

NFPA[®]

715

Standard for the
Installation of Fuel Gases Detection
and Warning Equipment

2023



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NFPA® 715

Standard for the

Installation of Fuel Gases Detection and Warning Equipment

2023 Edition

This edition of NFPA 715, *Standard for the Installation of Fuel Gases Detection and Warning Equipment*, was prepared by the Technical Committee on Fuel Gases Warning Equipment. It was issued by the Standards Council on March 20, 2022, with an effective date of April 9, 2022.

This edition of NFPA 715 was approved as an American National Standard on April 9, 2022.

Origin and Development of NFPA 715

There has been increased concern over fuel gas hazards after several recent major fatal incidents involving combustible gas releases within residential and commercial buildings that went unreported or undetected from its odor. While early warning detection devices exist for fuel gases, the requirements for use, installation, and placement of detection devices to maximize early warning detection capability for consumers are limited, and manufacturer's installation instructions are generally inconsistent across the product category. As a result, even where fuel gas warning devices are installed, improper installation could jeopardize building occupant safety in the event of a fuel gas leak in the building or from leaks of fuel gas entering the building from a breach in exterior piping or storage system. The National Fire Protection Association was petitioned to develop a document to produce consensus for technical-based requirements for the use, installation, and placement of fuel gas detectors and related equipment. The NFPA Standards Council approved the formation of the Technical Committee on Fuel Gases Warning Equipment to develop this document.



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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the installation, performance, maintenance, testing, and use of fuel gases warning equipment for the protection of life, property and mission continuity. This Committee shall address the selection, installation, operation, and maintenance of fuel gases warning equipment.

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NFPA 715**Standard for the****Installation of Fuel Gases Detection and
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2023 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration**1.1* Scope.**

1.1.1 This standard shall be concerned with life safety and protection of property.

1.1.2* This standard shall cover the selection, design, application, installation, location, performance, inspection, testing, and maintenance of fuel gas detection and warning equipment in buildings and structures.

1.1.3 This standard shall contain requirements for the selection, installation, operation, and maintenance of equipment that detects concentrations of fuel gases that could pose a life or property safety risk.

1.2* Purpose.

1.2.1 The purpose of this standard shall be to provide requirements for fuel gas detection and warning equipment intended to warn occupants of the presence of fuel gas in time to allow

occupants to either escape or take other action and to summon aid where needed.

1.2.2 The requirements provided by this standard shall address the means of signal initiation, transmission, notification, and annunciation; the levels of performance; and the reliability of fuel gas detection and warning equipment.

1.3 Application.

1.3.1 The requirements of this standard shall apply to the installation of fuel gas detection and warning equipment, including the following:

- (1) Single- and multiple-station fuel gas alarms
- (2) Fuel gas detectors and their related systems and components

1.3.2* Fuel gas detection and warning equipment shall not be used in lieu of fire or carbon monoxide detection or warning equipment required by NFPA 72, NFPA 101, or NFPA 5000.

1.4 Retroactivity.

1.4.1 Unless otherwise noted, the provisions of this document shall not be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of the document.

1.4.2 In those cases where it is determined by the authority having jurisdiction (AHJ) that the existing situation involves a distinct hazard to life or property, retroactive application of the provisions of this document shall be permitted.

1.5 Equivalency.

1.5.1 Nothing in this standard shall be intended to prevent the use of systems, methods, devices, or appliances of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.2 Technical documentation shall be submitted to the AHJ to demonstrate equivalency.

1.5.3 Systems, methods, devices, and appliances shall be approved for the intended purpose by the AHJ.

1.6 Units of Measure.

1.6.1 The units of measure in this standard shall be presented in US customary units (i.e., inch/pound units).

1.6.2 Where presented, International System (SI) units shall follow the inch/pound units in parentheses.

1.6.3 Where both systems of units are presented, either system shall be acceptable for satisfying the requirements in this standard.

1.6.4 Where both systems of units are presented, both of the following shall apply:

- (1) Users of this standard shall apply one set of units consistently.
- (2) Users of this standard shall not alternate between units.

1.6.5 The values presented for measurements in this standard shall be expressed with a degree of precision for application and enforcement.

1.6.6 It shall not be the intent that the application or enforcement of the values presented for measurements in this standard be more precise than the precision expressed.

1.6.7* Where extracted text contains values expressed in only one system of units, the values in the extracted text shall be retained without conversion to preserve the values established by the responsible technical committee in the source document.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, National Electrical Code®, 2023 edition.

NFPA 72®, National Fire Alarm and Signaling Code®, 2022 edition.

NFPA 101®, Life Safety Code®, 2021 edition.

NFPA 110, Standard for Emergency and Standby Power Systems, 2022 edition.

NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2022 edition.

NFPA 170, Standard for Fire Safety and Emergency Symbols, 2021 edition.

NFPA 1225, Standard Emergency Services Communications, 2022 edition.

NFPA 5000®, Building Construction and Safety Code®, 2021 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc. (operations) 25 West 43rd Street, 4th Floor, New York, NY 10036; (headquarters) 1899 L Street, NW, 11th Floor, Washington, DC 20036.

ANSI S1.4A, Electroacoustics — Sound Level Meters, 2014.

ANSI S3.41, Audible Emergency Evacuation (E2) and Evacuation Signals with Relocation Instructions (ESRI), 2015.

2.3.2 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, 2016.

2.3.3 IEEE Publications. IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141.

IEEE 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications, 2020.

IEEE 1106, Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications, 2015.

2.3.4 TIA Publications. Telecommunications Industry Association, 1310 North Courthouse Road, Suite 890, Arlington, VA 22201.

ANSI/TIA 568-C.3, Optical Fiber Cabling Components Standard, 2015.

2.3.5 ISO Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401 - 1214 Vernier, Geneva, Switzerland.

ISO 7731, Ergonomics — Danger signals for public and work areas — Auditory danger signals, 2003.

2.3.6 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 1484, Residential Gas Detectors, 2016.

UL 1638, Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories, 2016.

UL 1971, Signaling Devices for the Hearing Impaired, 2002, revised 2018.

UL 2075, Gas and Vapor Detectors and Sensors, 2017.

2.3.7 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 72®, National Fire Alarm and Signaling Code®, 2022 edition.

NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances, 2019 edition.

NFPA 1225, Standard for Emergency Services Communications, 2022 edition.

NFPA 5000®, Building Construction and Safety Code®, 2021 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evalua-

tion of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1* Acoustically Distinguishable Space (ADS). An emergency communications system notification zone, or subdivision thereof, that might be an enclosed or otherwise physically defined space, or that might be distinguished from other spaces because of different acoustical, environmental, or use characteristics, such as reverberation time and ambient sound pressure level. [72, 2022]

3.3.2 Alarm.

3.3.2.1 Fuel Gas Alarm. A single- or multiple-station fuel gas alarm intended for the purpose of detecting fuel gas and alerting occupants by a distinct audible signal comprising an assembly that incorporates a sensor, control components, and an alarm notification appliance in a single unit operated from a power source either located in the unit or obtained at the point of installation.

3.3.2.2 Multiple-Purpose Alarm. An alarm that incorporates detection capabilities for more than one hazardous condition, such as fire, fuel gas, or carbon monoxide.

3.3.2.3 Multiple-Station Alarm. A single-station fuel gas alarm capable of being interconnected to one or more additional alarms so that the actuation of one causes the appropriate alarm signal to operate in all interconnected alarms.

3.3.2.4 Single-Station Alarm. A fuel gas device comprising an assembly that incorporates a sensor, control components, and an alarm notification appliance in one unit operated from a power source either located in the unit or obtained at the point of installation.

3.3.3 Combination System. See 3.3.31, System.

3.3.4* Communications Center. A building or portion of a building that is specifically configured for the primary purpose of providing emergency communications services or public safety answering point (PSAP) services to one or more public safety agencies under the authority or authorities having jurisdiction. [1225, 2022]

3.3.5* Device (Class N). A supervised component of a life safety system that communicates with other components of life

safety systems and that collects environmental data or performs specific input or output functions necessary to the operation of the life safety system. [72, 2022]

3.3.6 Dwelling Unit. One or more rooms arranged for complete, independent housekeeping purposes, with space for eating, living, and sleeping; facilities for cooking; and provisions for sanitation. [5000, 2021]

3.3.7* Emergency Response Agency (ERA). Organizations providing law enforcement, emergency medical, fire, rescue, communications, and related support services. [1225, 2022]

3.3.8 Emergency Response Plan. A documented set of actions to address the planning for, management of, and response to natural, technological, and man-made disasters and other emergencies. [72, 2022]

3.3.9 End-of-Life Signal. An audible signal, differing from the alarm signal, intended to indicate that the device has reached the end of its useful life and should be replaced.

3.3.10 Fireplace. A hearth, fire chamber, or similarly prepared area and a chimney. [211, 2019]

3.3.11 Frequency. Minimum and maximum time between events. [72, 2022]

3.3.11.1 Weekly Frequency. Fifty-two times per year, once per calendar week. [72, 2022]

3.3.11.2 Monthly Frequency. Twelve times per year, once per calendar month. [72, 2022]

3.3.11.3 Quarterly Frequency. Four times per year with a minimum of 2 months, maximum of 4 months. [72, 2022]

3.3.11.4 Semiannual Frequency. Twice per year with a minimum of 4 months, maximum of 8 months. [72, 2022]

3.3.11.5 Annual Frequency. Once per year with a minimum of 9 months, maximum 15 of months. [72, 2022]

3.3.12* Fuel Gas. Any number of gasses that, when combined with an oxidizer (typically air or oxygen), could be burned to produce thermal energy.

3.3.13* Fuel-Gas-Burning Appliance. A device that burns gaseous fuel.

3.3.14* Fuel Gas Control Function Interface Device. A listed fuel gas detection system component that directly interfaces with the system that operates the fuel gas control function.

3.3.15 Fuel Gas Control Functions. Fuel gas control elements or systems that are initiated by the fuel gas detection system and either increase the level of life safety for occupants or control the spread of the harmful effects of fuel gas.

3.3.16* Fuel Gas Detection Control Unit (FGDCU). A component of the fuel gas detection system, provided with primary and secondary power sources, which receives signals from initiating devices or other fuel gas detection control units, and processes these signals to determine part or all of the required fuel gas detection system output function(s).

3.3.17 Fuel Gas Detector. A device having a sensor that responds to fuel gas that is connected to an alarm control unit.

3.3.18 Fuel Gas Warning Equipment. Any detector, alarm, device, or material related to single- and multiple-station alarms or household fuel gas detection systems.

3.3.19 Gateway. A device that is used in the transmission of serial data (digital or analog) from the fuel gas detection control unit to other building system control units, equipment, or networks and/or from other building system control units to the fuel gas detection control unit.

3.3.20* Lower Explosive Limit (LEL). The minimum concentration of a gas in air that, 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 [also known as the lower flammable limit (LFL)].

3.3.21* Nonrequired. A system component or group of components that is installed at the option of the owner, and is not installed due to a building or fire code requirement. [72, 2022]

3.3.22 Notification Appliance. A fuel gas system component such as a bell, horn, loudspeaker, visual notification appliance, or text display that provides audible, tactile, or visual outputs, or any combination thereof.

3.3.23 Occupiable. A room or enclosed space designed for human occupancy. [72, 2022]

3.3.24 Occupiable Area. An area of a facility occupied by people on a regular basis. [72, 2022]

3.3.25* Off-Premises Monitoring. Systems requiring transmission of signals to continuously attended locations providing supervising station service monitoring.

3.3.26 Operating Mode.

3.3.26.1 Private Operating Mode. Audible or visual signaling only to those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the area protected by the fuel gas detection system.

3.3.26.2 Public Operating Mode. Audible or visual signaling to occupants or inhabitants of the area protected by the fuel gas detection system.

3.3.27 Protected Premises. The physical location protected by a fuel gas detection system.

3.3.28* Sleeping Area. The area of a dwelling unit where the bedrooms or sleeping rooms are located. [72, 2022]

3.3.29 Signal.

3.3.29.1 Fuel Gas Alarm Signal. A signal indicating a concentration of fuel gas at or above the alarm threshold that could pose a risk to the life safety of the occupants and that requires immediate action.

3.3.29.2 Supervisory Signal. A signal indicating the need for action in connection with a prealarm condition, or in connection with the supervision of protected premises fuel gas safety functions or equipment, or the maintenance features of related systems.

3.3.29.3* Trouble Signal. A signal initiated by a system or device indicative of a fault in a monitored circuit, system, or component.

3.3.30 Supplementary. As used in this standard, *supplementary* refers to equipment or operations not required by this stand-

ard and designated as such by the authority having jurisdiction. [72, 2022]

3.3.31 System.

3.3.31.1 Combination Fuel Gas Detection System. A fuel gas detection system in which components are used, in whole or in part, in common with a non-fuel gas signaling system, and in which components are not used as part of a fuel gas detection system.

3.3.31.2* Combination System. A fire alarm system in which components are used, in whole or in part, in common with a non-fire signaling system. [72, 2022]

3.3.31.3 Fire Alarm System. A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals. [72, 2022]

3.3.31.4 Fuel Gas Detection System. A system or portion of a combination system that consists of a control unit, components, and circuits arranged to monitor and annunciate the status of fuel gas alarm initiating devices and to initiate the appropriate response to signals to protect life and property.

3.3.31.5 Household Fuel Gas Detection System. A system of devices that uses a control unit to produce an alarm signal in the household for the purpose of notifying the occupants of the presence of concentrations of fuel gas that could pose a life safety risk.

3.3.32 Zone. A defined area within the protected premises. A zone can define an area from which a signal can be received, an area to which a signal can be sent, or an area in which a form of control can be executed. [72, 2022]

Chapter 4 Fundamentals of Fuel Gas Detection Systems

4.1 Application.

4.1.1 The basic functions of a complete fuel gas detection system shall comply with the requirements of this chapter.

4.1.2 The requirements of this chapter shall apply to fuel gas detection systems, equipment, and components addressed in 5 through 8 of this document.

4.2 Purpose. The purpose of fuel gas detection systems shall be primarily to provide notification of predetermined exposure levels of fuel gas.

4.3 Equipment.

4.3.1 Equipment constructed and installed in conformity with this standard shall be listed in accordance with the following:

- (1) Residential fuel gas detectors and alarms shall be listed in accordance with UL 1484, *Residential Gas Detectors*.
- (2) Fuel gas detectors shall be listed in accordance with UL 2075, *Gas and Vapor Detectors and Sensors*.

4.3.2* Components.

4.3.2.1 System components shall be installed, tested, inspected, and maintained in accordance with the manufacturer's published instructions and this standard. [72:10.3.2]

4.3.3* All devices and appliances that receive their power from an initiating device circuit (IDC) or signaling line circuit

(SLC) of a control unit shall be listed for use with the control unit. [72:10.3.3]

4.3.4* Where no fuel gas detection product listing standard exists, products listed for fire alarm service shall be permitted provided all the requirements of this standard are met.

4.4 Personnel Qualifications.

4.4.1 System Designer.

4.4.1.1 Fuel gas detection system plans and specifications shall be developed in accordance with this standard by persons who are knowledgeable and experienced in the design, application, installation, and testing of the systems.

4.4.1.2 Where available, state or local licensure regulations shall be followed to determine qualified personnel.

4.4.1.3 Depending on state or local licensure regulations, qualified personnel shall be permitted to include, but not be limited to, one or more of the following:

- (1) Personnel who are factory trained and certified for fuel gas detection system design of the specific type and brand of system being designed and who are acceptable to the AHJ
- (2) Personnel with expertise in the design of fuel gas detection systems that are registered, licensed, or certified by state or local authority

4.4.1.4 The system designer shall be identified on the system design documents. [72:10.5.1.4]

4.4.1.5 The system designer shall provide evidence of their qualifications and/or certifications when required by the AHJ. [72:10.5.1.6]

4.4.2 System Installer.

4.4.2.1 Installation personnel shall be qualified or supervised by persons who are qualified in the installation, inspection, and testing of fuel gas detection systems.

4.4.2.2 Fuel gas alarms that receive their primary power from a battery or plug into an AC receptacle shall be permitted to be installed by the occupant of the dwelling unit in accordance with the manufacturer's published instructions.

4.4.2.3 Where available, state or local licensure regulations shall be followed to determine qualified personnel.

4.4.2.4 Depending on state or local licensure regulations, qualified personnel shall be permitted to include, but not be limited to, one or more of the following:

- (1) Personnel who are factory trained and certified for fuel gas detection system installation of the specific type and brand of system being designed and who are acceptable to the AHJ
- (2) Personnel with expertise in the installation of fuel gas detection systems that are registered, licensed, or certified by a state or local authority

4.4.2.5 The system installer shall provide evidence of their qualifications and/or certifications when requested by the AHJ. [72:10.5.2.5]

4.4.3* Inspection, Testing, and Service Personnel.

4.4.3.1* Inspection Personnel. Inspections shall be performed by personnel who have developed competence

through training and experience that are acceptable to the AHJ or meet the requirement of 4.4.3.4. [72:10.5.3.1]

4.4.3.2* Testing Personnel. Testing personnel shall have knowledge and experience of the testing requirements contained in this standard, of the equipment being tested, and of the test methods. That knowledge and experience shall be acceptable to the AHJ or meet the requirement of 4.4.3.4. [72:10.5.3.2]

4.4.3.3 Service Personnel. Service personnel shall have knowledge and experience of the maintenance and servicing requirements contained in this standard, of the equipment being serviced or maintained, and of the servicing or maintenance methods. That knowledge and experience shall be acceptable to the AHJ or meet the requirement of 4.4.3.4. [72:10.5.3.3]

4.4.3.4 Means of Qualification. Qualified personnel shall include, but not be limited to, one or more of the following:

- (1) Personnel who are factory trained and certified for the specific type and brand of system being serviced
- (2) Personnel who are certified by a nationally recognized certification organization acceptable to the AHJ
- (3) Personnel who are registered, licensed, or certified by a state or local authority to perform service on systems addressed within the scope of this standard, either individually or through their affiliation with an organization
- (4) Personnel who are employed and qualified by an organization listed by a nationally recognized testing laboratory for the servicing of systems within the scope of this standard [72:10.5.3.4]

4.4.3.5* Programming Personnel.

4.4.3.5.1 Personnel programming a system shall be certified by the system manufacturer. [72:10.5.3.5.1]

4.4.3.5.2 System installation personnel shall be permitted to configure systems in the field per manufacturers' published instructions. [72:10.5.3.5.2]

4.4.3.5.3 System end users shall be permitted to manage system operation per manufacturers' published instructions or training. [72:10.5.3.5.3]

4.4.3.6 Evidence of Qualification. Evidence of qualifications shall be provided to the AHJ upon request. [72:10.5.3.6]

4.5 Power Supplies.

4.5.1 Scope. The provisions of this section shall apply to power supplies used for fuel gas detection systems.

4.5.2 Code Conformance. All power supplies shall be installed in accordance with the applicable requirements of *NFPA 70*. [72:10.6.2]

4.5.3 Power Supply Sources.

4.5.3.1 Power shall be supplied in compliance with either 4.5.3.2 or 4.5.4. [72:10.6.3.1]

4.5.3.2 Unless configured in compliance with 4.5.4, at least two independent and reliable power supplies shall be provided, one primary and one secondary. [72:10.6.3.2]

4.5.3.3 Each power supply shall be of adequate capacity for the application. [72:10.6.3.3]

4.5.3.4 Monitoring the integrity of power supplies shall be in accordance with 4.13.16. [72:10.6.3.4]

4.5.3.5 The power supply voltage and ampacity shall be in accordance with the equipment manufacturer's installation instructions where the input voltage is no less than 85 percent or more than 110 percent of the equipment's nameplate rating.

4.5.4 Stored Energy Emergency Power Supply Systems (SEPSS).

4.5.4.1 An SEPSS that is not arranged in accordance with 10.6.4.2 of *NFPA 72* shall comply with all of the following:

- (1) An SEPSS shall be configured in compliance with *NFPA 111* for a Type O or U Level 1 system.
- (2) The SEPSS shall be capable of powering the maximum required system load.
- (3) The SEPSS shall have capacity in accordance with 4.5.6.2. [72:10.6.4.1]

4.5.4.2 An SEPSS shall comply with the requirements of 4.5.5. [72:10.6.4.3]

4.5.4.3 Failure of an SEPSS shall result in the initiation of a trouble signal in accordance with 4.9. [72:10.6.4.4]

4.5.5 Primary Power Supply.

4.5.5.1 Branch Circuit. The branch circuit supplying the fuel gas detection system equipment(s) shall be supplied by one of the following:

- (1) Commercial light and power
- (2) An engine-driven generator or equivalent in accordance with 4.5.10.2, where a person specifically trained in its operation is on duty at all times
- (3) An engine-driven generator or equivalent arranged for cogeneration with commercial light and power in accordance with 4.5.10.2, where a person specifically trained in its operation is on duty at all times

4.5.5.2* The branch circuit supplying the equipment shall supply no other loads. [72:10.6.5.1.2]

4.5.5.3 Circuit Identification and Accessibility.

4.5.5.3.1 The location of the branch circuit disconnecting means shall be permanently identified at the control unit. [72:10.6.5.2.1]

4.5.5.3.2 The circuit disconnecting means shall be both of the following:

- (1) Clearly marked
- (2) Accessible only to authorized personnel

4.5.5.4 Mechanical Protection. The branch circuit(s) and connections shall be protected against physical damage. [72:10.6.5.3]

4.5.5.5 Circuit Breaker Lock. Where a circuit breaker is the disconnecting means, an approved breaker locking device shall be installed. [72:10.6.5.4]

4.5.5.6 Overcurrent Protection. An overcurrent protective device shall be provided in accordance with *NFPA 70*. [72:10.6.5.5]

4.5.6 Secondary Power Supply.

4.5.6.1* Secondary Power Supply for Protected Premises Fuel Gas Detection Systems.

4.5.6.1.1 The secondary power supply shall consist of one of the following:

- (1) A storage battery dedicated to the fuel gas detection system arranged in accordance with 4.13.16
- (2) An automatic-starting, engine-driven generator serving the branch circuit specified in 4.5.5.1 and arranged in accordance with 4.5.10.3, and storage batteries dedicated to the fuel gas detection system with 4 hours of capacity arranged in accordance with 4.5.9

4.5.6.1.2 Secondary circuits that provide power to the control unit and are not integral to the unit shall be protected against physical damage. [72:10.6.7.3.2]

4.5.6.2 Capacity.

4.5.6.2.1* Where a combination (fire) system is used, the secondary power supply capacity requirements shall comply with 4.5.6.2.3 and with those of *NFPA 72*

4.5.6.2.2* Where a combination fuel gas detection system is used, the secondary power supply capacity requirements shall comply with 4.5.6.2.3 and with the provisions of the applicable *NFPA* code or standard.

4.5.6.2.3 The secondary power supply shall comply with both of the following:

- (1) Have sufficient capacity to operate the fuel gas detection system under quiescent load (i.e., system operating in a nonalarm condition) for a minimum of 24 hours
- (2) At the end of the 24-hour period, be capable of operating the fuel gas detection system and all notification appliances for 12 hours, unless otherwise permitted or required by 4.5.6.2.3.1 through 4.5.6.2.4.

4.5.6.2.3.1* As a minimum, battery calculations shall apply a correction factor of 1.25 for aging to ensure the battery can meet its current demand at the end of service life. [72:10.6.7.2.14]

4.5.6.2.3.2 The secondary power supply for in-building fuel gas detection system emergency voice/alarm communications service shall comply with both of the following:

- (1) Be capable of operating the system under quiescent load for a minimum of 24 hours
- (2) At the end of the 24-hour period, be capable of operating the system during a fire or other emergency condition for a period of 15 minutes at maximum connected load

4.5.6.2.3.3 The secondary power supply capacity for supervising station facilities and equipment shall be capable of supporting operations for a minimum of 24 hours. [72:10.6.7.2.5]

4.5.6.2.3.4 Reduction.

(A) The 12-hour requirement shall be permitted to be reduced to 5 minutes where the system is monitored by a supervising station and emergency response in accordance with Chapter 7.

(B) It shall not be permitted to utilize the 5-minute provision where 7.1.2 is utilized.

