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December 1, 1994

Revision pages for

Standard for

Residential Gas Detectors

UL 1484, Third Edition

Attached to this transmittal notice is a revision of the Third edition of UL 1484.

A CHANGE ON A PAGE DATED DECEMBER 1, 1994 IS INDICATED BY A SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM, PRECEDED AND FOLLOWED BY AN ASTERISK.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 1484-1994.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

Page	Date
1	November 30, 1994 (Reprinted December 1, 1994)
2	—
3 – 6	November 30, 1994
7	December 1, 1994
8 – 53, SA1 – SA21, A1	November 30, 1994

NOVEMBER 30, 1994
(Title Page Reprinted: December 1, 1994)



1

UL 1484

Standard for

Residential Gas Detectors

First Edition – June, 1993
Second Edition – January, 1991

Third Edition

November 30, 1994

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated November 30, 1994. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

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

Approved as ANSI/UL 1484-1994, July 8, 1994

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 published set of revision pages.

ISBN 1-55989-680-9

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INTRODUCTION

1 Scope

1.1 These requirements cover electrically operated gas detectors intended for installation in residential occupancies and recreational vehicles (RVs).

1.2 These requirements cover gas detectors intended to detect flammable gases such as propane and natural gas.

1.3 These requirements also cover all remote accessories that may be connected to a gas detector.

1.4 These requirements do not cover gas detectors for use in hazardous locations, as defined by the National Electrical Code, NFPA 70, for industrial or commercial use, or for use as smoke and fire detectors.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific provisions of this standard cannot be judged to comply with this standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.5 revised December 1, 1994

2 General

2.1 Components

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

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

- a) Involves a feature or characteristic not needed 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 recognized rating established for the intended conditions of use.

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

2.2 Units of measurement

2.2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.3 Terminology

2.3.1 The term "product" as used in these requirements refers to all or any part of a product covered by these requirements unless specifically noted otherwise.

2.4 Undated references

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

3 Glossary

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

3.2 ALARM SIGNAL — A signal intended to indicate a gas concentration in excess of the preset detector alarm level.

3.3 COMPONENTS:

a) Nonreliable Component — A component that is expected to fail and be periodically replaced and the failure of which is supervised. Typical examples of such components include incandescent lamps, electronic tube heaters, and functional heating elements.

b) Reliable Component — A component that is not expected to fail or be periodically replaced and is not supervised. A reliable component shall have a predicted failure rate of 3.5 or fewer failures per million hours.

3.4 DETECTION THRESHOLD — The minimum gas concentration at which the detector will alarm.

3.5 DETECTOR, GAS — A self-contained alarm device that consists of an assembly of electrical components including an element to detect gas concentration, an alarm sounding appliance, and provision for connection to a power supply source by either splice leads or a cord and plug arrangement. Terminals may be included for connection to a remote audible signaling appliance or accessory.

3.6 ELECTRICAL CIRCUITS:

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

b) Low-Voltage Circuit — A circuit involving a potential of not more than 30 volts AC, rms, 42.4 volts DC or AC peak and:

1) Supplied by an NEC Class 2 transformer, or by a transformer and fixed impedance each of which, as a unit, is in compliance with the requirements for a Class 2 transformer; or

2) Limited to a maximum of 100 volt-amperes.

A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply classified as a high-voltage circuit, is not considered to be a low-voltage circuit.

UL 1484

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Residential Gas Detectors



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UL Standards for Safety are developed under a procedure which provides for participation and comment from the affected public as well as industry. The procedure takes into consideration a survey of known existing standards and the needs and opinions of a wide variety of interests concerned with the subject matter of the standard. Thus manufacturers, consumers, individuals associated with consumer-oriented organizations, academicians, government officials, industrial and commercial users, inspection authorities, insurance interests and others provide input to UL in the formulating of UL Standards for Safety, to keep them consonant with social and technological advances.

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November 30, 1994

Standard for

Residential Gas Detectors

UL 1484, Third Edition

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

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1) Supplied by an NEC Class 2 transformer, or by a transformer and fixed impedance each of which, as a unit, is in compliance with the requirements for a Class 2 transformer; or

2) Limited to a maximum of 100 volt-amperes.

