



UL 268A

STANDARD FOR SAFETY

Smoke Detectors for Duct Application

UL Standard for Safety for Smoke Detectors for Duct Application, UL 268A

Fourth Edition, Dated December 11, 2008

Summary of Topics

This revision of ANSI/UL 268A dated August 25, 2023 is being issued to incorporate the following requirements:

– Electronic Installation Instructions, [55.1](#)

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The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated July 7, 2023.

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UL 268A

Standard for Smoke Detectors for Duct Application

Some requirements specified in this standard were previously covered in the Standard for Combustion Products Type Smoke Detectors for Fire Protective Signaling Systems, UL 167, and Photoelectric Type Smoke Detectors for Fire Protective Signaling Systems, UL 168.

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Fourth Edition

December 11, 2008

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The most recent designation of ANSI/UL 268A as an American National Standard (ANSI) occurred on August 22, 2023. 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 ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover air duct smoke detectors intended for indoor use within or protruding into a duct, or mounted in a housing with sampling tubes extending into or traversing a duct. Air duct smoke detectors are intended to be installed in ducts where the maximum air temperature inside the duct does not exceed 100°F (38°C), nor does the minimum temperature become less than 32°F (0°C), in accordance with the Standard for Automatic Fire Detectors, NFPA 72, and the Standard for the Installation of Air Conditioning and Ventilating Systems, NFPA 90A.

1.2 An air duct smoke detector unit, as covered by these requirements, is intended to detect smoke for the primary purpose of controlling blowers and dampers of air conditioning and ventilating systems to reduce the risk of panic and damage from distribution of smoke and gaseous products. Each unit consists of an assembly of electrical components, including a sensing means to detect smoke (sensing head or projected beam assembly), sampling tubes or equivalent (based on design), provision for connection to a source of power, and means for generating a signal when smoke is detected. It is not prohibited that remote control circuits be provided. A detector shall be powered from a commercial power source, separate power supply, or be connected to a control unit as part of a fire protection signaling system. Duct detectors are not intended as a substitute for open area protection.

1.3 These requirements cover detectors:

- a) Intended to control air conditioning and ventilating systems,
- b) Intended for control of releasing devices, such as fire and smoke dampers, or
- c) Both (a) and (b).

1.4 These requirements do not cover:

- a) Control units that are covered by the Standard for Control Units and Accessories for Fire Alarm Systems, UL 864, to which the air duct smoke detectors are connected.
- b) Single and multiple station smoke detectors covered by the Standard for Smoke Alarms, UL 217.
- c) Smoke detectors intended for open area protection or releasing device service, or both, covered by the Standard for Smoke Detectors for Fire Alarm Systems, UL 268.
- d) Smoke detectors integral with combination door closers and holders, covered by the Standard for Door Closers-Holders, With or Without Integral Smoke Detectors, UL 228.
- e) Commercial-resident detectors not intended for connection to a system control unit that are covered by the Standard for Smoke Detector Monitors and Accessories for Individual Living Units of Multifamily Residences and Hotel/Motel Rooms, UL 1730.

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 or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

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

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

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 purposes of this standard the following definitions apply.

3.2 COMBINATION SMOKE DETECTOR – A smoke detector that employs more than one smoke detecting means in one unit. In a combination smoke detector either each principle predominates, or contributes in response to at least one of the fire tests described in Fire Tests, Section [36](#).

3.3 COMPONENT, LIMITED-LIFE – A component that is expected to malfunction and be periodically replaced, and the malfunction of which is monitored when malfunction of the component affects detector operation or sensitivity or both.

3.4 COMPONENT, RELIABLE – A component that is not expected to malfunction or be periodically replaced and therefore is not monitored. A reliable component has a predicated failure rate of 2.5 or less failures per million hours. See Supplement [SA](#).

3.5 PHOTOELECTRIC LIGHT OBSCURATION SMOKE DETECTION – The principle of using a light source and photosensitive sensor onto which the principal portion of the source emissions is focused.

When smoke particles enter the light path, some of the light is scattered and some is absorbed, thereby reducing the light condition when it meets preset criteria.

3.6 PHOTOELECTRIC LIGHT-SCATTERING SMOKE DETECTION – The principle of using a light source and photosensitive sensor arranged so that the rays from the light source do not normally fall onto the photosensitive sensor. When smoke particles enter the light path, some of the light is scattered by reflection and refraction onto the sensor. The light signal is processed and used to convey an alarm condition when it meets preset criteria.

3.7 PROJECTED BEAM TYPE SMOKE DETECTOR – A type of photoelectric light obscuration smoke detector wherein the beam spans the protected area.