4.5.6.2.4 For systems not addressed by 4.5.6.2.3.1 through 4.5.6.2.4, the secondary power supply capacity required shall include all power supply loads that are not automatically disconnected upon the transfer to the secondary power supply.

4.5.6.3 Secondary Power Operation. Operation on secondary power shall not affect the required performance of a fuel gas detection system.

4.5.7* Continuity of Power Supplies.

4.5.7.1 The secondary power supply shall automatically provide power to the protected premises system within 10 seconds whenever the primary power supply voltage is insufficient for required system operation. [72:10.6.6.1]

4.5.7.2 The secondary power supply shall automatically provide power to the supervising station facility and equipment within 60 seconds whenever the primary power supply voltage is insufficient for required system operation. [72:10.6.6.2]

4.5.7.3 Required signals shall not be lost, interrupted, or delayed by more than 10 seconds as a result of the primary power failure. [72:10.6.6.3]

4.5.7.3.1 Storage batteries dedicated to the fuel gas detection system or an ESS arranged in accordance with the provisions of NFPA 111 shall be permitted to supplement the secondary power supply to ensure required operation during the transfer period.

4.5.7.3.2 Where an ESS is employed in 4.5.7.3.1, a positive means for disconnecting the input and output of the ESS system while maintaining continuity of power supply to the load shall be provided. [72:10.6.6.3.2]

4.5.8 Power Supply for Remotely Located Control Equipment.

4.5.8.1* Additional power supplies shall be comprised of a primary and secondary power supply that meet the same requirements as those required for system operation with 4.5.1 through 4.5.7 and 4.13.16.

4.5.8.2 The location of remotely located power supplies shall be identified at the master control unit. [72:10.6.8.2]

4.5.8.3 The master control unit display shall be permitted to satisfy the requirement of 4.5.8.2. [72:10.6.8.3]

4.5.8.4 The location of remotely located power supplies shall be identified on the record drawings. [72:10.6.8.4]

4.5.9 Storage Batteries.

4.5.9.1 Marking.

4.5.9.1.1 Batteries shall be marked with the month and year of manufacture using the month/year format. [72:10.6.10.1.1]

4.5.9.1.2 Where the battery is not marked with the month/year by the manufacturer, the installer shall obtain the date-code and mark the battery with the month/year of battery manufacture. [72:10.6.10.1.2]

4.5.9.2 Arrangement.

4.5.9.2.1 Storage batteries shall comply with the requirements of Article 480 of NFPA 70. [72:10.6.10.2.1]

4.5.9.2.2 Storage batteries shall be located so that the fuel gas detection equipment, including overcurrent devices, is not adversely affected by battery gases.

4.5.9.2.3 Batteries shall be insulated against ground-faults. [72:10.6.10.2.3]

4.5.9.2.4 Batteries shall be insulated to prevent short circuits between multiple cells. [72:10.6.10.2.4]

4.5.9.2.5 Batteries shall be protected from physical damage. [72:10.6.10.2.5]

4.5.9.2.6 Battery racks shall be protected against corrosion. [72:10.6.10.2.6]

4.5.9.2.7 If not located in or adjacent to the fuel gas detection control unit, the batteries and their charger location shall be permanently identified at the control unit.

4.5.9.3 Battery Charging.

4.5.9.3.1 Battery charging equipment shall be provided to keep the battery fully charged under all conditions of normal operation.

4.5.9.3.2 Battery charging equipment shall be provided to recharge batteries within 48 hours after fully charged batteries have been subject to a single discharge cycle as specified in 4.5.6.2. [72:10.6.10.3.2]

4.5.9.3.3 The battery charging equipment operation shall not damage the battery. [72:10.6.10.3.3]

4.5.9.3.4* Batteries shall be charged by listed means. [72:10.6.10.3.4]

4.5.9.3.5 Provisions for repair or replacement of failed battery charger equipment shall be maintained at supervising stations and used to restore operation prior to depletion of one-half of the battery capacity. [72:10.6.10.3.5]

4.5.9.4 Overcurrent Protection. Overcurrent devices shall be provided to protect the batteries from excessive load current. [72:10.6.10.4]

4.5.9.5 Metering. The battery charging equipment shall include integral meters or readily accessible terminals so that portable meters can be used to determine battery voltage and charging current. [72:10.6.10.5]

4.5.9.6 Monitoring Integrity of Battery Charging Equipment.

4.5.9.6.1 Means shall be provided to detect the failure of a battery charger. [72:10.6.10.6.1]

4.5.9.6.2 Failure of the battery charger shall result in a trouble signal in accordance with Section 4.9. [72:10.6.10.6.2]

4.5.10 Engine-Driven Generators.

4.5.10.1 Application and Installation. The application and installation of engine-driven generators shall be as specified in 4.5.10.2 through 4.5.10.7. [72:10.6.11.1]

4.5.10.2 Primary Power Supply.

4.5.10.2.1 Engine-driven generators arranged as the primary supply shall be designed in an approved manner. [72:10.6.11.2.1]

4.5.10.2.2 Engine-driven generators arranged as the primary supply shall be installed in an approved manner. [72:10.6.11.2.2]

4.5.10.3 Secondary Power Supplies.

4.5.10.3.1 Engine-driven generators used to provide secondary power for a protected fuel gas detection system shall comply with the requirements for a Type 10, Class 24, Level 1 System in Chapter 4 of NFPA 110.

4.5.10.3.2 Installation of engine-driven generators used to provide secondary power for a fuel gas detection system shall be in accordance with Article 700 of NFPA 70.

4.5.10.4 Performance, Operation, Testing, and Maintenance. The requirements for performance, operation, testing, and maintenance of engine-driven generators shall conform to the applicable provisions of NFPA 110. [72:10.6.11.4]

4.5.10.5 Capacity. The unit shall be of a capacity that is sufficient to operate the system under the maximum normal load conditions in addition to all other demands placed upon the unit. [72:10.6.11.5]

4.5.10.6 Fuel. Unless otherwise required or permitted in 4.5.10.6.1 and 4.5.10.6.2, fuel shall be available in storage sufficient for 6 months of testing plus the capacity specified in 4.5.6. [72:10.6.11.6]

4.5.10.6.1 If a reliable source of supply is available at any time on a 2-hour notice, it shall be permitted to have fuel in storage sufficient for 12 hours of operation at full load. [72:10.6.11.6.2]

4.5.10.6.2 Fuel systems using natural or manufactured gas supplied through utility mains shall not be required to have alternate fuel storage tanks unless located in Seismic Risk Zone 3 or greater as defined in ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*.

4.5.10.7 Battery and Charger.

4.5.10.7.1 A separate storage battery and separate automatic charger shall be provided for starting the engine-driven generator and shall not be used for any other purpose. [72:10.6.11.7.1]

4.5.10.7.2 The battery shall be sized in accordance with 5.6.4 of NFPA 110. [72:10.6.11.7.2]

4.6 Distinctive Signals.

4.6.1 Fuel gas alarm signals and fuel gas detection system supervisory and trouble signals shall be distinctively and descriptively annunciated.

4.6.2 Audible alarm notification appliances for a fuel gas detection system shall produce signals that are distinctive from other similar appliances used for other purposes in the same area that are not part of the fuel gas detection system.

4.6.3* An audible notification appliance on a control unit, on multiple control units that are interconnected to form a system, or at a remote location, shall be permitted to have the same audible characteristics for all alerting functions including, but not limited to, alarm, trouble, and supervisory, provided that the distinction between signals shall be by other means. [72:10.10.4]

4.6.4* Supervisory signals shall be distinctive in sound from other signals, and their sound shall not be used for any other purpose except as permitted in 4.6.3. [72:10.10.5]

4.6.5 Trouble signals required to indicate at the protected premises shall be indicated by distinctive audible signals, which

shall be distinctive from alarm signals except as permitted in 4.6.3. [72:10.10.6]

4.6.6 Where a fuel gas detection system is combined with either a fire alarm system or an intrusion detection system, trouble signals from each system shall be permitted to use a common audible signal.

4.7 Alarm Signals.

4.7.1 Fuel gas alarm signals shall comply with 5.8.6.5.

4.7.2 An alarm signal that has been deactivated at the protected premises shall comply with 4.7.2.1 and 4.7.2.2. [72:10.11.8]

4.7.2.1 The audible and visible alarm signal at the control unit only shall automatically reactivate every 24 hours or less until alarm signal conditions are restored to normal. [72:10.11.8.1]

4.7.2.2 The audible and visible alarm signal shall operate until it is manually silenced or acknowledged. [72:10.11.8.2]

4.7.3 Fuel Gas Alarm Notification Appliance Deactivation.

4.7.3.1* When an occupant notification alarm signal deactivation means is actuated, both audible and visual notification appliances shall be simultaneously deactivated. [72:10.12.2]

4.7.3.2 The fuel gas alarm notification deactivation means shall be key-operated or located within a locked cabinet, or arranged to provide equivalent protection against unauthorized use.

4.7.3.3 The means shall comply with the requirements of 4.12.1. [72:10.12.4]

4.7.3.4 Subsequent activation of addressable alarm initiating devices of a different type in the same room or addressable alarm initiating devices in a different room on signaling line circuits shall cause the notification appliances to reactivate. [72:10.12.5.2]

4.7.3.5 A fuel gas alarm notification deactivation means that remains in deactivation position when there is no alarm condition shall operate an audible trouble notification appliance until the means is restored to normal.

4.7.3.6* Resetting of alarm signals shall comply with 5.8.2.2. [72:10.11.6]

4.8 Supervisory Signals.

4.8.1 Latching Supervisory Signal Indication. Visible and audible indication of latching supervisory signals and visible indication of their restoration to normal shall be indicated within 90 seconds at the following locations:

- (1) Control unit for local fuel gas detection alarm systems
- (2) Building command center for in-building emergency voice/alarm communications systems
- (3) Supervising station location for systems installed in compliance with Chapter 7

4.8.2 Self-Restoring Supervisory Signal Indication. Visible and audible indication of self-restoring supervisory signals and visible indication of their restoration to normal shall be automatically indicated within 90 seconds at the following locations:

- (1) Control unit for local fuel gas detection alarm systems
- (2) Building command center for in-building emergency voice/alarm communications systems

(3) Supervising station location for systems installed in compliance with Chapter 7

4.8.3 Self-Restoring Signal. A supervisory signal initiating device shall be permitted to be self-restoring provided the control unit continues to indicate the supervisory condition.

4.8.4 Supervisory Notification Appliance Location. The audible supervisory notification appliances shall be located in an area where they are likely to be heard. [72:10.14.5]

4.8.5 Supervisory Signal Reactivation. A supervisory signal that has been deactivated at the protected premises shall comply with 4.8.5.1 and 4.8.5.2. [72:10.14.6]

4.8.5.1 The audible and visible supervisory signal at the control unit only shall automatically reactivate every 24 hours or less until supervisory signal conditions are restored to normal. [72:10.14.6.1]

4.8.5.2 The audible and visible supervisory signal shall operate until it is manually silenced or acknowledged. [72:10.14.6.2]

4.8.6 Supervisory Notification Appliance Deactivation.

4.8.6.1 A means for deactivating a supervisory notification appliance(s) shall be permitted only if it complies with 4.8.6.2 through 4.8.6.5.

4.8.6.2 The means shall be key-operated or located within a locked cabinet, or arranged to provide equivalent protection against unauthorized use. [72:10.14.7.2]

4.8.6.3 The means for deactivating supervisory notification appliances shall comply with the requirements of 4.12.2. [72:10.14.7.3]

4.8.6.4 Subsequent activation of supervisory initiating devices in other building zones shall cause supervisory notification appliances to activate as required by the system input/output matrix. [72:10.14.7.4]

4.8.6.5 A means for deactivating supervisory notification appliances that remains in the deactivated position when there is no supervisory condition shall operate an audible trouble notification appliance until the means is restored to normal. [72:10.14.7.5]

4.9 Trouble Signals.

4.9.1 Trouble signals and their restoration to normal shall be indicated within 200 seconds at the locations identified in 4.9.7 and 4.9.8. [72:10.15.1]

4.9.2 Indication of primary power failure trouble signals transmitted to a supervising station shall be in accordance with 4.13.16.4. [72:10.15.2]

4.9.3 An audible trouble signal shall be permitted to be intermittent provided it sounds at least once every 10 seconds, with a minimum duration of ½ second. [72:10.15.3]

4.9.4 A single audible trouble signal shall be permitted to annunciate multiple fault conditions. [72:10.15.4]

4.9.5 The audible trouble notification appliance shall be located in an area where they are to be heard. [72:10.15.5]

4.9.6 Activated notification appliances at the protected premises shall continue to operate unless they are manually silenced as permitted 4.9.9.1. [72:10.15.6]

4.9.7 Visible and audible trouble signals and visible indication of their restoration to normal shall be indicated at the following locations:

- (1) Control unit for fuel gas detection systems
- (2) Building command center for in-building emergency voice/alarm communications systems
- (3) Supervising stations for systems installed in compliance with Chapter 7

4.9.8 Trouble signals and their restoration to normal shall be visibly and audibly indicated at the proprietary supervising station for systems installed in compliance with Chapter 7. [72:10.15.8]

4.9.8.1* A trouble signal that has been deactivated at the protected premises shall comply with 4.9.8.2 and 4.9.8.3. [72:10.15.9]

4.9.8.2 The audible and visible trouble signal shall automatically reactivate at the control unit every 24 hours or less until trouble signal conditions are restored to normal. [72:10.15.9.1]

4.9.8.3 The audible and visible trouble signal associated with signaling the depletion or failure of the primary battery of a wireless system as required by 5.12.2.1(3) and (4) shall automatically resound every 4 hours or less until the depletion signal is restored to normal. [72:10.15.9.2]

4.9.9 Trouble Notification Appliances Deactivation.

4.9.9.1 A means for deactivating trouble notification appliance(s) shall be permitted only if it complies with 4.9.9.2 through 4.9.9.7.

4.9.9.2 The means shall be key-operated or located within a locked cabinet, or arranged to provide equivalent protection against unauthorized use. [72:10.15.10.2]

4.9.9.3 The means for deactivating trouble notification appliances shall comply with the requirements of 4.12.2. [72:10.15.10.3]

4.9.9.4 If an audible trouble notification appliance is also used to indicate a supervisory condition, as permitted by 4.6.3, a trouble notification appliance deactivation means shall not prevent subsequent actuation of supervisory notification appliances. [72:10.15.10.4]

4.9.9.5 Subsequent trouble signals shall cause trouble notification appliances to activate as required by the system input/output matrix. [72:10.15.10.5]

4.9.9.6 A means for deactivating trouble notification appliances that remains in the deactivated position when there is no trouble condition shall operate an audible trouble notification appliance until the means is restored to normal. [72:10.15.10.6]

4.9.9.7* Unless otherwise permitted by the AHJ, trouble notification appliances at the protected premises of a supervising station alarm system arranged in accordance with Chapter 7, that have been silenced at the protected premises shall automatically reactivate every 24 hours or less until the fault conditions are restored to normal.

4.10 Fuel Gas Control Function Status Indicators.

4.10.1 All controls provided specifically for the purpose of manually overriding any automatic fuel gas control function

shall provide visible indication of the status of the associated control circuits.

4.10.2* Where status indicators are provided for emergency equipment or fuel gas control functions, they shall be arranged to reflect the actual status of the associated equipment or function.

4.11 Performance and Limitations.

4.11.1 Operating Temperatures.

4.11.1.1* **Indoor Conditioned Spaces.** Equipment intended for use in indoor conditioned spaces shall be tested and listed at ambient temperatures of 32°F (0°C) and 120°F (49°C).

4.11.1.2* **Outdoors and Indoor Unconditioned Spaces.** Equipment intended for use outdoors and in indoor unconditioned spaces shall be tested and listed for the temperature range determined by the AHJ to be appropriate for the exposure temperatures anticipated at the location.

4.11.1.2.1 The manufacturer's published instructions shall identify if the product has been tested and listed for use at the minimum unconditioned space temperature extremes.

4.11.2 Design and Installation.

4.11.2.1* All systems shall be installed in accordance with the manufacturer's published installation instructions and applicable codes and standards.

4.11.2.2 All apparatus requiring resetting to maintain normal operation shall be restored to normal after each abnormal condition.

4.11.2.3 Devices and appliances shall be located and mounted so that accidental operation or failure is not caused by vibration or jarring. [72:10.4.2]

4.11.2.4 Equipment shall be installed in locations where conditions do not exceed the voltage, temperature, and humidity limits specified in the manufacturer's published instructions. [72:10.4.3]

4.12 Annunciation and Annunciation Zoning.

4.12.1 Alarm Annunciation.

4.12.1.1 The location of an actuated initiating device shall be annunciated by visible means.

4.12.1.2 Visible annunciation of the location of an operated initiating device shall be by an indicator lamp, alphanumeric display, printout, or other approved means. [72:10.18.1.1]

4.12.1.3 The visible annunciation of the location of operated initiating devices shall not be canceled by the means used to deactivate alarm notification appliances. [72:10.18.1.2]

4.12.2 Supervisory and Trouble Annunciation.

4.12.2.1 Supervisory or trouble annunciation shall be annunciated by visible means.

4.12.2.2 Visible annunciation shall be accomplished by an indicator lamp, an alphanumeric display, a printout, or other approved means.

4.12.2.3 The visible annunciation of supervisory or trouble conditions shall not be canceled by the means used to deactivate supervisory or trouble notification appliances. [72:10.18.2.2]

4.12.3* Annunciator Access and Location.

4.12.3.1 All required annunciation means shall be readily accessible to responding personnel. [72:10.18.3.1]

4.12.3.2 All required annunciation means shall be located as required by the AHJ to facilitate an efficient response to the situation. [72:10.18.3.2]

4.12.4 Alarm Annunciation Display. Visible annunciators shall be capable of displaying all zones in alarm. [72:10.18.4]

4.12.4.1 If all zones in alarm are not displayed simultaneously, the zone of origin shall be displayed. [72:10.18.4.1]

4.12.4.2 If all zones in alarm are not displayed simultaneously, there shall be an indication that other zones are in alarm. [72:10.18.4.2]

4.12.5 Annunciation Zoning.

4.12.5.1 For the purpose of alarm annunciation, each floor of the building shall be considered as a separate zone. [72:10.18.5.1]

4.12.5.2 Where the system serves more than one building, each building shall be annunciated separately. [72:10.18.5.3]

4.13* Monitoring Integrity and Circuit Performance of Installation Conductors and Other Signaling Channels.

4.13.1 Unless otherwise permitted or required by 5.4.3.1 through 5.4.3.7 and 4.13.3 through 4.13.10, all means of interconnecting equipment, devices, and appliances and wiring connections shall be monitored for the integrity of the interconnecting conductors or equivalent path so that the occurrence of a single open or a single ground-fault condition in the installation conductors or other signaling channels is automatically indicated within 200 seconds. [72:12.6.1]

4.13.2 Unless otherwise permitted or required by 5.4.3.1 through 5.4.3.7 and 4.13.3 through 4.13.10, all means of interconnecting equipment, devices, and appliances and wiring connections shall be monitored for the integrity of the interconnecting conductors or equivalent path so that the restoration to normal of a single open or a single ground-fault condition in the installation conductors or other signaling channels is automatically indicated within 200 seconds. [72:12.6.2]

4.13.3 Shorts between conductors shall not be required to be monitored for integrity, unless required by 4.13.12 or 4.13.13. [72:12.6.3]

4.13.4 Monitoring for integrity shall not be required for connections to and between supplementary system components, provided that single open, ground-fault, or short-circuit conditions of the supplementary equipment or interconnecting means, or both, do not affect the required operation of the fuel gas detection system.

4.13.5 Monitoring for integrity shall not be required for the circuit of an alarm notification appliance installed in the same room with the central control equipment, provided that the notification appliance circuit conductors are installed in conduit or are equivalently protected against mechanical injury. [72:12.6.6]

4.13.6 Monitoring for integrity shall not be required for a trouble notification appliance circuit. [72:12.6.7]

4.13.7* Monitoring for integrity shall not be required for the interconnection between listed equipment within a common enclosure. [72:12.6.8]

4.13.8 Monitoring for integrity shall not be required for the interconnection between enclosures containing control equipment located within 20 ft (6 m) of each other where the conductors are installed in conduit or equivalently protected against mechanical injury. [72:12.6.9]

4.13.9 Monitoring for integrity shall not be required for the conductors for ground-fault detection where a single ground-fault does not prevent the required normal operation of the system. [72:12.6.10]

4.13.10 Monitoring for integrity shall not be required for the interconnecting wiring of a stationary computer and the computer's keyboard, video monitor, mouse-type device, or touch screen, as long as the interconnecting wiring does not exceed 8 ft (2.4 m) in length; is a listed computer/data processing cable as permitted by NFPA 70; and failure of cable does not cause the failure of the required system functions not initiated from the keyboard, mouse, or touch screen. [72:12.6.12]

4.13.11 Interconnection means shall be arranged so that a single break or single ground-fault does not cause an alarm signal. [72:12.6.14]

4.13.12 A wire-to-wire short-circuit fault on any alarm notification appliance circuit shall result in a trouble signal in accordance with Section 4.9, except as permitted by 4.13.4 or 4.13.5. [72:12.6.15]

4.13.13 Where two or more systems are interconnected, the systems shall be connected using Class A, B, N, or X circuits as described in 5.4.3. [72:12.6.16]

4.13.14 The subsequent occurrence of a fault on an initiating device circuit or a signaling line circuit used for other than the interconnection of control units shall not affect previously transmitted unacknowledged alarm signals. [72:10.11.7]

4.13.15 An open, ground-fault, or short-circuit fault on the installation conductors of one alarm notification appliance circuit shall not affect the operation of any other alarm notification circuit for more than 200 seconds regardless of whether the short-circuit fault is present during normal or activated circuit state. [72:10.17.1]

4.13.15.1 Notification alarm circuits that do not have notification appliances connected directly to the circuit shall be considered control circuits.

4.13.15.2 Supervised notification appliance control circuits shall comply with all of the following:

- (1) A supervised notification appliance control circuit shall not serve more than one notification zone.
- (2) The supervised notification appliance control circuit shall be monitored for integrity in accordance with Section 4.13.
- (3) A fault in the supervised notification appliance control circuit installation conductors shall result in a trouble signal in accordance with Section 4.9.

[72:10.17.2]

4.13.16 Monitoring Integrity of Power Supplies.

4.13.16.1 Unless otherwise permitted or required by 4.13.16.1.3 through 4.13.16.1.6, all primary and secondary power supplies shall be monitored for the presence of voltage at the point of connection to the system. [72:10.6.9.1]

4.13.16.1.1 Failure of either the primary or secondary power supply shall result in a trouble signal in accordance with Section 4.9. [72:10.6.9.1.1]

4.13.16.1.2 Where the digital alarm communicator transmitter (DACT) is powered from a protected premises fuel gas detection control unit, power failure indication shall be in accordance with 4.13.16.1.

4.13.16.1.3 Monitoring shall not be required for a power supply for supplementary equipment. [72:10.6.9.1.3]

4.13.16.1.4 Monitoring shall not be required for the neutral of a three-, four-, or five-wire alternating current (ac) or direct current (dc) supply source. [72:10.6.9.1.4]

4.13.16.1.5 Monitoring shall not be required for the main power supply in a supervising station, provided the fault condition is otherwise indicated so as to be obvious to the operator on duty.

4.13.16.1.6 Monitoring shall not be required for the output of an engine-driven generator that is part of the secondary power supply, provided that the generator is tested weekly in accordance with Chapter 8. [72:10.6.9.1.6]

4.13.16.2* Power supply sources and electrical supervision for digital alarm communications systems shall be in accordance with Sections 4.5 and 4.13. [72:10.6.9.2]

4.13.16.3 Power supervisory devices shall be arranged so as not to impair the receipt of fuel gas alarm or supervisory signals.

4.13.16.4* Unless prohibited by the AHJ, where fuel gas detection systems are connected to a supervising station, the system shall be arranged to delay transmission of primary power failure signals for a period ranging from 60 to 180 minutes.

