product that is changed shall be assigned a different model number, or change in compatibility identification marking.

CONSTRUCTION

6 General

6.1 A control unit shall be intended and constructed for use with recognized signal initiating and indicating devices, and other equipment intended for connection to it to form a household fire alarm system of the type indicated by the installation wiring diagram.

6.2 Except where indicated otherwise, the construction requirements specified for control units shall apply also to control unit accessories.

6.3 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: 7.1.3, 7.1.4, 36.3, and Sections 10, 20, 21, 22, 23, 25, 26.1, 27, 28, and 32.

7 Frame and Enclosure

7.1 General

7.1.1 The frame and enclosure shall be sufficiently strong and rigid to resist total or partial collapse with attendant reduction of spacings, loosening or displacement of parts and development of other conditions which impairs its operation and increase the risk of fire, electric shock, or injury to persons.

7.1.2 All electrical parts of a control unit shall be enclosed to provide protection against contact with uninsulated live parts.

7.1.3 Space shall be provided within a terminal or wiring compartment for completing all wire connection as specified by the installation wiring diagram.

7.1.4 An enclosure shall have means for mounting, which shall be accessible without disassembling any operating part of the unit. Removal of a completely assembled panel or printed wiring board to mount the enclosure is not considered to be disassembly of an operating part.

7.1.5 A compartment enclosing electrical parts shall not be open to the floor or other support on which a unit rests.

7.2 Cast metal enclosures

7.2.1 The thickness of cast metal for an enclosure shall be as indicated in Table 7.1.

Exception: Cast metal having a thickness 1/32 inch (0.8 mm) less than that indicated in the table, if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that equivalent mechanical strength is provided, complies with this requirement.

Table 7.1
Cast metal electrical enclosures

Use, or dimensions of area involved	Minimum thickness			
	Die-cast metal		Cast metal of other than the die-cast type	
	inch	(mm)	inch	(mm)
Area of 24 square inches (155 cm^2) or less and not having a dimension greater than 6 inches (152 mm)	1/16	(1.6)	1/8	(3.2)
Area greater than 24 square inches (155 cm^2) or having any dimension greater than 6 inches (152 mm)	3/32	(2.4)	1/8	(3.2)
At a threaded conduit hole	1/4	(6.4)	1/4	(6.4)
At an unthreaded conduit hole	1/8	(3.2)	1/8	(3.2)

7.2.2 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is used, there shall not be fewer than 3-1/2 nor more than five threads in the metal, and the construction shall be such that a standard conduit bushing is capable of being attached.

7.2.3 If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall not be fewer than five full threads in the metal, and there shall be a smooth, well-rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

7.3 Sheet metal enclosures

7.3.1 The thickness of sheet metal used for the enclosure of a control unit shall not be less than that indicated in Table 7.2.

Exception: Sheet metal two gage sizes smaller, if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that equivalent mechanical strength is provided, complies with this requirement.

Table 7.2
Sheet metal electrical enclosures

Maximum enclosure dimensions				Minimum thickness of sheet metal					
				Steel					
				Zinc coated		Uncoated		Brass or aluminum	
Any linear dimension		Area of any surface		inch		inch		inch	
inches	(mm)	inches^2	(cm^2)	[GSG]	(mm)	[MSG]	(mm)	[AWG]	(mm)
12	(305)	90	(584)	0.035 [20]	(0.86)	0.032 [20]	(0.81)	0.045 [16]	(1.14)
24	(610)	360	(2322)	0.045 [18]	(1.14)	0.042 [18]	(1.07)	0.058 [14]	(1.47)
48	(1219)	1200	(7742)	0.056 [16]	(1.42)	0.053 [16]	(1.35)	0.075 [12]	(1.91)
60	(1524)	1500	(9678)	0.070 [14]	(1.78)	0.067 [14]	(1.70)	0.095 [10]	(2.41)
Over 60	(Over 1524)	Over 1500	(Over 9678)	0.097 [12]	(2.46)	0.093 [12]	(2.36)	0.122 [8]	(3.10)

7.3.2 At any point where conduit or metal-clad cable is to be attached, sheet metal shall be of such thickness or shall be formed or reinforced so that it will have stiffness at least equivalent to that of uncoated flat sheet steel having a minimum thickness of 0.053 inch (1.35 mm).

7.3.3 A plate or plug for an unused conduit opening or other hole in the enclosure shall have a minimum thickness of:

a) 0.014 inch (0.36 mm) for steel or 0.019 inch (0.48 mm) for nonferrous metal for a hole having a 1/4-inch (6.4-mm) maximum dimension.

b) 0.027 inch (0.69 mm) for steel or 0.032 inch (0.81 mm) for nonferrous metal for a hole having a 1-3/8-inch (34.9-mm) maximum dimension.

7.3.4 A closure for a larger hole shall have a thickness equal to that required for the enclosure of the device, or a standard knockout seal shall be used. Such plates or plugs shall be mechanically secure as mounted.

7.3.5 A knockout in a sheet-metal enclosure shall be secured but shall be capable of being removed without deformation of the enclosure.

7.3.6 A knockout shall be provided with a flat surrounding surface adequate for proper seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than the requirements in this standard.

7.4 Nonmetallic enclosures

7.4.1 A nonmetallic enclosure or enclosure part shall have mechanical strength and durability at least equivalent to a sheet-metal enclosure of the minimum thickness specified in Table 7.2. The enclosure or enclosure part shall protect persons from the risk of electric shock.

7.4.2 Among the factors taken into consideration when determining the acceptability of a nonmetallic enclosure are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility 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 is subjected under conditions of intended or abnormal usage. All these factors are considered with respect to aging.

7.4.3 The continuity of the grounding system shall not rely on the dimensional integrity of the nonmetallic material.

8 Electric Shock

8.1 Any part that is exposed only during operator servicing shall not present the risk of electric shock. See Electric Shock Current Test, Section 57.

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

Exception: The conductive connection need not be provided if:

a) Such a connection is established in the event of electrical breakdown of the antenna isolating means;

b) The breakdown does not result in a risk of electric shock; and

c) In a construction using an isolating power transformer, the resistance of the conductive connection between the supply circuit and chassis does not exceed 5.2 megohms.

8.3 The maximum value of 5.2 megohms mentioned in 8.2 is to include the maximum tolerance of the resistor value used, that is, a resistor rated 4.2 megohms with 20 percent tolerance or a resistor rated 4.7 megohms with a 10 percent tolerance may be used. When component comprised of a capacitor with a built-in shunt resistor that complies with the requirements for antenna isolating capacitors, it shall be rated a minimum of 1/4 watt.

8.4 The insertion in any socket of any vacuum tube or its glass or metal equivalent of like designation used in the product shall not result in a risk of electric shock.

9 Enclosure Openings

9.1 General

9.1.1 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 power-limited sources and controlling only power-limited loads.

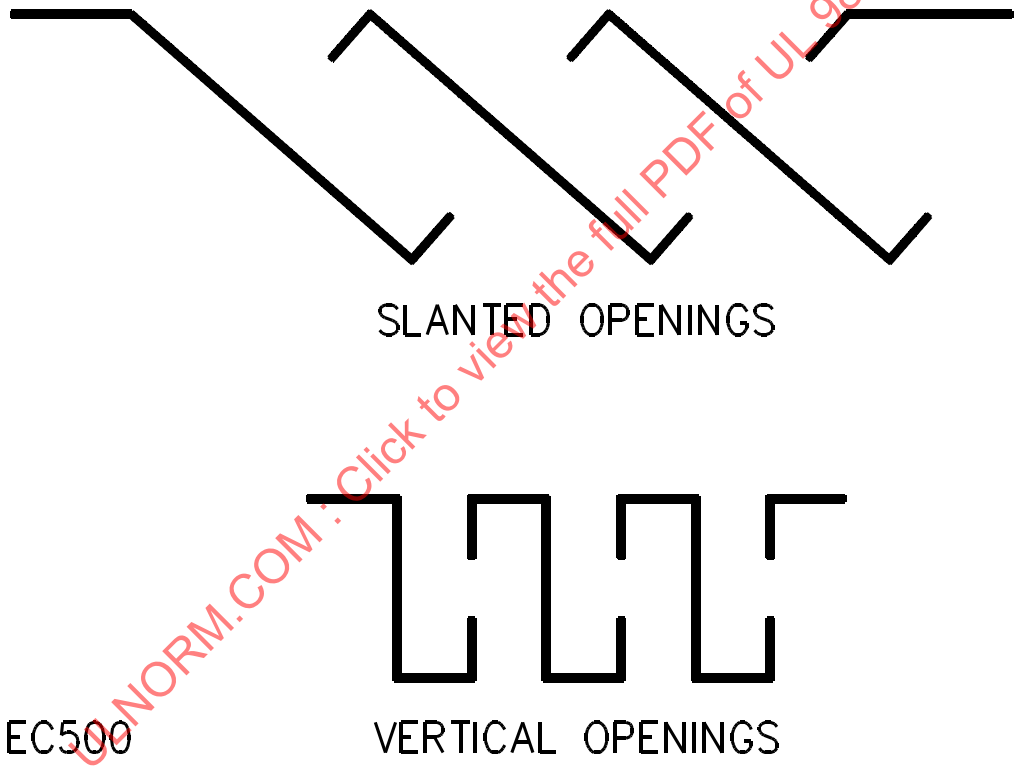
9.1.2 The requirement in 9.1.1 does not apply to an opening for a mounting screw or nail or for a manufacturing operation.

9.2 Enclosure top openings

9.2.1 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 9.1 for examples of top-cover designs complying with the intent of the requirement.

Figure 9.1

Cross-sections of top-cover designs



9.3 Enclosure side openings

9.3.1 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 9.1 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 9.3).

Figure 9.2

Louvers

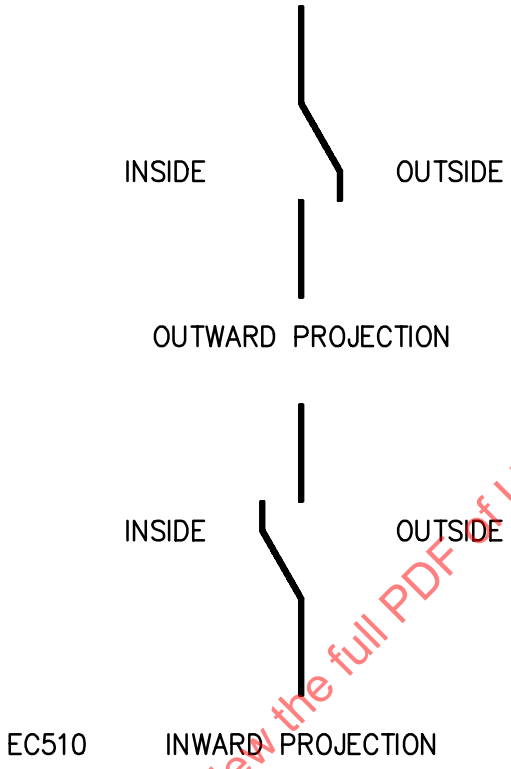
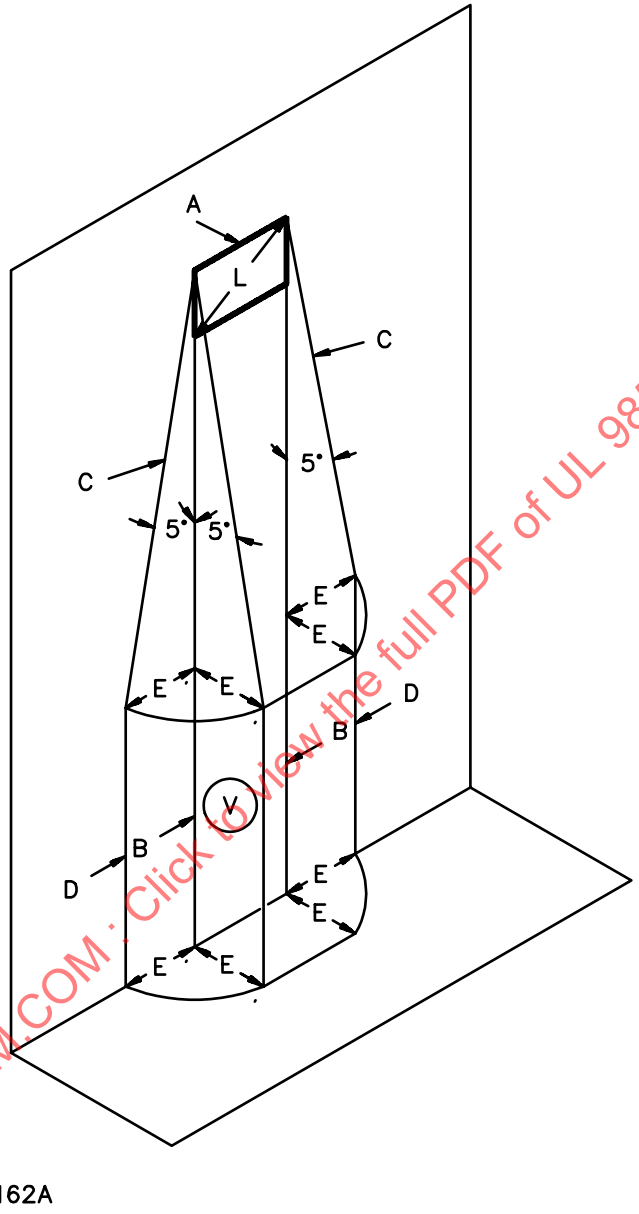


Figure 9.3

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).

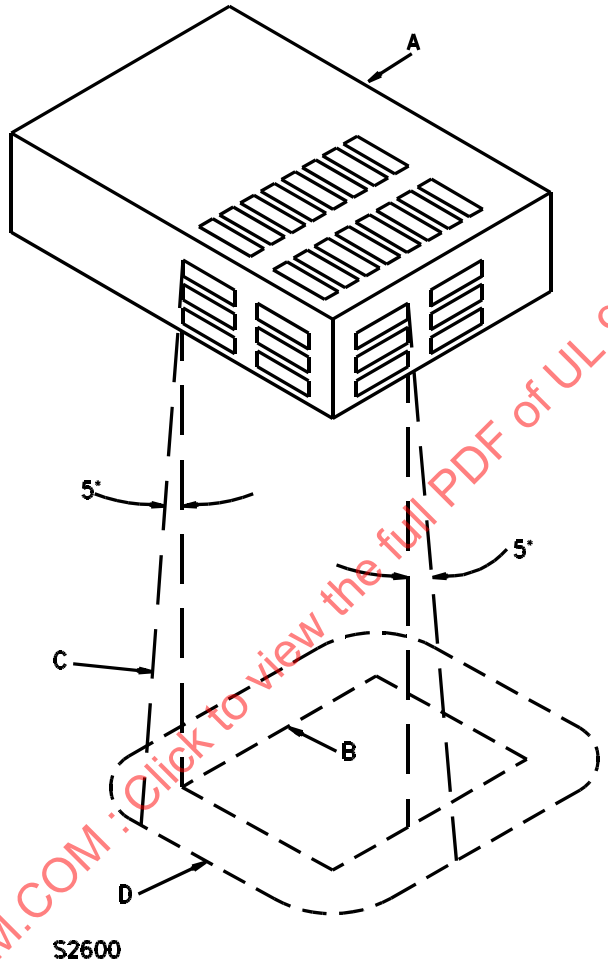
L – Maximum dimension of the enclosure side opening.

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

9.3.2 When a portion of a side panel falls within the area traced out by the 5-degree angle in Figure 9.4, that portion of the side panel shall be investigated as a bottom enclosure in accordance with 9.4.1 – 9.4.3.

Figure 9.4

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.

9.4 Enclosure bottom openings

9.4.1 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 9.4, that complies with the ventilation opening requirements in 9.2 and 9.3 unless a test demonstrates that the bottom enclosure provided contains flames, glowing particles or similar burning debris when all combustible material in the interior is ignited.

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

9.4.2 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 9.1, 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, 75.

Table 9.1
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)

9.4.3 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).

10 Metal Covers and Doors

10.1 An enclosure cover shall be hinged, sliding, pivoted, or similarly attached if:

a) It provides access to fuses or any other overcurrent-protective device the functioning of which requires renewal, or

b) It is necessary to open the cover in connection with the normal operation and maintenance of the unit.