3.8 SPOT TYPE SMOKE DETECTOR – A device with the detecting element concentrated at a particular location. A spot type detector is usually employed with a velocity shield or within a duct housing, and serves as the smoke sensing component.

3.9 TROUBLE SIGNAL – A signal initiated by the fire alarm system or device indicative of a fault in a monitored circuit or component.

3.10 VOLTAGE CIRCUITS: (For purposes of this standard only)

a) **Low-Voltage Circuit** – A circuit involving a potential of not more than 30 volts AC (42.4 volts peak or DC), and supplied from a circuit that is limited to a maximum of 100 volt-amperes.

b) **Line-Voltage Circuit** – A circuit having characteristics in excess of those of a low-voltage circuit.

3.11 MANUFACTURER'S PUBLISHED INSTRUCTIONS – Published installation and operating documentation provided for each product or component. The documentation includes directions and necessary information for the intended installation, maintenance, and operation of the product or component.

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4 Manufacturer's Published Instructions

4.1 A copy of the manufacturer's published instructions, which includes installation and operating instructions, related schematic wiring diagrams and installation drawings shall be used as a reference in the examination and test of the detector. For this purpose, a printed edition is not required. The information may be included in a manual or technical bulletin. See Marking, Section [54](#), Installation Wiring Diagram, Section [55](#), and Technical Bulletin, Section [56](#).

4.2 The manufacturer's published instructions and drawings shall include such directions and information as deemed by the manufacturer to be required for proper installation, testing, maintenance, operation, and use of the detector.

CONSTRUCTION

5 Enclosure

5.1 General

5.1.1 An electrical part of a product shall be enclosed so as to reduce the risk of contact with uninsulated live parts. A separate enclosure for field-wiring terminals enclosed by a back box is not required.

5.1.2 Enclosures for individual electrical components, outer enclosures, and combinations of the two are to be considered in determining compliance with the requirement in [5.1.1](#).

5.1.3 An enclosure of an air duct smoke detector assembly shall resist total or partial collapse with the subsequent reduction of spacings, loosening or displacement of parts, and other defects, that alone or in combination result in a risk of fire, electric shock, or injury to persons, or affect operation.

5.1.4 An enclosure of an air duct smoke detector shall be provided with means for mounting in the intended manner. Any fittings, such as brackets and hangers, required for mounting shall be furnished with the detector. The mounting means shall be accessible without disassembling any operating part of the assembly. The removal of a completely assembled panel, cover, sensing head, or equivalent, to mount the assembly is not considered to be disassembly of any operating part.

5.1.5 With reference to the requirements of [5.1.4](#), the sensing area unit is to be installed remote from the sampling tube assembly only when air-tight metal-protected tubing and compatible fittings are employed.

5.2 Cast metal enclosures

5.2.1 The thickness of cast metal used for an enclosure shall be as specified in [Table 5.1](#). Cast metal having a thickness 1/32 inch (0.8 mm) less than that specified in [Table 5.1](#) shall be employed only when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape, size, or both, of the surface is such that the mechanical strength is equivalent to that of material specified in [Table 5.1](#).

Table 5.1
Cast-metal 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 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) in thickness is obtained by reinforcing ribs subdividing a larger area.

5.2.2 When threads for the connection of conduit are tapped all the way through a hole in a metal enclosure wall, there shall not be less 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.

5.2.3 When threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall be a smooth, rounded inlet hole for the conductors that shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

5.3 Sheet metal enclosures

5.3.1 The thickness of sheet metal for an enclosure shall not be less than that specified in [Table 5.2](#).

Exception: Sheet metal of lesser thickness is not prohibited from being employed when the surface under consideration is curved, ribbed, or otherwise reinforced, or the shape, size, or both, of the surface provides mechanical strength equivalent to that provided by the values of [Table 5.2](#).

Table 5.2
Sheet metal enclosures

Maximum dimensions of enclosure				Minimum thickness of sheet metal								
Length or width,		Area,		Steel, zinc-coated,			Steel, uncoated,			Brass or aluminum,		
inch	(mm)	inch ²	(cm ²)	inch	(mm)	GSG	inch	(mm)	GSG	inch	(mm)	AWG
12	(305)	90	(581)	0.034	(0.86)	20	0.032	(0.81)	20	0.045	(1.14)	16
24	(610)	360	(2322)	0.045	(1.14)	18	0.042	(1.07)	18	0.058	(1.47)	14
48	(1219)	1200	(7742)	0.056	(1.42)	16	0.053	(1.35)	16	0.075	(1.91)	12
60	(1524)	1500	(9678)	0.070	(1.78)	14	0.067	(1.70)	14	0.095	(2.41)	10
Over 60	(1524)	Over 1500	(9678)	0.097	(2.46)	12	0.093	(2.36)	12	0.122	(3.10)	8

5.3.2 Sheet metal shall not be less than 0.032 inch thick (0.81 mm) when of uncoated steel, not less than 0.034 inch (0.86 mm) when of galvanized steel, and not less than 0.045 inch (1.14 mm) when of nonferrous metal at any point where conduit or metal-cable is to be attached.