4.14 Documentation.

4.14.1 Approval and Acceptance.

4.14.1.1 The AHJ shall be notified prior to installation or alteration of equipment or wiring. [72:10.20.2]

4.14.1.2 At the AHJ's request, complete information regarding the system or system alterations, including specifications, type of system or service, shop drawings, input/output matrix, battery calculations, and notification appliance circuit voltage drop calculations, shall be submitted for approval.

4.14.1.3 Before requesting final approval of the installation, if required by the AHJ, the installing contractor shall furnish a written statement stating that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's published instructions and the appropriate NFPA requirements. [72:7.5.2]

4.14.1.4* The fuel gas detection system record of completion form, Figure 4.14.1.4, shall be permitted to be a part of the written statement required in 4.14.1.3.

FUEL GAS DETECTION SYSTEM RECORD OF COMPLETION

To be completed by the system installation contractor at the time of system acceptance and approval.

It shall be permitted to modify this form as needed to provide a more complete and/or clear record.

Insert N/A in all unused lines.

Attach additional sheets, data, or calculations as necessary to provide a complete record.

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

Description of property: _____

Occupancy type: _____

Name of property representative: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Authority having jurisdiction over this property: _____

Phone: _____ Fax: _____ E-mail: _____

2. INSTALLATION, SERVICE, AND TESTING CONTRACTOR INFORMATION

Installation contractor for this equipment: _____

Address: _____

License or certification number: _____

Phone: _____ Fax: _____ E-mail: _____

Service organization for this equipment: _____

Address: _____

License or certification number: _____

Phone: _____ Fax: _____ E-mail: _____

A contract for test and inspection in accordance with NFPA standards is in effect as of: _____

Contracted testing company: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Contract expires: _____ Contract number: _____ Frequency of routine inspections: _____

3. DESCRIPTION OF SYSTEM OR SERVICE

☐ Fuel gas system (nonvoice)

☐ Fuel gas emergency voice/alarm communications system (EVACS)

☐ Combination fuel gas detection system, with the following components, describe: _____

NFPA 715 edition: _____ Additional description of system(s): _____

FIGURE 4.14.1.4 Fuel Gas Detection System Record of Completion.

3. DESCRIPTION OF SYSTEM OR SERVICE (continued)**3.1 Control Unit**

Manufacturer: _____ Model number: _____

3.2 System Documentation

☐ An owner's manual, a copy of the manufacturer's instructions, a written sequence of operation, and a copy of the numbered record drawings are stored on site. Location: _____

3.3 System Software

☐ This system does not have alterable site-specific software.

Operating system (executive) software revision level: _____

Site-specific software revision date: _____ Revision completed by: _____

☐ A copy of the site-specific software is stored on site. Location: _____

3.4 Off-Premises Signal Transmission

☐ This system does not have off-premises transmission.

Name of organization receiving alarm signals with phone numbers:

Alarm: _____ Phone: _____

Supervisory: _____ Phone: _____

Trouble: _____ Phone: _____

Entity to which alarms are retransmitted: _____ Phone: _____

Method of retransmission: _____

Specify the means of transmission from the protected premises to the supervising station or receiving station:

4. CIRCUITS AND PATHWAYS**4.1 Signaling Line Pathways****4.1.1 Pathways Class Designations**

Pathways class: _____ Quantity: _____

(See NFPA 715, 5.4.3.)

4.1.2 Pathways Utilizing Two or More Media

Quantity: _____ Description: _____

4.1.3 Device Power Pathways

☐ No separate power pathways from the signaling line pathway

☐ Power pathways are separate but of the same pathway classification as the signaling line pathway

☐ Power pathways are separate and different classification from the signaling line pathway

4.1.4 Isolation Modules

Quantity: _____

FIGURE 4.14.1.4 *Continued*

4. CIRCUITS AND PATHWAYS (continued)**4.2 Alarm Initiating Device Pathways****4.2.1 Pathways Class Designations**

Pathways class: _____ Quantity: _____

(See NFPA 715, 5.4.3.)

4.2.2 Pathways Utilizing Two or More Media

Quantity: _____ Description: _____

4.2.3 Device Power Pathways

- ☐ No separate power pathways from the initiating device pathway
- ☐ Power pathways are separate but of the same pathway classification as the initiating device pathway
- ☐ Power pathways are separate and different classification from the initiating device pathway

4.3 Non-Voice Audible System Pathways**4.3.1 Pathways Class Designations**

Pathways class: _____ Quantity: _____

(See NFPA 715, 5.4.3.)

4.3.2 Pathways Utilizing Two or More Media

Quantity: _____ Description: _____

4.3.3 Device Power Pathways

- ☐ No separate power pathways from the notification appliance pathway
- ☐ Power pathways are separate but of the same pathway classification as the notification appliance pathway
- ☐ Power pathways are separate and different classification from the notification appliance pathway

5. ALARM INITIATING DEVICES**5.1 Automatic Initiating Devices****5.1.1 Fuel Gas Detectors**

Type and number of devices: Addressable: _____ Conventional: _____

Other (specify): _____

Type of detector sensing technology: ☐ Electrochemical ☐ Catalytic ☐ Metal oxide semiconductor (MOS)

Other (specify): _____

5.1.2 Addressable Monitoring Modules

Number of devices: _____

☐ This system does not have monitoring modules.**5.1.3 Other Initiating Devices**

Describe: _____

☐ This system does have other initiating devices.**6. SUPERVISORY SIGNAL-INITIATING DEVICES****6.1 Supervisory Devices**

Type and number of devices: Addressable: _____ Conventional: _____ Coded: _____ Transmitter: _____

Describe: _____

☐ This system does not have supervisory devices.FIGURE 4.14.1.4 *Continued*

7. ANNUNCIATORS☐ This system does not have annunciators.**7.1 Location and Description of Annunciators**

Location 1: _____

Location 2: _____

Location 3: _____

8. ALARM NOTIFICATION APPLIANCES**8.1 Emergency Voice/Alarm Communications System**☐ This system does not have an EVACS.

Number of single voice alarm channels: _____ Number of multiple voice alarm channels: _____

Number of speakers: _____ Number of speaker circuits: _____

Location of amplification and sound-processing equipment: _____

Location of paging microphone stations: _____

Location 1: _____

Location 2: _____

Location 3: _____

8.2 Nonvoice Notification Appliances☐ This system does not have nonvoice notification appliances.

Horns: _____ With visual: _____ Bells: _____ With visual: _____

Chimes: _____ With visual: _____

Visual only: _____ Other (describe): _____

8.3 Notification Appliance Power Extender Panels☐ This system does not have power extender panels.

Quantity: _____

Locations: _____

9. FUEL GAS SAFETY FUNCTIONS

This system activates the following control functions: _____

Describe: _____

9.1 Addressable Control Modules☐ This system does not have control modules.

Number of devices: _____

Other (specify): _____

10. SYSTEM POWER**10.1 Control Unit****10.1.1 Primary Power**

Input voltage of control panel: _____ Control panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panel board): _____

Disconnecting means location: _____

FIGURE 4.14.1.4 *Continued*

10. SYSTEM POWER (continued)**10.1.2 Engine-Driven Generator**☐ This system does not have a generator.

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

10.1.3 Energy Storage System☐ This system does not have an ESS.

Equipment powered by an ESS system: _____

Location of ESS system: _____

Calculated capacity of ESS batteries to drive the system components connected to it: _____

In standby mode (hours): _____ In alarm mode (minutes): _____

10.1.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system: _____

In standby mode (hours): _____ In alarm mode (minutes): _____

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached _____**10.2 Emergency Voice/Alarm Communications System**☐ This system does not have an EVACS.**10.2.1 Primary Power**

Input voltage of EVACS panel: _____ EVACS panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panel board): _____

Disconnecting means location: _____

10.2.2 Engine-Driven Generator☐ This system does not have a generator.

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

10.2.3 Energy Storage System☐ This system does not have an ESS.

Equipment powered by an ESS system: _____

Location of ESS system: _____

Calculated capacity of ESS batteries to drive the system components connected to it: _____

In standby mode (hours): _____ In alarm mode (minutes): _____

10.2.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system: _____

In standby mode (hours): _____ In alarm mode (minutes): _____

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached _____FIGURE 4.14.1.4 *Continued*

10. SYSTEM POWER (continued)**10.3 Notification Appliance Power Extender Panels**☐ This system does not have power extender panels.**10.3.1 Primary Power**

Input voltage of power extender panel(s): _____ Power extender panel amps: _____

Overcurrent protection: Type: _____ Amps: _____

Location (of primary supply panel board): _____

Disconnecting means location: _____

10.3.2 Engine-Driven Generator☐ This system does not have a generator.

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

10.3.3 Energy Storage System☐ This system does not have an ESS.

Equipment powered by an ESS system: _____

Location of ESS system: _____

Calculated capacity of ESS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

10.3.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

☐ Batteries are marked with date of manufacture ☐ Battery calculations are attached**11. RECORD OF SYSTEM INSTALLATION***Fill out after all installation is complete and wiring has been checked for opens, shorts, ground faults, and improper branching, but before conducting operational acceptance tests.*This is a: ☐ New system ☐ Modification to an existing system Permit number: _____

The system has been installed in accordance with the following requirements: (Note any or all that apply.)

☐ NFPA 715, Edition: _____☐ NFPA 72, Edition: _____☐ NFPA 70, National Electrical Code, Article 760, Edition: _____☐ Manufacturer's published instructions

Other (specify): _____

System deviations from referenced NFPA standards: _____

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

FIGURE 4.14.1.4 *Continued*

12. RECORD OF SYSTEM OPERATIONAL ACCEPTANCE TEST☐ **New system**

All operational features and functions of this system were tested by, or in the presence of, the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements for the following:

☐ **Modifications to an existing system**

All newly modified operational features and functions of the system were tested by, or in the presence of, the signer shown below, on the date shown below, and were found to be operating properly in accordance with the requirements of the following:

☐ **NFPA 715, Edition:** _____☐ **NFPA 72, Edition:** _____☐ **NFPA 70, National Electrical Code, Article 760, Edition:** _____☐ **Manufacturer's published instructions**☐ **Other (specify):** _____☐ **Individual device testing documentation [Inspection and Testing Form (Figure 8.6.2.2) is attached]**

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

13. CERTIFICATIONS AND APPROVALS**13.1 System Installation Contractor:**

This system, as specified herein, has been installed and tested according to all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

13.2 System Service Contractor:

The undersigned has a service contract for this system in effect as of the date shown below.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

13.3 Supervising Station:

This system, as specified herein, will be monitored according to all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

FIGURE 4.14.1.4 *Continued*

13. CERTIFICATIONS AND APPROVALS *(continued)***13.4 Property or Owner Representative:**

I accept this system as having been installed and tested to its specifications and all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

13.5 Authority Having Jurisdiction:

I have witnessed a satisfactory acceptance test of this system and find it to be installed and operating properly in accordance with its approved plans and specifications, with its approved sequence of operations, and with all NFPA standards cited herein.

Signed: _____ Printed name: _____ Date: _____

Organization: _____ Title: _____ Phone: _____

**FIGURE 4.14.1.4** *Continued*

4.14.1.5* The record of completion documentation shall be completed by the installing contractor and submitted to the AHJ and the owner at the conclusion of the job. The record of completion documentation shall be permitted to be part of the written statement required in 4.14.1.3 and part of the documents that support the requirements of 4.14.1.3. When more than one contractor has been responsible for the installation, each contractor shall complete the portions of the documentation for which that contractor has responsibility. [72:7.5.6.2]

4.14.2 Shop Drawings (Installation Documentation).

4.14.2.1 The requirements of 4.14.2 shall apply only where required by other governing laws, codes, or standards; by other parts of this standard; or by project specifications or drawings. [72:7.4.1]

4.14.2.2* Shop drawings shall be drawn to an indicated scale, on sheets of uniform size, with a plan of each floor. [72:7.4.2]

4.14.2.3 Shop drawings for fuel gas detection systems shall provide both basic information and the basis for the record (as-built) drawings required in accordance with 4.14.1.3.

4.14.2.4 Shop drawings shall include the following information:

- (1) Name of protected premises, owner, and occupant (where applicable)
 - (2) Name of installer or contractor
 - (3) Location of protected premises
 - (4) Device legend and symbols in accordance with NFPA 170, or other symbols acceptable to the AHJ
 - (5) Date of issue and any revision dates
- [72:7.4.4]

4.14.2.5 Floor Plans.

4.14.2.5.1 Floor plan drawings shall be drawn to an indicated scale.

4.14.2.5.2 Floor plan drawings shall include the following information, where applicable for the particular system:

- (1) Floor or level identification
- (2) Point of compass (indication of North)
- (3) Graphic scale
- (4) All walls and doors
- (5) All partitions extending to within 15 percent of the ceiling height (where applicable and when known)
- (6) Room and area descriptions
- (7) System devices/component locations
- (8) Locations of fuel gas alarm primary power disconnecting means
- (9) Locations of monitor/control interfaces to other systems
- (10) System riser locations
- (11) Type and number of system components/devices on each circuit, on each floor or level
- (12) Type and quantity of conductors and conduit (if used) for each circuit
- (13) Identification of any ceiling over 10 ft (3 m) in height where automatic fuel gas detection is being proposed
- (14) Details of ceiling geometries, including beams and solid joists, where automatic fuel gas detection is being proposed
- (15) Where known, acoustic properties of spaces

4.14.2.6 System riser diagrams shall comply with both of the following:

- (1) Be coordinated with the floor plans
- (2) Include the following information, where applicable for the particular system:
 - (a) General arrangement of the system in building cross section
 - (b) Number of risers
 - (c) Type and number of circuits in each riser
 - (d) Type and number of system components/devices on each circuit, on each floor or level
 - (e) Number of conductors for each circuit
 - (f) Pathway class designation in accordance with 5.4.3, including the location of any end-of-line supervisory or power devices that are required by the pathway class
 - (g) Pathway survivability level designation in accordance with Section 12.4 of NFPA 72

[72:7.4.6]

4.14.2.7 Control unit diagrams shall be provided for all control equipment (i.e., equipment listed as either a control unit or control unit accessory), power supplies, battery chargers, and annunciators and shall include the following information:

- (1) Identification of the control equipment depicted
- (2) Location(s) of control equipment
- (3) All field wiring terminals and terminal identifications
- (4) All circuits connected to field wiring terminals and circuit identifications
- (5) All indicators and manual controls
- (6) Field connections to supervising station signaling equipment, releasing equipment, or emergency safety control interfaces, where provided

[72:7.4.7]

4.14.2.8 Typical wiring diagrams shall be provided for all initiating devices, notification appliances, remote indicators, annunciators, remote test stations, and end-of-line and power supervisory devices. [72:7.4.8]

4.14.2.9 A narrative description or input/output matrix of operation shall be provided to describe the sequence of operation. [72:7.4.9]

4.14.2.10 System calculations shall be included as follows:

- (1) Battery calculations
- (2) Notification appliance circuit voltage drop calculations
- (3) Other required calculations, such as line resistance calculations, where required

[72:7.4.10]

4.14.3 Completion Documents.

4.14.3.1 Preparation.

4.14.3.1.1* The preparation of the fuel gas detection system record of completion documentation (see Figure 4.14.1.4) shall be the responsibility of the qualified and experienced person described in 4.4.2.

4.14.3.1.2 The preparation of a fuel gas detection system record of completion (see Figure 4.14.1.4) shall be in accordance with 4.14.3.1.2.1 through 4.14.3.1.2.5.

4.14.3.1.2.1 Parts 1 through 11 of the record of completion shall be completed after the system is installed and the installation wiring has been checked.

4.14.3.1.2.2 Parts 12 and 13 of the record of completion shall be completed after the operational acceptance tests have been completed.

4.14.3.1.2.3 A preliminary copy of the record of completion shall be given to the system owner and, if requested, to other AHJs after completion of the installation wiring tests.

4.14.3.1.2.4 A final copy of the record of completion shall be provided after completion of the operational acceptance tests.

4.14.3.1.2.5 One copy of the record of completion shall be stored at the fuel gas detection control unit or other approved location.

4.14.3.1.2.6 The copy as stated in 4.14.3.1.2.5 shall be updated to reflect all system additions or modifications and maintained in a current condition at all times.

4.14.3.1.2.7 Where not stored at the main fuel gas detection control unit, the location of the documents listed in 4.14.3.1.2.1 through 4.14.3.1.2.6 shall be identified at the main fuel gas detection control unit.

4.14.3.1.2.8 If the documents listed in 4.14.3.1.2.1 through 4.14.3.1.2.6 are located in a separate enclosure or cabinet, the separate enclosure or cabinet shall be labeled **FUEL GAS DETECTION DOCUMENTS**.

4.14.4 Revisions. Fuel gas detection system modifications made after the initial installation shall be recorded on a revised version of the original record of completion.

4.14.4.1 All changes from the original information shall be shown.

4.14.4.2 The revised record of completion shall include a revision date. [72:7.5.6.6.2]

4.14.4.3 Documentation Required.

4.14.4.3.1 Every system shall include the following documentation:

- (1)* Owner's manual and manufacturer's published instructions covering all system equipment
- (2) Record drawings
- (3) For software-based systems, record copy of the site-specific software
- (4) Written sequence of operation

4.14.4.3.2 The documentation listed in 4.14.4.3.1 shall be delivered to the owner or the owner's representative upon final acceptance of the system.

Chapter 5 Protected Premises Fuel Gas Detection Systems

5.1 Application.

5.1.1 The application, installation, and performance of fuel gas detection systems within protected premises, including fuel gas alarm, supervisory, and trouble signals, shall comply with the requirements of this chapter.

5.1.2 The requirements of Chapters 4, 6, and 7 shall also apply, unless they are in conflict with this chapter.

5.1.3 The requirements of Chapter 8 shall apply.

5.1.4 The requirements of this chapter shall not apply to the fuel gas alarms and household fuel gas detection systems addressed in Chapter 9 unless otherwise noted.

5.2 General.

5.2.1 Purpose. The systems covered in Chapter 5 shall be for the protection of life or property by indicating the existence of fuel gas impacting the protected premises.

5.2.2 Software and Firmware Control.

5.2.2.1 A record of installed software and firmware version numbers shall be prepared and maintained in accordance with 4.14.3. [72:23.2.2.1]

5.2.2.1.1* Software and firmware within the fuel gas detection system that interfaces to other required software or firmware shall be functionally compatible.

5.2.2.1.2* The compatible software or firmware versions shall be documented at the initial acceptance test and at any reacceptance tests. [72:23.2.2.1.2]

5.2.2.2* All software and firmware shall be protected from unauthorized changes. [72:23.2.2.2]

5.2.2.3 All changes shall be tested in accordance with 8.4.2. [72:23.2.2.3]

5.2.3 Separate Systems. The requirements of this chapter shall not preclude the use of separate fire, life safety, and fuel gas detection systems, provided that the systems do not generate simultaneous conflicting notification to building occupants or conflicting activation of safety functions.

5.3 System Features. The features required for a protected premises fuel gas detection system shall be both of the following:

- (1) Documented as a part of the system design
- (2) Determined in accordance with 5.3.1 through 5.3.3

5.3.1 Required Systems. Features for required systems shall be based on the requirements of other applicable codes or statutes that have been adopted by the enforcing jurisdiction. [72:23.3.1]

5.3.2* Nonrequired (Voluntary) Systems and Components. The features for a nonrequired system shall be established by the system designer on the basis of the goals and objectives intended by the system owner. [72:23.3.2]

5.3.2.1 Nonrequired systems and components shall meet the requirements of this standard.

5.3.2.2 Nonrequired systems and components shall be identified on the record drawings required in 8.6.1.1. [72:23.3.2.2]

5.3.3 Required Features. Protected premises fuel gas detection systems that serve the general fuel gas alarm needs of a building or buildings shall include one or more of the following systems or functions:

- (1) Automatic alarm signal initiation
- (2) Activation of fuel gas safety functions
- (3) Activation of alarm notification appliances
- (4) Emergency voice/alarm communications
- (5) Activation of off-premises signals

- (6) Combination fuel gas detection systems
- (7) Integrated systems

5.4 System Performance and Integrity.

5.4.1 General. The performance and integrity of fuel gas detection systems shall comply with the applicable requirements of 5.4.2 through Section 5.7.

5.4.2 Circuits and Pathways.

5.4.2.1 Performance and survivability characteristics of signaling pathways (interconnections) shall comply with the defined designations of 5.4.2 and 5.4.3. [72:12.2.1]

5.4.2.2 A pathway (interconnection) class designation shall be dependent on the pathway (interconnection) capability to continue to operate during abnormal conditions. [72:12.2.2]

5.4.2.3 The installation of all pathway wiring, cable, and equipment shall be in accordance with *NFPA 70*, and the applicable requirements of 5.4.2.3.1 and 5.4.2.3.2. [72:12.2.3]

5.4.2.3.1 Optical fiber cables installed as part of the fuel gas detection system shall meet the requirements of Article 770 of *NFPA 70* and be protected against physical damage in accordance with Article 760 of *NFPA 70*.

5.4.2.3.2 Fuel gas detection system wiring and equipment, including all circuits controlled and powered by the fuel gas detection system, shall be installed in accordance with the requirements of this standard and of Article 760 of *NFPA 70*.

5.4.2.3.3 Ground Connections.

5.4.2.3.3.1 Unless otherwise permitted by 5.4.2.3.3.2, all fuel gas detection systems shall test free of grounds.

5.4.2.3.3.2 If permitted by the manufacturer's installation instructions, the requirements of 5.4.2.3.3.1 shall not be required where parts of circuits or equipment are intentionally and permanently grounded in order to provide ground-fault detection, noise suppression, emergency ground signals, and circuit protection grounding.

5.4.2.3.3.3 On conductive pathways, operational capability shall be maintained during the application of a signal ground connection. [72:12.2.4.3]

5.4.3* Pathway Class Designations. Pathways shall be designated as Class A, Class B, Class C, Class D, Class E, Class N, or Class X, depending on their performance. [72:12.3]

5.4.3.1* Class A. A pathway shall be designated as Class A when it performs as follows:

- (1) It includes a redundant path.
- (2) Operational capability continues past a single open, and the single open fault results in the annunciation of a trouble signal.
- (3) Conditions that affect the intended operation of the path are annunciated as a trouble signal.
- (4) Operational capability on metallic conductors is maintained during the application of a single ground fault.
- (5) A single ground condition on metallic conductors results in the annunciation of a trouble signal.

[72:12.3.1]

5.4.3.2 Class B. A pathway shall be designated as Class B when it performs as follows:

- (1) It does not include a redundant path.

- (2) Operational capability stops at a single open.
- (3) Conditions that affect the intended operation of the path are annunciated as a trouble signal.
- (4) Operational capability on metallic conductors is maintained during the application of a single ground fault.
- (5) A single ground condition on metallic conductors results in the annunciation of a trouble signal.

[72:12.3.2]

5.4.3.3* Class C. A pathway shall be designated as Class C when it performs as follows:

- (1) It includes one or more pathways where operational capability is verified via end-to-end communication, but the integrity of individual paths is not monitored.
- (2) A loss of end-to-end communication is annunciated.

[72:12.3.3]

5.4.3.4* Class D. A pathway shall be designated as Class D when it has fail-safe operation, where no fault is annunciated, but the intended operation is performed in the event of a pathway failure. [72:12.3.4]

5.4.3.5* Class E. A pathway shall be designated as Class E when it is not monitored for integrity. [72:12.3.5]

5.4.3.6 Class N. A pathway shall be designated as Class N when it performs as follows:

- (1) It includes two or more pathways where operational capability of the primary pathway and a redundant pathway to each device shall be verified through end-to-end communication.

Exception: When only one device is served, only one pathway shall be required.

- (2) A loss of intended communications between endpoints shall be annunciated as a trouble signal.
- (3) A single open, ground, short, or combination offaults on one pathway shall not affect any other pathway.
- (4) Conditions that affect the operation of the primary pathway(s) and redundant pathway(s) shall be annunciated as a trouble signal when the system's minimal operational requirements cannot be met.
- (5) Primary and redundant pathways shall not be permitted to share traffic over the same physical segment.

