



UL 985

Underwriters Laboratories Inc. Standard for Safety

Household Fire Warning System Units



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Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Household Fire Warning System Units, UL 985

Fifth Edition, Dated May 26, 2000

Revisions: This Standard contains revisions through and including October 31, 2008.

Summary of Topics

Revisions are being issued to reflect the recent reaffirmation of UL 985 as an American National Standard.

Announcement Bulletin(s): This Standard contains the announcement bulletin(s) dated January 26, 2001. The announcement bulletin is located at the end of the Standard.

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revisions dated October 31, 2008 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net/ulforeword.html>.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if

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Page	Date
1	October 31, 2008
2-4B	April 29, 2004
5	March 3, 2004
6-7	August 30, 2001
8	April 29, 2004
9-10	August 30, 2001
11-23	May 26, 2000
24-26A	April 29, 2004
26B	March 3, 2004
27-40	May 26, 2000
41-42B	March 3, 2004
43-53	May 26, 2000
54-56B	March 3, 2004
57	August 30, 2001
58-74	May 26, 2000
A1-A2	August 30, 2001

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This ANSI/UL Standard for Safety, which consists of the Fifth Edition with revisions through October 31, 2008 is under continuous maintenance, whereby each revision is ANSI approved upon publication.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI Standard.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

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CONTENTS

INTRODUCTION

1 Scope	9
2 General	10
2.1 Components	10
2.2 Units of measurement	10
2.3 Undated references	10
3 Glossary	10
4 Instructions and Drawings	12
5 Compatibility Information	13
5.1 General	13
5.2 Method of evaluation	13
5.3 Changes affecting compatibility	14

CONSTRUCTION

6 General	14
7 Frame and Enclosure	14
7.1 General	14
7.2 Cast metal enclosures	14
7.3 Sheet metal enclosures	15
7.4 Nonmetallic enclosures	16
8 Electric Shock	17
9 Ventilating Openings	17
10 Metal Covers and Doors	18
11 Glass Panels	18
12 Corrosion Protection	19
13 Insulating Material	19
14 Mounting of Electrical Components	20
15 Operating Mechanisms	21
16 Current-Carrying Parts	21
17 Servicing Protection	21

FIELD-WIRING CONNECTIONS

18 Primary Power Supply	22
19 Secondary Power Supply	22
20 Batteries	22

INSTALLATION WIRING CONNECTIONS

21 General	23
22 Field-Wiring Terminals	23
23 Field-Wiring Leads	23
24 Power-Supply Cord	24
25 Strain Relief	24
25A Power-Limited Circuits	25

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Documents

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INTERNAL WIRING AND ASSEMBLY

26 Internal Wiring	26
--------------------------	----

GROUNDING

27 Equipment Grounding	26A
28 Polarity Identification	26A

COMPONENTS

29 End-of-Line Devices	27
30 Printed Wiring Boards	27
31 Bushings	27
32 Coil Windings	28
33 Switches	28
34 Lampholders and Lamps	28
35 Protective Devices	28

SPACINGS

36 General	29
------------------	----

PERFORMANCE

37 General	30
38 Alarm Verification Feature (Optional)	30
39 Normal Operation Test	31
39.1 Fire alarm control unit	31
39.2 Combination control unit	32
39.3 Primary power supply	32
39.4 Alarm verification	33
40 Two-Wire Smoke Detector Compatibility Tests	33
40.1 Operating voltage determination	33
40.2 Alarm threshold impedance	34
40.3 Maximum current limitation	34
40.4 Multiple detector alarm capacity	34
40.5 Detectors with optional components	34
40.6 Dynamic load immunity	35
40.7 Electrical supervision	35
40.8 Detector reset	35
41 Electrical Supervision Test	35
42 Undervoltage Operation Test	36
43 Overvoltage Operation Test	36
44 Voltage and Current Measurements	37
44.1 Input circuit	37
44.2 Output circuit	37
45 Power-Limited Circuits	37
45.1 General	37
45.2 Maximum voltage	39
45.3 Maximum current	40
45.4 $V_{A_{max}}$ (not inherently limited circuits only)	40
46 Jarring Test	40

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Documents
Document Sharing Hub

47	Temperature Test	42
48	Charging Current Test	44
48.1	General	44
48.2	Discharged battery	44

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Documents
Document Sharing Hub

48.3	Charged battery	44
48.4	Discharged battery – second trial	44
49	Overload Test	44
49.1	Control unit	44
49.2	Separately energized circuits	45
50	Endurance Test	45
50.1	Control unit	45
50.2	Operating device	45
51	Variable Ambient Temperature Test	45
52	Humidity Test	46
53	Leakage Current Test	46
54	Electric Shock Current Test	46
55	Transient Test	50
55.1	General	50
55.2	Supply line (high-voltage circuit) transients	51
55.3	Internally induced transients	53
55.4	Input/output circuit (low-voltage circuit) transients	53
56	Dielectric Voltage-Withstand Test	53
57	Component Failure Test	54
58	Audibility Test	55
59	Abnormal Operation Test	56

SHORT RANGE RADIO FREQUENCY DEVICES

60	General	56
61	Reference Level Determination	56A
61.1	Method 1	56A
61.2	Method 2	58
62	Interference Immunity	61
63	Frequency Selectivity	62
64	Time to Report Alarm	63
65	Inoperative Transmitter Reporting	63
66	Clash	64
67	Error (Falsing) Rate	64
68	Throughput Rate	66
69	Maximum Duration of Transmission	67
70	Battery Status Indication	67
71	Transmitter Stability Tests	68
72	Transmitter Accelerated Aging Test	68
73	Installation Instructions and User Manual	68
74	Interference Protection	69

MANUFACTURING AND PRODUCTION TESTS

75	Production-Line Dielectric Voltage-Withstand Test	69
76	Production-Line Grounding-Continuity Test for High-Voltage, Cord-Connected Products	70

INSTALLATION DRAWING

77	General	70
----	---------------	----

INSTRUCTIONS

78 General	71
------------------	----

MARKINGS

79 General	72
------------------	----

APPENDIX A

Standards for Components.....	A1
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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 an indicating device 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, such as a battery, may 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 indicating appliances, such as bells, horns, 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 Deleted August 30, 2001

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.