5.3.3 A ferrous plate or plug closure for an unused conduit opening or other hole in the enclosure having a 1-3/8 inch (34.9 mm) diameter maximum dimension shall have a thickness not less than 0.027 inch (0.69 mm) for steel or 0.032 inch (0.81 mm) for nonferrous metal.

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

5.3.5 A knockout in a sheet metal enclosure shall be secured, and shall be removable without permanent deformation of the enclosure.

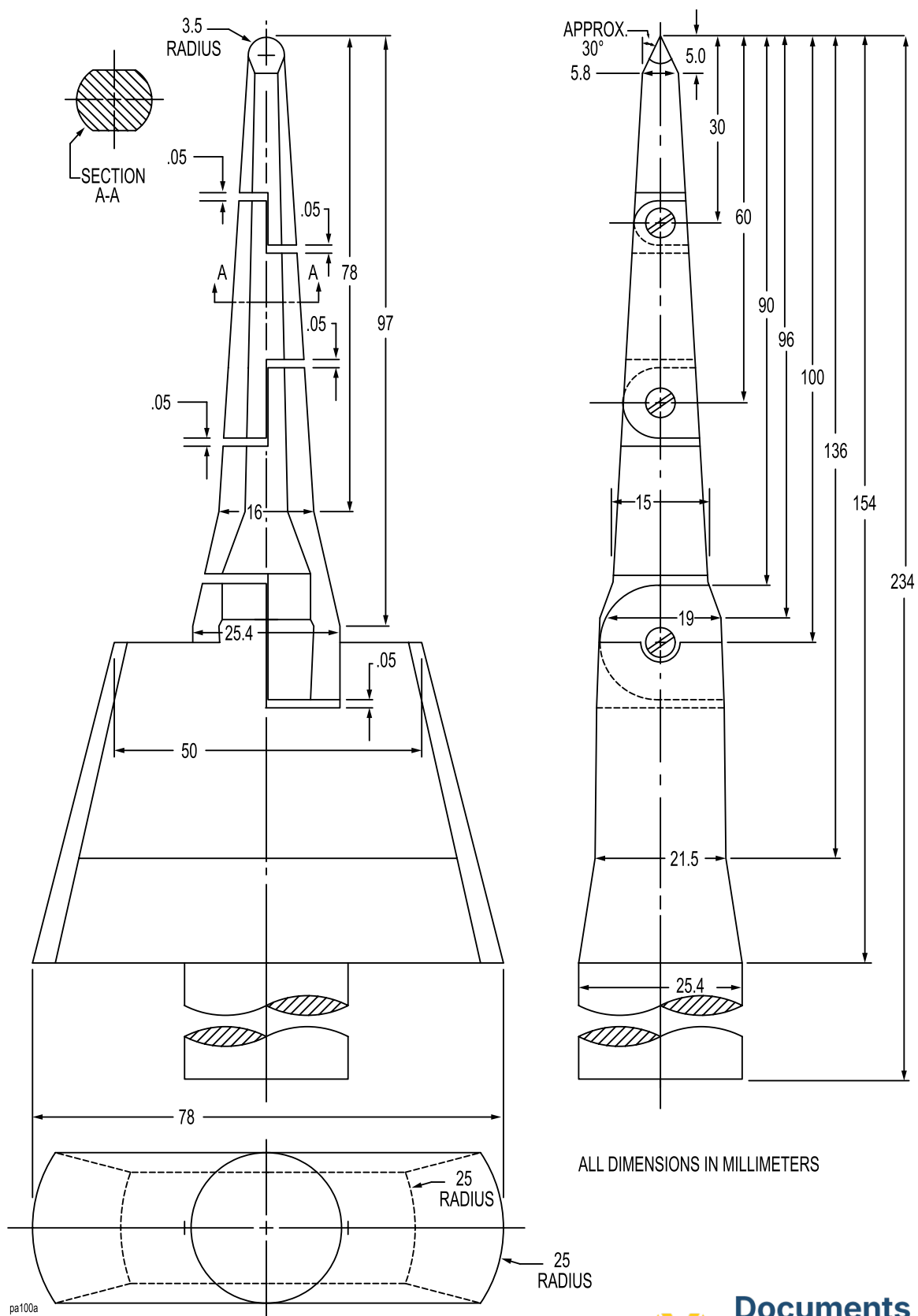
5.3.6 A knockout shall be provided with a surrounding surface for seating of a conduit bushing, and shall be located so that installation of a bushing at any knockout used during installation does not result in spacings between uninsulated live parts and the bushing of less than those required in (Spacings) General, Section [23](#).