[72:12.3.6]

5.4.3.7 Class X. A pathway shall be designated as Class X when it performs as follows:

- (1) It includes a redundant path.
- (2) Operational capability continues past a single open, and the single open fault results in the annunciation of a trouble signal.
- (3) Operational capability on metallic conductors continues past a single short-circuit, and the single short-circuit fault results in the annunciation of a trouble signal.
- (4) Operational capability on metallic conductors continues past a combination open fault and ground fault.
- (5) Conditions that affect the intended operation of the path are annunciated as a trouble signal.
- (6) Operational capability on metallic conductors is maintained during the application of a single ground fault.
- (7) A single ground condition on metallic conductors results in the annunciation of a trouble signal.

[72:12.3.7]

5.4.4 Circuit Designations. Initiating device circuits, notification appliance circuits, and signaling line circuits shall be designated by class, depending on the circuit's capability to continue to operate during specified fault conditions as indicated in Sections 5.5 through 5.7. [72:23.4.2]

5.4.4.1 Specified fault conditions shall result in the annunciation of a trouble signal at the protected premises within 200 seconds as required in Section 4.13. [72:23.4.2.1]

5.4.4.2* Where the power to a device is supplied over a separate circuit from the signaling line circuit or initiating device circuit, the operation of the power circuit shall meet the performance requirements of the initiating device circuit or signaling line circuit, unless different performance requirements are established in accordance with the evaluation in 5.4.5 and approved by the AHJ. [72:23.4.2.2]

5.4.4.3* Class A, Class N, and Class X circuits using physical conductors (e.g., metallic, optical fiber) shall be installed such that the outgoing and return conductors, exiting from and returning to the control unit, respectively, are routed separately.

5.4.4.4 The outgoing and return (redundant) circuit conductors shall be permitted in the same cable assembly (i.e., multi-conductor cable), enclosure, or raceway only under the following conditions:

- (1) For a distance not to exceed 10 ft (3 m) where the outgoing and return conductors enter or exit the initiating device, notification appliance, or control unit enclosures
- (2) Single drops installed in the raceway to individual devices or appliances
- (3) In a single room not exceeding 1000 ft² (93 m²) in area, a drop installed in the raceway to multiple devices or appliances that does not include any emergency control function devices

[72:12.3.8.1]

5.4.5 Pathway Classification.

5.4.5.1 The class of pathways shall be determined from an evaluation based on the path performance as required by governing laws, codes, standards, and a site-specific engineering analysis. [72:23.4.3.1]

5.4.5.2 When determining the integrity and reliability of the interconnecting signaling paths (circuits) installed within the protected premises, the following influences shall be considered:

- (1) Transmission media used
- (2) Length of the circuit conductors
- (3) Total building area covered by, and the quantity of initiating devices and notification appliances connected to, a single circuit
- (4) Effect of a fault in the fuel gas detection system that would hinder the performance objectives of the system that protects the occupants and mission of the protected premises
- (5) Nature of hazards present within the protected premises
- (6) Functional requirements of the system necessary to provide the level of protection required for the system
- (7) Size and nature of the population of the protected premises

5.4.5.3 Results of the evaluation required by 5.4.5.1 shall be included with the documentation required by 4.14.1.2. [72:23.4.3.3]

5.5 Performance of Initiating Device Circuits (IDCs). The assignment of class designations to initiating device circuits shall be based on their performance capabilities under abnormal (fault) conditions in accordance with the requirements for Class A or Class B pathways specified in 5.4.3. [72:23.5]

5.6 Performance of Signaling Line Circuits (SLCs). The assignment of class designations to signaling line circuits shall be based on their performance capabilities under abnormal (fault) conditions in accordance with the requirements for Class A, Class B, Class N, or Class X pathways specified in 5.4.3. [72:23.6]

5.6.1* SLC Zones. A single fault on a pathway connected to the addressable devices shall not cause the loss of the devices in more than one zone. [72:23.6.1]

5.6.1.1 For the purpose of this section, each floor of the building shall be considered a separate zone. [72:23.6.1.1]

5.6.1.2 For the purpose of this section, if a floor of the building is subdivided into multiple zones by fire or smoke barriers and the fire plan for the protected premises allows relocation of occupants from the zone of origin to another zone on the same floor, each zone on the floor shall be considered a separate zone. [72:23.6.1.2]

5.6.1.3* The requirements in 5.6.1 shall not apply to the following:

- (1) Circuits between enclosures containing transponders and control units regardless of the number of initiating devices, notification appliances, or control relays that might be connected to those control units
- (2) Circuits connecting short-circuit fault isolation modules to enclosures containing transponders and control units where the conductors are installed in metallic raceway or equivalently protected against mechanical injury and where the circuit does not exceed 3 ft (914 mm) in length
- (3) Alterations or modifications made to an existing SLC not required to comply with 5.6.1 when originally installed

5.6.1.4 The loss of more than one zone shall be permitted on a documented performance-based design approach. [72:23.6.1.4]

5.6.1.5* Performance-based designs submitted to the AHJ for review and approval shall include documentation, in an approved format, of each performance objective and applicable scenario, together with technical substantiation used in establishing the proposed zone performance. [72:23.6.1.5]

5.6.1.6 Performance-based design documentation for signaling line circuit zoning shall be in accordance with 5.6.1.4 and 5.6.1.5. [72:7.3.7.5]

5.6.2* Class N Devices. Unless permitted in 5.6.2.1 or 5.6.2.2, no area or zone shall be served solely by a single device where Class N pathways are deployed, such that a single device failure resulting from a multiple ground-fault pathway failure would render an area or zone incapable of initiating input signals or receiving output signals. [72:23.6.2]

5.6.2.1 Where a risk analysis shows that only one device is required and where acceptable to the AHJ, the requirements of 5.6.2 shall not apply. [72:23.6.2.1]

5.6.2.2 Multiple devices shall not be required in areas served by pathways not susceptible to ground faults, such as fiber or wireless pathways. [72:23.6.2.2]

5.6.2.3* Where a device as referenced by 5.6.2 is serviced by only a single pathway, it shall terminate that pathway with no ability to connect additional endpoint devices to the pathway. [72:23.6.2.3]

5.6.2.4* A single fault on a Class N pathway shall not cause the loss of more than one addressable device. [72:23.6.2.4]

5.6.3 Class N Shared Pathways. Class N pathways shall be required to use shared pathway Level 3 as specified in 5.6.3.9.4 except as permitted by 5.6.3.2. [72:23.6.3]

5.6.3.1 Accessibility. Class N pathways shall not be accessible to the general public or building occupants for any purpose other than specified in the network design analysis, maintenance, and deployment plans. [72:23.6.3.1]

5.6.3.2 Level 1 and Level 2. Shared pathways Levels 1 and 2 shall be permitted subject to approval of the AHJ, based on documentation of the deployment, change control, maintenance plans, management organization, network design analysis, and a risk analysis as identified in 5.6.3.3 through 5.6.3.8. [72:23.6.3.2]

5.6.3.3* Deployment Plan.

5.6.3.3.1 All equipment connected to shared pathways shall be documented in the deployment plan. [72:23.6.3.3.1]

5.6.3.3.1.1 The documentation shall include manufacturer, model, listings, and intended purpose and reason for inclusion on the shared network. [72:23.6.3.3.1.1]

5.6.3.3.1.2* The deployment plan shall identify how and where each piece of equipment is connected. [72:23.6.3.3.1.2]

5.6.3.3.2* All connection ports, used or spare, where any unauthorized or unintended equipment could be added to the shared network, shall be identified as for use only by equipment consistent with the deployment plan. [72:23.6.3.3.2]

5.6.3.3.3 Equipment Location.

5.6.3.3.3.1 The requirements of 5.6.3.3.3.2 through 5.6.3.3.3.4 shall apply to all equipment rooms, equipment closets, telecommunication rooms, telecommunication enclosures, or the like, for which both Class N life safety network infrastructure and non-life safety network equipment resides. [72:23.6.3.3.3.1]

5.6.3.3.3.2* Equipment rooms or enclosures shall be permitted to contain both Class N life safety networking cable, equipment, and associated infrastructure provided the deployment satisfies 5.6.3.3.3.3 through 5.6.3.3.3.4. [72:23.6.3.3.3.2]

5.6.3.3.3.3 Class N life safety network cabling, equipment, and infrastructure shall be clearly segregated and identified as "Life Safety Network." [72:23.6.3.3.3.3]

5.6.3.3.3.4 Equipment rooms or enclosures shall be accessible to only authorized personnel via a locked access or via an enclosure requiring the use of tools to open, as acceptable by the AHJ. [72:23.6.3.3.3.4]

5.6.3.4 Change Control Plan. Configuration upgrades and updates shall be governed by a change control plan that determines the policy and procedure of the change and ensures that all documentation is correspondingly updated. [72:23.6.3.4]

5.6.3.5 Management Organization.

5.6.3.5.1* An organization shall be established and maintained to manage the life safety network and shall perform the following:

- (1) Contain members appropriately certified by each manufacturer of the equipment and devices deployed on shared pathways to maintain such a network
- (2) Service and maintain all shared Class N pathways
- (3) Maintain the deployment and shared pathways plan for the lifetime of the shared pathways [72:23.6.3.5.1]

5.6.3.5.2* Other service personnel, even when certified to service a specific system (i.e., fire alarm or MNS), shall be authorized and managed by this organization to ensure any outages of any system are planned, managed, and documented and appropriate steps are taken during outages to provide alternate protection of life and property. [72:23.6.3.5.2]

5.6.3.6 Network Design Analysis.

5.6.3.6.1* The analysis shall be performed to determine and document communications capability as follows:

- (1) Calculation of minimum required bandwidth such that all life safety systems can be guaranteed to operate simultaneously and within required time limits
- (2) Total bandwidth provided by the network
- (3) Future bandwidth requirements
- (4) Method of providing and maintaining the prioritization of life safety traffic over non-life safety traffic [72:23.6.3.6.1]

5.6.3.6.2* The analysis shall determine and document the power distribution capability as follows:

- (1) The methods provided to maintain power to all shared pathway equipment
- (2) A calculation of power requirements of all connected equipment
- (3) Secondary power capacities provided to maintain all life safety equipment with minimum operational capacity in accordance with 4.5.6.2.3.2
- (4) Methods to disengage any non-life safety equipment in the event of emergency operation if required to support the minimum operational capacity requirements [72:23.6.3.6.2]

5.6.3.7 Maintenance Plan.

5.6.3.7.1* The maintenance plan shall identify policy and procedures to monitor, maintain, test, and control change of the shared pathways. [72:23.6.3.7.1]

5.6.3.7.2* Written procedures shall be presented in maintenance plans to govern the following:

- (1) Physical access to all parts of the Class N network equipment (i.e., switches, ports, server, controllers, devices, or components)
- (2) Electronic access to all parts of the Class N network (i.e., passwords, addresses)
- (3)* Service outage impairment process with notices of impairment and contingency plans for affected systems

- (4) Upgrade procedures
 - (5) Change control procedures, with consideration given to require an updated risk analysis if necessary
 - (6) Prioritization and/or segregation configuration information for life safety traffic
 - (7) Maintenance and testing plans to ensure the minimum operational capacity with respect to secondary power is maintained
 - (8) Other service, maintenance, or reconfiguration plans for any connected equipment
- [72:23.6.3.7.2]

5.6.3.8* Network Risk Analysis for Class N.

5.6.3.8.1 Each application of a Class N deployment shall be specific to the nature and anticipated risks of each facility for which it is designed. [72:23.6.3.8.1]

5.6.3.8.2 The risk analysis shall address both fire and non-fire emergencies when determining risk tolerances for the survivability of the network and the systems and devices it serves. [72:23.6.3.8.2]

5.6.3.8.3 The detail and complexity of the risk analysis shall be commensurate with the complexity of the facility for which the network is to be installed. [72:23.6.3.8.3]

5.6.3.8.4 The risk analysis shall be permitted to be limited in scope to address the requirements of an existing emergency response plan. [72:23.6.3.8.4]

5.6.3.8.5 The risk analysis shall consider characteristics of the buildings, areas, spaces, campuses or regions, equipment, and operations that are not inherent in the design specifications. [72:23.6.3.8.5]

5.6.3.8.6 Those elements that are not inherent in the design specifications, but that affect occupant behavior or the rate of hazard development, shall be explicitly identified and included in the risk analysis. [72:23.6.3.8.6]

5.6.3.8.7 The risk analysis shall consider the following types of potential events, which are not all-inclusive but reflect the general categories that shall be considered in the risk analysis:

- (1) Natural hazards—geological events
 - (2) Natural hazards—meteorological events
 - (3) Human caused—accidental events
 - (4) Human caused—intentional events
 - (5) Technological—caused events
- [72:23.6.3.8.7]

5.6.3.8.8 All other identified risks as required by the AHJ shall be discussed and addressed in the analysis and maintenance plans. [72:23.6.3.8.8]

5.6.3.9* Shared Pathway Designations. Shared pathways shall be designed as level 0, Level 1, Level 2, or Level 3, depending on their performance. [72:12.5]

5.6.3.9.1 Shared Pathway Level 0. Level 0 pathways shall not be required to segregate or prioritize life safety data from non-life safety data. [72:12.5.1]

5.6.3.9.2 Shared Pathway Level 1. Level 1 pathways shall not be required to segregate life safety data from non-life safety data, but shall prioritize all life safety data over non-life safety data. [72:12.5.2]

5.6.3.9.3 Shared Pathway Level 2. Level 2 pathways shall segregate all life safety data from non-life safety data. [72:12.5.3]

5.6.3.9.4 Shared Pathway Level 3. Level 3 pathways shall use equipment that is dedicated to the life safety system. [72:12.5.4]

5.7 Performance of Notification Appliance Circuits (NACs). The assignment of class designations to notification appliance circuits shall be based on their performance capabilities under abnormal (fault) conditions in accordance with the requirements for Class A, Class B, or Class X pathways specified in 5.4.3. [72:23.7]

5.8 System Requirements.

5.8.1* Actuation Time. Actuation of alarm notification appliances or emergency voice communications, fuel gas detection control function interface devices, and annunciation at the protected premises shall occur within 10 seconds after the activation of an initiating device.

5.8.2* Fuel Gas Detection Control Units.

5.8.2.1 Fuel gas detection systems shall be permitted to combine all detection, notification, and auxiliary functions in a single system or be a combination of component subsystems.

5.8.2.2 Arrangement.

5.8.2.2.1 Fuel gas detection system components shall be either of the following:

- (1) Permitted to share control equipment
- (2) Able to operate as stand-alone subsystems

5.8.2.2.2 Fuel gas detection system components shall be arranged to function as a single system for both 5.8.2.2.1(1) and 5.8.2.2.1(2).

5.8.2.3 All component subsystems shall be capable of simultaneous, full-load operation without degradation of the required overall system performance. [72:23.8.2.4]

5.8.2.4 Interconnection.

5.8.2.4.1 The method of interconnection of fuel gas detection control units shall meet the monitoring requirements of Section 4.13 and of Article 525 of *NFPA 70*.

5.8.2.4.2 The method of interconnection of fuel gas detection control units shall be achieved by the following recognized means:

- (1) Electrical contacts listed for the connected load
- (2) Data communications over signaling line circuit(s) dedicated to the fuel gas detection system or shared with other premises operating systems
- (3) Other listed methods

5.8.2.5 Where the signaling line circuit is shared by other premises operating systems, operation shall be in accordance with 5.8.4. [72:23.8.2.6]

5.8.2.5.1 All signal control and transport equipment (such as routers and servers) located in a critical fuel gas control function interface device signaling path shall comply with the following conditions:

- (1) The equipment meets the performance requirements of 4.11.1.

- (2) The equipment is provided with primary and secondary power and monitored for integrity as required in Section 4.5 and Section 4.13.
- (3) All programming and configuration ensure a fuel gas detection system actuation time as required in 5.8.1.
- (4) System bandwidth is monitored to confirm that all communications between equipment that is critical to the operation of the fuel gas detection system or fuel gas control function interface devices take place within 10 seconds; failure shall be indicated within 200 seconds.
- (5) Failure of any equipment that is critical to the operation of the fuel gas detection system or fuel gas control function interface devices is indicated at the master fuel gas detection control unit within 200 seconds.

5.8.2.5.2 A listed barrier gateway, integral with or attached to each control unit or group of control units, shall be provided to prevent the other systems from interfering with or controlling the fuel gas detection system.

5.8.2.6 Each interconnected fuel gas detection control unit shall be separately monitored for alarm, supervisory, and trouble conditions with supervised pathways that are in accordance with the manufacturers' published instructions.

5.8.2.7 Interconnected fuel gas detection control unit alarm signals shall be permitted to be monitored by zone or by combined common signals.

5.8.2.8 Protected premises fuel gas detection control units shall be capable of silencing building-wide notification from the alarm control unit at the protected premises unless otherwise permitted by 5.8.2.9 and the emergency response plan.

5.8.2.9 An initiating device with integral sounder shall be permitted to be silenced locally, provided the control unit continues to indicate an alarm function.

5.8.2.10 If the fuel gas dissipates, the initiating device shall not return to normal mode automatically but require manual intervention.

5.8.3 Protected Premises Fuel Gas Detection Systems Interconnected with Household Fuel Gas Detection System.

5.8.3.1 A protected premises fuel gas detection system shall be permitted to be interconnected to a household fuel gas detection system(s) for the purpose of activating the notification appliances connected to the household fuel gas detection system(s).

5.8.3.2 The status of dwelling unit fuel gas detectors shall be permitted to be displayed at the protected premises fuel gas detection system control unit and annunciators.

5.8.3.3 If interconnected, an alarm condition at the protected premises system shall cause the intended notification alarm signal of the household's warning equipment to become activated and remain activated until the protected premises system is silenced or reset. [72:23.8.3.3]

5.8.3.4 The interconnection circuit or path from the protected premises system to the household warning equipment shall be monitored for integrity by the protected premises system in accordance with Section 4.13. [72:23.8.3.4]

5.8.3.5 An alarm condition occurring at the household fire warning equipment or the operation of any test switches provided as part of the household warning equipment shall not

cause an alarm condition at the protected premises system. [72:23.8.3.5]

5.8.4 Combination Fuel Gas Detection Systems.

5.8.4.1* Fuel gas detection systems shall be permitted to share components, equipment, circuitry, and installation wiring with non-fuel gas detection systems.

5.8.4.2 Operation of non-fuel gas detection system function(s) originating within a connected non-fuel gas detection system shall not interfere with the required operation of the fuel gas detection system, unless otherwise required by applicable codes or standards.

5.8.4.3 For non-fuel gas detection system equipment listed to the performance requirements specified in 4.11.1, the requirements of 5.8.4.3.1 through 5.8.4.3.3 shall apply.

5.8.4.3.1 The equipment shall be permitted to be attached to a fuel gas detection system circuit, either among the fuel gas detection system devices or as a branch or extension of the fuel gas detection system pathways, when the following requirements are met:

- (1) All the equipment and pathways shall meet the monitoring for integrity requirements of Section 4.13.
- (2) All the equipment and pathways shall be maintained by a single service organization.
- (3) All the equipment and pathways shall be installed in accordance with the requirements of this standard.
- (4) All the equipment shall be either listed as compatible with the fuel gas detection system equipment or equipped with an interface listed as compatible with the fuel gas detection system equipment.

5.8.4.3.2 If the equipment is attached to the fuel gas detection system via separate pathways, then short circuits or open circuits in this equipment, or between this equipment and the fuel gas detection system pathways, shall not impede or impair the monitoring for integrity of the fuel gas detection system or prevent alarm, supervisory, or safety control signal transmissions.

5.8.4.3.3 Grounds in this equipment, or between this equipment and the fuel gas detection system pathways, shall be reported, annunciated, and corrected in the same manner as grounds in the rest of the fuel gas detection system.

5.8.4.4 For non-fuel gas detection system equipment not listed to the performance requirements specified in 4.11.1, the requirements of 5.8.4.4.1 through 5.8.4.4.3 shall apply.

5.8.4.4.1 Short circuits or open circuits in the equipment, or between the equipment and the fuel gas detection system pathways, shall not impede or impair the monitoring for integrity of the fuel gas detection system or prevent alarm, supervisory, or safety control signal transmissions.

5.8.4.4.2 Grounds in this equipment, or between this equipment and the fuel gas detection system pathways, shall be reported, annunciated, and corrected in the same manner as grounds in the rest of the fuel gas detection system.

5.8.4.4.3 Removal, replacement, failure, maintenance procedures, or ground on this hardware, software, or circuits shall not impair the required operation of the fuel gas detection system.

5.8.4.5 Loudspeakers used as mass notification or emergency communications systems installed in accordance with the requirements of *NFPA 72* shall also be permitted to be used as alarm notification appliances for fuel gas detection systems.

5.8.4.6* In combination fuel gas detection systems, fuel gas alarm signals shall be distinctive, recognizable, and take priority over signals associated with property protection.

5.8.4.7 Signals from fuel gas detectors and fuel gas detection systems transmitted to another alarm system shall be as a distinct fuel gas alarm signal unless otherwise required by the AHJ.

5.8.5 Fuel Gas Detection System Inputs.

5.8.5.1 General. All initiating devices shall be installed in accordance with 5.8.5 and tested in accordance with Chapter 8. [72:23.8.5.1.1]

5.8.5.1.1 Initiating devices subject to mechanical damage shall be protected. [72:17.4.2.1]

5.8.5.1.2 If guards or covers are employed, they shall be listed for use with the initiating device. [72:17.4.2.2]

5.8.5.1.3 Initiating devices shall be supported independently of their attachment to the circuit conductors.

5.8.5.1.4 Initiating devices shall be installed in a manner that provides accessibility for periodic inspection, testing, and maintenance. [72:17.4.3]

5.8.5.1.5* Duplicate terminals, leads, or connectors that provide for the connection of installation wiring shall be provided on each initiating device for the express purpose of connecting into the fuel gas detection system to monitor the integrity of the signaling and power wiring unless the initiating devices are connected to a system that provides the required monitoring.

5.8.5.1.6 The requirements of 5.8.5.1.5 shall not apply to initiating devices connected to a system that provides the required monitoring.

5.8.5.1.7 Initiating devices shall not be located in areas where environmental conditions cause an adverse effect on the initiating devices' ability to detect the targeted hazardous gas.

5.8.5.2 Alarm Signal Initiation—Initiating Devices with Separate Power and Signaling Wiring.

5.8.5.2.1 Automatic fuel gas alarm signal initiating devices that have integral trouble signal contacts shall be connected to the initiating device circuit so that a trouble condition within a device does not impair alarm transmission from any other initiating device, unless the trouble condition is caused by electrical disconnection of the device or by removing the initiating device from its plug-in base.

5.8.5.2.2 The requirements of 5.8.5.2.1 shall not apply where the trouble condition is caused by electrical disconnection of the device or by removing the initiating device from its plug-in base.

5.8.5.2.3* Automatic fuel gas alarm signal initiating devices that use a nonintegral device to monitor the integrity of the power supply wiring to the individual initiating devices shall have the nonintegral device connected to the initiating device circuit so that a fault on the power supply wiring does not

impair alarm transmission from any operational initiating device.

5.8.5.3 Requirements for Fuel Gas Detectors.

5.8.5.3.1 Fuel gas detectors shall be installed as specified in the manufacturer's published instructions in accordance with 5.8.5.3.1(1) or 5.8.5.3.1(2), and with 5.8.5.3.1(3) through 5.8.5.3.1(6) or with 5.8.5.3.1(7):

- (1)* For natural gas, the detector shall be installed on the ceiling or on the wall with the top of the detector within 12 in. (305 mm) of the ceiling in the same room as permanently installed fuel-gas-burning appliances.
- (2)* For liquefied petroleum gas (LP-Gas), the entire detector shall be installed on the wall within 18 in. (457 mm) of the floor in the same room as permanently installed fuel-gas-burning appliances.
- (3)* Detectors shall be installed more than 3 ft (914 mm) but no further than 10 ft (3 m) in a horizontal flow path from permanently installed fuel-gas-burning appliances.
- (4) Detectors shall not be installed in locations directly in the airstream of supply and return registers or directly above doorway openings.
- (5)* Detectors shall be installed in basements or other subgrade rooms with foundation penetrations that might convey migrating fuel gas leaks from outside the occupancy.
- (6) Combination fuel gas/carbon monoxide detectors that are an integral part of a carbon monoxide detector shall be located in accordance with the requirements for the applicable fuel gases being sampled.
- (7) Detectors shall be installed based on a performance-based design in accordance with 5.8.5.3.2.