A circuit derived from a source of supply classified as a high-voltage circuit, by connecting resistance in series with the supply classified as a high-voltage circuit, is not considered to be a low-voltage circuit.

3.7 LOWER EXPLOSIVE LIMIT (LEL) – The minimum concentration of a gas in air which, if ignited, will propagate flame throughout the gas-air mixture independently of continued application of the source of ignition; expressed as a percent by volume of gas in air.

3.8 NORMAL STANDBY CONDITION – The operating condition of the detector as intended by the manufacturer in which the detector is ready for alarm-signaling performance.

3.9 TROUBLE SIGNAL – A visual or audible signal intended to indicate a fault or trouble condition, such as an open or shorted condition of a component in the device or an open or ground in the connected wiring.

4 Detector Reliability Prediction

4.1 A detector unit shall be intended for a failure rate of not more than:

a) 4.0 failures per million hours as calculated by a full part stress analysis prediction as described in Section 2.0 of MIL-HBK 217E (October 1986) or

b) 3.5 failures per million hours as calculated by a simplified parts count-reliability prediction as described in Section 3.0 of MIL-HBK 217E, or equivalent. A Ground Fixed (G_F) environment is to be used for all calculations. If equivalent data is available from the manufacturer, it may be used in lieu of the projected data for the purpose of determining acceptable reliability.

4.2 Any component, the failure of which results in an audible trouble signal, shall not be included in the failure rate calculation. The audible signal appliance shall not be included in the reliability prediction.

5 Installation and Operating Instructions

5.1 A copy of the installation and operating instructions and related schematic wiring diagrams and installation drawings shall be used as guides in the examination and test of the detector. For an investigation, a printed edition is not required; however, in accordance with Instructions, General, Section 51, a printed edition is required to be provided with each finished product. The information may be included in a user's manual.

5.2 The instructions and drawings shall include such directions and information deemed by the manufacturer as necessary for correct installation, testing, maintenance, operation, and use of the detector.

CONSTRUCTION

ASSEMBLY

6 Product Assembly

6.1 A product shall be factory-built as a complete assembly and shall include all the essential components necessary for its intended function when installed as intended.

6.2 A product shall be constructed so that disassembly is not possible without at least the use of a common hand tool. Disassembly of any part of the detector shall not be necessary for intended installation.

Exception: A removable detector cover, with or without the use of a hand tool, may be used if removal of the cover does not expose the installer to a risk of electric shock.

7 Detection-Threshold Adjustment

7.1 If a field detection-threshold adjustment is provided, it shall be accessible with the detector installed as intended, marked to indicate the upper or lower detection threshold, and employ a mechanical stop at both extremes. The detection threshold at the upper detection threshold end shall be within the limits specified in 43.1.1.

7.2 Removal of a snap-on cover to gain access to the detection threshold control is permissible if no high-voltage parts can be contacted by the user.

8 Supplementary Signaling Feature

8.1 A supplementary signaling feature, such as a transmitter for remote signaling, integral with a gas detector, shall be compatible with the device with which it is intended to be used and shall comply with the requirements in this standard.

9 Sharp Edges

9.1 An enclosure, a frame, a guard, a handle, or the like of a gas detector shall be smooth and rounded so as not to cause an injury when contacted during use, and shall be evaluated in accordance with the Standard for Test for Sharpness of Edges on Equipment, UL 1439.

10 Enclosures

10.1 General

10.1.1 The enclosure of a detector shall be sufficiently strong and rigid to resist the abuses likely to be encountered in intended use. The degree of resistance to abuse inherent in the detector shall preclude total or partial collapse with the consequent reduction of spacings, loosening or displacement of parts, and other defects that alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

10.2 Electrical component enclosures

10.2.1 Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be considered in determining compliance with the requirement in 10.1.1.

10.2.2 All electrical parts of a detector, including a separate power supply, except for plug-in blades, shall be enclosed to reduce the risk of unintentional contact with uninsulated live parts. A separate enclosure is not required for field-wiring terminals that will be enclosed by a back box.