10.2 With reference to 10.1, normal operation is considered to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit that requires such action in connection with its intended performance.

10.3 A hinged cover is not required where the only fuse(s) enclosed is intended to provide protection to portions of internal circuits such as used on a separate printed wiring board or circuit subassembly, to prevent excessive circuit damage resulting from a fault. Such a fuse(s) may be used if the following or

equivalent marking is indicated on the cover: "CIRCUIT FUSE(S) INSIDE – Disconnect Power Prior To Servicing."

10.4 A hinged cover shall be provided with a latch, screw, or catch to hold it closed. An unhinged cover shall be held in place by screws or the equivalent.

11 Glass Panels

11.1 Glass covering an observation opening shall be secured in place and shall provide mechanical protection for the enclosed parts. The thickness of a glass cover shall not be less than that indicated in Table 11.1.

Table 11.1
Thickness of glass covers

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

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

11.2 A glass panel for an opening having an area of more than 144 square inches (930 cm^2), or having any dimension greater than 12 inches (305 mm), shall be supported by a continuous groove not less than 3/16 inch (4.8 mm) deep along all four edges of the panel.

11.3 A transparent material other than glass used as a cover over an opening in an enclosure shall have equivalent mechanical strength to that of glass, and shall not create a risk of fire, distort, nor become less transparent at the temperature to which it is subjected under intended or abnormal service conditions.

12 Corrosion Protection

12.1 Except as indicated in 12.2, iron and steel parts, except bearings and the like where such protection cannot be provided, shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

12.2 The requirement of 12.1 applies to all enclosing cases whether of sheet steel or cast iron, and to all springs and other parts upon which mechanical operation depends. Parts made of stainless steel, polished or treated if necessary, do not require additional protection against corrosion. Bearing surfaces shall be of such materials and construction as to resist binding due to corrosion.

13 Insulating Material

13.1 Insulating materials for the support or separation of live parts shall be of a nonflammable, moisture-resistant insulating material, such as porcelain, phenolic or cold-molded composition, or other material which is recognized for the support of live parts.

13.2 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 which are not staked, upset, sealed, or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

13.3 Vulcanized fiber or other material providing equivalent insulative properties shall be used for insulating bushings, washers, separators, and barriers, but not for the sole support of live parts.

13.4 The thickness of a flat sheet of insulating material, such as phenolic composition used for panel-mounting of parts, shall not be less than that indicated in Table 13.1.

Table 13.1
Thickness of flat sheets of insulating material

Maximum dimensions				Minimum thickness,	
Length or width,		Area,			
inches	(mm)	inches^2	(cm^2)	inch	(mm)
24	(610)	360	(2323)	3/8[a]	(9.5)
48	(1219)	1152	(7432)	1/2	(12.7)
48	(1219)	1728	(11148)	5/8	(15.9)
Over 48	(Over 1219)	Over 1728	(Over 11148)	3/4	(19.1)

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

13.5 A terminal block mounted on a metal surface which may be grounded shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base which are not staked, upset, sealed, or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

13.6 A countersunk, sealed part shall be covered with a waterproof insulating compound which will not melt at a temperature 15°C (27°F) higher than the maximum normal 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).

14 Mounting of Electrical Components

14.1 All parts of a household control unit shall be secured to their supporting surfaces so that they will be prevented from loosening or turning if such motion adversely affects the intended performance of the control unit, or increases the risk of fire or injury to persons resulting from operation of the control unit.

14.2 A switch, lampholder, attachment-plug receptacle, or plug connector shall be mounted as intended and, except as noted in 14.3 and 14.4, shall be prevented from turning.

14.3 The requirement that a switch be prevented from turning is waived if all the following conditions are met:

a) The switch is of a push button 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 operation of the switch.

b) The means of mounting the switch is not subject to loosening as the result of its operation.

c) The spacings are not reduced below the minimum required values if the switch does rotate.

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

14.5 The means for preventing turning of a device shall consist of more than friction between surfaces; for example, a lock washer, properly applied, may be used as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

14.6 Uninsulated live parts, including terminals, shall be secured to their supporting surfaces by methods other than friction between surfaces, so that they will be prevented from turning or shifting in position if such motion results in reduction of spacings to less than those required. The security of contact assemblies shall be such as to ensure the continued alignment of contacts.

15 Operating Mechanisms

15.1 Operating parts, such as switches, relays, and similar devices, shall be protected by individual protection and/or dust-tight cabinets, against fouling by dust or by other material which adversely affects their intended operation.

15.2 A part shall be constructed of material that is required for its intended application.

15.3 The assembly of an operating mechanism included as a part of a control unit shall be such that it will not be affected adversely by any condition of its intended operation.

15.4 Moving parts shall have sufficient play at bearing surfaces to prevent binding.

15.5 Provision shall be made to prevent adjusting screws and similar adjustable parts from loosening under the conditions of actual use.

15.6 Manually-operated parts shall have the necessary strength to withstand the stresses to which they will be subjected in operation.

15.7 An electromagnetic device shall provide reliable and positive electrical and mechanical performance as evidenced by compliance with the Performance requirements in this standard.

16 Current-Carrying Parts

16.1 A current-carrying part shall have the necessary mechanical strength and current-carrying capacity for the service, and shall be of a metal, such as silver, copper or a copper alloy, or other material which will provide equivalent performance.

16.2 Bearings, hinges, and the like shall not be used for carrying current between interrelated fixed and moving parts.

17 Grounding for Products Containing High-Voltage Circuits

17.1 A product which involves high-voltage circuits shall have provision for the grounding of all exposed dead metal parts that might become energized from circuits involving a risk of electric shock.

Exception: Metal parts as described in (a) – (d):

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

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

c) Panels and covers that do not enclose uninsulated live parts when wiring is positively separated from the panel or cover so that it is not liable to become energized.

d) Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material that is a minimum of 0.8 mm (1/32 inch) thick.

17.2 On fixed equipment, the provision of a knockout or other opening in a metal enclosure for the connection of metal-clad cable, conduit, metal raceway, or the like is permitted as a means for grounding.

17.3 When a product is provided with means for separate connection to more than one power supply, each such connection shall be provided with a means for grounding.

17.4 All dead-metal parts that are accessible during intended use or user servicing, and that are capable of becoming energized from circuits involving a risk of electric shock, shall be connected together and to the grounding means.

Exception: Metal parts as described in the Exception to 17.1.

17.5 The following circuits of fire alarm system circuits shall be bonded to ground under the indicated conditions:

a) Alternating current circuits less than 50 volts:

1) Where supplied by transformers if the transformer supply system exceeds 150 volts to ground.

2) Where supplied by transformers if the transformer supply system is ungrounded.

3) Where installed as overhead conductors outside of buildings.

b) Alternating current circuits of 50 volts and over:

1) Where the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts.

2) Where the system is nominally rated 240/120 volts, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor.

c) Direct-current circuits operating at 51 – 300 volts.

17.6 All bonding to ground connections shall be by a positive means, such as by clamping, riveting, brazing, welding, or by being a bolted or screwed connection. The bonding connection shall penetrate nonconductive coatings such as paint. Bonding around a resilient mount shall not rely on the clamping action of rubber or similar material.

17.7 A bolted or screwed connection that incorporates a star washer or serrations under the screw head for penetrating nonconductive coatings is identified as complying with 17.6.

17.8 Where the bonding means depends upon screw threads, the use of two or more screws or two full threads of a single screw engaging metal is in compliance with 17.6.

17.9 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size specified in Table 17.1.

Table 17.1
Bonding wire conductor size

Rating of overcurrent device, amperes	Size of bonding conductor[a]			
	Copper wire,		Aluminum wire,	
	AWG	(mm^2)	AWG	(mm^2)
15	14	(2.1)	12	(3.3)
20	12	(3.3)	10	(5.3)
30	10	(5.3)	8	(8.4)
40	10	(5.3)	8	(8.4)
60	10	(5.3)	8	(8.4)
100	8	(8.4)	6	(13.3)
200	6	(13.3)	4	(21.2)

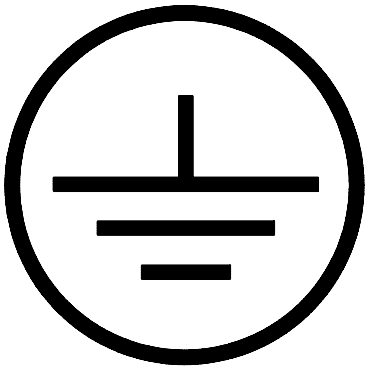
[a] Or equivalent cross-sectional area.

17.10 The size of a copper or aluminum conductor used to bond an electrical enclosure shall be based on the rating of the branch-circuit overcurrent device by which the equipment will be protected. The size of the conductor shall be in accordance with Table 17.1.

17.11 Splices shall not be used in wire conductors used for bonding.

17.12 A wire-binding screw or a pressure wire connector intended for the connection of an equipment-grounding conductor shall have a green-colored head or shall be plainly identified as such by being marked "G," "GR," "GND," "Ground," "Grounding," or the like, or with the Symbol 5019 graphic from IEC Publication 60417-1 shown in Figure 17.1, or by a marking on the wiring diagram provided on the product. The wire-binding screw or pressure wire connector shall be located so that it is not able to be removed during intended servicing of the product. When used alone, the Symbol 5019 graphic from IEC Publication 60417-1 shall be defined in the installation instructions provided with the equipment.

Figure 17.1
International electrical symbol



IEC417, Symbol 5019

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

17.14 The grounding conductor in a flexible cord shall be green with or without one or more yellow stripes. The grounding conductor shall be secured to the frame or enclosure of the product by means of a screw, rivet, or similar equipment that is not removable during intended servicing not involving the supply cord. Solder shall not be used alone for securing the grounding conductor. The grounding conductor shall be connected to the grounding terminal of an attachment plug.

17.15 When a means for grounding is provided on the product, even though it is not required, it shall comply with the requirements in 17.1 – 17.14.

17.16 Metal-to-metal hinge-bearing members for doors or covers are considered to meet the requirement for bonding the door or cover to ground, when a multiple bearing pin type (piano-type hinge) is used.

Exception: Slip-joint or similar, hinge-bearing members are not required to comply with this requirement when the resistance between the two parts connected by the bonding element is not more than 0.1 ohm. The resistance shall be determined by a resistance-measuring instrument. When unacceptable results are recorded, an alternating or direct current of at least 20 amperes from a power supply of not more than 12 volts shall be passed between the two parts connected by the bonding element. The resulting drop in potential and the test current shall be measured between the two points. The resistance in ohms shall be determined by dividing the drop in potential in volts by the current in amperes.

18 Servicing Protection

18.1 Uninsulated live parts or hazardous moving parts shall be located, guarded, or enclosed so as to prevent contact by persons during servicing such as relamping, changing fuses, adjusting controls, battery replacement and maintenance, and operating switches. Protection from contact may be provided by insulating tape, barriers, or the equivalent, over exposed current-carrying parts operating in excess of 30 volts AC rms (42.4 volts peak or direct current).

FIELD-WIRING CONNECTIONS

19 Power Connections

19.1 Household fire warning systems shall have two independent power sources consisting of a primary source that uses commercial light and power and a secondary source that consists of a rechargeable battery.

19.2 A primary battery is not prohibited from being used as the sole source of power for a low-power wireless transmitter when the conditions of 64.8 are met.

20 Primary Power Supply

20.1 A household fire alarm control unit shall have provision for connection to a commercial light and power source normally available in a home. This shall be in the form of a permanent connection by means of wiring terminals or leads in a separate wiring compartment having provision for the connection of conduit or metal-clad cable, or by means of a power-supply cord and attachment plug.

20.2 Control units intended to be installed by other than a qualified electrician shall be powered from a power-limited power supply.

20.3 The primary power supply shall be of sufficient capacity to operate the system under all conditions of loading with any standby rechargeable battery fully discharged (85 percent of its marked nominal rating).

21 Secondary Power Supply

21.1 The secondary power supply shall be of sufficient capacity to supply the maximum power to the system for 24 hours in the intended standby condition and thereafter be able to operate the control unit for fire alarm signals for at least 4 minutes continuously.

22 Batteries

22.1 For a rechargeable type battery, the maximum charging current, as well as the maximum trickle charging current available, shall not exceed the battery manufacturer's specifications.

22.2 Provision shall be made for an automatic test of the standby battery at least once every 4 hours. The test shall be conducted under a load sufficient to determine if the battery requires service, has been removed, or is disconnected. A battery requiring service is defined as a battery which is not capable of providing 4 minutes of alarm signaling during a power failure. If the automatic battery test determines that the battery requires service or is disconnected, an audible trouble signal shall be provided.

22.3 In all cases the marking on the unit shall also include battery replacement instructions for a primary battery.

22.4 Batteries included as part of a control unit shall be located and mounted so that terminals of cells will not come in contact with uninsulated live parts of the control unit, with terminals of adjacent cells, or with metal parts of the enclosure as a result of shifting.

22.5 A battery compartment intended for use with rechargeable batteries that emit gases during charging shall be provided with vent holes.

22.6 Access shall be available to the battery compartment to facilitate battery replacement without disassembly of any part of the control unit except for a cover or door.

22.7 Lead or terminal connections to batteries shall be identified with the proper polarity (plus or minus signs), and provided with strain relief.

22.8 If required by local, state or federal ordinances or regulations for disposal reasons, rechargeable type batteries shall be removable.

INSTALLATION WIRING CONNECTIONS

23 General

23.1 A control unit intended for permanent connection shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the National Electrical Code, ANSI/NFPA 70, corresponding to the electrical rating of the unit.

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

24 Field-Wiring Terminals

24.1 The terminal parts to which wiring connections are made shall consist of binding screws with terminal plates having upturned lugs, or the equivalent, to hold the wires in position. Other terminal connections shall only be provided when found to be equivalent.

24.2 A wire-binding screw used at a field-wiring terminal shall be a No. 6 (3.5 mm) or No. 8 (4.2 mm) screw. A No. 6 screw shall only be used for the connection of a 14 AWG (2.1 mm^2) or smaller conductor.

24.3 Except as noted in 24.4, a terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick for a No. 8 (4.2 mm) or larger screw, and not less than 0.030 inch (0.76 mm) thick for a No. 6 (3.5 mm) screw, and shall have not less than two full threads in the metal.

24.4 A terminal plate shall have the metal extruded at the tapped hole for the binding screw so as to provide two full threads in the metal. Other constructions shall be used if they are determined to provide equivalent security.

25 Field-Wiring Leads

25.1 Where leads are provided in lieu of wiring terminals, they shall not be less than 6 inches (152 mm) long, shall be provided with strain relief, and shall not be smaller than 22 AWG (0.32 mm^2) except leads intended for connection of a high-voltage source shall be not smaller than 18 AWG (0.82 mm^2), shall utilize rubber or thermoplastic insulation not be less than 0.030 inch (0.76 mm) minimum average and 0.027 inch (0.69 mm) minimum at any point.

Exception No. 1: The lead may be less than 6 inches (152 mm) long if it is evident that the use of a longer lead may result in damage to the 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) The voltage does not exceed 30 V rms or 42.4 volts DC or AC peak;

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

d) The assembled conductors comply with the requirements of Section 27, Strain Relief; and

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

26 Power-Supply Cord

26.1 A cord-connected household control unit shall be provided with not less than 6 feet (1.83 m) of flexible cord and a two- or three-prong attachment plug cap.

26.2 The flexible cord shall be Type SP-2, SPT-2, SV, SVT, SJ, SJT, or equivalent, and shall have minimum 18 AWG (0.82 mm^2) conductors. The cord shall be rated for use at the voltage and ampacity rating of the appliance.

26.3 Means shall be provided to reduce the risk of the flexible cord being pushed into the enclosure through the cord-entry hole if such displacement presents a risk of:

a) Mechanical damage;

b) Exposure to a temperature higher than that for which the cord is rated;

c) Reduction of spacings below the minimum required; or

d) Damage to internal components.

26.4 Where a flexible cord passes through any opening in a wall barrier, or enclosing case, the edges of the hole shall be smooth and rounded, without burrs, fins, or sharp edges which presents a risk of damage to the cord jacket.