5.8.5.3.2 Performance-Based Design.

5.8.5.3.2.1 Performance-based designs submitted to the AHJ for review and approval shall include documentation, in an approved format, of each performance objective and applicable scenario, together with any calculations, modeling, or other technical substantiation used in establishing the proposed design's life safety and property protection performance.

5.8.5.3.2.2 The AHJ shall determine whether such identified performance objectives are appropriate and have been met. [72:17.3.2]

5.8.5.3.2.3 The AHJ shall approve modifications to or variations from the approved design or design basis in advance. [72:17.3.3]

5.8.5.3.3* Alarm Threshold.

5.8.5.3.3.1* Each fuel gas detector shall be designed to alarm at a concentration threshold at or below 25 percent LEL and be listed in accordance with UL 2075, *Gas and Vapor Detectors and Sensors*.

5.8.5.3.3.2* Each fuel gas detector shall be designed to alarm at a concentration threshold at or below 25 percent LEL and meet the sensitivity testing and alarm thresholds of UL 1484, *Residential Gas Detectors*.

5.8.5.3.3.3 Fuel gas detectors shall be marked in accordance with their listing.

5.8.5.3.4 All fuel gas detectors shall be located and mounted so that accidental operation will not be caused by jarring or vibration.

5.8.5.3.5 The selection and placement of fuel gas detectors shall take into account both the performance characteristics of the detector and the areas into which the detectors are to be installed to prevent nuisance and unintentional alarms or improper operation after installation.

5.8.5.3.6 The installation of fuel gas detectors in conditioned and unconditioned indoor spaces and in outdoor locations shall comply with 4.11.1.

5.8.5.3.7* The location of fuel gas detectors shall be based on an evaluation of potential ambient sources and flows of fuel gas, moisture, temperature, dust, or fumes, and electrical or mechanical influences to minimize nuisance alarms.

5.8.5.3.8 Unless tested and listed for recessed mounting, fuel gas detectors shall not be recessed into the mounting surface.

5.8.5.3.9 Protection During Construction.

5.8.5.3.9.1 Where detectors are installed for signal initiation during construction, they shall be replaced prior to the final commissioning of the system.

5.8.5.3.9.2 Where detection is not required during construction, detectors shall not be installed until after all other construction trades have completed cleanup. [72:17.7.2.3]

5.8.5.4 Fuel Gas Detectors for Control of Fuel Gas Spread.

5.8.5.4.1 System designers shall consider the spread of fuel gas through an occupancy through the HVAC system.

5.8.5.4.2 Interaction with smoke control systems, if such is provided, shall be coordinated. [72:17.12.9.2]

5.8.5.5* Nonrequired Coverage.

5.8.5.5.1 Detection installed for reasons of achieving specific fire safety objectives, but not required by any laws, codes, or standards, shall meet all of the requirements of this standard, with the exception of the prescriptive spacing criteria of Chapter 5. [72:17.5.3.3.1]

5.8.5.5.2 Where nonrequired detectors are installed for achieving specific fire safety objectives, additional detectors not necessary to achieve the objectives shall not be required. [72:17.5.3.3.2]

5.8.6 Fuel Gas Detection Alarm System Notification Outputs.

5.8.6.1 General. The performance, location, and mounting of notification appliances used to initiate or direct action, evacuation, or relocation of the occupants, or for providing information to occupants or staff, shall comply with Chapter 6.

5.8.6.2 Occupant Notification.

5.8.6.2.1 Except as permitted in 5.8.6.2.2, occupant notification shall be throughout the protected premises.

5.8.6.2.2 Where fuel gas alarm signals are transmitted to a constantly attended on-site location or off-premises location in accordance with Chapter 7, selective public mode occupant notification shall be permitted to be limited to the notification zone encompassing the area where the fuel gas alarm signal was initiated.

5.8.6.3 Notification Zones.

5.8.6.3.1 Notification zones shall be consistent with the emergency response or evacuation plan for the protected premises. [72:23.8.6.3.1]

5.8.6.3.2* The boundaries of notification zones shall be coincident with the area where the alarm initiation originated and other signaling zones in accordance with the building's emergency response plan.

5.8.6.4 Circuits for Addressable Notification Appliances.

5.8.6.4.1 Circuit configuration for addressable notification appliances shall comply with the applicable performance requirements for notification zones. [72:23.8.6.4.1]

5.8.6.4.2 Where there are addressable notification appliances on a signaling line circuit that serves different notification zones, a single open, short-circuit, or ground on that signaling line circuit shall not affect operation of more than one notification zone. [72:23.8.6.4.2]

5.8.6.5 Distinctive Signal.

5.8.6.5.1* The audible fuel gas alarm signal shall be distinct from similar appliances used for other purposes in the same area and in compliance with the following:

- (1)* The signal shall be a continuous or temporal pattern that emits a distinguishable sound until the alarm resets or is silenced.
- (2) The duration of the signal shall not be less than 180 seconds unless the alarm resets or is silenced.
- (3) The alarm shall persist for the entire time the gas detector is in the presence of a detectable concentration of gas.
- (4) After 4 minutes of continuous or temporal alarm, an alarm signal pause for up to 60 seconds shall be permitted before resuming the audible alarm.

5.8.6.5.2* The audible alarm signal shall be synchronized within a notification zone.

5.8.7 Emergency Voice/Alarm Communications. Where a voice/alarm communications system is installed for the purpose of occupant notification related to fuel gas detection, it shall meet the requirements of Section 24.4 of NFPA 72 excluding the requirements of 24.4.8.6.

5.9 Signal Annunciation.

5.9.1 Protected premises fuel gas detection systems shall be arranged to annunciate fuel gas alarm, supervisory, and trouble signals in accordance with Section 4.12.

5.9.2* If a remote alarm indicator is provided, the location of the fuel gas detector and the area protected by the detector shall be prominently indicated at the remote alarm indicator by a permanently attached placard or by other approved means.

5.10 Off-Premises Signals.

5.10.1 Systems requiring transmission of signals to continuously attended locations providing supervising station service (e.g., central station, proprietary supervising station, remote supervising station) shall also comply with the applicable requirements of Chapter 7. [72:23.12.1]

5.10.2 Relays or modules providing transmission of trouble signals to a supervising station shall be arranged to provide fail-safe operation. [72:23.12.2]

5.10.3 Means provided to transmit trouble signals to supervising stations shall be arranged so as to transmit a trouble signal to the supervising station for any trouble condition received at the protected premises control unit, including loss of primary or secondary power. [72:23.12.3]

5.10.4* It shall be permitted to provide supplementary transmission of real-time data from the fuel gas detection system to off-premises equipment.

5.10.4.1 Transmission of real-time data off-premises shall not affect the operation or response of the fuel gas detection control unit.

5.10.4.2 Any data transmitted shall be consistent with the data generated by the system. [72:23.12.4.2]

5.11 Protected Premises Fuel Gas Control Functions. Where provided, the interconnection of control functions shall comply with the requirements of 5.11.1 through 5.11.9.

5.11.1 Fuel gas control functions shall be permitted to be performed automatically.

5.11.2* A fuel gas control function interface device shall be located within 3 ft (914 mm) of the component controlling the fuel gas control function where the control circuit is not configured as a Class D circuit.

5.11.3 The fuel gas control function interface device shall function within the voltage and current limitations of the fuel gas detection control unit.

5.11.4 The installation wiring between the fuel gas detection control unit and the fuel gas control function interface device shall be Class A, Class B, Class D, Class N, or Class X in accordance with 5.4.3.

5.11.5 Fuel gas control functions shall not interfere with other operations of the fuel gas detection system.

5.11.6 The method(s) of interconnection between the fuel gas detection system and fuel gas control function interface device shall be monitored for integrity in accordance with Section 4.13.

5.11.7 The method(s) of interconnection between the fuel gas control function interface device and the component controlling the fuel gas control function shall comply with the applicable provisions of *NFPA 70*.

5.11.8 The method(s) of interconnection between the fuel gas control function interface device and the component controlling the fuel gas control function shall be achieved by one of the following recognized means:

- (1) Electrical contacts listed for the connected load
- (2) Data communications over a signaling line circuit(s) dedicated to the fuel gas detection or shared with other premises operating systems
- (3) Other listed methods

5.11.9 If a fuel gas detection system is a component of a life safety network and it communicates data to other systems providing life safety functions, or it receives data from such systems, the following shall apply:

- (1) The path used for communicating data shall be monitored for integrity, including monitoring the physical communications media and the ability to maintain intelligible communications.
- (2) Data received from the network shall not affect the operation of the fuel gas detection system in any way other than to display the status of life safety network components.
- (3) Where non-fuel gas detection systems are interconnected to the fuel gas detection system using a network or other digital communications technique, a signal (e.g., heartbeat, poll, ping, query) shall be generated between the fuel gas detection system and the non-fuel gas detection system.
- (4) Failure of the fuel gas detection system to receive confirmation of the transmission described in 5.11.9(3) shall cause a trouble signal to indicate within 200 seconds.

5.12* Special Requirements for Low-Power Radio (Wireless) Systems.

5.12.1* Listing Requirements. Compliance with Section 5.12 shall require the use of low-power radio equipment specifically listed for the purpose. [72:23.16.1]

5.12.2* Power Supplies. A primary battery(s) (dry cell) that meets the requirements of 5.12.2.1 or 5.12.2.2 shall be permitted to be used as the sole power source for devices incorporating a low-power radio transmitter/transceiver. [72:23.16.2]

5.12.2.1 The following conditions shall be met when one or more primary batteries are utilized and a catastrophic (open or short) single battery failure affects the alarm operation of the device:

- (1) Each transmitter/transceiver shall comply with both of the following:
- (2) Serve only one device
- (3) Be individually identified at the fuel gas detection system control unit
- (4) The battery(s) shall be capable of operating the low-power radio transmitter/transceiver and its associated device for not less than 1 year before the battery depletion threshold is reached.
- (5) A low battery signal shall be transmitted before the device is no longer capable of providing 7 days of trouble signal operation followed by the signaling of a single nontrouble response.
- (6) The low battery signal shall comply with all of the following:
- (7) Be distinctive from alarm, supervisory, tamper, and trouble signals
- (8) Visibly identify the affected low-power radio transmitter/transceiver
- (9) When silenced, automatically resound at least once every 4 hours
- (10) Catastrophic (open or short) battery failure shall cause both of the following:
- (11) A trouble signal identifying the affected low-power radio transmitter/transceiver at the fuel gas detection system control unit
- (12) When silenced, the trouble signal automatically resounds at least once every 4 hours
- (13) Any mode of failure of a primary battery in a low-power radio transmitter/transceiver shall not affect any other low-power radio transmitter/transceiver.

5.12.2.2 The following conditions shall be met when multiple batteries are utilized and a catastrophic (open or short) single battery failure does not affect the alarm operation of the device:

- (1) Two or more batteries shall be provided.
- (2) The combined batteries shall be capable of operating the low-power radio transmitter/transceiver and its associated device for not less than 1 year before the battery depletion threshold in 5.12.2.2(3) is reached.
- (3) A low battery signal shall be transmitted before the device is no longer capable of providing 7 days of trouble signal operation followed by the signaling of a single nontrouble response.
- (4) Each individual battery, primary and secondary, shall comply with both of the following:
 - (a) Each battery shall be separately monitored for the battery depletion threshold.
 - (b) A low-battery signal shall be transmitted when an individual battery has reached the battery depletion threshold.
- (5) Following the failure of a single battery, the remaining battery(s) shall be capable of operating the low-power radio transmitter/transceiver and its associated device for not less than 7 days when the battery depletion threshold in 5.12.2.2(3) is reached.
- (6) The low-battery signal shall comply with all of the following:
 - (a) Be distinctive from alarm, supervisory, tamper, and trouble signals
 - (b) Visibly identify the affected low-power radio transmitter/transceiver
 - (c) When silenced, automatically resound at least once every 4 hours
- (7) Catastrophic (open or short) failure of any individual battery shall cause both of the following:
 - (a) A trouble signal identifying the affected low-power radio transmitter/transceiver at the fuel gas detection system control unit
 - (b) When silenced, the trouble signal shall automatically resounds at least once every 4 hours
- (8) Each transmitter/transceiver shall be both of the following:
 - (a) Permitted to serve more than one device
 - (b) Individually identified at the fuel gas detection system control unit

5.12.3 Fuel Gas Alarm Signals.

5.12.3.1* When a wireless initiating device is actuated, its low-power radio transmitter/transceiver shall comply with 5.12.3.1.1 through 5.12.3.1.4. [72:23.16.3.1]

5.12.3.1.1 The low-power radio transmitter/transceiver shall automatically transmit an alarm signal and be identified at the fuel gas detection system.

5.12.3.1.2 To ensure the receipt of an alarm signal by the fuel gas detection control unit, the low-power radio transmitter/transceiver shall automatically repeat alarm transmissions at intervals not exceeding 60 seconds until the transmitter/trans-

ceiver receives a signal confirming receipt of the alarm signal by the fuel gas detection control unit.

5.12.3.1.3* Signals shall have priority in accordance with 5.8.4.6. [72:23.16.3.1.3]

5.12.3.1.4 Response time shall be in accordance with 5.8.1. [72:23.16.3.1.4]

5.12.3.2* An alarm signal from a low-power radio transmitter/transceiver shall both latch at the fuel gas detection control unit until manually reset and identify the particular initiating device in alarm.

5.12.4 Monitoring for Integrity.

5.12.4.1 The low-power radio transmitter/transceiver shall be specifically listed as using a transmission method that is highly resistant to misinterpretation of simultaneous transmissions and to interference (e.g., impulse noise and adjacent channel interference). [72:23.16.4.1]

5.12.4.2 The occurrence of any single fault that disables communication between any low-power radio transmitter/transceiver and the receiver/transceiver fuel gas detection control unit shall cause a latching trouble signal within 200 seconds at the system control unit that individually identifies the affected device.

5.12.4.3 A single fault on the signaling channel shall not cause a fuel gas alarm signal.

5.12.4.4 The periodic communication required to comply with 5.12.4.2 shall ensure successful alarm transmission. [72:23.16.4.4]

5.12.4.5 Removal of a low-power radio transmitter/transceiver from its installed location shall cause immediate transmission of a distinctive trouble signal that indicates its removal and individually identifies the affected device. [72:23.16.4.5]

5.12.4.6 Reception of any unwanted (interfering) transmission by a retransmission device (repeater) or by the main receiver/control unit, for a continuous period of 20 seconds or more, shall cause an audible and visible trouble indication at the main receiver/control unit to identify the specific trouble condition as an interfering signal.

5.12.5 Output Signals from a Wireless Receiver/Transceiver of a Control Unit. When the receiver/control is used to actuate remote appliances, such as notification appliances and relays, by wireless means, the remote appliances shall meet the following requirements:

- (1) Power supplies shall comply with Chapter 4 or the requirements of 5.12.2.
- (2) All supervision requirements of Chapter 4 and Chapter 5 shall apply.
- (3) The maximum allowable response delay from activation of an initiating device to activation of required fuel gas detection functions shall be 10 seconds.
- (4) Each receiver/control shall automatically repeat fuel gas alarm signal transmission at intervals not exceeding 60 seconds or until confirmation that the output appliance has received the fuel gas alarm signal.

Chapter 6 Notification Appliances for Fuel Gas Detection Systems

6.1* Application.

6.1.1 The requirements of this chapter shall apply where required by the AHJ governing laws, codes, or standards; or other parts of this standard. [72:18.1.1]

6.1.2 The requirements of this chapter shall address the reception of a notification signal and not the signal's information content. [72:18.1.2]

6.1.3 The performance, location, and mounting of notification appliances used to initiate or direct evacuation or relocation of the occupants, or for providing information to occupants or staff, shall comply with this chapter. [72:18.1.3]

6.1.4 The performance, location, and mounting of annunciators, displays, and printers used to display or record information for use by occupants, staff, responding emergency personnel, or supervising station personnel shall comply with this chapter. [72:18.1.4]

6.1.5* The requirements of this chapter shall apply to the areas, spaces, or system functions where required by the AHJ governing laws, codes, or standards; or other parts of this standard requiring compliance with this chapter. [72:18.1.5]

6.1.6 Notification appliances shall be permitted to be used within buildings or outdoors and to target the general building, area, or space, or only specific parts of a building, area, or space designated in specific zones and subzones. [72:18.1.6]

6.1.7 The requirements of Chapters 4, 5, and 8 shall apply to the interconnection of notification appliances, the cybersecurity of control and communication configurations, the power supplies, and the use of the information provided by notification appliances. [72:18.1.7]

6.2 Purpose. Notification appliances shall provide stimuli for initiating emergency action and provide information to users, emergency response personnel, and occupants. [72:18.2]

6.3 General.

6.3.1 Listing. All notification appliances installed in conformity with Chapter 6 shall be listed for the purpose for which they are used. [72:18.3.1]

6.3.2 Nameplates.

6.3.2.1 Notification appliances shall include on their nameplates reference to electrical requirements and rated audible or visual performance, or both, as defined by the listing authority. [72:18.3.2.1]

6.3.2.2 Audible appliances shall include on their nameplates reference to their parameters or reference to installation documents (supplied with the appliance) that include the parameters in accordance with 6.4.2 or 6.4.3. [72:18.3.2.2]

6.3.2.3 Visual notification appliances shall include on their nameplates reference to their parameters or reference to installation documents (supplied with the appliance) that include the parameters in accordance with 6.5.3.1 or Section 6.6. [72:18.3.2.3]

6.3.3 Physical Construction.

6.3.3.1 Appliances intended for use in special environments, such as outdoors versus indoors, high or low temperatures, high humidity, dusty conditions, and hazardous locations, or where subject to tampering, shall be listed for the intended application. [72:18.3.3.1]

6.3.3.2* Notification appliances used solely for signaling other than fuel gas detection shall not have the word FUEL GAS, or any fuel gas symbol, in any form (i.e., stamped, imprinted, etc.) on the appliance visible to the public.

6.3.3.3 Multipurpose notification appliances with multiple visible elements used for signaling other than fire shall be permitted to have fire markings only on those visible elements used for fire signaling.

6.3.4* Mechanical Protection.

6.3.4.1 Appliances subject to mechanical damage shall be suitably protected. [72:18.3.4.1]

6.3.4.2 If guards, covers, or lenses are employed, they shall be listed for use with the appliance. [72:18.3.4.2]

6.3.4.3 The effect of guards, covers, or lenses on the appliance's field performance shall be in accordance with the listing requirements. [72:18.3.4.3]

6.3.5 Mounting.

6.3.5.1 Appliances shall be supported independently of their attachments to the circuit conductors. [72:18.3.5.1]

6.3.5.2 Appliances shall be mounted in accordance with the manufacturer's published instructions. [72:18.3.5.2]

6.3.6* Connections. Terminals, leads, or addressable communication that provide for monitoring the integrity of the notification appliance connections shall be provided. [72:18.3.6]

6.4 Audible Characteristics.

6.4.1 General Requirements.

6.4.1.1 An average ambient sound level greater than 105 dBA shall require the use of a visual notification appliance(s) in accordance with Section 6.5 where the application is public mode or Section 6.6 where the application is private mode. [72:18.4.1.1]

6.4.1.2 The total sound pressure level produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance. [72:18.4.1.2]

6.4.1.3* Sound from normal or permanent sources, having a duration greater than 60 seconds, shall be included when measuring maximum ambient sound level. [72:18.4.1.3]

6.4.1.4 Sound from temporary or abnormal sources lasting less than 60 seconds shall not be required to be included when measuring maximum ambient sound level. [72:18.4.1.4]

6.4.1.5 Audible alert and evacuation signal tones, including those that precede or follow voice messages, shall meet the requirements of 6.4.2, 6.4.3, 6.4.4, or 6.4.5, as applicable. [72:18.4.1.5]

6.4.1.5.1* The designer of the audible notification system shall identify the rooms and spaces that will have audible notification.

cation and those where audible notification will not be provided [72:18.4.1.5.1]

6.4.1.5.2 Unless otherwise required by other sections of this standard, the coverage area for audible occupant notification shall be as required by other governing laws, codes, or standards. [72:18.4.1.5.2]

6.4.1.5.3 Where the other governing laws, codes, or standards require audible occupant notification for all or part of an area or space, coverage shall only be required in occupiable area as defined in 3.3.24. [72:18.4.1.5.3]

6.4.1.5.4 The sound pressure levels that must be produced by audible appliances in the coverage areas to meet the requirements of this standard shall be documented by the system designer during the planning and design of the notification system. [72:18.4.1.5.4]

6.4.1.5.5 The greater of the expected average ambient sound pressure level or expected maximum sound pressure level having a duration of at least 60 seconds shall also be documented for the coverage area by the system designer to ensure compliance with 6.4.2, 6.4.3, 6.4.4, or 6.4.5 for the coverage area.

6.4.1.5.6 The design sound pressure levels to be produced by the notification appliances for the various coverage areas shall be documented for use during acceptance testing of the system. [72:18.4.1.5.6]

6.4.1.5.7 Where required by the AHJ, documentation of the design sound pressure levels for the various coverage areas shall be submitted for review and approval. [72:18.4.1.5.7]

6.4.1.6 Voice messages shall not be required to meet the audibility requirements of 6.4.2, 6.4.3, 6.4.4, or 6.4.5, but shall meet the intelligibility requirements of 6.4.8 where voice intelligibility is required. [72:18.4.1.6]

6.4.2* Public Mode Audible Requirements.

6.4.2.1 To ensure that audible public mode signals are clearly heard, unless otherwise permitted by 6.4.2.2 through 6.4.2.5, they shall have a sound level at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 5 ft (1.5 m) above the floor in the area required to be served by the system using the A-weighted scale (dBA). [72:18.4.4.1]

6.4.2.2 Where approved by the AHJ or other governing codes or standards, the requirements for audible signaling shall be permitted to be reduced or eliminated when visual signaling is provided in accordance with Section 6.5. [72:18.4.4.2]

6.4.2.3 Audible notification appliances installed in elevator cars shall be permitted to use the audibility criteria for private mode appliances detailed in 6.4.3.1. [72:18.4.4.3]

6.4.2.4 If approved by the AHJ, audible notification appliances installed in restrooms shall be permitted to use the audibility criteria for private mode appliances detailed in 6.4.3.1. [72:18.4.4.4]

6.4.2.5 A fuel gas detection system arranged to stop or reduce ambient noise shall comply with 6.4.2.5.1 through 6.4.2.5.3.

6.4.2.5.1 A fuel gas detection system arranged to stop or reduce ambient noise shall produce a sound level at least 15 dB above the reduced average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds after reduction of the ambient noise level, whichever is greater, measured 5 ft (1.5 m) above the floor in the area required to be served by the system using the A-weighted scale (dBA).

6.4.2.5.2 Visual notification appliances shall be installed in the affected areas in accordance with Sections 6.5 or 6.6. [72:18.4.4.5.2]

6.4.2.5.3 Relays, circuits, or interfaces necessary to stop or reduce ambient noise shall meet the requirements of Chapter 4 and Chapter 5. [72:18.4.4.5.3]

6.4.3 Private Mode Audible Requirements.

6.4.3.1 To ensure that audible private mode signals are clearly heard, they shall have a sound level at least 10 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured 5 ft (1.5 m) above the floor in the area required to be served by the system using the A-weighted scale (dBA). [72:18.4.5.1]

6.4.3.2* Where approved by the AHJ or other governing codes or standards, the requirements for audible signaling shall be permitted to be reduced or eliminated when visual signaling is provided in accordance with Section 6.5. [72:18.4.5.2]

6.4.3.3 A system arranged to stop or reduce ambient noise shall comply with 6.4.3.3.1 through 6.4.3.3.3. [72:18.4.5.3]

6.4.3.3.1 A system arranged to stop or reduce ambient noise shall be permitted to produce a sound level at least 10 dB above the reduced average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds after reduction of the ambient noise level, whichever is greater, measured 5 ft (1.5 m) above the floor, using the A-weighted scale (dBA). [72:18.4.5.3.1]

6.4.3.3.2 Visual notification appliances shall be installed in the affected areas in accordance with Sections 6.5 or 6.6. [72:18.4.5.3.2]

6.4.3.3.3 Relays, circuits, or interfaces necessary to stop or reduce ambient noise shall meet the requirements of Chapter 4 and Chapter 5. [72:18.4.5.3.3]

6.4.4 Sleeping Area Requirements.

6.4.4.1 Where audible appliances are installed to provide signals for sleeping areas, they shall have a sound level of at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds or a sound level of at least 75 dBA, whichever is greater, measured at the pillow level in the area required to be served by the system using the A-weighted scale (dBA). [72:18.4.6.1]

6.4.4.2 If any barrier, such as a door, curtain, or retractable partition, is located between the notification appliance and the pillow, the sound pressure level shall be measured with the barrier placed between the appliance and the pillow. [72:18.4.6.2]

6.4.4.3* Audible appliances provided for the sleeping areas to awaken occupants shall produce a low frequency alarm signal that complies with the following:

- (1) The waveform shall have a fundamental frequency of 520 Hz \pm 10 percent.
- (2)* The notification equipment shall be listed for producing the low frequency waveform.