10.3 Sheet metal enclosures

10.3.1 The thickness of sheet metal used for the enclosure of a detector shall not be less than specified in Table 10.1.

Exception: Sheet metal 20 percent thinner may be used if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size of the surface is such that equivalent mechanical strength is determined to be provided.

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

Table 10.1
Sheet metal enclosures

Maximum dimensions of enclosure				Minimum thickness of sheet metal					
				Steel				Aluminum or brass,	
Length or width, Inches	(mm)	Area, Inches ²	(cm ²)	Zinc-coated, Inch	(mm)	Uncoated, Inch	(mm)		
12	305	90	581	0.034	0.86	0.032	0.81	0.045	1.14
24	610	360	2322	0.045	1.14	0.042	1.07	0.058	1.47
48	1219	1200	7742	0.056	1.42	0.053	1.35	0.075	1.91
60	1524	1500	9678	0.070	1.78	0.067	1.70	0.095	2.41
Over 60	1524	Over 1500	9678	0.097	2.46	0.093	2.36	0.122	3.10

10.4 Cast metal enclosures

10.4.1 The thickness of cast metal for an enclosure shall be as specified in Table 10.2. Cast metal having a thickness 1/32 inch (0.8 mm) less than that specified in the table may be used if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size of the surface is such that equivalent mechanical strength is provided.

Table 10.2
Cast-metal enclosures

Use, or dimensions of area involved	Minimum thickness			
	Die-cast metal, Inch (mm)		Cast metal other than die-cast, Inch (mm)	
Area of 24 square inches (155 cm ²) or less and having no dimension greater than 6 inches (152 mm)	1/16 ^a	1.6	1/8	3.2
Area greater than 24 square inches (155 cm ²) or having any dimension greater than 6 inches (152 mm)	3/32	2.4	1/8	3.2
At a threaded conduit hole	1/4	6.4	1/4	6.4
At an unthreaded conduit hole	1/8	3.2	1/8	3.2

^a The area limitation for metal 1/16 inch (1.6 mm) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

10.4.2 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, there shall not be less than three and one-half nor more than five threads in the metal, and the construction shall permit a standard conduit bushing to be attached.

10.4.3 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 less than three and one-half full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors that shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

10.5 Nonmetallic enclosures

10.5.1 An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength and durability and be formed so that operating parts will be protected against damage. The mechanical strength of the enclosure shall be at least equivalent to a sheet metal enclosure of the minimum applicable thickness specified in Table 10.1. See the Tests of Thermoplastic Materials, Section 40.

10.6 Product mounting

10.6.1 The enclosure of a detector shall be provided with means for mounting in the intended manner. Any fittings, such as brackets, hangers, or the like, necessary for intended mounting shall be furnished with the detector. The mounting means shall be accessible without disassembling any operating part of the detector. A detector cover is not to be considered an operating part if its removal does not expose the installer to a risk of electric shock.

10.6.2 If the detector is intended for permanent connection, the enclosure shall either have provision for the connection of metal-clad cable, conduit, or nonmetallic sheathed cable or have provision for mounting on an outlet box.

10.7 Ventilating openings

10.7.1 Ventilating openings in an enclosure for high-voltage circuits 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 openings will permit passage of a rod having a diameter of 9/64 inch (3.6 mm). An enclosure for a fuse or other overload protective device provided with ventilating openings shall afford protection against the emission of flame or molten metal.

10.8 Screens and expanded metal

10.8.1 Perforated sheet metal used for expanded metal mesh shall not be less than 0.042 inch (1.07 mm) thick, 0.046 inch (1.17 mm) thick if zinc coated.

Exception: If the indentation of the guard or enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to reduce spacings below the minimum values required, 0.021 inch (0.53 mm) expanded metal mesh or perforated sheet metal, 0.024 inch (0.61 mm) if zinc coated, may be employed under the following conditions:

- a) The exposed mesh on any one side or surface of the product 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 (88.9 mm).*

10.8.2 The wires forming a screen protecting high-voltage current-carrying parts shall not be smaller than No. 16 AWG (1.3 mm²) and the screen openings shall not be greater than 1/2 square inch (3.2 cm²) in area.