26.5 A restraining means shall be provided for securing the attachment-plug cap to the receptacle.

Exception: Products utilizing a secondary power source meeting the requirements of Section 51, Charging Current Test, and where loss of the AC primary power source results in annunciation of an audible trouble signal meeting 44.3, Trouble signals.

27 Strain Relief

27.1 A strain relief means shall be provided for a power-supply cord, supply leads, battery leads, and internal connected wires or cords which are subject to movement, in conjunction with operation or servicing of a household control unit, to reduce the risk of a mechanical stress being transmitted to terminals and internal connections. Inward movement of the cord or leads provided with a ring-type strain relief shall not damage internal connections or components.

27.2 The strain relief means provided on the flexible cord shall be capable of withstanding for 1 minute without displacement, a pull of 35 pounds (156 N) applied to the cord with the connections within the control unit disconnected.

27.3 A 35-pound (15.9-kg) weight is to be suspended on the cord and supported by the control unit so that the strain relief means will be stressed from any angle that the construction of the unit permits. The strain relief does not comply if at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress on the connections.

27.4 Each lead used for field connections shall be capable of withstanding for 1 minute a pull of 10 pounds (44.5 N) without any evidence of damage or of transmitting the stress to internal connections.

28 Power-Limited Circuits

28.1 When the design of the product is such that it is possible for fire alarm power-limited circuit conductors to occupy the same enclosure as electric light, power, Class 1, non-power limited fire alarm, or medium power network-powered broadband communication circuit conductors, the condition of (a) and (b) shall be met.

a) The enclosure shall provide either:

1) A minimum of two cable openings into the enclosure, or

2) A single opening, with a continuous and firmly fixed nonconductive barrier, such as flexible tubing.

The installation document of the product shall completely detail cable entry routing of all conductors into the product.

b) The product shall be constructed so that, with all field-wiring connected to the product, either:

1) A minimum 1/4 inch (6.4 mm) separation is provided between fire alarm power-limited conductros and all electric light, Class 1, power, non-power-limited fire alarm, and medium power network-powered broadband communication signaling conductors, or

2) For circuit conductors operation at 150 volts or less to ground where fire alarm power-limited conductors are installed using Type FPL, FPLR, or FPLP cables, a minimum 1/4 inch (6.4 mm) separation is provided between these fire alarm power-limited cable conductors extending beyond the jacket and all electric light, power, Class 1, non-power-limited fire alarm, and medium power network-powered broadband communication conductors.

Compliance shall be achieved by specific wire routing configurations that are detailed in the installation document. If a wire routing scheme will not maintain the required separation, barriers or nonconductive shelving shall be used to provide separation.

INTERNAL WIRING AND ASSEMBLY

29 Internal Wiring

29.1 The internal wiring of a control unit shall consist of copper conductors or equivalent having adequate insulation, mechanical strength, and current-carrying capacity for the service. The wiring shall be routed away from moving parts and sharp projections and held in place with clamps, string ties, or equivalent, unless of sufficient rigidity to retain a shaped form.

29.2 Leads connected to parts mounted on a hinged cover shall be of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged to reduce the likelihood of abrasion of insulation and jamming between parts of the enclosure.

29.3 If the use of a short length of insulated conductor is not possible – for example, a short coil lead, or the like– electrical insulating tubing, in place of insulated conductor, shall be used. The tubing shall not be subjected to sharp bends, tension, compression, or repeated flexing, and shall not contact sharp edges, projections, or corners. The wall thickness shall comply with the requirements for such tubing, except that the thickness at any point for polyvinyl chloride tubing 3/8 inch (9.5 mm) or less shall not be less than 0.017 inch (0.43 mm). For insulating tubing of other types, the wall thickness shall not be less than that required to provide the mechanical strength, dielectric properties, heat- and moisture-resistant characteristics, at least equal to 0.017-inch thick polyvinyl chloride tubing.

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

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

29.6 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or equivalently arranged to provide reliable connections.

29.7 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of adequate spacing between the splice and uninsulated metal parts is not assured.

29.8 Splices shall be located, enclosed, and supported so that they are not subject to damage from flexing, motion, or vibration.

29.9 Internal wiring of circuits which operate at different potentials shall be separated by barriers or shall be segregated unless the conductors of the circuits of lower voltage are provided with insulation rated for the highest voltage. Segregation of insulated conductors shall be accomplished by clamping, routing, or equivalent means which is determined to provide permanent separation.

29.10 A metal barrier shall have a thickness not less than that required by Table 7.2, based on the size of the barrier. A barrier of insulating material shall not be less than 0.028 inch (0.71 mm) thick and shall be thicker if there is a risk of its deformation so as to defeat its purpose. Any clearance between the edge of a barrier and a compartment wall shall not be more than 1/16 inch (1.6 mm).

GROUNDING

30 Equipment Grounding

30.1 A control unit intended for permanent connection to an electrical supply shall be provided with means for grounding. This shall consist of a knockout in a metal enclosure for the connection of conduit, metal-clad cable, or a grounding lead or terminal. The grounding means shall be reliably connected to all exposed dead metal parts which are at risk of becoming energized and all dead metal parts within the enclosure which are exposed to contact during servicing.

30.2 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green, with or without one or more yellow stripes. No other lead shall be so identified. The lead shall be of a gage size equivalent to that of the conductors supplying the unit.

30.3 A field-wiring terminal intended for connection of an equipment-grounding conductor shall be plainly identified, such as being marked "G," "GR," "Ground," "Grounding," or the equivalent, or by a suitable marking on a wiring diagram provided on the appliance. The field-wiring terminal shall be located so that it will not be removed during servicing of the appliance.

30.4 The grounding conductor of a power-supply cord shall be green, with or without one or more yellow stripes. The grounding conductor shall be secured to the frame or enclosure by means of a screw that is not likely to be removed during any servicing operation not involving the power-supply cord, or by other equivalent means. Ordinary solder alone shall not be used for securing the grounding conductor. The grounding conductor shall be connected to the grounding blade or equivalent contacting member of the attachment plug.

31 Polarity Identification

31.1 A lead intended for the connection of a grounded power-supply conductor shall be finished to show a white or grey color and shall be readily distinguishable from all other leads.

31.2 A terminal such as a plate and screw that is intended for the connection of a grounded power-supply conductor shall be identified by means of a metallic coating, substantially white in color, distinguishable from the other terminals, or identification of the terminal shall be clearly shown in some other manner, such as on an attached or referenced wiring diagram or manual.

COMPONENTS

32 End-of-Line Devices

32.1 An end-of-line device provided for connection to a household control unit, such as an end-of-line resistor or diode, shall be constructed as follows:

a) If the circuit in which the end-of-line device is to be connected is intended for connection by conduit or metal-clad cable, the device shall be arranged for mounting inside of a box to which such connections are capable of being made. Mounting on an outlet box cover with terminals or leads provided for field connection, or an equivalent arrangement, is one means of complying with this requirement.

b) If the circuit in which the end-of-line device is to be connected is rated for wiring by limited energy cable, the end-of-line device is not required to be enclosed in a metal box. The device shall terminate in splice leads, or spade type terminals with upturned lugs or equivalent, for making field connections. The exposed live parts of the assembly, except for the connection portion of the terminal, shall be covered with at least 0.013 inch (0.33 mm) of insulating tubing or equivalent.

33 Printed Wiring Boards

33.1 Printed wiring boards shall comply with the Standard for Printed-Wiring Boards, UL 796. 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 shall not result in damage to the board or in a risk of fire or electric shock.

34 Bushings

34.1 Where a lead or wire harness passes through an opening in a wall, barrier, or enclosure, there shall be a metal or insulating-type bushing, or the equivalent, which shall have a smoothly rounded surface.

34.2 If the opening is in phenolic composition, or other nonconducting material, a smoothly rounded surface is considered to be the equivalent of a bushing.

34.3 Ceramic materials and some molded compositions may be used for insulating bushings; but separate bushings of wood and of hot-molded shellac are not considered to comply with these requirements.

34.4 When fiber is used, it shall be used in locations 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 formed and secured in place so that it will not be affected adversely by conditions of ordinary moisture.

34.5 If a soft-rubber or neoprene bushing is used in a hole in metal, the hole shall be free from sharp edges, burrs, or projections, so as not to cut into the rubber.

34.6 An insulating metal grommet would be considered to comply with these requirements in lieu of an insulating bushing, provided that the insulating material used is not less than 1/32 inch (0.8 mm) thick and fills completely the space between the grommet and the metal in which it is mounted.

35 Coil Windings

35.1 The insulation of coil windings on relays, transformers, and the like shall resist the absorption of moisture.

35.2 Enameled wire is not required to be given additional treatment to prevent moisture absorption.

36 Switches

36.1 A switch provided as part of a device shall have a current and voltage rating not less than that of the circuit which it controls when the device is operated under any condition of intended service.

36.2 If a reset switch is provided it shall be of a self-restoring type.

36.3 A switch to de-energize the power to the control unit, or to silence sounding devices, shall not be provided unless its "off-normal" position is indicated by a visual or audible trouble signal. If a remote switch is additionally used, the trouble signal shall also be provided at the remote location. Visual indication to signal its "off-normal" position is not required for a switch used to deenergize other than a fire alarm circuit in a combination system.

37 Lampholders and Lamps

37.1 Lampholders and lamps shall be rated for the circuit in which they are used when the control unit is operated under any condition of intended service.

37.2 The screw shell of any Edison-base lampholder used in the supply circuit operating in excess of 30 volts AC rms (42.4 volts peak or direct current) shall be connected to the identified (grounded) conductor.

37.3 A single pole switching device shall not be connected to the identified (grounded) conductor.

37.4 If more than one Edison-base lampholder is provided, the screw shells of all such lampholders shall be connected to the same conductor unless there is no risk of electric shock present (30 volts rms or less) when replacing the lamps.

37.5 A lampholder shall be constructed or installed so that uninsulated live parts other than the screw shell will not be exposed to contact by persons removing or replacing lamps in service.

38 Protective Devices

38.1 Fuseholders, fuses, and circuit breakers provided on a control unit shall be rated for the application.

SPACINGS

39 General

39.1 A control unit shall provide reliably maintained spacings between uninsulated live parts and dead metal parts and between uninsulated current-carrying parts of opposite polarity. The spacings shall not be less than those indicated in Table 39.1.

Table 39.1
Minimum spacings

Point of application	Minimum spacings[a,b]				
	Voltage range [d]	Through air		Over surface	
	volts	inch	(mm)	inch	(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)

Table 39.1 Continued on Next Page

Table 39.1 Continued

Point of application	Minimum spacings[a,b]				
	Voltage range [d]	Through air		Over surface	
	volts	inch	(mm)	inch	(mm)
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	3/8	(9.5)	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.

39.2 The spacings between an insulated live part and a:

a) Wall or cover of a metal enclosure;

b) Fitting for conduit or metal-clad cable; and

c) Metal piece attached to a metal enclosure, where deformation of the enclosure is liable to reduce spacings,

shall not be less than that indicated in Table 39.1.

39.3 The spacing between an uninsulated live part and an:

a) Uninsulated live part of opposite polarity;

b) Uninsulated, grounded, dead metal part other than the enclosure; and

c) Exposed dead metal part which is isolated (insulated)

shall not be less than that indicated in Table 39.1.

39.4 The spacings within snap switches, lampholders, and similar wiring devices applied as part of a unit are evaluated on the basis of the requirements for such devices. See 2.1.1.

39.5 A barrier or liner of insulating material which is used to provide spacings shall be of material such as impregnated fiber, phenolic composition, or the equivalent, and shall not be less than 0.028 inch (0.71 mm) thick. A barrier or liner which is used in conjunction with not less than one-half the required spacing through air shall not be less than 0.013 inch (0.33 mm) thick, and located so that it will not be affected adversely by operation of the control unit.

39.6 Insulating material having a thickness less than that specified in 39.5 may be used if it is determined to have equivalent mechanical and electrical properties.

39.7 Film-coated wire is considered to be a bare current-carrying part in determining compliance of a device with the spacing requirements, but film coating may be used as turn-to-turn insulation in coils.

PERFORMANCE

40 General

40.1 Except as otherwise indicated, the performance of a household control unit shall be investigated by subjecting a representative sample in commercial form to the tests described in these Performance sections and, as far as applicable, in the same order as presented.

40.2 Power supply terminals are to be connected to a supply circuit of rated voltage and frequency. Rated voltage is considered to be 120 volts.

40.3 The type of battery with which the control unit is intended to be used shall be connected to the control unit.

40.4 In a combination control unit, separate circuits shall be used for fire alarm initiating devices and other than fire alarm (burglary) devices.

40.5 If a control unit must be mounted in a definite position in order to function as intended, it is to be tested in that position.

40.6 Products that currently meet all the requirements of the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio, Video, and Similar Electronic Apparatus-Safety Requirements, UL 60065, are not required to be evaluated to Sections: 56, 57, and 59.

41 Normal Operation Test

41.1 Fire alarm control unit

41.1.1 A household control unit shall be capable of operating reliably and uniformly for all conditions of its intended performance when used in conjunction with initiating devices and notification appliances and other devices to form a system combination of the type indicated by the installation wiring diagram and any supplementary information provided.

41.1.2 Notification appliances and initiating devices are to be connected to the control unit as specified by the installation wiring diagram to form a typical combination, and the control unit is then to be operated for each condition of its intended performance.

41.1.3 The initiating devices, heat detectors, smoke detectors, manual boxes, and the like, used for testing are to be those specified by the installation wiring diagram of the control unit, except that substitute devices are only to be used if they produce equivalent signal indication and circuit loading. Substitute load devices are considered to be those which have been found by investigation to provide the same load conditions as those obtained with the devices intended to be used with the control unit in service.

41.1.4 A control unit is to be in the supervisory "standby" condition and prepared for intended signaling operation when it is connected to related devices and circuits as specified on the installation wiring diagram provided by the manufacturer. A "power on" visual indication is to be obtained at the user interface.

41.1.5 The operation of any initiating device shall cause the control unit to operate related and notification appliances so as to produce a clearly defined signal of the type for which the combination is designed.

41.1.6 Whenever the intended occupant response is to evacuate the building, an audible alarm notification appliance shall produce a 3-pulse temporal pattern. The pattern shall consist of an "on" phase lasting 0.5 second ±10 percent followed by an "off" phase lasting 0.5 second ±10 percent, for three successive "on" periods, which is then followed by an "off" phase lasting 1.5 seconds ±10 percent. The signal shall be repeated for a minimum of 4 minutes or until manually silenced. A single stroke bell or chime sounded at "on" intervals lasting 1 second ±10 percent, with a 2-second ±10 percent "off" interval after each third "on" stroke is acceptable.

41.1.7 Audible alarms utilizing a low-frequency tone shall comply with the fundamental and harmonic frequency requirements in the section for Determination of low frequency signal format in the Standard for Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories, UL 464.

41.1.8 A voice message shall be permitted to be included with the standardized alarm signal in one or both of the formats noted below:

a) A voice message of 1.5 seconds or less in length shall be permitted to be inserted into any or all of the 1.5 second off phases of the temporal pattern.

b) A voice message that exceeds 1.5 seconds but does not exceed 10 seconds in length shall be permitted to be inserted following a minimum of 8 cycles of the initial "three pulse" temporal pattern. This voice message shall be followed by not less than 2 cycles of the "three pulse" temporal pattern. The voice message shall then be permitted to be repeatedly inserted provided that each additional use of the voice message follows at least 2 cycles of the "three pulse" temporal pattern.

41.1.9 Visible alarm notification appliances shall comply with the requirements of the Standard for Signaling Devices for the Hearing Impaired, UL 1971.

41.1.10 Operation of the test switch shall result in the same indication as operation of an initiating device.

41.1.11 An alarm signal of a household control unit initiated from a circuit containing heat detectors shall be maintained continuously (locked in) by the control unit until a resetting device in the control unit is operated manually. An alarm signal initiated from a circuit containing smoke detectors need not lock in. If both heat and smoke detectors are connected in the same initiating device circuit, lock-in is required. If a lock-in is provided for an alarm signal originating from a circuit to which only smoke detectors are connected, a switch to preclude the lock-in is not prohibited.

41.1.12 If the "off-normal" position of any normally preset mechanism or similar part of a control unit requires manual restoration in order to permit signaling performance of the control unit, such position shall be indicated by a visual or audible trouble signal.