[72:18.4.6.3]

6.4.5* Narrow Band Tone Signaling for Exceeding Masked Thresholds.

6.4.5.1 Masked Threshold Allowance. Audible tone signaling shall be permitted to comply with the masked threshold requirements in this subsection in lieu of the A-weighted signaling requirements in 6.4.2 and 6.4.3. [72:18.4.7.1]

6.4.5.2* Calculation Method. The effective masked threshold shall be calculated in accordance with ISO 7731, *Ergonomics — Danger signals for public and work places — Auditory danger signals*. [72:18.4.7.2]

6.4.5.3 Noise Data. Noise data for calculating the effective masked threshold shall be the peak value of noise lasting 60 seconds or more for each octave or one-third octave band. [72:18.4.7.3]

6.4.5.4 Documentation. Analysis and design documentation shall be submitted to the AHJ and shall contain the following information:

- (1) Frequency data for the ambient noise, including the date, time, and location where measurements were taken for existing environments, or projected data for environments not yet constructed
- (2) Frequency data of the audible notification appliance
- (3) Calculations of the effective masked threshold for each set of noise data
- (4) A statement of the sound pressure level that would be required by 6.4.2 or 6.4.3 if masked threshold signaling had not been done

[72:18.4.7.4]

6.4.5.5 Sound Pressure Level. For masked threshold signaling, the audible signal tone shall meet the requirements of either 6.4.5.5.1 or 6.4.5.5.2 but not for the reproduction of prerecorded, synthesized, or live messages. [72:18.4.7.5]

6.4.5.5.1 The sound pressure level of the audible tone signal shall exceed the masked threshold in one or more octave bands by at least 10 dB in the octave band under consideration. [72:18.4.7.5.1]

6.4.5.5.2 The sound pressure level of the audible tone signal shall exceed the masked threshold in one or more one-third octave bands by at least 13 dB in the one-third octave band under consideration. [72:18.4.7.5.2]

6.4.6 Location of Audible Notification Appliances for a Building or Structure.

6.4.6.1 If ceiling heights allow, and unless otherwise permitted by 6.4.6.2 through 6.4.6.7, wall-mounted appliances shall have their tops above the finished floors at heights of not less than 90 in. (2.29 m) and below the finished ceilings at distances of not less than 6 in. (150 mm). [72:18.4.9.1]

6.4.6.2* For notification appliances installed in the same space with fuel gas detectors, for lighter than air fuel gases, the

detector shall be installed above the notification appliance horizontal plane location and in accordance with 5.8.5.3.1.

6.4.6.3 Ceiling-mounted or recessed appliances shall be permitted. [72:18.4.9.2]

6.4.6.4 Where ceiling-mounted or recessed appliances are utilized in the same space with fuel gas detectors, detectors installed in accordance with 5.8.5.3.1 shall also be ceiling-mounted or recessed.

6.4.6.5 If combination audible/visual appliances are installed, the location of the installed appliance shall be determined by the requirements of 6.5.5. [72:18.4.9.3]

6.4.6.6 Appliances that are an integral part of a fuel gas detector, fuel gas alarm, or other initiating device shall be located in accordance with the requirements for that device.

6.4.6.7 Mounting heights other than required by 6.4.6.1 and 6.4.6.3 shall be permitted, provided that the sound pressure level requirements of 6.4.2 for public mode or 6.4.3 for private mode, or 6.4.4 for sleeping areas, based on the application, are met. [72:18.4.9.5]

6.4.7 Location of Audible Notification Appliances for Wide-Area Signaling. Audible notification appliances for wide-area signaling shall be installed in accordance with the requirements of the AHJ, approved design documents, and the manufacturer's installation instruction to achieve the required performance. [72:18.4.10]

6.4.8* Voice Intelligibility. Within the acoustically distinguishable spaces (ADS) where voice intelligibility is required, voice communications systems shall reproduce prerecorded, synthesized, or live (e.g., microphone, telephone handset, and radio) messages with voice intelligibility. [72:18.4.11]

6.4.8.1* ADSs shall be determined by the system designer during the planning and design of all emergency communications systems. [72:18.4.11.1]

6.4.8.2 Each ADS shall be identified as requiring or not requiring voice intelligibility. [72:18.4.11.2]

6.4.8.3* Unless specifically required by other governing laws, codes or standards, or by other parts of this standard, intelligibility shall not be required in all ADSs. [72:18.4.11.3]

6.4.8.4* Where required by the AHJ; governing laws, codes, or standards; or by other parts of this standard, ADS assignments shall be submitted for review and approval. [72:18.4.11.4]

6.4.8.5 Quantitative measurements shall not be required. [72:18.4.11.5]

6.4.8.6 Quantitative measurements shall be permitted.

6.5* Visual Characteristics—Public Mode.

6.5.1* Visual Signaling.

6.5.1.1 Public mode visible signaling shall meet the requirements of Section 6.5 using visual notification appliances. [72:18.5.1.1]

6.5.1.2* The coverage area for visual notification shall be as required by other governing laws, codes, or standards. [72:18.5.1.2]

6.5.1.3 Where other governing laws, codes, or standards require visual notification for all or part of an area or space,

coverage shall only be required in occupiable areas as defined in 3.3.24. [72:18.5.1.3]

6.5.2 Area of Coverage.

6.5.2.1 The designer of the visual notification system shall document the rooms and spaces that will have visible notification and those where visible notification will not be provided. [72:18.5.2.1]

6.5.2.2* Unless otherwise specified or required by other sections of this standard, the required coverage area for visual occupant notification shall be as required by other governing laws, codes, or standards. [72:18.5.2.2]

6.5.2.3 Where required by the AHJ, documentation of the effective intensity (cd) of the visual notification appliances for the area of coverage shall be submitted for review and approval. [72:18.5.2.3]

6.5.3 Light, Color, and Pulse Characteristics.

6.5.3.1 The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance. [72:18.5.3.1]

6.5.3.2 The maximum light pulse duration shall be 20 milliseconds, except as permitted in 6.5.3.3. [72:18.5.3.2]

6.5.3.3 Light pulse durations greater than 20 milliseconds, but not greater than 100 milliseconds, shall be permitted where the alerting capability of the visual notification appliance is demonstrated to be equal to or greater than visual notification appliances with a 20-millisecond pulse duration. [72:18.5.3.3]

6.5.3.4 The pulse duration shall be defined as the time interval between initial and final points of 10 percent of maximum signal. [72:18.5.3.4]

6.5.3.5 Visual notification appliances used for fuel gas alarm signaling only or to signal the intent for complete evacuation shall be both of the following:

- (1) Clear or nominal white
- (2) Less than 1000 cd (effective intensity)

6.5.3.6 Visual notification appliances used to signal occupants to seek information or instructions shall be clear, nominal white, or other color as required by the emergency response plan and the AHJ for the area or building.

6.5.3.7 The visual synchronization requirements of this chapter shall not apply where the visible notification appliances located inside the building are viewed from outside of the building. [72:18.5.3.7]

6.5.4 Appliance Photometrics. The light output shall comply with the polar dispersion requirements for public mode signaling as described in UL 1638, *Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories*, or equivalent. [72:18.5.4]

6.5.5 Appliance Location.

6.5.5.1 Wall-mounted appliances shall be mounted such that the entire lens is not less than 80 in. (2.03 m) and not greater than 96 in. (2.44 m) above the finished floor or at the mounting height specified using the performance-based alternative of 6.5.5.7. [72:18.5.5.1]

6.5.5.2 Where low ceiling heights do not permit wall mounting at a minimum of 80 in. (2.03 m), wall mounted visual notification appliances shall be mounted within 6 in. (150 mm) of the ceiling. [72:18.5.5.2]

6.5.5.3 Where low ceiling heights do not permit wall mounting at a minimum of 80 in. (2.03 m), the room size covered by a visual notification appliance of a given value shall be reduced by twice the difference between the minimum mounting height of 80 in. (2.03 m) and the actual lower mounting height. [72:18.5.5.3]

6.5.5.4* Visual notification appliances listed for mounting parallel to the floor shall be permitted to be located on the ceiling or suspended below the ceiling. [72:18.5.5.4]

6.5.5.5* Spacing in Rooms.

6.5.5.5.1 Spacing shall be in accordance with either Table 6.5.5.5.1(a) and Figure 6.5.5.5.1 or Table 6.5.5.5.1(b). [72:18.5.5.7.1]

6.5.5.5.2 Visual notification appliances shall be installed in accordance with Table 6.5.5.5.1(a) or Table 6.5.5.5.1(b) using one of the following:

- (1) A single visual notification appliance.
- (2) Two groups of visual notification appliances, where visual notification appliances of each group are synchronized, in the same room or adjacent space within the field of view. This shall include synchronization of visual appliances operated by separate systems.
- (3) More than two visual notification appliances or groups of synchronized appliances in the same room or adjacent space within the field of view that flash in synchronization.

[72:18.5.5.7.2]

6.5.5.5.3 Room spacing in accordance with Table 6.5.5.5.1(a) and Figure 6.5.5.5.1 for wall-mounted appliances shall be based on locating the visual notification appliance at the halfway distance of the wall. [72:18.5.5.7.3]

6.5.5.5.4 In square rooms with appliances not centered or in nonsquare room configurations that are not square rooms, the effective intensity (cd) from one visual wall-mounted notification appliance shall be determined by maximum room size dimensions obtained either by measuring the distance to the farthest wall or by doubling the distance to the farthest adjacent wall, whichever is greater, as required by Table 6.5.5.5.1(a) and Figure 6.5.5.5.1.

6.5.5.5.5 If a room configuration is not square, the square room size that allows the entire room to be encompassed or allows the room to be subdivided into multiple squares shall be used. [72:18.5.5.7.5]

6.5.5.5.6* If ceiling heights exceed 30 ft (9.14 m), ceiling-mounted visual notification appliances shall be suspended at or below 30 ft (9.14 m) or at the mounting height determined using the performance-based alternative of 6.5.5.7, or wall-mounted visible notification appliances shall be installed in accordance with Table 6.5.5.5.1(a). [72:18.5.5.7.6]

6.5.5.5.7 Table 6.5.5.5.1(b) shall be used if the ceiling-mounted visual notification appliance is at the center of the room. [72:18.5.5.7.7]

Table 6.5.5.5.1(a) Room Spacing for Wall-Mounted Visual Notification Appliances

Maximum Room Size		Minimum Required Light Output [Effective Intensity (cd)]	
		One Visual Notification Appliance per Room	Four Visual Notification Appliances per Room (One per Wall)
ft	m		
20 × 20	6.10 × 6.10	15	NA
28 × 28	8.53 × 8.53	30	NA
30 × 30	9.14 × 9.14	34	NA
40 × 40	12.2 × 12.2	60	15
45 × 45	13.7 × 13.7	75	19
50 × 50	15.2 × 15.2	94	30
54 × 54	16.5 × 16.5	110	30
55 × 55	16.8 × 16.8	115	30
60 × 60	18.3 × 18.3	135	30
63 × 63	19.2 × 19.2	150	37
68 × 68	20.7 × 20.7	177	43
70 × 70	21.3 × 21.3	184	60
80 × 80	24.4 × 24.4	240	60
90 × 90	27.4 × 27.4	304	95
100 × 100	30.5 × 30.5	375	95
110 × 110	33.5 × 33.5	455	135
120 × 120	36.6 × 36.6	540	135
130 × 130	39.6 × 39.6	635	185

NA: Not allowable.

[72:Table 18.5.5.7.1 (a)]

Table 6.5.5.5.1(b) Room Spacing for Ceiling-Mounted Visual Notification Appliances

Maximum Room Size		Maximum Lens Height*		Minimum Required Light Output (Effective Intensity); One Visual Notification Appliance (cd)
ft	m	ft	m	
20 × 20	6.1 × 6.1	10	3.0	15
30 × 30	9.1 × 9.1	10	3.0	30
40 × 40	12.2 × 12.2	10	3.0	60
44 × 44	13.4 × 13.4	10	3.0	75
20 × 20	6.1 × 6.1	20	6.1	30
30 × 30	9.1 × 9.1	20	6.1	45
44 × 44	13.4 × 13.4	20	6.1	75
46 × 46	14.0 × 14.0	20	6.1	80
20 × 20	6.1 × 6.1	30	9.1	55
30 × 30	9.1 × 9.1	30	9.1	75
50 × 50	15.2 × 15.2	30	9.1	95
53 × 53	16.2 × 16.2	30	9.1	110
55 × 55	16.8 × 16.8	30	9.1	115
59 × 59	18.0 × 18.0	30	9.1	135
63 × 63	19.2 × 19.2	30	9.1	150
68 × 68	20.7 × 20.7	30	9.1	177
70 × 70	21.3 × 21.3	30	9.1	185

*This does not preclude mounting lens at lower heights.

[72:Table 18.5.5.7.1(b)]

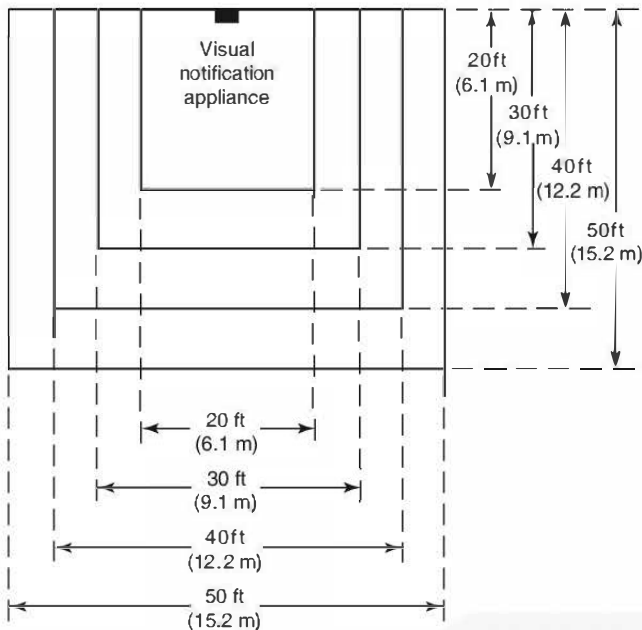


FIGURE 6.5.5.5.1 Room Spacing for Wall-Mounted Visual Notification Appliances. [72:Figure 18.5.5.7.1]

6.5.5.5.8 If the ceiling-mounted visual notification appliance is not located at the center of the room, the effective intensity (cd) shall be determined by doubling the distance from the appliance to the farthest wall to obtain the maximum room size. [72:18.5.5.7.8]

6.5.5.6* Spacing in Corridors.

6.5.5.6.1 The installation of visual notification appliances in corridors 20 ft (6.1 m) or less in width shall be in accordance with the requirements of either 6.5.5.5 or 6.5.5.6. [72:18.5.5.8.1]

6.5.5.6.2 Paragraph 6.5.5.6 shall apply to corridors not exceeding 20 ft (6.1 m) in width. [72:18.5.5.8.2]

6.5.5.6.3 In a corridor application, visual notification appliances shall be rated not less than 15 cd. [72:18.5.5.8.3]

6.5.5.6.4 Corridors greater than 20 ft (6.1 m) wide shall comply with the spacing requirements for rooms in accordance with 6.5.5.5. [72:18.5.5.8.4]

6.5.5.6.5* Visual notification appliances shall be located not more than 15 ft (4.57 m) from the end of the corridor with a separation not greater than 100 ft (30.5 m) between appliances.

6.5.5.6.6 If there is an interruption of the concentrated viewing path, such as a fire door or an elevation change, the area shall be treated as a separate corridor. [72:18.5.5.8.6]

6.5.5.6.7 In corridors where more than two visual notification appliances are in any field of view, they shall flash in synchronization. [72:18.5.5.8.7]

6.5.5.6.8 Visual notification appliances in corridors shall be permitted to be mounted on the ceiling, end wall, or the side wall of the corridor. [72:18.5.5.8.8]

6.5.5.7 Performance-Based Alternative.

6.5.5.7.1 Any design that provides a minimum of 0.0375 lumens/ft² (0.4036 lumens/m²) of illumination at any point within the covered area at all angles specified by the polar dispersion planes for wall- or ceiling-mounted public mode visual notification appliances in UL 1638, *Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories*, or equivalent, as calculated for the maximum distance from the nearest visual notification appliance, shall be permitted in lieu of the requirements of 6.5.5, excluding 6.5.5.8. [72:18.5.5.9.1]

6.5.5.7.2 Documentation provided to the AHJ shall include inverse square law calculations using each of the vertical and horizontal polar distribution angles in UL 1638, *Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories*, or equivalent. [72:18.5.5.9.2.1]

6.5.5.7.2.1 The inverse square law calculations shall account for the effects of polar distribution using one of the following:

- (1) The percentages from the applicable table(s) in UL 1638, *Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories*, or equivalent
- (2) The actual results of laboratory tests of the specific appliance to be used as recorded by the listing organization [72:18.5.5.9.2.2]

6.5.5.8 Sleeping Areas.

6.5.5.8.1 Combination fuel gas detectors and visual notification appliances or combination fuel gas alarms and visual notification appliances shall be installed in accordance with the applicable requirements of Chapter 5, Chapter 6, and Chapter 9.

6.5.5.8.2 For rooms with a linear dimension greater than 16 ft (4.87 m), the visual notification appliance shall be located within 16 ft (4.87 m) of the pillow.

6.5.6 Location of Visual Notification Appliances for Wide Area Signaling. Visual notification appliances for wide-area signaling shall be installed in accordance with the requirements of the AHJ, approved design documents, and the manufacturer's published instructions to achieve the required performance. [72:18.5.6]

6.6* Visual Characteristics—Private Mode. Visual notification appliances used in the private mode shall be of a sufficient quantity and intensity and located so as to meet the intent of the user and the AHJ. [72:18.6]

6.7 Supplementary Visible Signaling Methods.

6.7.1 A supplementary visual notification appliance shall be intended to augment an audible or visual signal. [72:18.7]

6.7.2 Supplementary visual notification appliances shall be permitted to be located less than 80 in. (2.03 m) above the floor. [72:18.7.2]

6.8 Textual Audible Appliances.

6.8.1 Loudspeaker appliances. Loudspeaker appliances shall comply with Section 6.4. [72:18.8.1.1]

6.8.2* The sound pressure level, in dBA, of the tone produced by a signaling loudspeaker shall comply with all the requirements in 6.4.2 (public), 6.4.3 (private), or 6.4.4 (sleeping) for the intended mode or shall comply with the requirements of 6.4.5 (narrow band tone signaling). [72:18.8.1.2]

6.9* Textual and Graphical Visible Appliances.

6.9.1 Application

6.9.1.1 Textual and graphical visual appliances shall be permitted to be used to signal information about fuel gases or other emergency conditions or to direct intended responses to those conditions.

6.9.1.2 This section does not apply to means of egress signs, room identification signs, and other signage that could be required by other governing laws, codes, or standards. [72:18.9.1.2]

6.9.1.3 Textual visual appliance messages shall be permitted to be static, flashing, or scrolling. [72:18.9.1.3]

6.9.2 Location.

6.9.2.1 Private Mode. Unless otherwise permitted or required by other governing laws, codes, or standards, or by other parts of this standard or by the AHJ, all textual and graphical visual notification appliances in the private mode shall be located in rooms that are accessible only to those persons directly concerned with the implementation and direction of emergency response in the areas protected by the system. [72:18.9.2.1]

6.9.2.2 Public Mode. Textual and graphical visual notification appliances used in the public mode shall be located to ensure visibility to the occupants of the protected area or to the intended recipients. [72:18.9.2.2]

6.9.2.3 Mounting. Desktop and surface-mounted textual and graphical visual notification appliances shall be permitted. [72:18.9.2.3]

6.9.3 Performance. The information produced by textual and graphical visual appliances shall be clear and legible at the intended viewing distance. [72:18.9.3]

6.9.4* Character and Symbol Requirements and Viewing Distance.

6.9.4.1 This section applies to visual characters and graphic elements and does not address raised characters or braille that could be required by other governing laws, codes, or standards [72:18.9.4.1]

6.9.4.2* Characters and symbols shall contrast with their background using either positive contrast (light on a dark background) or negative contrast (dark on a light background). [72:18.9.4.2]

6.9.4.3 Characters and symbols and their background shall have a nonglare finish. [72:18.9.4.3]

6.9.4.4* Characters shall be permitted to be uppercase or lowercase, or a combination of both. [72:18.9.4.4]

6.9.4.5 Characters shall be conventional in form and not italic, oblique, script, highly decorative, or of other unusual form and shall use sans serif fonts. [72:18.9.4.5]

6.9.4.6 Characters shall be selected from fonts where the width of the uppercase letter "O" is 55 percent minimum and 110 percent maximum of the height of the uppercase letter "I". [72:18.9.4.6]

6.9.4.7* Character and symbol height for appliances other than desktop monitors or displays shall meet all of the following criteria:

- (1) Minimum character height shall comply with Table 6.9.4.7.
 - (2) Viewing distance shall be measured as the horizontal distance between the character and an obstruction preventing further approach towards the appliance.
 - (3) Character height shall be based on the uppercase letter "I."
- [72:18.9.4.7]

6.9.4.8* All characters and symbols displayed by textual and graphical visual notification appliances shall be a minimum of 40 in. (1.02 m) above the ground or finished floor. [72:18.9.4.8]

6.9.4.9 Stroke thickness of the uppercase letter "I" shall be minimum 10 percent and maximum 30 percent of the height of the character. [72:18.9.4.9]

6.9.4.10 Character spacing shall be measured between the two closest points of adjacent characters, excluding word spaces. Spacing between individual characters shall be minimum 10 percent and maximum 35 percent of character height. [72:18.9.4.10]

6.9.4.11 Spacing between the baselines of separate lines of characters within a message shall be 135 percent minimum and 170 percent maximum of the character height. [72:18.9.4.11]

6.10 Tactile Appliances.

6.10.1 Application. Tactile appliances shall be permitted if used in addition to audible and/or visual notification appliances. [72:18.10.1]

6.10.2* Performance. Tactile appliances shall meet the performance requirements of UL 1971, *Signaling Devices for the Hearing Impaired*, or equivalent. [72:18.10.2]

6.11* Emergency Services Interfaces. Where required by the enforcing authority; governing laws, codes, or standards; or other parts of this standard, annunciators, information display systems, and controls for portions of a system provided for use by emergency service personnel shall be designed, arranged, and located in accordance with the requirements of the organizations intended to use the equipment. [72:10.18.6]

Table 6.9.4.7 Visual Character and Graphic Symbol Heights Based on Height and Distance

Horizontal Viewing Distance		Minimum Character or Symbol Height for Installed Elevation					
		At 40 in. to 70 in. (1.0 m to 1.8 m) Above the Floor		At Greater Than 70 in. to 120 in. (1.8 m to 3.1 m) Above the Floor		At Greater Than 120 in. (3.0 m) Above the Floor	
		in.	mm	in.	mm	in.	mm
1	0.3	$\frac{5}{8}$	16	2	51	3	76
2	0.6	$\frac{5}{8}$	16	2	51	3	76
3	0.9	$\frac{5}{8}$	16	2	51	3	76
4	1.2	$\frac{5}{8}$	16	2	51	3	76
5	1.5	$\frac{5}{8}$	16	2	51	3	76
6	1.8	$\frac{5}{8}$	16	2	51	3	76
7	2.1	$\frac{3}{4}$	19	2	51	3	76
8	2.4	$\frac{7}{8}$	22	2	51	3	76
9	2.7	1	25	2	51	3	76
10	3	$1\frac{1}{8}$	29	2	51	3	76
11	3.4	$1\frac{1}{4}$	32	2	51	3	76
12	3.7	$1\frac{3}{8}$	35	2	51	3	76
13	4	$1\frac{1}{2}$	38	2	51	3	76
14	4.3	$1\frac{5}{8}$	41	2	51	3	76
15	4.6	$1\frac{3}{4}$	44	2	51	3	76
16	4.9	$1\frac{7}{8}$	48	$2\frac{1}{8}$	54	3	76
17	5.2	2	51	$2\frac{1}{4}$	57	3	76
18	5.5	$2\frac{1}{8}$	54	$2\frac{3}{8}$	60	3	76
19	5.8	$2\frac{1}{4}$	57	$2\frac{1}{2}$	64	3	76
20	6.1	$2\frac{3}{8}$	60	$2\frac{5}{8}$	67	3	76
21	6.4	$2\frac{1}{2}$	64	$2\frac{3}{4}$	70	3	76
22	6.7	$2\frac{3}{4}$	67	$2\frac{7}{8}$	73	$3\frac{1}{8}$	79
23	7	$2\frac{7}{8}$	70	3	76	$3\frac{1}{4}$	83
24	7.3	$2\frac{7}{8}$	73	$3\frac{1}{8}$	79	$3\frac{3}{8}$	86
25	7.6	3	76	$3\frac{1}{4}$	83	$3\frac{1}{2}$	89
>25	>7.6	$3 + h^*$	$76 + h^*$	$3\frac{1}{4} + h^*$	$83 + h^*$	$3\frac{1}{2} + h^*$	$89 + h^*$

*For each foot of horizontal viewing distance greater than 25 ft (7.6 m), add $\frac{1}{8}$ in. (3 mm) to the character or symbol height.