5.4 Nonmetallic enclosures

5.4.1 An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength required to comply with Tests of Polymeric Materials, Section [49](#), and Tests of Elastomeric Materials, Section [50](#).

5.4.2 Openings in an enclosure for line-voltage circuits, including perforated holes, louvers, and openings protected by means of wire screening, expanded metal, or a perforated cover, shall be of such size or shape and so arranged that a probe, as illustrated in [Figure 5.1](#), is incapable of being made to contact any line-voltage, uninsulated live electrical parts when inserted through the opening in a straight or articulated position.

Figure 5.1
Articulate probe



5.4.3 An enclosure for a fuse(s) or other overload protective device that is provided with openings shall afford protection against the emission of flame or molten metal.

5.4.4 Openings provided for cleaning shall be such that no damage to functional internal components occurs during such cleaning operations.

5.4.5 Perforated sheet metal and sheet metal employed for expanded metal mesh shall not be less than 0.042 inch (1.07 mm) thick when uncoated, and not less than 0.046 inch (1.17 mm) when zinc coated.

Exception: When the indentation of the guard or enclosure does not alter the spacing between uninsulated live parts and grounded metal so as to reduce spacings below the minimum value required, 0.021 inch (0.53 mm) expanded metal mesh or perforated sheet metal [0.024 inch (0.61 mm) when zinc coated] is employable under the following conditions:

a) The exposed area on any one side or surface of the product is not more than 72 square inches (464 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).

5.4.6 The wires of a screen protecting line-voltage current-carrying parts shall be not smaller than 16 AWG (1.3 mm²), and a screen opening shall be not larger than 1/8 square inch (0.81 mm²) in area.

5.5 Covers

5.5.1 An enclosure cover or door of an air duct smoke detector shall be hinged, sliding, pivoted, or similarly attached when:

a) It provides ready access to circuit protective devices that require renewal, such as fuses or circuit breakers or

b) It is required to periodically open the cover in connection with the intended operation of the assembly.

For the purpose of this requirement, intended operation is considered to be operation of a switch for testing, connection of equipment to measure air flow through the assembly, or operation of any other component of the assembly that requires such action in connection with its intended performance.

5.5.2 A cover that is intended to be removed only for periodic cleaning of the sensing chamber or replacement of a lamp shall be secured by any one of the following equivalent means: positive snap catch, plug-in or twist action, snap tab with two screws, or four screws.

Exception: A ready-access cover or door is not required where the only circuit protective device(s) enclosed is intended to provide protection to portions of internal circuits to prevent excessive circuit damage resulting from a fault. The outside of an assembly employing line-voltage circuits shall be marked with the word "DANGER " and the following or equivalent text: "Risk of Electric Shock. Disconnect Power Prior to Servicing." This marking is not required when only low-voltage circuits are involved.

5.5.3 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.

5.6 Glass panels

5.6.1 Glass covering an opening in an enclosure shall be held in place so that it is not displaced in service and shall provide mechanical protection of the enclosed parts. The thickness of a glass cover shall be not less than that indicated in [Table 5.3](#).

Table 5.3
Thickness of glass covers

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

^a 1/8 inch (3.2 mm) or more, based upon the size, shape, and mounting of the glass panel. A glass panel for an opening having an area of more than 144 square inches (929 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.

5.6.2 A glass panel for an opening having an area of more than 144 square inches (929 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.

5.6.3 A transparent material other than glass employed as a cover over an opening in an enclosure shall have mechanical strength equivalent to that of glass and not distort or become less transparent at the temperature to which it is subjected under all anticipated conditions of use.

5.6.4 The transparency of a lens, light filter, or similar part of an air duct smoke detector shall not be affected by service conditions as represented by the tests described in the Performance sections of this standard.

6 Remote Accessories

6.1 General

6.1.1 Unless specifically indicated otherwise, the construction requirements specified for a duct detector shall apply also for any accessories intended to be employed with the detector.