41.1.13 The intended operation of a household control unit shall not depend upon any ground connection.

41.1.14 Any manual means for turning off activated alarm notification appliances (silencing) shall comply with the following requirements:

a) Alarm signal deactivating of activated notification appliances of a control unit/system shall be indicated by a constantly displayed and identified visual indicator;

b) An alarm signal deactivating means left in the off-normal condition when there is no alarm shall activate an audible trouble signal until the means is restored to normal;

c) An alarm-signal deactivation switch shall be either:

1) A key-lock type, with the key removable only in the normal position;

2) Located inside of a locked enclosure;

3) Access limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

d) The activation of the alarm signal deactivating means during an alarm condition shall not result in resetting any actuated circuit other than the notification appliance circuit(s) or zone(s) being deactivated; and

e) The alarm condition shall be indicated and maintained by a lamp or other visual indicator with the deactivating means activated.

41.1.15 Fire alarm activation at a keypad shall require a manual operation of a minimum of two simultaneous or sequential operations.

41.1.16 Actuation of a sprinkler waterflow alarm initiating device shall be permitted to activate an alarm signal.

41.1.17 Actuation of a sprinkler waterflow supervisory initiating device, such as a valve tamper switch, shall activate a supervisory signal.

41.1.18 Smoke and/or heat alarms interconnected to the household fire warning system equipment shall meet the requirements of Section 41, Normal Operation Test, 44.2 electrical supervision, and Sections 63 – 75, short range radio frequency devices.

Exception: Smoke alarms interconnected to household fire warning 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 41.2.2(c);

e) A maximum of 18 initiating device alarms, with no more than 12 smoke alarms;

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

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

h) 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 this standard, Sections 45, 46, 49, 52, 53, 54, and 55, as applicable. D_{EOAT} is a "line of sight" distance equivalent to 30.5 m (100 ft) indoors as defined by the following equations.

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

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

$$L_b = 4X(L_W) + 2X(L_f)$$

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.

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

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}.

41.2 Supervising stations

41.2.1 Supplementary functions, including the extension of an alarm beyond the residential occupancy, shall not interfere with the operation and monitoring for integrity requirements of this Standard.

41.2.2 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:

a) Shall only require a single telephone line;

b) Shall only require a call to a single digital alarm communicator receiver (DACR) number;

c) Test signals shall be transmitted at least monthly; and

d) The DACT signal shall be permitted to be transmitted over a dedicated cellular telephone connection.

41.2.3 Communications path(s) other than those described in 41.2.2, such as internet signaling shall comply with the following:

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

b) 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.

c) Alarm, trouble, and supervisory signals, and their restoration to normal, transmitted from the protected premise 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 premise.

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

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

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

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

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

f) 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.

41.2.4 The time period for the minimum required test signals specified in 41.2.2(c) and 41.2.3(a), as applicable, shall be the default programming setting for the transmitter and the test signals shall be automatically implemented when signaling to a supervising station is utilized.

41.3 Combination control unit

41.3.1 General

41.3.1.1 In a combination control unit, such as a combination household fire-burglar alarm control unit, the following operation shall be obtained:

a) A fire alarm signal shall take precedence or be clearly recognizable over any other signal even when the nonfire-alarm signal is initiated first.

b) Distinctive alarm signals shall be obtained between fire alarm and other functions, such as burglar alarm. The use of a common sounding appliance for fire 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.

c) The following priority of signaling shall be maintained:

1) Fire alarms;

2) Carbon monoxide alarms and medical alarms;

3) Sprinkler supervisory;

4) Security alarms;

5) Fire and carbon monoxide Trouble Signals;

6) Other signals.

41.3.1.2 When a fire alarm system is intended to share components, equipment, circuitry, or installation wiring with non-fire equipment, the requirements of 41.3.2.1 – 41.3.2.4 shall apply.

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

41.3.1.4 Single ground faults which impede or impair the monitoring for integrity of the fire alarm system, or impede or impair any fire supervisory or trouble signal transmissions or operation shall be reported at the household fire alarm system user interface per the requirements of 44.2 whether they occur in the fire alarm equipment, non-fire alarm equipment, or wiring.

41.3.1.5 Single ground faults in the non-fire alarm equipment shall not impair the alarm operation of the fire alarm system.

41.3.1.6 The required operation of the fire alarm equipment shall not be impaired by any failure of the 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-fire equipment.

41.3.2 Carbon monoxide signaling

41.3.2.1 Where the combination system activates audible 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 ±10% "on" and 100 ms ±10% "off," followed by 5 seconds ±10% "off."

b) After the initial 4 minutes of alarm, the five-second "off" time shall be permitted to be changed to 60 seconds ±10%.

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

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

41.3.2.3 Priority and display of the signaling shall be in accordance with 41.3.1.1(c).

41.3.2.4 The circuit and pathways to carbon monoxide initiating devices and notification appliances shall be monitored for integrity in the same manner as fire alarm circuits and pathways described in 44 and 64.

41.3.2.5 Where the system has provision for signaling off premise, the signaling of carbon monoxide alarms shall meet the requirements of 41.2.

41.3.2.6 The faults on non-fire, other than carbon monoxide, equipment and wiring described in 41.3.1.2 shall not impede or impair the monitoring for integrity the carbon monoxide portion of the system or impede or impair any carbon monoxide signal transmissions or operations.

41.3.2.7 Carbon monoxide alarms interconnected to the household fire warning system equipment shall meet the requirements of Section 41, Normal Operation Test, Section 44.2, Electrical Supervision, and Sections 63 – 75, short range radio frequency devices in the same manner as fire alarms.

Exception: Carbon monoxide alarms interconnected to household fire warning system equipment when 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 on the wired interconnections do not prevent the operation of each individual carbon monoxide alarm or the remaining operation of the household fire warning system; and

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

41.4 Primary power supply

41.4.1 With the standby rechargeable battery fully discharged (85 percent of its marked nominal rating) or the nonrechargeable-type battery disconnected, the household control unit shall operate as specified in 41.1.1 – 41.2.1. There shall not be a change in the operation of the control unit. In the normal supervisory condition, the battery charger portion of the unit shall charge the rechargeable battery as intended; and in the alarm condition, the standby battery shall not be in a discharge mode of operation (a drain greater than 1 percent of its ampere-hour rating).

42 Alarm Verification Feature (Optional)

42.1 To reduce the effect of electrical and migratory smoke transients, a system control unit may have provision for an alarm verification feature for alarm signals received from smoke detectors or smoke monitoring heads. If used, the feature shall be:

a) Integral in the control unit;

b) A module that can be wired or plugged into a control unit;

c) A separate entity that can be field wired to interface between the control unit and initiating device circuit; or

d) Another arrangement determined to be equivalent.

Alarm verification shall be arranged on a per circuit (zone) basis, except it may be accomplished on a multiple circuit (zone) or system basis if the retard-reset-restart duration of the verification procedure is not more than 30 seconds. Alarms from devices other than smoke detection shall not be delayed by more than 10 seconds when this option is employed.

42.2 If an alarm verification feature is provided, the maximum retard-reset period before an alarm signal can be confirmed and indicated at the control unit, including any control unit reset time and the power-up time for the detector to become operational for alarm, shall not exceed 60 seconds. Any alarm during the 60-second alarm confirmation period following the retard-reset period shall result in an immediate alarm from the control unit. See Figure 3.1.

42.3 The retard-reset period of alarm verification need not include the polling time of a multiplex system control unit if alarm verification is provided at the data gathering panel (DGP) to which the smoke detectors are connected, but shall include the polling time if the alarm verification is provided at the central receiving control unit.

42.4 Alarm verification shall not be used in initiating device circuits intended for cross zone operation.

42.5 Control units incorporating an alarm verification feature shall not be used with smoke detectors using an alarm verification feature.

Exception: This requirement does not apply to smoke detectors that use less than 10 seconds for signal processing time and do not reset themselves.

42.6 Alarm verification shall apply to alarm signals from smoke detectors only, and not to alarm signals from other initiating devices, such as manual stations, heat detectors, water flow indicators, and the like, which may be connected to the same circuit. See 42.1 for requirements covering alternative configurations.

42.7 The alarm verification feature is permitted to be used to process the alarm signals described in 42.1 – 42.6 relative to both actuate notification appliances in the residence and the transmission of alarm signals to a remote location, or only for the transmission of alarm signals to a remote location.

42.8 The maximum retard-reset-restart period of alarm verification of a system control unit, including any time delay due to system reset and power-up time of the smoke detector to become operational for alarm, shall not exceed 60 seconds. During the 60-second alarm confirmation period following the retard-reset-restart period, reactuation of the same detector that initiated the alarm verification cycle, actuation of another smoke detector on the same circuit (zone), or a fire alarm from another zone shall result immediately in an alarm signal from the control unit.

Exception: When two or more protected premises units are connected to a central receiving unit, each zone panel (protected premises unit) may be configured to permit its own alarm verification feature.

42.9 To determine the retard duration of the alarm verification feature (not including the power-up time of a smoke detector unless the detector is connected), a control unit is to be connected to a rated source of electrical supply as specified in 40.2. Each initiating device circuit provided with alarm verification is to be placed into alarm by a switch representing detector contacts, or by actuation of the specific detector to be used with the control unit, or by other means to produce an alarm. The time between initiation of the detector alarm and energization of the control unit alarm circuit is the retard period. The retard-reset period is to be determined by adding the maximum power-up time of the smoke detector(s), intended to be connected to the control unit as indicated in the control unit installation drawing, to the retard period.

42.10 To determine that an alarm is obtained from the control unit during the 60-second alarm confirmation period, the control unit and initiating device circuit (or detector) are to be energized in the normal standby condition. The initiating device circuit (or detector) is then to be placed in alarm to actuate the alarm verification cycle of the control unit and restored to the nonalarm condition. At the beginning, middle, and end of the alarm confirmation period, the initiating device circuit (or detector) is to be placed in alarm at which time the control unit is to alarm.

43 Two-Wire Smoke Detector Compatibility Tests

43.1 Operating voltage determination

43.1.1 The voltage range determined during 43.1.2 (a) – (e) shall not be below the minimum, nor above the maximum manufacturer's ratings specified for the control unit initiating circuit.

43.1.2 For control unit-smoke detector compatibility considerations, the operating voltage of an initiating device circuit is determined while the control unit is operating at each of the conditions specified in (a) – (e) as follows:

a) Rated primary and secondary input voltage, maximum initiating circuit series line resistance, and rated load conditions.

b) Overvoltage condition of ac input, as described in 46.1, with no load on the control unit, the initiating circuit disconnected from the end-of-line device, zero initiating circuit line resistance, and the standby power source disconnected.

c) Overvoltage condition of the standby input voltage, as described in 46.1, with no load on the control unit, the initiating circuit disconnected from the end-of-line device, zero initiating circuit line resistance, and the primary power source disconnected.

d) Undervoltage condition of ac input, as described in 45.1, with maximum rated load connected to the control unit, maximum initiating circuit series line resistance, and standby power source disconnected.

e) Primary AC supply disconnected, standby voltage adjusted to 85 percent of rated voltage, and maximum load and initiating circuit series line resistance, connected to the control unit. See 45.3.

43.1.3 The operating voltage of a two-wire smoke detector is considered compatible with an initiating device circuit if the detector's operating voltage range coincides with or overlaps the initiating circuit's rated voltage range at both the high and low end.

43.2 Alarm threshold impedance

43.2.1 The initiating circuit of a control unit shall be rated to indicate the maximum impedance that will reliably trip the circuit into the alarm condition.

43.2.2 Compliance with 43.2.1 is determined by connecting a variable resistor in parallel with the end-of-line device and slowly reducing the resistance until the control unit latches into the alarm condition.

43.2.3 The test is to be repeated for 43.1.2 (a) – (e). The lowest resistance setting recorded that will trip the alarm condition shall be equal to or greater than the rated value.

43.3 Maximum current limitation

43.3.1 Some two-wire smoke detectors that do not include internal current limitation are susceptible to damage during the alarm condition if the available initiating circuit current exceeds the detector maximum current ratings. A two-wire detector would be considered compatible with a control unit initiating circuit if the maximum available initiating circuit current does not exceed the maximum alarm current rating of the noncurrent limited detector, when the initiating circuit is loaded with a single detector, or equivalent impedance, in the alarm condition.

43.3.2 Compliance with 43.3.1 is determined by connecting a variable resistor and ammeter across the initiating circuit and reducing the resistance to not less than the minimum equivalent impedance of the

detector in the alarm condition until maximum current is recorded. This test is repeated for 43.1.2 (a) – (e). The maximum recorded current shall not exceed the manufacturer's ratings.

43.4 Multiple detector alarm capacity

43.4.1 A control unit initiating circuit intended to respond to or support more than one smoke detector in the alarm condition shall maintain a rated voltage as determined by 43.1.2 (a) – (e) while connected to the minimum impedance that would be imposed by one or more detectors in the alarm condition.

43.5 Detectors with optional components

43.5.1 Some smoke detectors incorporate optional components such as relays and audible devices. These optional components are intended to operate during the alarm condition, and therefore, the initiating circuit shall maintain rated voltage during the alarm condition to provide intended operation of these optional components.

43.5.2 If a control unit initiating circuit is intended to be used with a detector as described in 43.5.1, the control unit shall be rated to indicate the minimum impedance during the alarm condition that will permit minimum rated alarm condition voltage during conditions 43.1.2 (a) – (e). Unless the product is intended to be compatible with only one smoke detector, the minimum alarm impedance shall be expressed in range of voltage versus current or impedance values.

43.6 Dynamic load immunity

43.6.1 A control unit having initiating device circuits intended for use with two-wire smoke detectors with pulsing normal operating current shall not false alarm due to the random pulsing load presented by the maximum number of detectors permitted to be connected to the circuit.

43.6.2 The control unit is to be energized from a source of rated voltage and frequency and the maximum number of two-wire smoke detectors specified in the installation wiring diagram are to be connected to an initiating device circuit. The combination is to be operated in the normal supervisory condition for 30 days. During that time, no false alarms shall occur. The test is to be repeated for each type and combination of smoke detector specified on the installation wiring diagram.

Exception: A control unit that provides an alarm retard of 1 – 3 seconds on the initiating device circuit need not be subjected to the test if the two-wire detectors intended to be connected to the circuits have power pulse durations, in seconds, equal to or less than the reciprocal of the maximum number of detectors.

43.7 Electrical supervision

43.7.1 A control unit, while connected to the maximum number of two-wire detectors indicated on the installation wiring diagram, shall provide supervision of an open circuit beyond the last detector in the initiating device circuit. The trouble signal shall be the same with or without detectors connected.

43.7.2 The control unit shall produce the same type of audible trouble signal when operated under conditions 43.1.2 (a), (b), and (d).

43.8 Maximum capacitance loading

43.8.1 The initiating circuit of a product shall be rated to indicate the maximum capacitance loading that can be placed on the circuit without affecting the normal operating characteristics.

43.8.2 Compliance with 43.8.1 is to be determined by:

a) Connecting the maximum specified capacitance in parallel with the end-of-line device simultaneously with the operation of the product's reset switch; and

b) Confirming that the circuit resets to the normal supervisory condition.

43.8.3 The test is to be repeated for the conditions described in 43.1.2 (a) – (e).

43.9 Alarm reset voltage and time

43.9.1 The initiating circuit of a product shall be rated to indicate the maximum alarm reset voltage and the minimum alarm reset time.

43.9.2 Compliance with 43.9.1 is to be determined by activating the reset switch and recording:

a) The highest voltage which remains on the initiating circuit; and

b) The time interval the circuit was de-energized below the maximum specified reset voltage.

43.10 Alarm verification (optional)

43.10.1 Products providing alarm verification shall meet the timing requirements specified in 42.

43.11 Minimum normal standby impedance (optional)

43.11.1 The initiating circuit of the product shall be rated to indicate the minimum impedance that will reliably not trip the circuit into the alarm condition.

43.11.2 Compliance with 43.11.1 is to be determined by conducting the test described in 43.2. The test is to be repeated for the conditions described in 43.1.2 (a) – (e).

43.11.3 The highest impedance recorded that will trip the alarm condition shall be less than the rated value.

43.12 Minimum impedance where second alarm will not occur (optional)

43.12.1 The initiating circuit of the product shall be rated to indicate the minimum impedance that will reliably not result in the occurrence of the second alarm condition for a counting zone.