[72:Table 18.9.4.7]

Chapter 7 Off-Premises Signal Transmission

7.1 Application.

7.1.1 The performance, installation, and operation of fuel gas detection systems at a continuously attended supervising station or a communications center and between the protected premises and the receiving station shall comply with the requirements of this chapter.

7.1.2* Communication from the fuel gas detection system equipment to a receiving location other than as required by 7.1.1 shall be both of the following:

- (1) Permitted
- (2) Not required to comply with the requirements of this chapter

7.1.3 The requirements of Chapters 4, 5, and 8 shall also apply unless they are in conflict with this chapter.

7.2 General. Connections to supervising stations or communications centers shall be in accordance with this chapter.

7.2.1 Signals.

7.2.1.1 Alarm Signal Priority and Disposition. A fuel gas alarm signal shall take precedence over supervisory or trouble signals.

7.2.1.1.1 The actuation of a fuel gas detector or system shall be distinctively indicated as a fuel gas alarm signal.

7.2.1.1.2* Servicing of a system in alarm that cannot be reset shall comply with both of the following:

- (1) Be in accordance with Chapter 8
- (2) Occur within 4 hours of the fuel gas alarm signal

7.2.1.2 Fuel Gas Detection System Trouble Signal Disposition.

7.2.1.2.1 Upon receipt of a fuel gas detection system trouble signal, the responsible party(ies) shall be notified.

7.2.1.2.2 Servicing of a system in trouble shall comply with both of the following:

- (1) Be in accordance with Chapter 8
- (2) Occur within 4 hours of the trouble indication

7.2.2* Supervising Station. Upon receipt of a fuel gas alarm signal, supervising station personnel shall perform the following actions in the order listed:

- (1) Immediately retransmit indication of the fuel gas alarm signal to the communications center
- (2) Contact the responsible party(ies) in accordance with the notification plan

7.2.3* Emergency Response Agency (ERA). Where a fuel gas alarm signal is transmitted directly to a communications center, communications center personnel shall perform the following actions in the order listed:

- (1) Follow standard operating procedures
- (2) Contact the responsible party(ies) in accordance with the notification plan

7.3 Prearranged Testing. Where the signal results from a prearranged test, the action required by 7.2.2 and 7.2.3 shall not be required.

7.4 Operation and Record Keeping.

7.4.1 The operation, staffing, and recordkeeping for a supervising station shall be in accordance with *NFPA 72*.

7.4.2 The operation, staffing, and recordkeeping for a communications center shall be in accordance with *NFPA 1225*.

Chapter 8 Inspection, Testing, and Maintenance

8.1 Application. This chapter covers the requirements for the inspection, testing, and maintenance of fuel gas alarms, detectors, systems, and their components.

8.1.1 More stringent inspection, testing, or maintenance procedures shall be permitted.

8.1.2 Inspection testing and maintenance programs shall encompass all of the following:

- (1) Compliance with the requirements of this chapter
- (2) Conformity with the equipment manufacturers' published instructions
- (3) Verification of operation of the fuel gas alarms, detectors, systems, and their components

8.1.3 The use of alternative test methods or testing devices shall be permitted, provided such methods or devices are equivalent in effectiveness and safety and meet the intent of the requirements of this chapter.

8.2 General.

8.2.1 Responsibilities.

8.2.1.1 The property or building or system owner or the owner's designated representative shall be responsible for inspection, testing, and maintenance of the system and for alterations or additions to this system. [72:14.2.3.1]

8.2.1.2 Where the property owner is not the occupant, the property owner shall be permitted to delegate the authority and responsibility for inspecting, testing, and maintaining the fuel gas detection systems to the occupant, management firm, or managing individual through specific provisions in the lease, written use agreement, or management contract.

8.2.1.3 Inspection, testing, or maintenance shall be permitted to be done by the building or system owner or a person or organization other than the building or system owner if conducted under a written contract. [72:14.2.3.3]

8.2.1.4 Where the building or system owner has delegated any responsibilities for inspecting, testing, or maintenance, a copy of the written delegation required by 8.2.1.3 shall be provided to the AHJ upon request. [72:14.2.3.4]

8.2.1.5* Service Personnel Qualifications and Experience. Service personnel shall be qualified and experienced in accordance with the requirements of 4.4.3. [72:14.2.3.6]

8.2.2* Notification.

8.2.2.1 Before proceeding with any testing, all persons and facilities receiving alarm, supervisory, or trouble signals and all building occupants shall be notified of the testing to prevent unnecessary response. [72:14.2.4.1]

8.2.2.2 The owner or the owner's designated representative and service personnel shall coordinate system testing to prevent interruption of critical building systems or equipment. [72:14.2.4.3]

8.2.3 System Documentation. Prior to system maintenance or testing, the record of completion and the information regarding the system and system alterations, including specifications, wiring diagrams, and floor plans, shall be provided by the owner or a designated representative to the service personnel upon request.

8.2.4* Test Plan.

8.2.4.1 A test plan shall be developed to clearly establish the scope of the testing for the fire alarm or signaling system. [72:14.2.10.1]

8.2.4.2 The test plan and results shall be documented with the testing records. [72:14.2.10.2]

8.3 Inspection.

8.3.1* Unless otherwise permitted by 8.3.2, visual inspections shall be performed in accordance with the schedules in Table 8.3.1 or more often if required by the AHJ. [72:14.3.1]

8.3.2 Devices or equipment that is inaccessible for safety considerations (e.g., continuous process operations, energized electrical equipment, radiation, and excessive height) shall be permitted to be inspected during scheduled shutdowns if approved by the AHJ. [72:14.3.2]

8.3.3 Extended intervals shall not exceed 18 months. [72:14.3.3]

8.3.4 Initial and reacceptance inspections shall be made to ensure compliance with approved design documents and to ensure installation in accordance with this standard and other required installation standards. [72:14.3.4]

8.3.5 Periodic visual inspections in accordance with Table 8.3.1 shall be made to assure that there are no changes that affect equipment performance. [72:14.3.5]

8.4 Testing.

8.4.1 Initial Acceptance Testing.

8.4.1.1 All new systems shall be inspected and tested in accordance with the requirements of Chapter 8. [72:14.4.1.1]

8.4.1.2 The AHJ shall be notified prior to the initial acceptance test. [72:14.4.1.2]

8.4.2* Reacceptance Testing.

8.4.2.1 When an initiating device, notification appliance, or control relay is added, it shall be functionally tested. [72:14.4.2.1]

8.4.2.2 When an initiating device, notification appliance, or control relay is deleted, another device, appliance, or control relay on the circuit shall be operated. [72:14.4.2.2]

8.4.2.3 When modifications or repairs to control equipment hardware are made, the control equipment shall be tested in accordance with Table 8.4.3, items 2(1) and 2(4). [72:14.4.2.3]

8.4.2.4 When changes are made to site-specific software, the following shall apply:

- (1) All functions known to be affected by the change, or identified by a means that indicates changes, shall be tested end to end from the affected sensor(s) to final action(s). (See 8.2.4.)
- (2) In addition, 10 percent of initiating devices that are not directly affected by the change, up to a maximum of 50 devices, also shall be both of the following:
 - (a) Tested
 - (b) Verified for correct system operation
- (3) A revised record of completion in accordance with 4.14.1.4 shall be prepared to reflect these changes.

8.4.2.5* Changes to the system executive software shall require at least a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify critical system functions such as notification appliances, control functions, and off-premises reporting.

8.4.3* Test Methods. Fuel gas detection systems and associated equipment shall be tested according to Table 8.4.3.

8.4.4* Testing Frequency. Unless otherwise permitted by other sections of this standard, testing shall be performed in accordance with the schedules in Table 8.4.3, or more often if required by the AHJ. [72:14.4.4]

8.4.4.1* Devices or equipment that are inaccessible for safety considerations shall be permitted to be tested during scheduled shutdowns if approved by the AHJ.

8.4.4.2 Extended intervals shall not exceed 18 months.

8.4.4.3 If automatic testing is performed at least weekly by a remotely monitored fuel gas detection control unit specifically listed for the application, both of the following shall apply:

- (1) The manual testing frequency shall be permitted to be extended to annually.
- (2) Table 8.4.3 shall apply.

8.4.5 Functional Test of Fuel Gas Detectors.

8.4.5.1 Fuel gas detector tests shall be performed at initial acceptance and annually by the introduction of fuel gas into the sensing chamber or element.

8.4.5.2 An electronic check (e.g., magnets, analog values, etc.) shall not be sufficient to comply with this requirement.

8.4.5.3 The functional test shall be performed in accordance with the manufacturer's published instructions.

8.4.5.4* The result of each fuel gas detector test shall be confirmed through indication at the detector and the control unit.

8.4.5.5 All tests and results shall be recorded.

8.5 Maintenance.

8.5.1 Fuel gas detection system equipment shall be maintained in accordance with the manufacturer's published instructions.

Table 8.3.1 Visual Inspection Frequencies

Component		Initial Acceptance	Periodic Frequency	Method	Reference
1.	All equipment	X	Annual	Ensure there are no changes that affect equipment performance. Inspect for building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, and degree of cleanliness.	8.3.4
2.	Control equipment:				
	(1) Fuel gas detection systems monitored for alarm, supervisory, and trouble signals			Verify a system normal condition.	
	(a) Fuses	X	Annual		
	(b) Interfaced equipment	X	Annual		
	(c) Lamps and LEDs	X	Annual		
	(d) Primary (main) power supply	X	Annual		
	(e) Trouble signals	X	Annual		
	(2) Fuel gas detection systems unmonitored for alarm, supervisory, and trouble signals			Verify a system normal condition.	
	(a) Fuses	X	Weekly		
	(b) Interfaced equipment	X	Weekly		
	(c) Lamps and LEDs	X	Weekly		
	(d) Primary (main) power supply	X	Weekly		
	(e) Trouble signals	X	Weekly		
3.	Reserved				
4.	Emergency voice/alarm communications equipment	X	Semiannual	Verify location and condition.	
5.	Reserved				
6.	Reserved				
7.	Reserved				
8.	Batteries				4.5.9
	(1) Valve-regulated lead-acid (VRLA) batteries				
	(a) General	X	N/A	Ensure month and year of manufacture is marked in the month/year format on each battery cell/unit. Verify tightness of battery connections. Inspect terminals for corrosion, excessive container/cover distortion, cracks in cell/unit or leakage of electrolyte. Replace any battery cell/unit if corrosion, distortion, or leakage is observed.	
	(b) Marking	N/A	Semiannual	Verify marking of the month/year of manufacture on each battery cell/unit. Replace any cell/unit if alarm equipment manufacturer's replacement date has been exceeded.	

(continues)

Table 8.3.1 *Continued*

Component		Initial Acceptance	Periodic Frequency	Method	Reference
(2) Primary (dry cell) other than those used in low-power radio (wireless) systems in accordance with Chapter 5		X	Semiannual	Verify marking of the month/year of manufacture. Replace if alarm equipment/battery manufacturer's replacement date has been exceeded. Replacement date not to exceed 12 months. Verify tightness of connections. Inspect for corrosion or leakage. Replace any battery cell/unit if corrosion or leakage is observed.	
9.	Remote annunciators	X	Semiannual	Verify location and condition.	
10.	Notification appliance circuit power extenders	X	Annual	Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment.	Section 4.5
11.	Remote power supplies	X	Semiannual	Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment.	Section 4.5
12.	Transient suppressors	X	Semiannual	Verify location and condition.	
13.	Reserved				
14.	Fiber-optic cable connections	X	Annual	Verify location and condition.	
15.	Initiating devices			Verify location and condition (all devices).	
	(1) Fuel gas air sampling				
	(a) General	X	Semiannual	Verify that in-line filters, if any, are clean.	
	(b) Sampling system piping and sampling ports	X		Verify that sampling system piping and fittings are installed properly, appear airtight, and are permanently fixed. Confirm that sampling pipe is conspicuously identified. Verify that sample ports or points are not obstructed.	
	(2) Fuel gas duct detectors				
	(a) General	X	Semiannual	Verify that detector is rigidly mounted. Confirm that no penetrations in a return air duct exist in the vicinity of the detector. Confirm the detector is installed so as to sample the airstream at the proper location in the duct.	
	(b) Sampling tube	X		Verify proper orientation. Confirm the sampling tube protrudes into the duct in accordance with system design.	
	(3) Electromechanical releasing devices	X	Semiannual		
	(4) Supervisory signal devices	X	Quarterly		

(continues)

Table 8.3.1 *Continued*

	Component	Initial Acceptance	Periodic Frequency	Method	Reference
16.	Fuel gas alarm control interface and carbon monoxide emergency control function interface	X	Semiannual	Verify location and condition.	
17.	Notification appliances			Verify location and condition (all appliances).	
	(1) Audible appliances	X	Semiannual		
	(2) Audible textual notification appliances	X	Semiannual		
	(3) Visual appliances				
	(a) General	X	Semiannual		6.5.5
	(b) Candela rating	X		Verify that the candela rating marking agrees with the approved drawings.	6.5.5

Note: N/A = not applicable, no minimum requirement established.

*For other than VRLA or primary (dry) cell batteries, refer to the battery manufacturer's published instructions or IEEE 450, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, for vented lead-acid batteries; and IEEE 1106, *Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, for nickel-cadmium batteries.

8.5.2 Resetting.

8.5.2.1 Fuel gas apparatus that require resetting to maintain normal operation shall be restored to normal as promptly as possible after each test and alarm and kept in normal condition for operation.

8.5.2.2 All test signals received shall be recorded to indicate date and time.

8.6 Records.

8.6.1 Permanent Records. After successful completion of acceptance tests approved by the AHJ, the requirements in 8.6.1.1 and 8.6.1.2 shall apply. [72:14.6.1]

8.6.1.1 A set of reproducible as-built installation drawings, operation and maintenance manuals, and a written sequence of operation shall be provided to the building owner or the owner's designated representative. [72:14.6.1.1]

8.6.1.2 The system owner shall be responsible for maintaining these records for the life of the system for examination by any AHJ. Paper or electronic media shall be permitted. [72:14.6.1.3]

8.6.2 Maintenance, Inspection, and Testing Records.

8.6.2.1 Records shall be retained until the next test and for 1 year thereafter. [72:14.6.2.1]

8.6.2.2 A record of all inspections, testing, and maintenance shall be provided in accordance with Figure 8.6.2.2. [72:14.6.2.4]

8.6.2.3 The system shall be identified by a placard, sticker, or other means to indicate the next regularly scheduled inspection period in accordance with Figure 8.6.2.2.

8.6.2.4 The existing means of indicating the next regularly scheduled inspection period shall be permitted, instead of the

requirements of 8.6.2.3, if the devices have been tested as part of the normal fuel gas alarm testing.

8.6.2.5 If off-premises monitoring is provided, records of signals, tests, and operations recorded at the monitoring center shall be maintained for not less than 12 months.

8.6.2.6 Upon request, a hard copy record shall be available for examination by the AHJ.

8.6.2.7 Paper or electronic media shall be permitted.

8.7 Single- and Multiple-Station Fuel Gas Alarms.

8.7.1 Single- and multiple-station fuel gas alarms and all connected appliances shall be inspected and tested in accordance with the manufacturer's published instructions at least monthly.

8.7.2 Alarms shall be replaced in the following instances:

- (1) When either the end-of-life signal is activated or the manufacturer's replacement date is reached
- (2) When the alarm fails to respond to operability tests

8.7.3 Any combination of smoke/carbon monoxide/fuel gas alarms shall be replaced when the end-of-life signal activates or 10 years from the date of manufacture, whichever comes first, unless otherwise provided by the manufacturer's published instructions.

8.7.4 Where batteries are used as a source of energy for alarms, the batteries shall be replaced in accordance with the alarm equipment manufacturer's published instructions.

8.7.5* The occupant of a dwelling unit shall be deemed qualified to perform inspection, testing, and maintenance on single- and multiple-station fuel gas alarms and all connected appliances protecting that dwelling unit when provided with the manufacturer's published instructions.

Table 8.4.3 Testing

	Component	Initial Acceptance	Periodic Frequency	Method
1.	All equipment	X		See Table 8.3.1.
2.	Control equipment and transponder			
	(1) Functions	X	Annually	Verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of ac power and disconnection of secondary batteries.
	(2) Fuses	X	Annually	Verify rating and supervision.
	(3) Interfaced equipment	X	Annually	Verify integrity of single or multiple circuits providing interface between two or more control units. Test interfaced equipment connections by operating or simulating operation of the equipment being supervised. Verify signals required to be transmitted at the control unit.
	(4) Lamps and LEDs	X	Annually	Illuminate lamps and LEDs.
	(5) Primary (main) power supply	X	Annually	Disconnect and test all secondary (standby) power under maximum load, including all alarm appliances requiring simultaneous operation. Reconnect all secondary (standby) power at end of test. Test redundant power supplies separately.
3.	Fuel gas detection control unit trouble signals			
	(1) Audible and visual	X	Annually	Verify operation of control unit trouble signals. Verify ring-back feature for systems using a trouble-silencing switch that requires resetting.
	(2) Disconnect switches	X	Annually	If control unit has disconnect or isolating switches, verify performance of intended function of each switch. Verify receipt of trouble signal when a supervised function is disconnected.
	(3) Ground-fault monitoring circuit	X	Annually	If the system has a ground detection feature, verify the occurrence of ground-fault indication whenever any installation conductor is grounded.
	(4) Transmission of signals to off-premises location	X	Annually	Actuate an initiating device and verify receipt of alarm signal at the off-premises location. Create a trouble condition and verify receipt of a trouble signal at the off-premises location. Actuate a supervisory device and verify receipt of a supervisory signal at the off-premises location. If a transmission carrier is capable of operation under a single- or multiple-fault condition, activate an initiating device during such fault condition and verify receipt of an alarm signal and a trouble signal at the off-premises location.
4.	Supervising station alarm – transmitting equipment	X	Annually	Test all system functions and features in accordance with the equipment manufacturer's published instructions for correct operation in conformance with the applicable sections of Chapter 7. Except for DACT, actuate initiating device and verify receipt of the correct initiating device signal at the supervising station within 90 seconds. Upon completion of the test, restore the system to its functional operating condition. If test jacks are used, conduct the first and last tests without the use of the test jack. ^a
5.	Engine-driven generator	X	Monthly	If an engine-driven generator dedicated to the system is used as a required power source, verify operation of the generator in accordance with NFPA 110 by the building owner.

(continues)

Table 8.4.3 *Continued*

Component		Initial Acceptance	Periodic Frequency	Method
6.	Secondary (standby) power supply	X	Annually	Disconnect all primary (main) power supplies and verify the occurrence of required trouble indication for loss of primary power. Measure or verify the system's standby and alarm current demand and verify the ability of batteries to meet standby and alarm requirements using manufacturer's data. Operate general alarm systems a minimum of 5 minutes and emergency/voice communications systems for a minimum of 15 minutes. Reconnect primary (main) power supply at end of test.
7.	Emergency storage system (ESS)	X	Annually	If an ESS dedicated to the system is used as a required power source, verify by the building owner operation of the UPS system in accordance with NFPA 111.
8.	VRLA battery and charger ^b			Prior to conducting any battery testing, verify by the person conducting the test, that all system software stored in volatile memory is protected from loss.
	(1) Temperature test	X	Semiannually	Upon initially opening the cabinet door, measure and record the temperature of each battery cell/unit at the negative terminal with an infrared thermometer. Replace any battery cell/unit if the temperature is greater than 18°F (10°C) above ambient.
	(2) Charger test ^c	X	Semiannually	With the battery fully charged and connected to the charger, measure the voltage across the battery with a voltmeter. Verify the voltage is within the battery/alarm equipment manufacturer's recommendations. If the voltage is outside of the specified limits, either adjust the charger to within limits or replace the charger.
	(3) Cell/Unit voltage test	X	Semiannually	With the battery fully charged and connected to the charger, measure the voltage of each cell/unit with a voltmeter. Replace the battery when any cell/unit measures a voltage less than 13.26 volts.
	(4) Ohmic test ^d	X	N/A	When the battery is installed, establish a baseline ohmic value for each battery cell/ unit or where available use baseline ohmic values provided by the battery or test equipment manufacturer. In either case record the base line ohmic value on each battery cell/ unit.
			Semiannually	With the battery fully charged and connected to the charger, measure the internal ohmic value of each battery cell/unit. Record the test date and ohmic value on each cell/unit. Replace the battery when the ohmic measurement of any cell/ unit deviates from the established baseline by 30% or more for conductance and 40% or more for resistance or impedance. Where the battery or test equipment manufacturer's baseline ohmic values are used, replace the battery when any cell/unit has an internal ohmic value outside of the acceptable range.
	(5) Replacement/Load test ^c		3 years	Replace the battery or conduct a load test of the battery capacity. Load test the battery based on the manufacturer's specifications for a discharge rate of 3 hours or more by applying the current indicated for the selected hourly discharge rate continuously, until the terminal voltage decreases to the end voltage specified by the manufacturer. Record the test duration and calculate the battery capacity including adjustment for ambient temperature. Replace the battery if capacity is less than or equal to 80% or at the next scheduled test interval if battery capacity is less than 85%.
9.	Remote annunciators	X	Annually	Verify the correct operation and identification of annunciators. If provided, verify the correct operation of annunciator under a fault condition.
10.	Reserved			
11.	Reserved			
12.	Reserved			

(continues)

Table 8.4.3 *Continued*

Component		Initial Acceptance	Periodic Frequency	Method
13.	Conductors—metallic			
	(1) Stray voltage	X	N/A	Test all installation conductors with a volt/ohmmeter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Verify the maximum allowable stray voltage does not exceed 1 volt ac/dc, unless a different threshold is specified in the published manufacturer's instructions for the installed equipment.
	(2) Ground faults	X	N/A	Test all installation conductors, other than those intentionally and permanently grounded, for isolation from ground per the installed equipment manufacturer's published instructions.
	(3) Short-circuit faults	X	N/A	Test all installation conductors, other than those intentionally connected together, for conductor-to-conductor isolation per the published manufacturer's instructions for the installed equipment. Also test these same circuits conductor-to-ground.
	(4) Loop resistance	X	N/A	With each initiating and indicating circuit installation conductor pair short-circuited at the far end, measure and record the resistance of each circuit. Verify that the loop resistance does not exceed the limits specified in the published manufacturer's instructions for the installed equipment.
	(5) Circuit integrity	X	N/A	For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fuel gas detection control unit. Open one connection at not less than 10 percent of the initiating devices, notification appliances and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit. Confirm all circuits perform as indicated in Sections 5.5, 5.6, and 5.7.
		N/A	Annually	
14.	Conductors—nonmetallic			
	(1) Fiber optics	X	N/A	Test the fiber-optic transmission line by the use of an optical power meter or by an optical time domain reflectometer used to measure the relative power loss of the line. Test result data must meet or exceed ANSI/TIA 568-C.3, <i>Optical Fiber Cabling Components Standard</i> , related to fiber-optic lines and connection/splice losses and the control unit manufacturer's published specifications.
	(2) Circuit integrity	X	N/A	For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fuel gas detection control unit. Open one connection at not less than 10 percent of the initiating devices, notification appliances, and controlled devices on every initiating device circuit, notification appliance circuit, and signaling line circuit. Confirm all circuits perform as indicated in Sections 5.5, 5.6, and 5.7.
		N/A	Annually	For periodic testing, test each initiating device circuit, notification appliance circuit, and signaling line circuit for correct indication at the control unit. Confirm all circuits perform as indicated in Sections 5.5, 5.6, and 5.7.
15.	Initiating devices			
	(1) Fuel gas detectors—functional test			Functionally test all fuel gas system detectors in accordance with 8.4.5.
	(a) Air sampling	X	Annually	Test with smoke or a listed and labeled product acceptable to the manufacturer or in accordance with their published instructions. Test from the end sampling port or point on each pipe run. Verify airflow through all other ports or points.
	(b) Duct type	X	Annually	Test or inspect air duct detectors to ensure that the device will sample the airstream. Ensure the test is in accordance with the manufacturer's published instructions.