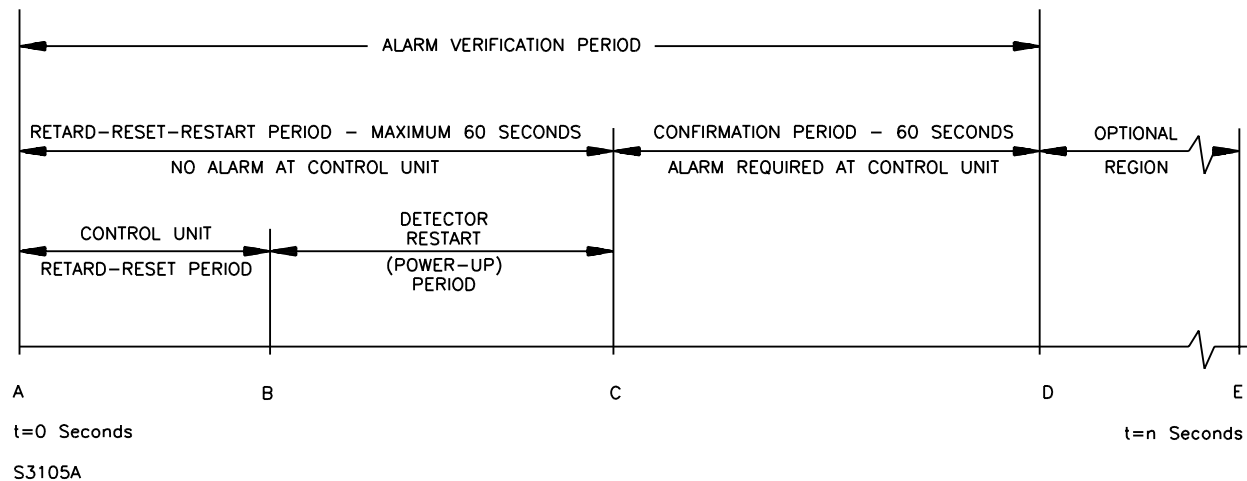
3 Glossary

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 Tables 45.1 and 45.2.

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 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 77, and Instructions, General, Section 78.

4.3 In addition to the information given in 4.1 and 4.2, the manufacturer shall provide an evacuation plan as specified in 78.2.

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 40.1.1 – 40.1.3.
- b) Alarm threshold impedance, as described in 40.2.1 – 40.2.3.
- c) Maximum current limitation, as described in 40.3.1 and 40.3.2.
- d) Multiple detector alarm capacity, as described in 40.4.1.
- e) Detectors with optional components, as described in 40.5.1 and 40.5.2.

- f) Dynamic load immunity, as described in 40.6.1 and 40.6.2.
- g) Electrical supervision, as described in 40.7.1 and 40.7.2.
- h) Detector reset, as described in 40.8.1 – 40.8.3.

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.

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				Brass or aluminum,	
Any linear dimension, inches (mm)		Area of any surface, inches ² (cm ²)		Zinc coated, inch (mm)		Uncoated, inch (mm)			
				[GSG]	(mm)	[MSG]	(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	(2.46)	0.093	(2.36)	0.122	(3.10)

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Maximum enclosure dimensions				Minimum thickness of sheet metal					
				Steel				Brass or aluminum, inch [AWG] (mm)	
Any linear dimension, inches (mm)		Area of any surface, inches ² (cm ²)		Zinc coated, inch [GSG] (mm)		Uncoated, inch [MSG] (mm)			
				[12]		[12]		[8]	

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 54.

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 Ventilating Openings

9.1 Ventilating openings in an enclosure, including perforated holes, louvers, and openings protected by means of wire screening, expanded metal, or perforated covers, shall be of such size or shape that no opening will permit passage of a rod having a diameter of 9/64 inch (3.6 mm). An enclosure for fuses or other overload-protective devices and having ventilating openings shall provide adequate protection against the emission of flame or molten metal.

9.2 Except as noted in 9.3, perforated sheet metal and sheet metal used for expanded-metal mesh shall not be less than 0.042 inch (1.07 mm) in average thickness, 0.046 inch (1.17 mm) if zinc coated.

9.3 If the indentation of a guard or enclosure will not alter the clearance between uninsulated, movable, live parts and grounded metal so as to affect performance adversely or reduce spacings below the minimum values given under Spacings, Section 36, 0.021 inch (0.53 mm) expanded-metal mesh [0.024 inch (0.61 mm) if zinc coated] shall be used, provided that:

a) The exposed mesh on any one side or surface of the device so protected has an area of not more than 72 square inches (465 cm²) and has no dimension greater than 12 inches (305 mm) or

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

9.4 The wires of a screen shall not be smaller than No. 16 AWG (1.3 mm²) and the screen openings shall not be greater than 1/8 inch (3.2 mm) square in area.

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 cm²), 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 Servicing Protection

17.1 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).