43.12.2 Compliance with 43.12.1 is to be determined by conducting the test described in 43.2. The test is repeated for the conditions described in 43.1.2 (a) – (e).

43.12.3 The highest impedance recorded that will trip the second alarm condition shall be less than the rated value.

44 Electrical Supervision Test

44.1 Power supplies

44.1.1 Interruption and restoration of any source of electrical energy connected to a control unit shall not cause an alarm signal.

Exception: An audible or visual alarm signal shall be permitted if it does not exceed 2 seconds.

44.1.2 An open in the primary supply of a household control unit shall be shown by de-energization of the "power on" indicator at the user interface.

44.1.3 Provision shall be made for an automatic test of the standby battery at least once every 4 hours. The test shall be conducted under a load sufficient to determine if the battery requires service, has been removed, or is disconnected. A battery requiring service is defined as a battery which is not capable of providing 4 minutes of alarm signaling during a power failure. If the automatic battery test determines that the battery requires service or is disconnected, a distinctive audible and visual trouble signal shall be provided at the user interface.

44.2 Interconnecting circuits and pathways

44.2.1 Household fire alarm system smoke detectors, initiating devices and notification appliances shall be monitored for integrity so that within 200 s 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. See 81.1(i).

44.2.2 An initiating device circuit of a control unit using radio frequency (RF) transmission is to be supervised in accordance with Section 64, Operation.

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

44.2.4 A single break or single ground fault in any initiating device or indicating device circuit or any circuit extending from the control unit shall not cause an alarm signal.

44.3 Trouble signals

44.3.1 A trouble signal shall be indicated by the operation of a distinctive sounding appliance.

44.3.2 A 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 fire and non-fire related signals, distinction shall be achieved visually.

44.3.3 In a combination system, both the fire alarm and non-fire-alarm circuits are not prohibited from using the same trouble signal.

44.3.4 A means for silencing a trouble sounding device shall comply with all of the following:

a) Limiting access by being one of the below:

1) Key operated with the key removable only in the normal position;

2) Located within a locked cabinet;

3) Limited by a software security code providing a minimum of 1000 combinations and with a maximum 30-minute time-out feature after the last activity; or

4) Arranged to provide equivalent protection against unauthorized use.

b) A visible trouble indicator remains activated or is simultaneously activated when the sounding device is de-energized.

c) The audible trouble signal shall sound when the means is in the "silence" position and no trouble exists.

d) The visible indicator shall be located and identified so that the user will recognize the signal as soon as it is activated.

44.4 Keypads

44.4.1 Keypads and other operator interfaces 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 system for alarms, alarm transmissions to a supervising station, or the signal representative of a failure to complete a signal transmission with a supervising station. The trouble annunciation shall be at an operator interface or audible at the operator interface. 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 keypad interconnections to the control unit extending not more than 3 feet (0.91 m) from the control unit.

44.4.2 Annunciation of the audible trouble signal required by 44.4.1 is permitted to be remote from an operator interface, when the product's installation instructions alert the user that the product sounding the audible is to be installed in a location where the audible signal can be heard at the operator interface.

45 Undervoltage Operation Test

45.1 A household control unit shall operate successfully for its intended signaling performance while energized at 85 percent of its rated voltage. If provided, a standby battery is to be disconnected during the test.

45.2 The control unit is to be subjected to rated voltage during the intended supervisory condition for at least 3 hours and then tested immediately for the intended signaling condition at the reduced voltage. The voltage is to be reduced by a means which will maintain a stable potential of the required value under the most severe conditions of intended loading.

45.3 When a standby battery is used with the control unit, the reduced voltage value to the control unit battery terminals (leads) is to be 85 percent of the marked rated nominal battery voltage.

45.4 If the maximum impedance of an initiating circuit extended from a control unit is required to be less than 100 ohms in order to obtain successful operation, the undervoltage operation test is to be conducted with the maximum impedance connected to the circuit. If no impedance limitation is indicated in the marking, 100 ohms is to be used in the initiating device circuit.

46 Overvoltage Operation Test

46.1 A household control unit shall be capable of withstanding 110 percent of its rated supply voltage continuously without damage during the intended standby condition and shall operate successfully for its intended signaling performance at the increased voltage.

46.2 The control unit is to be subjected to the increased voltage in the standby condition for approximately 16 hours (overnight) and then tested for its intended signaling performance. For this test zero line impedance is to be used in the initiating device circuit.

47 Voltage and Current Measurements

47.1 Input circuit

47.1.1 The input current of a control unit shall not exceed the marked rating of the control unit by more than 10 percent when the control unit is operated under conditions of intended use while connected to a rated source of supply.

47.2 Output circuit

47.2.1 The measured voltage of a household unit output circuit shall not be more than 130 percent of rated voltage at no load conditions and not less than 100 percent of rated voltage at maximum rated load conditions. The same proportionate limits shall be maintained at the output circuit when the supply voltage is varied between 85 and 110 percent of rating. The rated loads are to be connected with the control unit connected to a rated source of supply.

47.2.2 The measured voltages at the output circuits, with the minimum and maximum (rated) loads applied in turn, shall be compatible with the rating of the device or appliance intended to be connected to the circuit.

48 Power-Limited Circuits

48.1 General

48.1.1 All field-wiring circuits that derive energy from power sources connected to a control unit shall be classified as a power-limited or nonpower-limited circuit. A circuit shall be considered nonpower-limited unless otherwise identified in the installation documentation and marking on the product.

48.1.2 The power source (or sources) supplying a power-limited circuit shall be either:

a) Inherently limited requiring no overcurrent protection, or

b) Limited by a combination of a power source and overcurrent protection devices such that a power-limited circuit has electrical characteristics described in Table 48.1 for AC circuits or Table 48.2 for DC circuits.

Table 48.1
Power source limitations for alternating current fire protective signaling circuits

Power source type	Circuit voltage V_{max} [a] (volts)	Power source maximum nameplate ratings, VA (volt-amps)	Power source maximum nameplate ratings, Current (amps)	Current limitations I_{max} [b] (amps)	Power limitations $(VA)_{max}$ [c] (volt-amps)	Maximum overcurrent protection (amps)
Inherently limited power source (overcurrent protection not required)	0 to 20	5.0 × V_{max}	5.0	8.0	–	–
	Over 20 to 30	100	100/V_{max}	8.0	–	–
	Over 30 to 100	100	100/V_{max}	150/V_{max}	–	–
Not inherently limited power source (overcurrent protection required)	0 to 20	5.0 × V_{max}	5.0	1000/V_{max}	250[d]	5.0
	Over 20 to 100	100	100/V_{max}	1000/V_{max}	250	100/V_{max}
	Over 100 to 150	100	100/V_{max}	1.0	N.A.	1.0

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

[b] I_{max}: Maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed, if used. When a transformer limits the output current, Imax limits apply after 1 minute of operation. Where a current limiting impedance is used in combination with a nonpower-limited transformer or a stored energy source, such as a storage battery, in order to limit the output current, Imax limits apply after 5 seconds.

[c] $(VA)_{max}$: Maximum volt-ampere output after 1 minute of operation regardless of load, and with overcurrent protection bypassed, if used. Current-limiting impedance shall not be bypassed when determining I_{max} and VA_{max}.

[d] If the power source is a transformer, $(VA)_{max}$ is 350 volt-amperes or less when V_{max} is 15 volts or less.

Table 48.2
Power source limitations for direct current fire protective signaling circuits

Power source type	Circuit voltage V_{max} [a] (volts)	Power source maximum nameplate ratings, VA (volt-amps)	Power source maximum nameplate ratings, Current (amps)	Current limitations I_{max} [b] (amps)	Power limitations $(VA)_{max}$ [c] (volt-amps)	Maximum overcurrent protection (amps)
Inherently limited power source (overcurrent protection not required)	0 to 20	5.0 × V_{max}	5.0	8.0	–	–
	Over 20 to 30	100	100/V_{max}	8.0	–	–
	Over 30 to 100	100	100/V_{max}	150/V_{max}	–	–
Not inherently limited power source (overcurrent protection required)	0 to 20	5.0 × V_{max}	5.0	1000/V_{max}	250[d]	5.0
	Over 20 to 100	100	100/V_{max}	1000/V_{max}	250	100/V_{max}
	Over 100 to 150	100	100/V_{max}	1.0	N.A.	1.0

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

[b] I_{max}: Maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed, if used. When a transformer limits the output current, Imax limits apply after 1 minute of operation. Where a current limiting impedance is used in combination with a nonpower-limited transformer or a stored energy source, such as a storage battery, in order to limit the output current, I_{max} limits apply after 5 seconds.

[c] $(VA)_{max}$: Maximum volt-ampere output after 1 minute of operation regardless of load, and with overcurrent protection bypassed, if used. Current-limiting impedance shall not be bypassed when determining I_{max} and VA_{max}.

[d] If the power source is a transformer, $(VA)_{max}$ is 350 volt-amperes or less when V_{max} is 15 volts or less.

48.1.3 With regard to 48.1.2, means that may be used for current limiting include:

a) Transformer winding impedance,

b) A thermal link embedded within the winding overwrap of a transformer,

c) Circuit components (resistors, regulators, transistors, and the like) that comply with the Temperature Test, Section 50, under I_{max} conditions, and

d) Current limiting impedances determined to be suitable for the application (positive temperature coefficient varistor or the like).

Circuit component burnout, permanent (by soldered means or the like) or replaceable fuses, opening of conductors on printed wiring boards, or opening of internal wiring conductors, shall not be used as a means of current limiting.

48.1.4 The overcurrent protection device specified in 48.1.2 shall be of the noninterchangeable type such that it cannot be renewed in the field with an overcurrent device having a higher current rating.

48.1.5 If the product contains a float battery charger, the V_{max}, I_{max}, and VA_{max} are to be measured with both the AC power source and the battery connected to the product. If the circuit contains a battery transfer relay or a trickle charge battery circuit, the V_{max}, I_{max}, and VA_{max} are to be measured first with the product energized only from the AC power source and then measured a second time with the product energized solely from the battery. The battery used during these measurements is to have the largest capacity specified in the manufacturer's installation document and is to be charged for a period of time that will result in the battery being fully charged for this test.

48.1.6 When measuring the I_{max} and VA_{max}, all overcurrent protection devices of the control unit are to be short-circuited. However, current limiting devices are not to be bypassed and are to remain functional.

48.2 Maximum voltage

48.2.1 With the circuit energized only from its rated primary power source, the output voltage of the circuit under test is to be measured while the circuit is connected to full rated load and under open circuit conditions. The maximum voltage under these two conditions is to be considered V_{max}. If the product incorporates a secondary source of supply, the test is to be repeated with the circuit energized solely from the secondary power source and with the primary source disconnected. The V_{max} value obtained from each power source is to be considered separately when applying the requirements in Table 48.1 or Table 48.2.

48.3 Maximum current

48.3.1 In order to determine compliance with the I_{max} limitation, a variable load resistor is to be connected across the circuit. While monitoring the current through the load resistor, the load resistor is to be adjusted from open circuit to short circuit as quickly as possible and the highest current noted. The load resistor is then to be readjusted to produce the highest current obtained and the current through the load resistor is to be measured after 1 minute or after 5 seconds as determined by Table 48.1 or Table 48.2.

48.3.2 If the maximum current through the load resistor cannot be maintained for 5 seconds due to current limiting devices (opening of thermal link, power supply foldback, PTC varistor affect, and the like), the circuit load resistor is to be adjusted to a value that will produce a current just above the I_{max} value indicated in Table 48.1 or Table 48.2. The results are acceptable if the I_{max} value stated in Table 48.1 or Table 48.2 cannot be maintained for more than 5 seconds.

48.3.3 If a transformer limits the value of I_{max}, and if I_{max} cannot be maintained for 1 minute due to transformer burnout, a plot of current versus time is to be generated and the graph extrapolated to 1 minute. The results are acceptable if the extrapolated value of I_{max} at 1 minute does not exceed the I_{max} limitations as indicated in Table 48.1 or Table 48.2.

48.4 VA_{max} (not inherently limited circuits only)

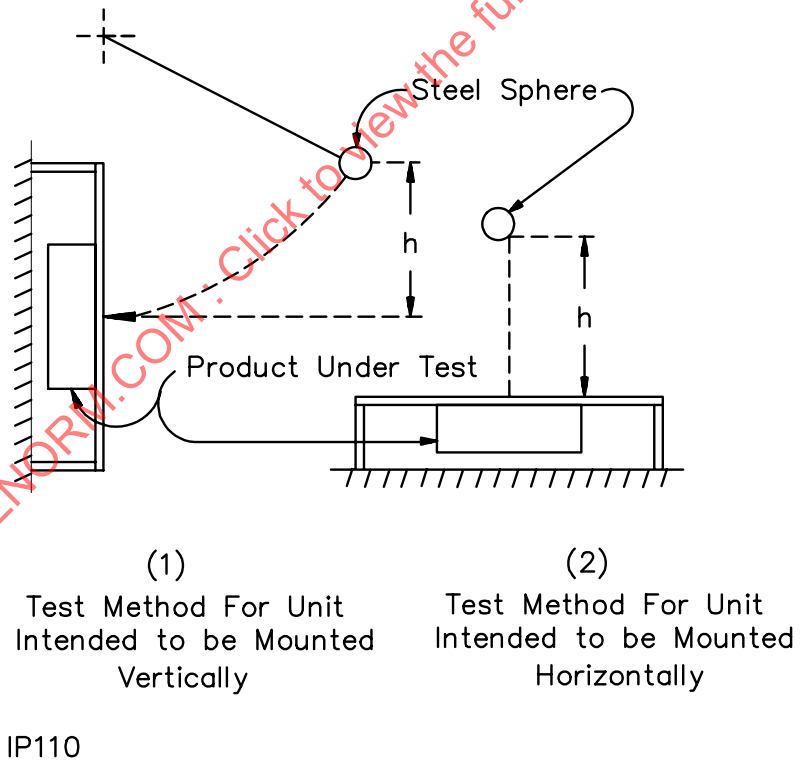
48.4.1 The circuit is to be energized from a rated source of supply and then the circuit under test open-circuited. A variable load resistor, initially set to draw rated circuit current, is then to be connected across the circuit. The circuit voltage and current are to be recorded and the load is to be removed. The resistance of the load is then to be decreased, momentarily reconnected across the circuit while recording the voltage and current, and then removed. This procedure is to be repeated until the load resistance has been reduced to a short circuit. Using the recorded voltage and current, the maximum volt-ampere, VA_{max}, output under each load condition is to be calculated. The load resistor is then to be adjusted to that value which produced the maximum volt-ampere, VA_{max}, calculated and then connected to the circuit. After 1 minute, the voltage and current are again to be measured. The calculated volt-ampere, VA, output of the circuit after 1 minute shall not exceed the values specified in Table 48.1 or Table 48.2, as appropriate.

49 Jarring Test

49.1 A household control unit and related accessories shall be capable of withstanding jarring resulting from impact and vibration such as experienced in use without causing signaling operation of any part and without affecting adversely the subsequent intended operation. See Figure 49.1.

Figure 49.1

Jarring test



49.2 The unit is to be mounted in a position of intended use at the center of a 6- by 4-foot (1.8- by 1.2-m), 3/4-inch (19.1-mm) thick plywood board which is secured in place at four corners. Three 3-foot-pound (4.1-J) impacts are to be applied to the center of the reverse side of the board by means of a 1.18-pound (0.54-kg), 2-inch (50.8-mm) diameter steel sphere swung through a pendulum arc from a height (h) of 2.54 feet (775 mm) or dropped form a height (h) of 2.54 feet (775 mm), depending on the mounting of the equipment, to apply the 3-foot-pound impact.

49.3 The effects of jarring are to be determined by supporting the unit in its intended position and conducting the jarring test with the unit in its intended standby condition and connected to a rated source of supply. Following the jarring test the unit(s) is to be tested for its intended signaling performance.

50 Component Temperature Test

50.1 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 Table 50.1 and Table 50.2.

Exception: A component with a temperature exceeding that indicated in Table 50.1 is not prohibited from being used when reliability data at the higher temperature is provided by the manufacturer to justify its use.