6.2 Sensitivity indicating means

6.2.1 A detector shall be provided with a means for measuring or indicating the nominal sensitivity or sensitivity range of the detector, as described in [6.2.2](#), or with a sensitivity test feature, as described in [6.2.3](#), after it has been installed as intended. Removal of a snap-on cover to gain access to the sensitivity control is not appropriate when high-voltage parts are exposed or capable of being contacted by the user.

6.2.2 The measuring or indicating means shall be:

- a) A jack or terminals for connection of a meter;
- b) A visual indication such as a change in frequency of a pulsing light which is visible with the detector installed;
- c) A mechanical device as described in [6.2.3](#); or
- d) an equivalent arrangement.

The use of an adapter that is connected to metering equipment, and that is able to be inserted between the base and plug-in head of a detector assembly, is not prohibited. A plug-in type detector that is readily removed and connected to metering equipment is also not prohibited.

6.2.3 It is not prohibited that the test feature consist of an electrical or mechanical means to simulate a specified level of smoke in the detector sensing chamber. The test feature is to be calibrated to simulate gray smoke having an obscuration of not more than 6 percent per foot [0.027 optical density per foot (OD/ft) (0.088 OD/m)] using gray smoke as measured in the sensitivity test smoke box referenced in [53.1a](#)(1).

6.2.4 A detector that incorporates a variable sensitivity control intended to be field adjusted shall have a mechanical stop on the adjusting means at the maximum and minimum settings.

6.3 Radioactive materials

6.3.1 The manufacture, importation, distribution, marking, and disposal of smoke detectors containing radioactive material are subject to the safety requirements of the U. S. Nuclear Regulatory Commission, of local or state radiation control agencies, or of both.

6.3.2 Verification of the compliance of such detectors with the requirements of the regulating agency involved shall be established prior to, or established concurrently with, the establishment of compliance with the requirements of this standard.

7 Air Flow Monitoring

7.1 General

7.1.1 To corroborate the operation of the detector during the Fire Tests, Section [36](#), and to verify intended operation after field installation, a duct detector employing sampling tubes or other arrangement to divert air flow from the duct to a sensing area inside the duct housing shall be provided with a means or instructions for measuring the air flow in the sensing area or for measuring pressure differential between sampling tubes, or equivalent. See [54.7](#) for marking information required.

7.1.2 The measuring or indicating means shall be metering equipment, visual indicators, operation of a mechanical device, or an equivalent arrangement.

7.1.3 The air flow or pressure measurement shall apply through the entire range of air velocities and tube lengths with which the detector is to be employed in service. See Fire Tests, Section [36](#). To simulate the use of a length of sampling tube longer than 1 foot (0.30 m), the total hole area of the longest tube to be employed in service is to be drilled into the tube under test using the same size holes spaced equal distances apart.

7.2 Alignment and secureness

7.2.1 Sampling tubes shall be provided with positive alignment means, such as a pin/slot arrangement or equivalent, to prevent turning. The use of only a lock washer is prohibited.

8 Protection Against Corrosion

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

Exception: Parts made of stainless steel, polished or treated when required, do not require additional protection.

8.2 The requirement of [7.1.1](#) applies to all enclosures, whether of sheet steel or cast iron, and to all springs and other parts upon which operation depends. It does not apply to minor parts, such as washers,

screws, or bolts, when the corrosion of such unprotected parts does not affect the intended operation of the product.

8.3 Bearing surfaces shall be of materials that do not bind as a result of corrosion.

8.4 Metals shall not be used in combinations that result in galvanic action to the extent that the intended function of cabinets or enclosures are affected.

8.5 Hinges and other attachments shall be resistant to corrosion.

8.6 Nonferrous cabinets and enclosures are able to be employed without corrosion protection.

9 Field-Wiring Connections

9.1 General

9.1.1 An air duct smoke detector 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 system.

9.1.2 Duplicate terminals or leads, or an equivalent arrangement, shall be provided for circuits supplying operating power to the detector (where the operating power is monitored by an end-of-line device) and for circuits transmitting alarm signals from the detector to the control unit when specified, one for each incoming and one for each outgoing wire. It is permissible that a common terminal be used in lieu of duplicate terminals when it is intended to prevent the looping of an unbroken wire around or under a terminal screw in a manner that permits the looped wire to remain unbroken during installation, thereby precluding monitoring in the event the wire becomes dislodged from under the terminal. A notched clamping plate under a single securing screw, where separate conductors are intended to be inserted in each notch, is an equivalent arrangement. When duplicate terminals or leads are used and there is no provision to prevent looping an unbroken wire around or under one terminal, the marking in [55.3\(e\)](#) shall be provided. In addition, terminals intended only for connection to an initiating device circuit of a system control unit shall be marked in accordance with [55.3\(e\)](#).