10.8.3 Openings provided to permit cleaning or openings which may be used to clean internal parts shall be constructed to reduce the risk of damage to functional internal components during such cleaning operations.

10.8.4 A ferrous plate or plug closure for an unused conduit opening or other hole in the enclosure shall not be less than 0.027 inch (0.69 mm) thick, and a nonferrous metal plate or plug closure shall not be less than 0.032 inch (0.81 mm) thick, for a hole having a diameter not larger than 1-3/8 inch (34.9 mm).

10.8.5 A closure for a hole larger than 1-3/8 inch (34.9 mm) diameter 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 securely mounted.

10.8.6 A knockout in a sheet-metal enclosure shall be secure but still able to be removed without deformation of the enclosure to the extent that:

- a) Spacings are reduced;
- b) Parts are loosened or displaced; or
- c) There is an increased risk of fire, electric shock, or injury to persons.

10.8.7 A knockout shall be provided with a surrounding surface for correct 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 those specified in Spacings, General, Section 27.

10.9 Glass panels

10.9.1 Glass covering an enclosure opening shall:

- a) Not be less than 1/16 inch (1.6 mm) thick,
- b) Be securely held in place so that it cannot be displaced in service, and
- c) Provide mechanical protection of the enclosed parts.

10.9.2 A transparent material, other than glass, used as a cover over an opening in an enclosure shall:

- a) Be mechanically equivalent to glass,
- b) Not distort, and
- c) Not become less transparent at the temperature to which it may be subjected under normal or abnormal service conditions.

11 Protection Against Corrosion

11.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

11.2 The requirement in 11.1 applies to all enclosures whether of sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend. It does not apply to minor parts, such as washers, screws, bolts, and the like, if the corrosion of such unprotected parts would not result in risk of fire, electric shock, or impaired operation of the detector. Parts made of stainless steel, polished or treated, do not require additional protection.

11.3 Bearing surfaces shall be of such materials as to prevent binding due to corrosion.

11.4 Metals used in combination for enclosures shall be galvanically compatible.

11.5 Hinges and other attachments shall be resistant to corrosion.

11.6 Nonferrous enclosures without corrosion protection may be used.

FIELD-WIRING CONNECTIONS

12 General

12.1 The primary power supply of a residential gas detector shall be a commercial power source available in a residential unit. Connection shall be:

- a) In the form of permanent wiring to terminals or leads in a separate wiring compartment having provision for the connection of conduit, metal-clad or nonmetallic sheathed cable;
- b) By means of a power-supply cord and attachment plug; or
- c) By means of a separate power supply.

12.2 If a separate power supply is provided, it shall use low-voltage circuitry. See 3.6(b).

12.3 The primary power supply of an RV gas detector shall be:

- a) A vehicle battery,
- b) A backup battery,
- c) A D-C converter, or
- d) A 120-volt supply.

Connection shall be by wiring to terminals or leads that comply with the applicable requirements in 14.3.1–14.5.3.

13 Cord-Connected Products

13.1 A cord-connected detector shall be provided with not less than 6 feet (1.83 m) nor more than 20 feet (6.10 m) of flexible cord and a two or three prong attachment-plug of the type and rating for connection to the supply circuit.

13.2 The flexible cord shall be of Type SP-1, SPT-1, SP-2, SPT-2, SV, SVT, SJ, SJT, or that which has been determined to be the equivalent, and shall be a minimum of No. 18 AWG (0.82 mm²) in size. It shall be rated for use at the voltage and ampacity rating of the detector in accordance with the National Electrical Code, ANSI/NFPA 70-1993.

13.3 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 can:

- a) Subject the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is rated,
- b) Reduce spacings below the minimum required values, or
- c) Result in damage to internal components.

13.4 Where a flexible cord passes through an opening in a wall, barrier, or enclosing case, the edges of the hole shall be smooth and rounded, without burrs, fins, or sharp edges that may damage the cord jacket.

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

13.6 The supply cord for a detector shall be provided with a strain relief to prevent stresses on the supply cord from being transmitted to internal wiring or connections. See the Strain-Relief Test, Section 45.

14 Permanently Connected Products

14.1 General

14.1.1 A detector 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 70-1993, corresponding to the rating of the detector.