Table 50.1
Maximum temperature rises – 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) °F	(°C)	Alarm condition (i.e. short term operating condition of fire, security, or emergency signaling) °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 50.1 or the component reliability assessment specified in 50.2, exception (b) or (c).

[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 or 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.

[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:

Table 50.1 Continued on Next Page

Table 50.1 Continued

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) °F	(°C)	Alarm condition (i.e. short term operating condition of fire, security, or emergency signaling) °F	(°C)
a) For integrated circuitsthe 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 50.2
Maximum temperature rises – materials and component parts

Materials and component parts	°F	(°C)
1. Varnished cloth insulation	180	(60)
2. Fuses		
a) Class 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	126	(70)
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)

Table 50.2 Continued on Next Page

Table 50.2 Continued

Materials and component parts	°F	(°C)
10. Class 155 insulation systems on windings of relays, solenoids, magnets, transformers and similar parts:		
Thermocouple method	198	(105)
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].	243	(135)
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.

[c] Temperatures on the surface of any printed-wiring board shall not exceed the temperature limits of the board.

50.2 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 Table 50.1 and Table 50.2 are to be reduced by the amount of the difference between that higher ambient temperature and 77°F.

50.3 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.

50.4 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.

50.5 A product that is rated for use at more than one voltage or for a range of voltages shall be tested at each supply voltage.

50.6 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.

50.7 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 50.1 is questionable and, therefore, requiring the measurements indicated in 50.8.

50.8 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.

50.9 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.

50.10 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.

50.11 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.

50.12 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.

50.13 Component temperature is to be determined while the product is operated under the following conditions:

a) Normal supervisory condition (i.e. any long term fire or security condition of operation or any non-fire or non-emergency operating condition) 16 hours or until constant temperatures occurs. If the product is intended to charge standby batteries, this test shall be conducted while connected to a discharged battery (85 percent of its marked nominal rating).

b) Alarm condition (i.e. any short term operating condition of fire, smoke control, or emergency signaling which produces the maximum component temperature dissipation) under maximum rated load conditions – 1 hour.

c) Alarm condition, with notification appliances silenced – 7 hours.

50.14 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.

50.15 In a product having provision for multiple zones, all initiating circuits shall be actuated during the alarm condition.

50.16 When a time-limit cutout is provided as part of the product, and is not intended to limit the time of alarm-signal operation, it is to be shunted out of the circuit for the duration of the test.

51 Charging Current Test

51.1 General

51.1.1 This test is to be conducted in conjunction with the Temperature Test, Section 50, on products provided with standby batteries. The product shall operate as intended during this test.

51.2 Discharged battery

51.2.1 The measured voltage of an output circuit with the battery discharged as specified in 51.2.2 – 51.2.4 shall not be less than 85 percent of the marked output circuit rating.

51.2.2 The battery is first to be charged by applying AC input power to the product for 48 hours, during which the product is to be operated continuously with the normal standby load connected. AC input is then to be disconnected, and terminal voltage of the battery is to be measured one minute after disconnection.

51.2.3 The battery is then to be discharged by maintaining the normal standby load connected to the output for a minimum of 24 hours, or the marked standby time, whichever is greater.

51.2.4 At the conclusion of the discharge period, the loads indicated in 51.2.5 – 51.2.6 are to be applied. The battery terminal voltage of the discharge battery and the voltage of all output circuits are then to be measured.

51.2.5 The maximum alarm load is to be applied for 4 minutes for fire alarm conditions.

51.2.6 Where a combination system includes carbon monoxide signaling, the following load(s) are to be applied, as applicable to achieve minimum 12 hours of carbon monoxide audible alarm:

a) The product is to be placed in a carbon monoxide alarm condition and the maximum carbon monoxide alarm load is to be applied for 12 hours when the secondary power source (battery) of the product supplies power for the carbon monoxide audible alarm signal specified in 41.3.2.1;

b) The product is to be placed in a carbon monoxide alarm condition and the maximum carbon monoxide alarm load is to be applied for 4 minutes when all of the following conditions are met:

1) the secondary power source (battery) of the product does not supply power for the carbon monoxide audible alarm signal(s) specified in 41.3.2;

2) the interconnected product(s) employing the audible device(s) signaling the carbon monoxide audible alarm signal specified in 41.3.2.1 individually meet the 24 hour normal standby period followed by the 12 hour alarm period requirements; and

3) the carbon monoxide audible alarm signal specified in 41.3.2.1 is maintained for the 12 hour period independent of the control panel (product) maintaining secondary power after the standby period specified in 51.2.3.

51.3 Charged battery

51.3.1 The voltage of the charged battery as specified in 51.3.2 shall be at least 95 percent of the voltage measured in 51.2.2.

51.3.2 At the conclusion of the test sequence described in 51.2.2 – 51.2.4, AC input power is to be reapplied to the product for 48 hours. During the charging, the product is to be operated continuously with the normal standby load connected. At the conclusion of the 48-hour recharge time, AC power is to be disconnected and the battery-terminal voltage measured after one minute.

51.4 Discharged battery – second trial

51.4.1 The measured voltage of all output circuits shall not be less than 85 percent of the marked ratings of the output circuits after the battery has been discharged as specified in 51.2.3 and 51.2.4 following the charging as specified in 51.3.2.

52 Overload Test

52.1 Control unit

52.1.1 A household control unit shall be capable of operating in the intended manner after being subjected for 50 cycles of alarm signal operation at a rate of not more than 15 cycles per minute with the supply circuit maintained at 115 percent of rated voltage and frequency. Each cycle shall consist of starting with the control unit energized in the intended standby condition, initiation for an alarm, and restoration to intended standby.

52.1.2 Rated test loads are to be connected to those output circuits of the control unit which are energized from the control unit power supply, such as bells, buzzers, and the like. The test loads are to be those devices, or the equivalent, normally intended for connection. If an equivalent load is used for a device consisting of an inductive load, a power factor of 60 percent is to be used. The rated loads are established initially with the control unit connected to rated supply voltage and frequency, following which the voltage is raised to 115 percent of rating.

52.1.3 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 circuit is to be equal to 0.6 times the current measured with the load connected to a direct current circuit when the voltage of each circuit is the same.

52.2 Separately energized circuits

52.2.1 A household control unit shall be capable of operating in the intended manner after being subjected to 50 cycles of alarm signal operation at a rate of not more than 15 cycles per minute while connected to a source of rated voltage and frequency and 150 percent rated loads applied to output circuits which do not receive energy from the control unit. There shall not be electrical or mechanical failure of any of the components.

52.2.2 The test loads are to be set at 150 percent of rated current at rated voltage and frequency and 0.6 power factor.

53 Endurance Test

53.1 Control unit

53.1.1 A control unit shall be capable of operating in the intended manner after being subjected to 6000 cycles of signal operation at a rate of not more than 16 cycles per minute with the supply circuit at rated voltage and frequency and with rated devices or equivalent loads connected to the output circuits. There shall not be electrical or mechanical failure or evidence of failure of the control unit components. Each cycle is to consist of starting with the control unit in the intended standby condition, initiation for an alarm, and restoration to intended standby.

53.2 Operating device

53.2.1 An operating device, such as test switch, relay, and the like, supplied as part of a household control unit, or as an accessory, shall be capable of performing in the intended manner when operated for 6000 cycles at a rate of not more than 15 cycles per minute. When 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 is to represent that which the device is intended to control. The endurance tests of the devices may be conducted in conjunction with the endurance test of the control unit. There shall not be electrical or mechanical failure of the device, undue pitting, burning, or welding of the contacts.

54 Variable Ambient Temperature Test

54.1 A household control unit and related accessories shall be capable of operating in the intended manner when the temperature of the ambient air is any temperature over the range from 49 to 0°C (120 to 32°F).

54.2 The unit is to be maintained at each temperature for a sufficient length of time to ensure that thermal equilibrium has been reached, at least 3 hours, and then tested at that temperature for intended operation while connected to a source of rated voltage and frequency.

55 Humidity Test

55.1 A household control unit shall operate in the intended manner 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 30 ±2°C (86 ±3°F). The performance is to be determined with the control unit in the humidity ambient.

56 Leakage Current Test

56.1 The leakage current from a household control unit, directly powered from a source greater than 42.2 volts peak, shall not be more than 0.5 milliampere as measured between any exposed section of the enclosure to the grounded leg of the alternating current supply.

56.2 The leakage current measurement is to be made on the sample within 1 minute after it has been removed from the ambient in the Humidity Test, Section 55. The sample is to be connected to a source of rated voltage and frequency in the intended standby condition.

56.3 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 4 by 8 inches (10 by 20 cm) placed in contact with the surface. Where the surface is less than 4 by 8 inches, 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.

56.4 The unit is to be mounted on an insulating table. The grounding pin connection from the attachment plug is to be disconnected prior to making the leakage current measurement.

56.5 The measurement circuit for the leakage current test is to be as illustrated in Figure 56.1. The measurement instrument is defined in (a) – (c). The meter used for a measurement need only indicate the same numerical value for the particular measurement as would the defined instrument. The meter is not required to have all of the attributes of the defined instrument.

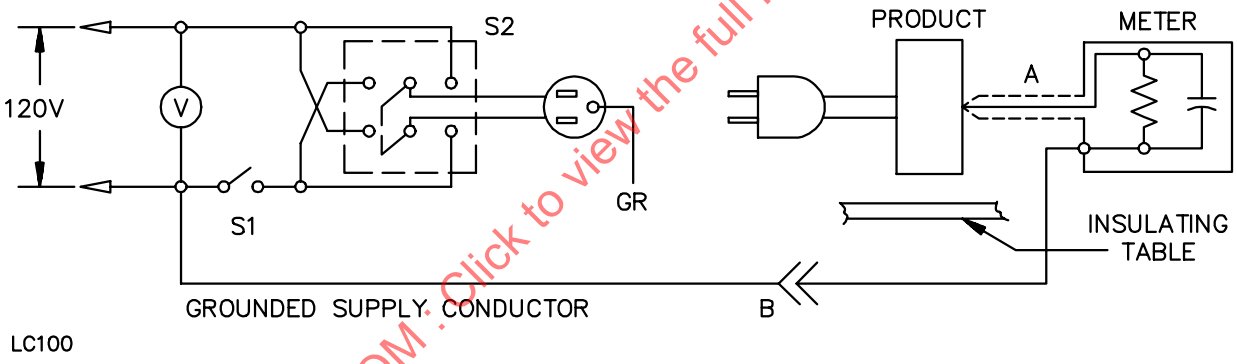
a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad;

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor;

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

Figure 56.1

Leakage current measurement circuits



56.6 Unless the meter is being used to measure the leakage current from one part of a product to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

56.7 Systems of interconnected equipment with individual connections to primary power are to have each piece of equipment tested separately. Systems of interconnected equipment with one common connection to primary power shall are to be treated as a single piece of equipment. Equipment designed for multiple (redundant) supplies shall are to be tested with only one supply connected.

56.8 A sample of the product is to be tested in the as-received condition initially with all switches indicated below closed, but with its grounding conductor, when provided, open at the attachment plug. A product that has not been energized for a minimum of 48 hours prior to the test, and that is at room temperature, is determined to be in the as-received condition. The supply voltage is to be the maximum voltage marked on the product but not less than 120 or 240 volts. The test sequence (with regard to Figure 56.1) is to be as follows:

a) With switch S1 open, the product is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2, and with the product switching devices in all of their normal operating positions;

b) Switch S1 is then to be closed, energizing the product, and within 5 seconds the leakage current is to be measured using both positions of switch S2 and with the product switching devices in all their normal operating positions;

c) Leakage current is to be monitored until thermal stabilization occurs. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation of the product as in the Component Temperature Test, Section 50.

57 Electric Shock Current Test

57.1 If the open circuit potential between any part that is exposed only during operator servicing and either:

a) Earth ground; or

b) Any other exposed accessible part

exceeds 42.4 volts peak, the part shall comply with the requirements in 57.2 – 57.4, as applicable.

57.2 The continuous current flow through a 500-ohm resistor shall not exceed the values specified in Table 57.1 when the resistor is connected between any part that is exposed only during operator servicing and either earth ground or any other exposed accessible part.

Table 57.1
Maximum current during operator servicing

Frequency, hertz[a]	Maximum current through a 500-ohm resistor, milliamperes peak
0 – 100	7.1
500	9.4
1,000	11.0
2,000	14.1
3,000	17.3
4,000	19.6
5,000	22.0
6,000	25.1
7,000 or more	27.5

[a] Use linear interpolation between adjacent values to determine the maximum current corresponding to frequencies not shown. The table applies to repetitive nonsinusoidal or sinusoidal waveforms.

57.3 The duration of a transient current flowing through a 500-ohm resistor connected as described in 57.2 shall not exceed:

a) The value determined by the following equation:

$$T \leq \left(\frac{20\sqrt{2}}{I} \right)^{1.43}$$

in which:

T is the interval, in seconds, between the time that the instantaneous value of the current first exceeds 7.1 milliamperes and the time that the current falls below 7.1 milliamperes for the last time and

I is the peak current in milliamperes and

b) 809 milliamperes, regardless of duration.

The interval between occurrences shall be equal to or greater than 60 seconds if the current is repetitive. Typical calculated values of maximum acceptable transient current duration are shown in Table 57.2.

Table 57.2
Maximum transient current duration

Maximum peak current (I) through 500-ohm resistor, milliamperes	Maximum duration (T) of waveform containing excursions greater than 7.1 milliamperes peak
7.1	7.26 seconds
8.5	5.58
10.0	4.42
12.5	3.21
15.0	2.48
17.5	1.99
20.0	1.64
22.5	1.39
25.0	1.19
30.0	919 milliseconds
40.0	609
50.0	443
60.0	341
70.0	274
80.0	226
90.0	191
100.0	164
150.0	92
200.0	61
250.0	44
300.0	34
350.0	27
400.0	23
450.0	19
500.0	16
600.0	12
700.0	10
809.0	8.3

57.4 The maximum capacitance between the terminals of a capacitor that is accessible during operator servicing shall comply with the following equations:

$$C = \frac{88{,}400}{E^{1.43}(In\ E - 1.26)} \quad for \quad 42.4 \leq E \leq 400$$

$$C = 35{,}288E^{-1.5364} \quad for \quad 400 \leq E \leq 1000$$

in which:

C is the maximum capacitance of the capacitor in microfarads and

E is the potential in volts across the capacitor prior to discharge.

E is to be measured 5 seconds after the capacitor terminals are made accessible, such as by the removal or opening of an interlocked cover, or the like. Typical calculated values of maximum capacitance are shown in Table 57.3.

Table 57.3
Electric shock – stored energy

Potential in volts, across capacitance prior to discharge	Maximum capacitance in microfarads
1000	0.868
900	1.02
800	1.22
700	1.50
600	1.90
500	2.52
400	3.55
380	3.86
360	4.22
340	4.64
320	5.13
300	5.71
280	6.40
260	7.24
240	8.27
220	9.56
200	11.2
180	13.4
160	16.3
140	20.5
120	26.6
100	36.5
90	43.8
80	53.8
70	68.0
60	89.4
50	124.0
45	150.0
42.4	169.0

57.5 With reference to the requirements of 57.2 and 57.3, the current is to be measured while the resistor is connected between ground and:

a) Each accessible part individually and

b) All accessible parts collectively if the parts are simultaneously accessible.

The current is also to be measured while the resistor is connected between one part or group of parts and another part or group of parts, if the parts are simultaneously accessible.

57.6 With reference to 57.5, parts are considered to be simultaneously accessible if they can be contacted by one or both hands of a person at the same time. For the purpose of these requirements, one hand is to be considered to be able to contact parts simultaneously if the parts are within a 4- by 8-inch (102- by 203-mm) rectangle; and two hands of a person are considered to be able to contact parts simultaneously if the parts are not more than 6 feet (1.8 m) apart.

57.7 Electric shock current refers to all currents, including capacitively coupled currents.

57.8 If the product has a direct-current rating, measurements are to be made with the product connected in turn to each side of a 3-wire, direct-current supply circuit.

57.9 Current measurements are to be made:

a) With any operating control, or adjustable control that is subject to user operation, in all operating positions; and

b) Either with or without a vacuum tube, separable connector, or similar component in place.

These measurements are to be made with controls placed in the position that causes maximum current flow.