9.2 Field wiring compartment

9.2.1 The field wiring compartment area shall be sized 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 conduit connected to the compartment when a bushing is required for installation.

9.2.2 An enclosure shall have provision for the connection of metal-clad cable, conduit, or nonmetallic sheathed cable.

Exception: An enclosure without such provision is not prohibited when instructions are provided that indicate the sections of the enclosure that are intended to be drilled in the field for the connection of raceways, or when the assembly is intended for mounting on an outlet box.

9.2.3 An outlet box or compartment in which field wiring connections are to be made shall be located so that the connections are able to be inspected after the system is installed as intended. The removal of not more than two mounting screws, or an equivalent arrangement, to view the field wiring connections, is considered to comply with this requirement.

9.2.4 Protection from sharp edges for internal components in the wiring area and wire insulation shall be provided by insulating or metal barriers having smooth, rounded edges or equivalent means of protection.

9.3 Field wiring terminals (general)

9.3.1 A field-wiring terminal to which field-wiring connections are made shall comply with the requirements in:

- a) [9.3.2](#) – [9.3.5](#);
- b) The field-wiring requirements in the Standard for Electrical Quick-Connect Terminals, UL 310;
- c) The Standard for Wire Connectors, UL486A-486B;
- d) The Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E; or
- e) The Standard for Terminal Blocks, UL 1059, rated for field-wiring (FW) Code 2 applications and also suitable for the voltage, current, wire range, and wire type of the intended application.

9.3.2 Nonferrous soldering lugs or solderless (pressure) wire connectors shall be used for 10 AWG (5.3 mm²) and larger wires. When the connectors or lugs are secured to a plate, the plate thickness shall not be less than 0.050 inch (1.3 mm) thick. Securing screws of plated steel have been determined to meet the requirements.

9.3.3 A wire-binding screw used at a wiring terminal shall not be smaller than No. 8 (4.2 mm) diameter. Plated screws are not prohibited.

Exception: A No. 6 (3.5 mm) diameter screw is appropriate for use for the connection of a 14 AWG (2.1 mm²) and a No. 4 (2.8 mm) diameter screw is appropriate for use for the connection of a 19 AWG (0.65 mm²) or smaller conductor.

9.3.4 Terminal plates tapped for wire-binding screws shall:

- a) Have not less than two full threads in the metal (the terminal plate metal may be extruded to provide the two full threads) and shall have upturned lugs, clamps, or the equivalent, to hold the wires in position. Other constructions may be used if they provide equivalent thread security of the wire-binding screw.
- b) Be of a nonferrous metal not less than 0.050 inch (1.3 mm) thick when used with a No. 8 (4.2 mm) diameter or larger screw, and not less than 0.030 inch (0.76 mm) thick when used with a No. 6 (3.5 mm) diameter or smaller screw.

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

9.4 Field wiring leads

9.4.1 Leads provided for field connections shall be not less than 6 inches (152 mm) long, shall be provided with strain relief, and shall not be smaller than 18 AWG (0.82 mm²). The insulation, when rubber or thermoplastic, shall be not less than 1/32 inch (0.8 mm) thick. Wire shall be of stranded copper.

9.5 Grounding terminals and leads

9.5.1 A line-voltage air duct smoke detector, that:

- a) Is provided with an overall nonmetallic enclosure and cover,
- b) Is intended to be internally serviced, and
- c) Employs internal dead metal parts that are able to become energized under a fault condition,

shall have an equipment grounding terminal or lead or the equivalent.

9.5.2 An equipment grounding terminal or lead is not required for:

- a) A low-voltage detector,
- b) A line-voltage detector that is provided with an overall nonmetallic enclosure and cover and that:
 - 1) Is not intended to be internally serviced; or
 - 2) Does not employ internal dead metal parts that become energized under a fault condition and are able to be contacted during servicing, or dead metal parts that are insulated; or
 - 2A) Has internal dead metal parts that are insulated; or
 - 3) Includes internal dead metal parts that are able to be contacted during servicing, and employs a two-pole disconnect switch that de-energizes both legs of the supply circuit upon removal of the cover.

9.5.3 The grounding means shall be connected to all exposed dead metal parts that are capable of being energized and all dead metal parts within the enclosure that are exposed to contact during servicing and maintenance. See Bonding for Grounding, Section [11](#).

9.5.4 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; and no other lead visible to the installer, other than grounding conductors, shall be so identified.

9.5.5 A field wiring terminal intended for connection of an equipment grounding conductor shall be plainly identified, such as by 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 not removed during servicing or installation of the assembly.