14.2 Field-wiring compartment

14.2.1 The field-wiring compartment area is to be of sufficient size for completing all field-wiring connections as specified by the installation wiring diagram. There shall be space within the compartment to permit the use of a standard conduit bushing on the conduit connected to the compartment if a bushing would be required for the intended installation.

14.2.2 Protection from sharp edges for internal components and wire insulation shall be provided by insulating barriers or metal barriers having smooth, rounded edges.

14.3 Field-wiring terminals

14.3.1 The parts to which wiring connections are to be made shall consist of binding screws with terminal plates having upturned lugs, or the equivalent, to hold the wires in position. Other terminal connections may be provided if determined to be equivalent.

14.3.2 If a wire-binding screw is employed at a field-wiring terminal, the screw shall not be smaller than a No. 6 (3.5 mm diameter).

14.3.3 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick and shall not have less than two full threads in the metal. A terminal plate may have the metal extruded at the tapped hole for the binding screw so as to provide two full threads. Other constructions may be used if they provide equivalent security.

14.4 Field-wiring leads

14.4.1 Power supply leads provided for field connection shall not be less than 6 inches (152 mm) long, shall be provided with a strain relief, shall not be smaller than No. 18 AWG (0.82 mm²), and the insulation, if of rubber or thermoplastic, shall not be less than 1/32 inch (0.8 mm) thick.

14.4.2 Leads provided for field connection to a power limited circuit or for connection to a remote signaling device shall not be smaller than No. 16 AWG (1.3 mm²) for a single conductor, No. 19 AWG (0.65 mm²) for two or more conductors, and No. 22 AWG (0.32 mm²) for four or more conductors of a multiconductor cable. The conductor shall be solid, stranded, or bunch tinned stranded copper wire. However, stranded copper wire, consisting of not more than seven strands, may be used only for No. 18 AWG (0.82 mm²) and larger conductors.

14.4.3 For a detector that is intended to be connected to a separate remote power supply, such as a transformer, the cord is not required to be factory wired to the detector, or to the transformer terminals or leads, if the installation instructions provided with the detector specify in detail the method of connection. The size of conductors between the detector and remote power supply shall not be less than No. 18 AWG (0.82 mm²) and shall not be longer than 20 feet (6.1 m). The interconnecting wiring is to be provided with the detector and the transformer by the manufacturer.

14.5 Grounded supply terminals and leads

14.5.1 A field-wiring terminal for the connection of a grounded supply conductor shall be identified by means of a metallic-plated coating, substantially white in color, and shall be readily distinguishable from the other terminals, or identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

Exception: This requirement does not apply to a terminal in a low-voltage or NEC Class 2 circuit.

14.5.2 A field-wiring lead provided for connection of a grounded supply conductor shall be finished to show a white or natural gray color and shall be readily distinguishable from other leads. No other leads, other than grounded conductors, shall be so identified.

Exception: This requirement does not apply to a lead for connection to a low-voltage or NEC Class 2 circuit.

14.5.3 A terminal or lead identified for the connection of the grounded supply conductor shall not be electrically connected to a single-pole manual switching device that has an off position or to a single-pole overcurrent (not thermal) protective device.

15 Supplementary Signaling Circuits

15.1 The source of energy for a detector employing a supplementary signaling circuit that is energized from a separate source of supply shall not be more than 100 volt-amperes and not more than 30 volts, 60 hertz, rms, 42.4 volts peak or DC.

Exception: The source of energy for a detector intended to be connected to a fixed wiring system, and employing a separately energized signaling circuit, may exceed the limits specified if the connections are made as a Class 1 wiring system as defined in the National Electrical Code, ANSI/NFPA 70-1993.

16 Grounding

16.1 An equipment-grounding terminal or lead or equivalent is required for a high-voltage detector that is provided with an overall nonmetallic enclosure and cover and that is intended to be serviced internally and that uses internal noncurrent-carrying metal parts that can be energized under a fault condition.

16.2 The grounding means for a cord-connected detector shall consist of a separate ground lead integral with the supply cord and terminating in the grounding pin of a parallel blade attachment plug if the detector has an overall nonmetallic enclosure and cover and is intended to be serviced internally.