58 Transient Test

58.1 General

58.1.1 A household control unit and any equipment intended to be connected to it shall:

a) Not false alarm,

b) Operate for its intended signaling performance,

c) Not be affected adversely, and

d) Retain required stored memory (such as date, type, and location of a signal transmission) within the unit when subjected to 500 supply line (high-voltage circuit) transients, 500 internally induced transients, and 60 input/output circuit (low-voltage circuit) transients, while energized from a source of supply in accordance with 40.2.

Supplemental information stored within the unit need not be retained. At the conclusion of each test, the control unit and any equipment intended to be connected to the signaling circuits shall comply with the requirements in the Normal Operation Test, Section 41.

58.2 Supply line ring wave surge voltage transients

58.2.1 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.

58.2.2 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, C62.41.

58.2.3 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. 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.

58.3 Internally induced transients

58.3.1 The control unit is to be energized in the normal standby condition from a rated source of supply which is to be interrupted for a total of 500 times. Each interruption is to be for approximately 1 second at a rate of not more than 6 interruptions per minute.

58.4 Input/output circuit (low-voltage circuit) transients

58.4.1 The product unit is to be energized in the normal standby condition while connected to a source of supply in accordance with 40.2. All field-wiring circuits are to be tested as specified in 58.4.2 and 58.4.3.

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.

58.4.2 For this test, each output circuit is to be subjected to the transient waveforms specified in the following table, 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.

Table 58.1
Transient waveforms

Peak voltage level, V	Minimum energy level, J	Minimum pulse duration, µs	Figure No.
2400	1.0	80	Figure 58.1
1000[a]	0.31	150	Figure 58.2
500[a]	0.10	250	Figure 58.3
100	0.011	1120	Figure 58.4

[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 58.5) and minimum energy level (Figure 58.6) parameters, and shall have an equal or faster minimum transient pulse rise time than that specified in Figure 58.7.

Figure 58.1

Signal line transients – 2400V curve

(Note: the x axis is to be 10 microseconds/div)