9.6 Grounded supply terminals and leads

9.6.1 A field wiring terminal for the connection of the grounded supply conductor of a line-voltage circuit 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 shown in some other manner, such as on an attached wiring diagram.

9.6.2 A field wiring lead provided for connection of the grounded supply conductor of a line-voltage circuit shall be finished to show a white or gray color and shall be readily distinguishable from other leads and no other leads visible to the installer, other than grounded conductors, shall be so identified.

9.6.3 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, nonthermal, overcurrent-protective device.

9.7 Isolated (nongrounded) detectors

9.7.1 When an air duct smoke detector is constructed so that the exposed metal enclosure serves as a current-carrying part of the circuit, an insulated (nonmetallic) mounting plate, or a metal mounting plate with insulated bushed holes through which metal mounting screws are employed, or an equivalent arrangement, shall be provided for installation between the detector current-carrying parts and metal back box.

9.7.2 The arrangement described in [9.7.1](#) is permissible only on a detector intended for connection to a low-voltage circuit. In addition, the detector shall be marked adjacent to the detector wiring area with the word "CAUTION," and the following or the equivalent text, in letters at least 1/8 inch (3.2 mm) high: "INSTALL ENCLOSURE ISOLATED FROM GROUND ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS AND USING HARDWARE PROVIDED. GROUNDING COULD RESULT IN A FALSE ALARM OR NONOPERATION."

9.8 Special field-wiring terminals (qualified application)

9.8.1 Any of the following terminal configurations are suitable for connection of field wiring when all of the conditions in [9.8.2](#) are met:

- a) Quick-Connect Terminals – Nonferrous, quick-connect (push-type) terminals consisting of male posts permanently secured to the device and provided with compatible, female connectors for connection to field wiring. These require a special tool for crimping of field wires. Mating terminals shall be shipped with the control unit with instructions for their installation;
- b) Push-In Terminals – Nonferrous (screwless), push-in terminals of the type used on some switches and receptacles. Solid conductors are pushed into slots containing spring-type contacts. The leads are removable by means of a tool inserted to relieve the spring tension on the conductor. Push-in terminals are not to be used with aluminum conductors. The marking adjacent to the terminal shall indicate that copper conductors only are to be used; and
- c) Other Terminals – Other terminal connections are not prohibited when determined to be equivalent to (a) and (b) and are limited to the same restrictions.

9.8.2 Any of the terminal configurations listed in [9.8.1](#) are appropriate for connection of field wiring provided all of the following conditions are met:

- a) When a special tool is required for connection, it shall be provided and its use indicated on the installation wiring diagram by name of the manufacturer and the model number or equivalent.
- b) The range of wire sizes shall be indicated on the installation wiring diagram. The minimum permissible wire size to be used shall not be less than 26 AWG (0.13 mm²) for a jacketed, multi-conductor cable or 18 AWG (0.82 mm²) for a single conductor wire.
- c) The wire size to be used shall be rated for the current-carrying capacity of the circuit application.
- d) The special field-wiring terminal assembly shall comply with the strain relief test as outlined in [51.3](#).

10 Internal Wiring

10.1 General

10.1.1 The internal wiring of an air duct smoke detector shall consist of conductors having:

- a) Insulation rated for the potential involved,

- b) Insulation rated for the temperatures to which they are subjected, and
- c) The current-carrying capacity for the service.

10.1.2 The wiring shall be routed away from moving parts and sharp projections and held in place with clamps, string, ties, or the equivalent, unless the wiring is determined to be rigid enough to retain a shaped form.

10.1.3 Leads or a cable assembly 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, arranged, or both, to prevent abrasion of insulation and jamming between parts of the enclosure. Wire shall be stranded copper.

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

10.1.5 Internal wiring of circuits operating 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 equivalent to that required for the highest voltage involved. Segregation of insulated conductors is to be accomplished by clamping, routing, or by an equivalent means, that ensures permanent separation. See [10.4](#), Barriers.

10.1.6 Stranded conductors clamped under a wire binding screw or under a similar part shall have the individual strands soldered together or shall be equivalently arranged to provide secure connections.

10.2 Wireways

10.2.1 Wireways shall be smooth and free from sharp edges, burrs, fins, and moving parts that result in abrasion of the conductor insulation.

10.3 Splices

10.3.1 Each splice and connection shall be mechanically secured and bonded electrically. Tack soldering of components or electrical leads is permitted where the construction precludes mechanical security only when 5 samples resist a pull-force of 8.9 N (2 lb) applied for 3 seconds and the connection is subjected to 100 percent inspection and testing with the same pull force by the manufacturer.