16.3 An equipment grounding terminal or lead is not required for a low-voltage detector, or a high-voltage detector provided with an overall nonmetallic enclosure.

16.4 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green, with or without one or more yellow stripes. No other leads visible to the installer, other than grounding conductors, shall be so identified.

16.5 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 marking on a wiring diagram provided on the detector. The field-wiring terminal shall be located so that it is unlikely to be removed during normal servicing of the detector.

INTERNAL WIRING

17 General

17.1 The internal wiring of a detector shall consist of conductors having insulation rated for the potential involved and the temperatures to which it may be subjected and having required 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.

17.2 If the use of an insulated conductor is not feasible (for example, a short coil lead or the like), electrical insulating tubing may 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 of the tubing shall comply with the requirements for such tubing, except that the wall thickness at any point for polyvinyl chloride tubing of 3/8 inch (9.5 mm) diameter or less shall not be less than 0.017 inch (0.43 mm) thick. For insulating tubing of other types, the wall thickness shall not be less than that required to at least equal the mechanical strength, dielectric properties, heat and moisture resistant characteristics, and the like of polyvinyl chloride tubing having a wall 0.017 inch thick.

17.3 Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or arranged in a manner that has been determined to be equivalent.

18 Wiring Methods

18.1 Wireways

18.1.1 Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, and the like that may cause abrasion of the conductor insulation.

18.2 Splices

18.2.1 All splices and connections shall be mechanically secured.

18.2.2 A splice shall be provided with insulation determined to be equivalent to that of the wires involved if permanence of electrical spacing between the splice and uninsulated metal parts is not maintained.

18.2.3 A splice shall be located, enclosed, and supported so that it is not subject to damage from flexing, motion, or vibration.

18.3 Bushings

18.3.1 Where a lead or wire harness passes through an opening in a wall, barrier, or enclosing case, there shall be a metal or insulating type bushing, or the equivalent, that shall be substantial, secured in place, and have a smooth, rounded surface against which the wire may bear.

18.3.2 If the opening is in a phenolic composition or other nonconducting material or in a metal more than 0.042 inch (1.07 mm) thick, a smooth surface having rounded edges is considered to be the equivalent of a bushing.

18.3.3 Ceramic materials and some molded compositions may be used for insulating bushings. Separate bushings of wood and of hot-molded shellac shall not be used.

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

18.3.5 If a soft-rubber bushing or similar material that may deteriorate with age is used in a hole in metal, the hole shall be free from sharp edges, burrs, projections, and the like, that would be likely to cut into the bushing and wire insulation.

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

18.4 Barriers

18.4.1 A metal barrier shall have a thickness equal to at least that required by Table 10.1 as determined by the size of the barrier.

18.4.2 A barrier of insulation material shall not be less than 0.028 inch (0.71 mm) thick but shall be of greater thickness if its deformation may be readily accomplished, defeating its purpose. Any clearance between the edge of a barrier and a compartment wall shall not exceed 1/16 inch (1.6 mm).

19 Separation of Circuits

19.1 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 determined to be equivalent to that required for the highest voltage involved. Segregation of insulated conductors may be accomplished by clamping, routing, or other means that provide permanent separation.

20 Bonding for Grounding

20.1 Except as indicated in 16.3, an exposed noncurrent-carrying metal part of a high-voltage detector that may become energized shall be bonded to the point of connection of the field equipment-grounding terminal or lead, if provided or required, and to the metal surrounding the knockout, hole, or bushing provided for field power-supply connections.

20.2 A bonding conductor shall be of material acceptable for use as an electrical conductor. If of ferrous metal, it shall be protected against corrosion by painting, plating, or the equivalent.

20.3 The conductor shall not be smaller than the maximum size wire used in the circuit wiring of the component or part. A separate bonding conductor or strap shall be installed so that it is protected from mechanical damage.

20.4 The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connecting, brazing, welding, or soldering of a mechanically secured component. The bonding connection shall penetrate nonconductive coatings, such as paint. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material.

20.5 A bolted or screwed connection that incorporates a star washer under the screw head is acceptable for penetrating nonconductive coatings.