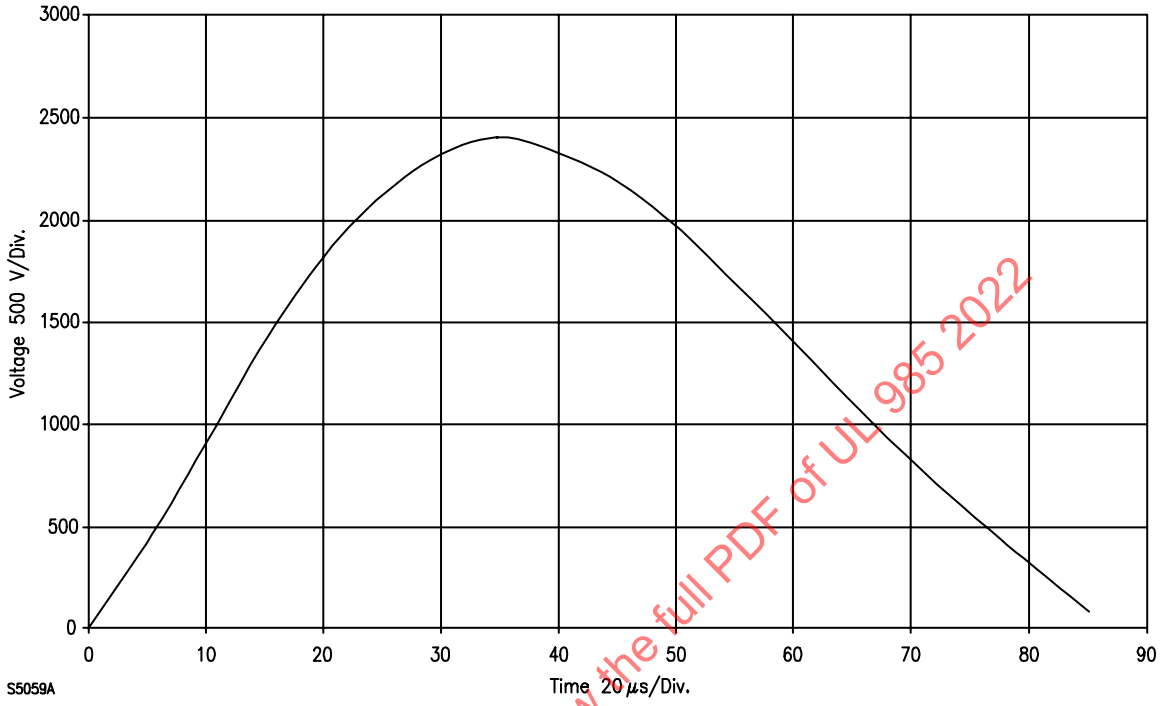


Figure 58.2

Signal line transients – 1000V curve

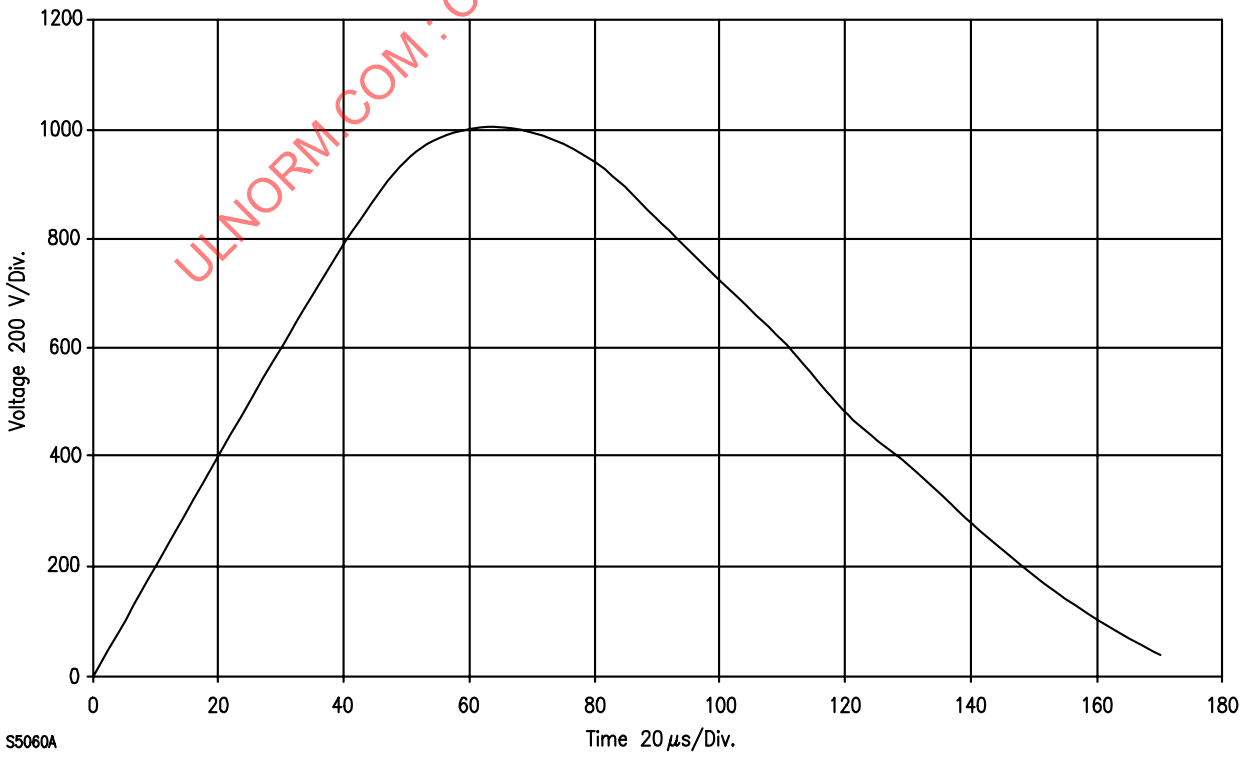


Figure 58.3

Signal line transients – 500V curve

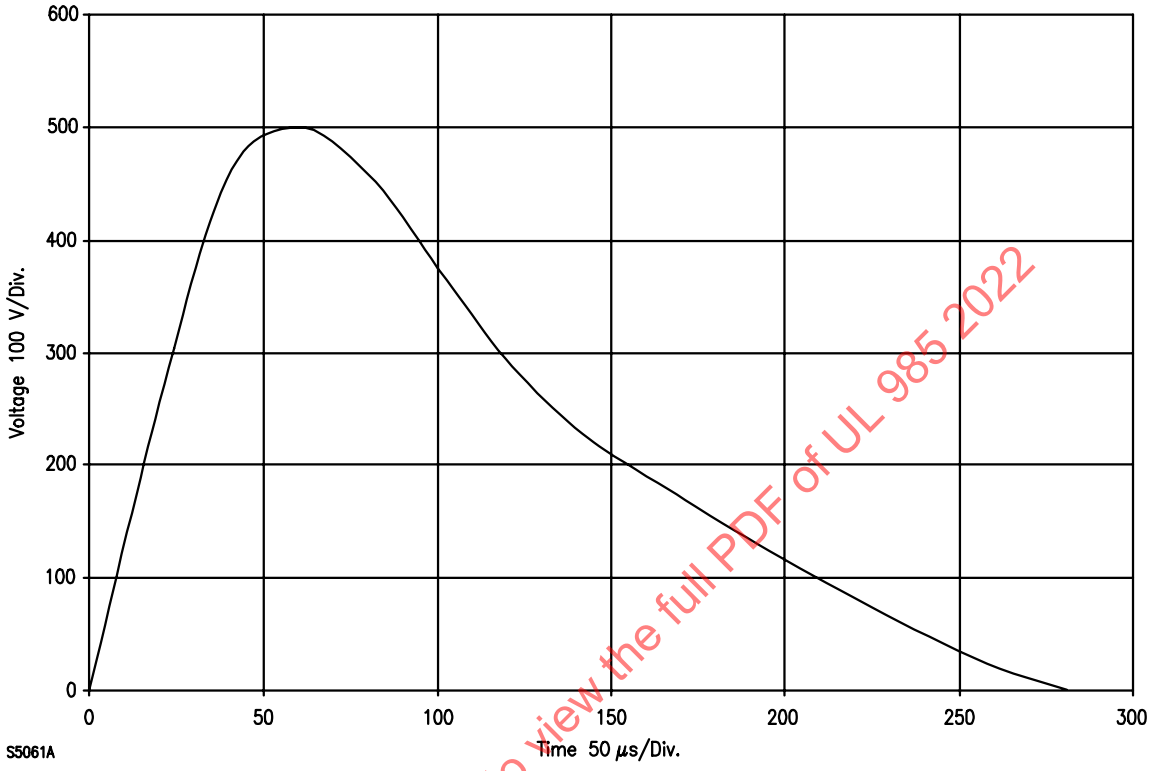


Figure 58.4

Signal line transients – 100V curve

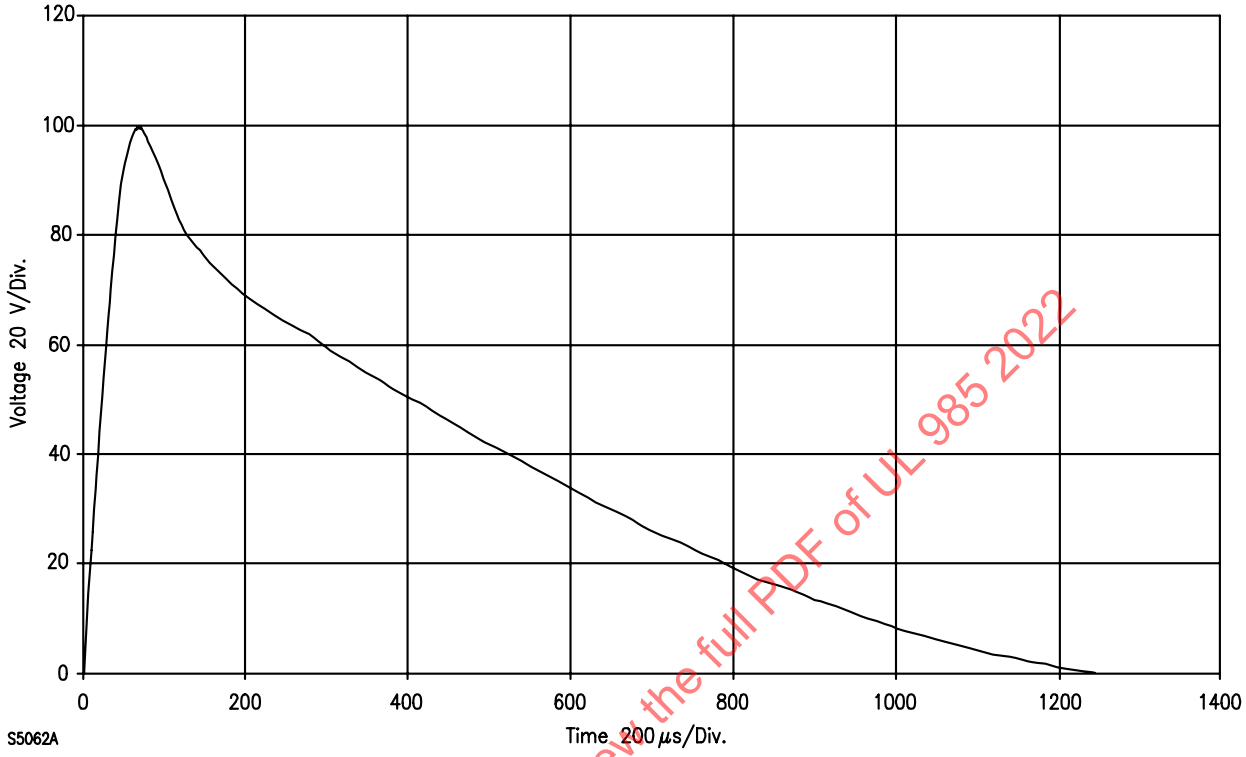


Figure 58.5

Minimum transient pulse duration vs. transient peak voltage

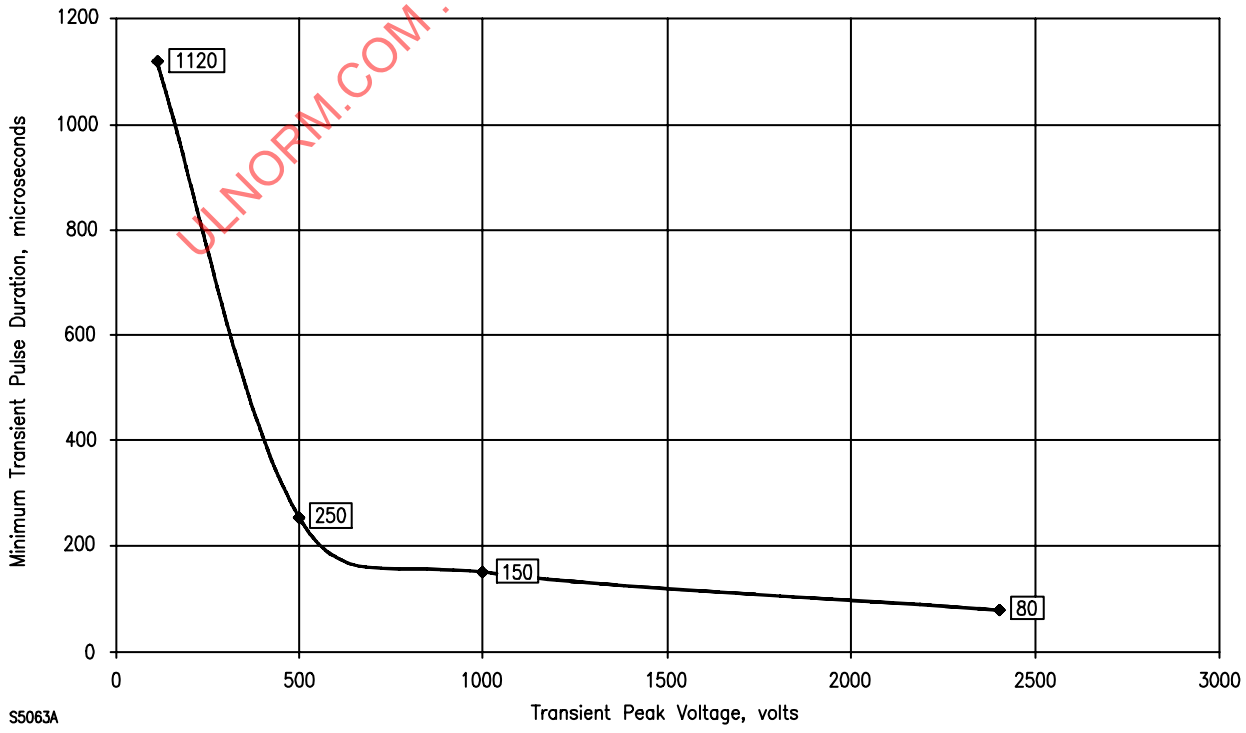


Figure 58.6

Minimum transient energy level vs. transient peak voltage

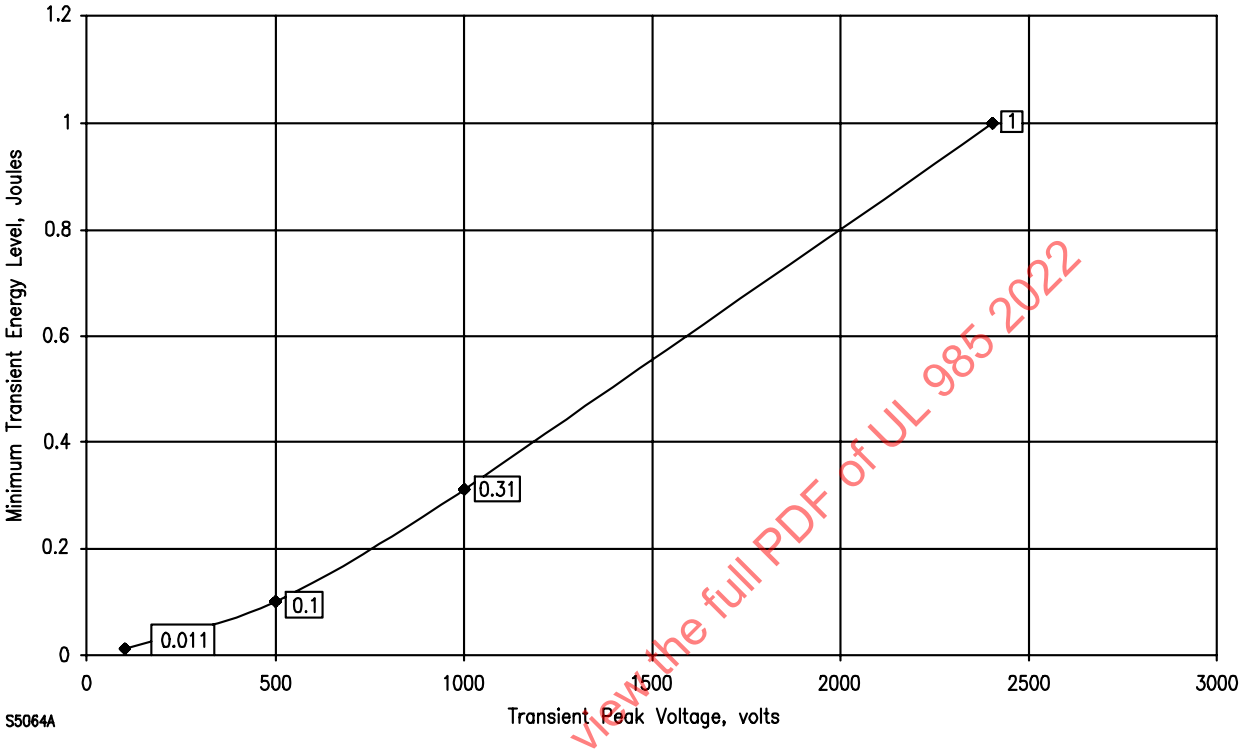
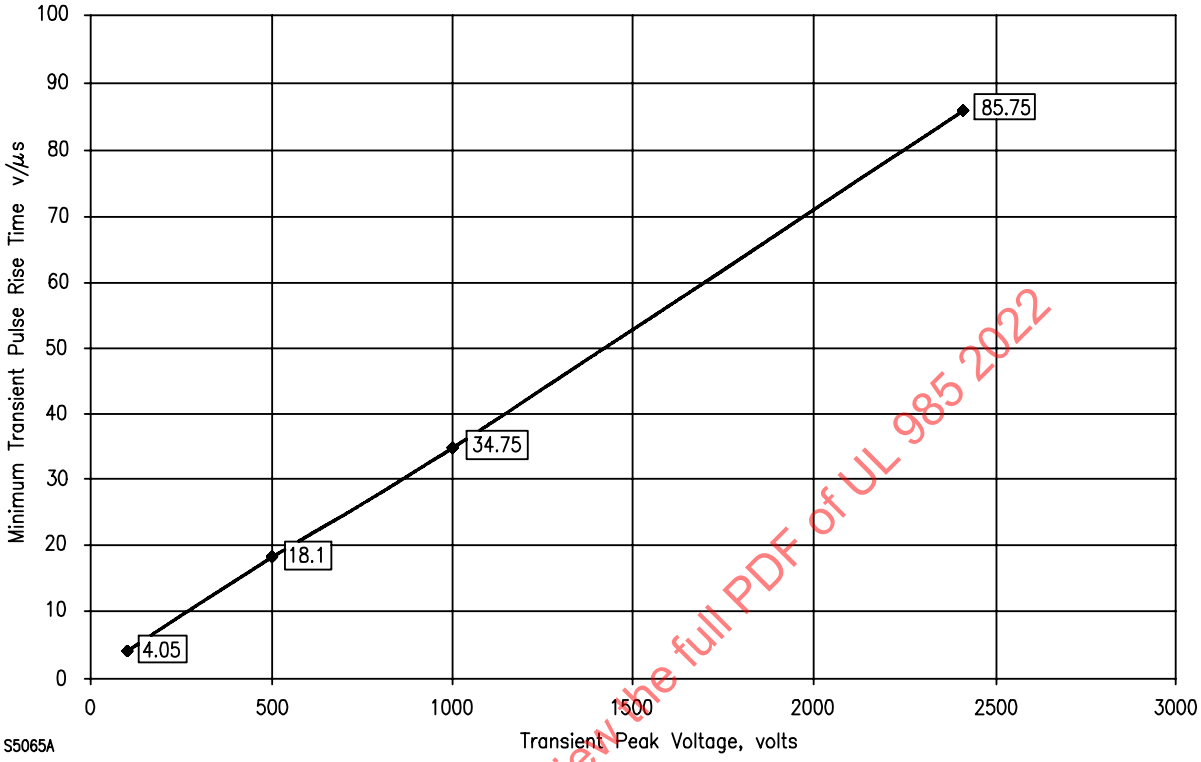


Figure 58.7

Minimum transient pulse rise time vs. transient peak voltage



58.4.3 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 58.4.2) 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 58.4.2) between any two circuit leads or terminals consisting of ten pulses of one polarity and ten pulses of the opposite polarity.

59 Dielectric Voltage-Withstand Test

59.1 A household control unit and related accessories 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, live parts and exposed dead metal parts, and live parts of circuits operating at different potentials or frequencies. The test potential is to be (also, see 59.2):

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 more than 30 and not more than 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).

59.2 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 59.1 (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.

59.3 If an autotransformer is in the circuit, the primary of the transformer is to be disconnected and an AC test potential in accordance with 59.1(c) is to be applied directly to all wiring involving more than 250 volts.

59.4 If the charging current through a capacitor or capacitor type filter connected across the line, or from line to earth ground, prevents maintenance of the specified AC test potential, the capacitor or filter is to be tested using a DC test potential in accordance with 59.1.

59.5 The test potential is to be obtained from a 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.

59.6 A printed wiring assembly or other electronic circuit component that is at risk of being damaged by the application of, or short-circuiting, the test potential, is to be removed, disconnected, or otherwise rendered inoperative before the test. The entire assembly or a representative subassembly is to be tested. When required, rectifier diodes in the power supply are to be individually shunted before the test to avoid destroying them in the case of malfunction elsewhere in the secondary circuits.

60 Component Failure Test

60.1 Opening or shorting of capacitors shall either not have an effect on intended operation or be indicated by a trouble or an alarm signal.

60.2 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 60.1;

b) 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; 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.

Table 60.1
Capacitor derating parameters

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

Table 60.1 Continued on Next Page

Table 60.1 Continued

Type	Derating parameter	Derating level[a]
	Temperature from maximum limit	20°C
Electrolytic tantalum	Normal operating voltage	60 percent
	Temperature from maximum limit	20°C
Solid tantalum	Normal operating voltage	60 percent
	Maximum operating temperature	85°C

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

61 Audibility Test

61.1 An alarm sounding appliance, either integral with the household control unit or intended to be connected separately, shall provide a sound output equivalent to that of an omnidirectional source with an A-weighted sound pressure level of at least 85 decibels at 10 feet (3.05 m) while connected to a source of rated voltage in accordance with 40.2.

61.2 The sound power output of the alarm sounding appliance shall be measured in a reverberant room qualified of ISO 3741, Acoustics Determination of Sound Power Levels of Noise Sources Using Sound Pressure Precision Method for Reverberation Rooms – Technical Corrigendum 1. The sound power in each one-third octave band shall be determined using the comparison method. The A-weighting factor shall be added to each one-third octave band. The total power shall then be determined on the basis of actual power. The total power shall then be converted to an equivalent sound pressure level for a radius of 10 feet (3.05 m) using the following formula:

$$L_p = L_w - 14\text{Log}_{10}R - 0.6$$

in which:

L_p is the converted sound pressure level,

L_w is the sound power level measured in the reverberation room, and

R is the radius for the converted sound pressure level (10 feet).

Exception: This requirement does not apply to trouble signals.

62 Abnormal Operation Test

62.1 A household control unit shall be capable of operating continuously under abnormal conditions without resulting in a risk of fire or electric shock. Leakage current measurements shall not exceed 0.5 milliampere.

62.2 A unit is to be operated under the most severe abnormal conditions likely to be encountered in service while connected to a source of rated supply. There shall not be emission of flame or molten metal or any other manifestation of a risk of fire. Leakage current following the test is to be measured in accordance with the Leakage Current Test, Section 56.

62.3 In determining if a household control unit complies with the requirements with respect to circuit fault conditions, 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.

62.4 If 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.

SHORT RANGE RADIO FREQUENCY DEVICES

63 General

63.1 These requirements are applicable to control units and systems that utilize initiating, annunciating, and remote control devices that are not interconnected by a solid medium, such as cable, optical fiber, or the like.

63.2 The requirements specified in Sections 1 – 62 shall apply to short range radio frequency (RF) devices except that in the event of conflict, the requirements of this Section shall apply.

63.3 These requirements are applicable:

a) To a system configuration consisting of multiple transmitters and a single receiver with the transmitters operating on a random basis; and

b) With modifications, to a system using such configurations as multiple receivers or a two-way interrogated response system.

63.4 For low power radio frequency devices initiating circuit transmitters that are powered by a primary battery shall serve only one initiating device.

64 Operation

64.1 General

64.1.1 These requirements cover the operation of products and systems that utilize initiating, annunciating, and remote control devices that provide signaling by means of low-power radio-frequency (RF).

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

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

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

c) By another equivalent means.

64.2 Signaling

64.2.1 The transmitter/receiver combination shall be arranged so that the occurrence of an alarm or emergency condition at any transmitter will be communicated and annunciated at the receiver/control unit in a period of more than 10 seconds.

64.2.2 A fire alarm signal from a RF initiating device shall latch at the receiver/control unit until manually reset, and shall identify the particular RF initiating device in alarm.

64.2.3 To provide higher priority to alarm and supervisory signals than to other signals, 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. See 72.1 for requirements for maximum duration of transmission.

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

64.2.4 The maximum allowable response delay from activation of an initiating device to wireless activation of required alarm functions shall be 10 seconds.

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

64.3 Sprinkler supervisory signals

64.3.1 A transmitter/receiver combination intended to provide sprinkler 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 64.3.2.

64.3.2 Restoration from off-normal to the normal 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.

64.4 Maximum duration of transmission

64.4.1 When required to increase the probability of an alarm or emergency 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.

Exception: Transmitters that are manually activated are exempt from this requirement.

64.5 Inoperative transmitter reporting

64.5.1 A receiver/control unit shall report and identify an inoperative transmitter in the system within 200 seconds.

Exception No. 1: A transmitter intended to be carried on one's person, such as a medical transmitter, need not comply with this requirement.

Exception No. 2: Where monitoring for integrity of the transmitter/transceiver and receiver/control unit complies with each of the following:

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

b) 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 identifying the specific inoperative transmitter/device.

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

d) 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/control unit.

64.6 Tamper signal

64.6.1 The audible tamper trouble signal of the receiver/control unit may be silenceable when provided with an automatic feature to resound the signal at intervals not exceeding 4 hours. Both of the following actions shall cause the annunciation of a tamper trouble signal at the receiver/control unit additionally identifying the affected device within 200 seconds:

a) Removal of an initiating-device transmitter, RF appliance receiver or retransmission device from its installed location, including displacement of a removable surface such as a ceiling tile; and

b) Removal of a cover exposing a transmitter/transceiver primary battery without the need to remove the initiating device transmitter/transceiver, RF appliance receiver/transceiver or retransmission device from its installed location.

64.7 Interference protection

64.7.1 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).

64.8 Battery status indication

64.8.1 A primary battery is not prohibited from being used as the sole source of power for a low-power radio transmitter when all of the following conditions are met:

a) The capacity of the primary battery shall be monitored for integrity. The battery shall be monitored while loaded by:

1) Transmission of the transmitter; or

2) A load equivalent to the load imposed by transmission.

b) A required battery trouble status signal shall be transmitted to the receiver for a minimum of 7 days before the battery capacity of the transmitter has depleted to a level insufficient to maintain proper non-alarm operation of the transmitter. The battery trouble signal annunciation at the receiver/control unit is not prohibited from initially being delayed up to 4 hours. The battery trouble signal shall be retransmitted at intervals not exceeding four hours until the battery is replaced.

c) 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 (b) is reached.

d) Annunciation of the battery trouble status signal at the receiver/control unit shall be distinctly different from alarm, supervisory, tamper, and initiating circuit trouble signals. It shall consist of an audible and visual signal that shall identify the affected transmitter.

e) The audible trouble signal of the receiver/control unit is not prohibited from being silenceable when provided with an automatic feature to resound the signal at intervals not exceeding 4 hours.

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

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

h) Each transmitter serves only one initiating device and is individually identified at the receiver/control unit.

64.8.2 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.

64.8.3 For a primary battery, data on battery life, including discharge curves, shall be provided for the investigation to evaluate battery shelf aging and performance characteristics.

65 Reference Level Determination

65.1 The installation document for the system shall include a description of the equipment and procedures to be used during the installation of the system to determine whether or not the actual signal strength received is above the minimum acceptable level and the actual ambient noise level is below the maximum acceptable level.

65.2 For the purpose of these requirements, the minimum signal strength specified by the manufacturer which is required for normal operating performance is designated as the reference signal level.

65.3 Unless indicated otherwise, the test setup is to employ a transmitter that is to be connected directly to the receiver via a shielded electrical connection, and all measurements shall be taken in a RF-shielded room. The signal shall be attenuated such that the level measured at the receiver (using the method described in 65.1) equals the reference signal level or minimum signal to noise level.

Exception: When the transmitter is not capable of being connected via a shielded electrical connection, the transmission path is to be free field in a RF-anechoic room.

65.4 The reference level determination test is to be repeated with the transmitter/transceiver's batteries depleted to the trouble level as specified in 64.8. For the purpose of this requirement, a depleted battery is defined as a battery that is at the level (terminal voltage under load) that results in a trouble signal as required in 64.8. For test purposes, a depleted battery may be substituted by a circuit arrangement that does not affect the RF characteristic (±6 decibels as measured at the receiver), but does simulate the characteristics of a depleted battery as specified in 64.8(b).

65.5 For test purposes, products employing spread spectrum technology, shall provide a means to establish the reference signal level by operating on a fixed frequency.

66 Interference Immunity

66.1 A receiver/transmitter combination at the minimum reference signal level determination described in Section 65, Reference Level Determination, shall operate for its intended signaling performance in the noise environment as described in 70.2 – 70.3.

Exception: The noise environment is not applicable to products utilizing spread spectrum technology.