10.3.2 A splice shall be provided with insulation equivalent to that of the wires involved when permanence of electrical spacings between the splice and uninsulated metal parts is not provided.

10.3.3 Splices shall be located, enclosed, and supported so that flexing, movement, or vibration does not damage the insulation or affect the integrity of the splice.

10.4 Barriers

10.4.1 A metal barrier shall have a thickness at least equal to that required by [Table 5.2](#) as determined by the size of the barrier.

10.4.2 A barrier of insulating material shall be not less than 0.028 inch (0.71 mm) thick.

10.4.3 The clearance between the edge of a barrier and a compartment wall shall be not more than 1/16 inch (1.6 mm).

10.4.4 Internal components and wire insulation shall be shielded from sharp edges by insulating barriers or metal barriers having smooth rounded edges.

10.5 Strain relief

10.5.1 A strain relief means shall be provided for the field supply leads, and all internally connected wires or cords that are subject to movement in conjunction with the installation, operation, or servicing of a detector to reduce the risk of any mechanical stress being transmitted to internal connections and terminals. Inward movement of the cord or leads provided with a ring-type cord grip shall not damage internal connections or components, or result in a reduction of required electrical spacings. See Strain Relief Test, Section [51](#).

11 Bonding for Grounding

11.1 An exposed noncurrent-carrying metal part of a detector operating at more than 30 Vrms that is liable to become energized shall be reliably 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 powersupply connections. This requirement also applies to a detector equipped with auxiliary function contacts rated at more than 30 Vrms. Bonding for Grounding is not applicable if the criteria defined in [9.5.2](#) are met.

11.2 Except as indicated in [11.2A](#), uninsulated metal parts of electrical enclosures, motor frames and mounting brackets, controller mounting brackets, capacitors, and other electrical components shall be bonded for grounding when it is possible that they be contacted by the user or by a service person servicing or operating the equipment.

11.2A Metal parts as described below are not required to comply with the requirement specified in [11.2](#):

- a) Adhesive attached metal foil markings, screws, and handles, that are located on the outside of the detector enclosure and isolated from electrical components or wiring by grounded metal parts so that they do not become energized.
- b) Isolated metal parts, such as small assembly screws, mechanically and electrically that are separated from wiring and uninsulated live parts.
- c) Panels and covers that do not enclose uninsulated live parts, when wiring is separated from the panel or cover so that the panel or cover do not become energized.
- d) Panels and covers that are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material not less than 1/32 inch (0.8 mm) thick and secured in place.

11.3 A bonding conductor shall be of material determined to be capable for use as an electrical conductor. When of ferrous metal, it shall be protected against corrosion by painting, plating, or the equivalent. The conductor shall be not smaller than the maximum size wire employed 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.

11.4 The bonding shall be by a positive means, such as by clamping, riveting, brazing, welding, or by a bolted or screwed connection. 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.

11.5 A bolted or screwed connection that incorporates a star washer under the screwhead is appropriate for penetrating nonconductive coatings.

11.6 When the bonding means depends upon screw threads, two or more screws, or two full threads of a single screw engaging metal is considered to meet the intent of the requirement.

11.7 The continuity of any grounding system to which an air duct smoke detector is to be connected shall not rely on the dimensional integrity of nonmetallic material.

11.8 Metal-to-metal hinge-bearing members of doors or covers are considered as a means for bonding the door or cover for grounding only when a multiple bearing-pin type hinge is employed.

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

11.10 Splices shall not be employed used for conductors used to bond electrical enclosures or components.

COMPONENTS

12 General

12.1 Mounting of components

12.1.1 A switch, lampholder, attachment-plug receptacle, plug connector, or similar electrical component, and uninsulated live parts shall be mounted securely and shall be prevented from turning.

Exception No. 1: It is not required that a switch be prevented from turning when all of the conditions specified in (a) – (d) are complied with:

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

b) The means for mounting the switch makes it doubtful that the operation of the switch shall loosen it.

c) The spacings are not reduced below the minimum required values in cases where the switch rotates.

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

Exception No. 2: A lampholder of the type in which the lamp is not able to be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, are not required to be prevented from turning when rotation does not reduce spacings below the minimum required values.

12.1.2 Uninsulated live parts, such as field wiring terminals, shall be secured to their supporting surfaces by methods other than friction between surfaces so that they are prevented from turning or shifting in position when such motion results in reduction of spacings below the minimum required values. This is accomplished by two screws or rivets, by square shoulders or mortises, by a dowel pin, lug, or offset, by a connecting strap or clip fitted into an adjacent part, or by some other equivalent method. A toothed lock washer with spring takeup complies with this requirement.