(continues)

Table 8.4.3 *Continued*

Component		Initial Acceptance	Periodic Frequency	Method
(2) Fuel gas detectors with control output functions		X	Annually	Verify that the control capability remains operable even if all of the initiating devices connected to the same initiating device circuit or signaling line circuit are in an alarm state.
16.	Interface equipment	X		Test interface equipment connections by operating or simulating the equipment being supervised. Verify signals required to be transmitted are received at the control unit. Test frequency for interface equipment is the same as the frequency required by the applicable NFPA standard(s) for the equipment being supervised.
17.	Alarm notification appliances			
	(1) Audible ^f	X	N/A	For initial and reacceptance testing, measure sound pressure levels for signals with a sound level meter meeting ANSI S1.4A, <i>Electroacoustics — Sound Level Meters</i> , Type 2 requirements. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with Chapter 6. Set the sound level meter in accordance with ANSI S3.41, <i>Audible Emergency Evacuation (E2) and Evacuation Signals with Relocation Instructions (ESRI)</i> , using the time-weighted characteristic F (FAST).
		N/A	Annually	For periodic testing, verify the operation of the notification appliances. ^g
	(2) Audible textual notification appliances (e.g., speakers and other appliances to convey voice messages)	X	N/A	For initial and reacceptance testing, measure sound pressure levels for signals with a sound level meter meeting ANSI S1.4A, <i>Electroacoustics — Sound Level Meters</i> , Type 2 requirements. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with Chapter 6. Set the sound level meter in accordance with ANSI S3.41, <i>Audible Emergency Evacuation (E2) and Evacuation Signals with Relocation Instructions (ESRI)</i> , using the time-weighted characteristic F (FAST). Verify audible information to be distinguishable and understandable and in compliance with 6.4.8.
		N/A	Annually	For periodic testing, verify the operation of the notification appliances. ^f
	(3) Visual	X	N/A	Perform initial and reacceptance testing in accordance with the manufacturer's published instructions. Verify appliance locations to be per approved layout and confirm that no floor plan changes affect the approved layout. Verify that the candela rating marking agrees with the approved drawing. Confirm that each appliance flashes.
		N/A	Annually	For periodic testing, verify that each appliance flashes.
18.	Fuel gas control functions ^h	X	Annually	For initial, reacceptance, and periodic testing, verify fuel gas control function interface device activation. Where a fuel gas control function interface device is disabled or disconnected during initiating device testing, verify that the disabled or disconnected fuel gas control function interface device has been properly restored.
19.	Special procedures			
	(1) Multiplex systems	X	Annually	Verify communications between sending and receiving units under both primary and secondary power. Verify communications between sending and receiving units under open-circuit and short-circuit trouble conditions. Verify communications between sending and receiving units in all directions where multiple communications pathways are provided. If redundant central control equipment is provided, verify switchover and all required functions and operations of secondary control equipment. Verify all system functions and features in accordance with manufacturer's published instructions.

(continues)

Table 8.4.3 *Continued*

Component		Initial Acceptance	Periodic Frequency	Method
20.	Low-power radio (wireless systems)	X	N/A	The following procedures describe additional acceptance and reacceptance test methods to verify wireless protection system operation: (1) Use the manufacturer's published instructions and the as-built drawings provided by the system supplier to verify correct operation after the initial testing phase has been performed by the supplier or by the supplier's designated representative. (2) Starting from the functional operating condition, initialize the system in accordance with the manufacturer's published instructions. Confirm the alternative communications path exists between the wireless control unit and peripheral devices used to establish initiation, indication, control, and annunciation. Test the system for both alarm and trouble conditions. (3) Check batteries for all components in the system monthly unless the control unit checks all batteries and all components daily.

Notes:

^aSome transmission equipment (such as, but not limited to, cable modems, fiber-optic interface nodes, and VoIP interfaces) are typically powered by the building's electrical system using a secondary (standby) power supply that does not meet the requirements of this standard. This is intended to ensure that the testing authority verifies full secondary (standby) power as required by Chapter 4. Additionally, refer to Table 8.4.3, items 7 and 8, for secondary (standby) power supply testing.

^bThe battery tests in Table 8.4.3, Item 8, are based on VRLA batteries and it is the intent that the tests specified in (1) through (4) be performed in order. For other secondary battery types, refer to the battery manufacturer's published instructions or IEEE 450, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, for vented lead-acid batteries; and IEEE 1106, *Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, for nickel-cadmium batteries.

^cIf the charger is adjustable, adjust the output voltage to 2.265 volts per cell ± 0.015 volts at 77°F (25°C) or as specified by the alarm equipment manufacturer.

^dSee A.8.4.3 Item 8(4). A load test per Item 8(5) is permitted in lieu of an ohmic test.

^eSee A.8.4.3 Item 8(5).

^fChapter 6 would require 15 dB over average ambient sound for public mode spaces. Sometimes the ambient sound levels are different from what the design was based upon. Private operating mode would require 10 dB over average ambient at the location of the device.

^gWhere building, system, or occupancy changes have been observed, the owner should be notified of the changes. New devices might need to be installed and tested per the initial acceptance testing criteria.

^hSee A.8.4.3 and Table 8.4.3, Item 18.

8.8 Household Fuel Gas Detection Systems.

8.8.1 Testing of Household Fuel Gas Detection Systems.

8.8.1.1* Household fuel gas detection systems shall be tested by a qualified service technician at least every 3 years according to the methods in Table 8.4.3.

8.8.1.2 Fuel gas detectors used in household fuel gas detection systems shall be tested in accordance with the manufacturer's published instructions.

8.8.1.3 Fuel gas detectors shall be replaced when the end-of-life signal is actuated, the manufacturer's replacement date is

reached, or when they fail to respond to operability tests, whichever comes first.

8.8.2 Maintenance of Household Fuel Gas Detection Systems. Maintenance of household fuel gas detection systems shall be conducted according to the manufacturer's published instructions.

8.8.3* Qualifications. The occupant of a dwelling unit shall be deemed qualified to perform inspection, testing, and maintenance on household fuel gas detection systems protecting that dwelling unit when provided with the manufacturer's published instructions.

FUEL GAS DETECTION SYSTEM RECORD OF TESTING AND INSPECTION

*To be completed by the system inspector or tester at the time of the inspection or test.
It shall be permitted to modify this form as needed to provide a more complete and/or clear record.*

Insert N/A in all unused lines.

Attach additional sheets, data, or calculations as necessary to provide a complete record.

Date of this inspection or test: _____ Time of inspection or test: _____

1. PROPERTY INFORMATION

Name of property: _____

Address: _____

Description of property: _____

Occupancy type: _____

Name of property representative: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Authority having jurisdiction over this property: _____

Phone: _____ Fax: _____ E-mail: _____

2. INSTALLATION, SERVICE, AND TESTING CONTRACTOR INFORMATION

Service and/or testing organization for this equipment: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Service technician or tester: _____

Qualifications of technician or tester: _____

A contract for test and inspection in accordance with NFPA standards is in effect as of: _____

The contract expires: _____ Contract number: _____ Frequency of tests and inspections: _____

Monitoring organization for this equipment: _____

Address: _____

Phone: _____ Fax: _____ E-mail: _____

Entity to which alarms are retransmitted: _____ Phone: _____

3. TYPE OF SYSTEM OR SERVICE

☐ Fuel gas system (nonvoice)

☐ Fuel gas with emergency voice/alarm communications system (EVACS)

☐ Combination fuel gas detection system, with the following components, describe: _____

NFPA 715 edition: _____ Additional description of system(s): _____

FIGURE 8.6.2.2 System Record of Inspection and Testing.

3. TYPE OF SYSTEM OR SERVICE (continued)**3.1 Control Unit**

Manufacturer: _____ Model number: _____

3.2 System Documentation

☐ An owner's manual, a copy of the manufacturer's instructions, a written sequence of operation, and a copy of the record drawings are stored on site. Location: _____

3.3 System Software

☐ This system does not have alterable site-specific software.

Software revision number: _____ Software last updated on: _____

☐ A copy of the site-specific software is stored on site. Location: _____

4. SYSTEM POWER**4.1 Control Unit****4.1.1 Primary Power**

Input voltage of control panel: _____ Control panel amps: _____

4.1.2 Engine-Driven Generator

☐ This system does not have a generator.

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

4.1.3 Energy Storage System

☐ This system does not have an ESS.

Equipment powered by an ESS system: _____

Location of ESS system: _____

Calculated capacity of ESS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

4.1.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

☐ Batteries are marked with date of manufacture.

4.2 Emergency Voice/Alarm Communications System

☐ This system does not have an EVACS.

4.2.1 Primary Power

Input voltage of EVACS panel: _____ EVACS panel amps: _____

4.2.2 Engine-Driven Generator

☐ This system does not have a generator.

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

FIGURE 8.6.2.2 Continued

4. SYSTEM POWER (continued)**4.2.3 Energy Storage System**☐ This system does not have an ESS.

Equipment powered by an ESS system: _____

Location of ESS system: _____

Calculated capacity of ESS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

4.2.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

☐ Batteries are marked with date of manufacture.**4.3 Notification Appliance Power Extender Panels**☐ This system does not have power extender panels.**4.3.1 Primary Power**

Input voltage of power extender panel(s): _____ Power extender panel amps: _____

4.3.2 Engine-Driven Generator☐ This system does not have a generator.

Location of generator: _____

Location of fuel storage: _____ Type of fuel: _____

4.3.3 Energy Storage System☐ This system does not have an ESS.

Equipment powered by an ESS system: _____

Location of ESS system: _____

Calculated capacity of ESS batteries to drive the system components connected to it:

In standby mode (hours): _____ In alarm mode (minutes): _____

4.3.4 Batteries

Location: _____ Type: _____ Nominal voltage: _____ Amp/hour rating: _____

Calculated capacity of batteries to drive the system:

In standby mode (hours): _____ In alarm mode (minutes): _____

☐ Batteries are marked with date of manufacture.**5. ANNUNCIATORS**☐ This system does not have annunciators.**5.1 Location and Description of Annunciators**

Annunciator 1: _____

Annunciator 2: _____

Annunciator 3: _____

FIGURE 8.6.2.2 *Continued*

6. NOTIFICATIONS MADE PRIOR TO TESTING

Monitoring organization	Contact: _____	Time: _____
Building management	Contact: _____	Time: _____
Building occupants	Contact: _____	Time: _____
Authority having jurisdiction	Contact: _____	Time: _____
●ther, if required	Contact: _____	Time: _____

7. TESTING RESULTS**7.1 Control Unit and Related Equipment**

Description	Visual Inspection	Functional Test	Comments
Control unit	<input type="checkbox"/>	<input type="checkbox"/>	
Lamps/LEDs/LCDs	<input type="checkbox"/>	<input type="checkbox"/>	
Fuses	<input type="checkbox"/>	<input type="checkbox"/>	
Trouble signals	<input type="checkbox"/>	<input type="checkbox"/>	
Disconnect switches	<input type="checkbox"/>	<input type="checkbox"/>	
Ground-fault monitoring	<input type="checkbox"/>	<input type="checkbox"/>	
Supervision	<input type="checkbox"/>	<input type="checkbox"/>	
Local annunciator	<input type="checkbox"/>	<input type="checkbox"/>	
Remote annunciators	<input type="checkbox"/>	<input type="checkbox"/>	
Power extender panels	<input type="checkbox"/>	<input type="checkbox"/>	
Isolation modules	<input type="checkbox"/>	<input type="checkbox"/>	
●ther (specify)	<input type="checkbox"/>	<input type="checkbox"/>	

7.2 Control Unit Power Supplies

Description	Visual Inspection	Functional Test	Comments
120-volt power	<input type="checkbox"/>	<input type="checkbox"/>	
Generator or ESS	<input type="checkbox"/>	<input type="checkbox"/>	
Battery condition	<input type="checkbox"/>	<input type="checkbox"/>	
Load voltage	<input type="checkbox"/>	<input type="checkbox"/>	
Discharge test	<input type="checkbox"/>	<input type="checkbox"/>	
Charger test	<input type="checkbox"/>	<input type="checkbox"/>	
●ther (specify)	<input type="checkbox"/>	<input type="checkbox"/>	

FIGURE 8.6.2.2 *Continued*

7. TESTING RESULTS (continued)**7.3 Emergency Voice/Alarm Communications Equipment**

Description	Visual Inspection	Functional Test	Comments
Control unit	<input type="checkbox"/>	<input type="checkbox"/>	
Lamps/LEDs/LCDs	<input type="checkbox"/>	<input type="checkbox"/>	
Fuses	<input type="checkbox"/>	<input type="checkbox"/>	
Primary power supply	<input type="checkbox"/>	<input type="checkbox"/>	
Secondary power supply	<input type="checkbox"/>	<input type="checkbox"/>	
Trouble signals	<input type="checkbox"/>	<input type="checkbox"/>	
Disconnect switches	<input type="checkbox"/>	<input type="checkbox"/>	
Ground-fault monitoring	<input type="checkbox"/>	<input type="checkbox"/>	
Panel supervision	<input type="checkbox"/>	<input type="checkbox"/>	
System performance	<input type="checkbox"/>	<input type="checkbox"/>	
Sound pressure levels ●occupied <input type="checkbox"/> Yes <input type="checkbox"/> No Ambient _____ dBA Alarm _____ dBA (attach report with locations, values, and weather conditions)	<input type="checkbox"/>	<input type="checkbox"/>	
System intelligibility <input type="checkbox"/> CSI <input type="checkbox"/> STI (attach report with locations, values, and weather conditions)	<input type="checkbox"/>	<input type="checkbox"/>	
●ther (specify)	<input type="checkbox"/>	<input type="checkbox"/>	

7.4 Notification Appliance Power Extender Panels

Description	Visual Inspection	Functional Test	Comments
Lamps/LEDs/LCDs	<input type="checkbox"/>	<input type="checkbox"/>	
Fuses	<input type="checkbox"/>	<input type="checkbox"/>	
Primary power supply	<input type="checkbox"/>	<input type="checkbox"/>	
Secondary power supply	<input type="checkbox"/>	<input type="checkbox"/>	
Trouble signals	<input type="checkbox"/>	<input type="checkbox"/>	
Ground-fault monitoring	<input type="checkbox"/>	<input type="checkbox"/>	
Panel supervision	<input type="checkbox"/>	<input type="checkbox"/>	
●ther (specify)	<input type="checkbox"/>	<input type="checkbox"/>	

FIGURE 8.6.2.2 *Continued*

7. TESTING RESULTS *(continued)***7.5 Combination Fuel Gas Detection/Security Systems**

Description	Visual Inspection	Functional Test	Comments
Combination fuel gas detection/security system	<input type="checkbox"/>	<input type="checkbox"/>	
●ther (specify)	<input type="checkbox"/>	<input type="checkbox"/>	

7.6 Monitored Systems

Description (specify)	Visual Inspection	Functional Test	Comments
Specify	<input type="checkbox"/>	<input type="checkbox"/>	

7.7 Auxiliary Functions

Description	Visual Inspection	Functional Test	Comments
Describe	<input type="checkbox"/>	<input type="checkbox"/>	

7.8 Alarm Initiating Device

☐ Device test results sheet attached listing all devices tested and the results of the testing

7.9 Supervisory Alarm Initiating Device

☐ Device test results sheet attached listing all devices tested and the results of the testing

7.10 Alarm Notification Appliances

☐ Appliance test results sheet attached listing all appliances tested and the results of the testing

7.11 Supervisory Station Monitoring

Description	Yes	No	Time	Comments
Alarm signal	<input type="checkbox"/>	<input type="checkbox"/>		
Alarm restoration	<input type="checkbox"/>	<input type="checkbox"/>		
Trouble signal	<input type="checkbox"/>	<input type="checkbox"/>		
Trouble restoration	<input type="checkbox"/>	<input type="checkbox"/>		
Supervisory signal	<input type="checkbox"/>	<input type="checkbox"/>		
Supervisory restoration	<input type="checkbox"/>	<input type="checkbox"/>		

FIGURE 8.6.2.2 *Continued*

8. NOTIFICATIONS THAT TESTING IS COMPLETE

Monitoring organization

Contact: _____

Time: _____

Building management

Contact: _____

Time: _____

Building occupants

Contact: _____

Time: _____

Authority having jurisdiction

Contact: _____

Time: _____

●ther, if required

Contact: _____

Time: _____

9. SYSTEM RESTORED TO NORMAL OPERATION

Date: _____

Time: _____

10. CERTIFICATION

10.1 Inspector Certification:

This system, as specified herein, has been inspected and tested according to all NFPA standards cited herein.

Signed: _____

Printed name: _____

Date: _____

Organization: _____

Title: _____

Phone: _____

10.2 Acceptance by Owner or Owner’s Representative:

The undersigned has a service contract for this system in effect as of the date shown below.

Signed: _____

Printed name: _____

Date: _____

Organization: _____

Title: _____

Phone: _____

DEVICETEST RESULTS
(Attach additional sheets if required)

Device Type	Address	Location	Test Results

FIGURE 8.6.2.2 Continued

Chapter 9 Single- and Multiple-Station Alarms and Household Fuel Gas Detection

9.1 Application.

9.1.1* General.

9.1.1.1 The performance, selection, installation, operation, and use of single- and multiple-station alarms and household fuel gas detection systems shall be in accordance with the listing, the manufacturer's published instructions and the requirements of this chapter.

9.1.2 Fuel gas detectors or systems shall be installed in all occupancies where required by applicable laws, codes, or standards.

9.1.3 The requirements of Chapter 4 through Chapter 6 shall not apply unless otherwise indicated.

9.1.4 The installation of fire or carbon monoxide alarms and detectors shall comply with the requirements of NFPA 72.

9.1.5 Fuel gas alarm and detection system installers shall comply with the requirements of 4.4.2.

9.2 Purpose. Fuel gas warning equipment for residential, and mixed-use occupancies that include residential, shall provide a reliable means to notify the occupants of the presence of levels of fuel gases that constitute a potential life safety or property risk and the need for action as a consequence of those levels.

9.3 Basic Requirements.

9.3.1 All devices, combinations of devices, and equipment to be installed in conformity with this chapter shall be listed for the purposes for which they are intended.

9.3.2 Fuel gas warning equipment shall be installed in accordance with the listing and manufacturer's published instructions.

9.3.3* Installation Arrangement.

9.3.3.1 The installation of fuel gas alarms or fuel gas detectors, systems, or combinations of these, shall comply with the requirements of this chapter.

9.3.3.2 The installation of fuel gas alarms or fuel gas detectors, systems, or combinations of these, shall satisfy the minimum requirements for number and location of fuel gas alarms or fuel gas detectors by one of the following arrangements:

- (1) The first arrangement shall be as follows:
 - (a) The required minimum number and location of fuel gas detection devices shall be satisfied (independently) through the installation of fuel gas alarms.
 - (b) The installation of additional fuel gas alarms shall be permitted.
 - (c) The installation of additional system-based fuel gas detectors, including partial or complete duplication of the fuel gas alarms satisfying the required minimum, shall be permitted.
- (2) The second arrangement shall be as follows:
 - (a) The required minimum number and location of fuel gas detection devices shall be satisfied (independently) through the installation of system fuel gas detectors.

- (b) The installation of additional fuel gas detectors shall be permitted.
- (c) The installation of additional fuel gas alarms, including partial or complete duplication of the fuel gas detectors satisfying the required minimum, shall be permitted.

9.3.4 Supplementary functions, including the extension of an alarm beyond the residential occupancy, shall be permitted and shall not interfere with the performance requirements of this chapter. [72:29.3.4]

9.4 Required Protection.

9.4.1* Fuel Gas Alarms and Detectors. The warning functions intended in this standard shall be performed by single- or multiple-station alarms or by detectors connected to a control unit and associated equipment, in accordance with 9.3.3.

9.4.1.1* Fuel gas alarms or detectors shall be installed in other than ancillary buildings as follows:

- (1)* Alarms or detectors shall be installed more than 3 ft (914 mm) but no further than 10 ft (3 m) in a horizontal flow path from permanently installed fuel-gas-burning appliances.
- (2) Alarms or detectors shall be installed in basements or other subgrade rooms of buildings served by fuel gas service, where the point of entry is below grade.
- (3)* Alarms or detectors shall be installed in attached garages where the fuel gas point of delivery or fuel-burning equipment is installed within the garage.
- (4)* Where interconnection of alarms is required by 9.6.4, alarms shall be located outside of each separate sleeping area in the immediate vicinity of the bedroom.
- (5) Alarms or detectors shall not be installed in locations directly in the airstream of supply and return registers or directly above doorway openings.
- (6) Alarms or detectors shall be installed in other locations where required by applicable laws, codes, or standards.

9.4.1.2 Each fuel gas alarm or detector shall be located on the wall, ceiling, or other location as specified in the manufacturer's published instructions as follows:

- (1)* For natural gas, the gas alarm or detector shall be installed on the ceiling or on the wall with the top of the alarm or detector within 12 in. (305 mm) of the ceiling.
- (2)* For liquefied petroleum gas (LP-Gas), the entire gas alarm or detector shall be installed on the wall within 18 in. (457 mm) of the floor.
- (3) Combination fuel gas/carbon monoxide alarms and detectors that are an integral part of a carbon monoxide detector or carbon monoxide alarm shall be located in accordance with the requirements for the applicable fuel gases being sampled.

9.4.2 Alarm Notification Appliances.

9.4.2.1 General. Each fuel gas alarm or detector shall cause the operation of an alarm notification appliance that meets the performance requirements of 6.4.2, 6.4.6.2, 6.4.6.4 and, if applicable, 9.4.2.4.

9.4.2.2 Signals from notification appliances shall not be required to be synchronized. [72:29.5.11]

9.4.2.3* Distinctive Signal. The audible fuel gas alarm signal shall be distinct from similar appliances used for other purposes in the same area and in compliance with the following:

- (1)* The signal shall be a continuous or temporal pattern that emits a distinguishable sound until the alarm resets or is silenced.
- (2) The duration of the signal shall not be less than 180 seconds unless the alarm resets or is silenced.
- (3) The alarm signal shall persist for the entire time the gas alarm or detector is in the presence of a detectable concentration of gas.
- (4) After 4 minutes of continuous or temporal alarm, an alarm signal pause for up to 60 seconds shall be permitted before resuming the audible alarm.

9.4.2.4* Alarm Notification Appliances for the Hearing Impaired.

9.4.2.4.1 Notification appliances provided in sleeping rooms and guest rooms for those with hearing loss shall comply with 9.4.2.4.1.1 and 9.4.2.4.1.2, as applicable. [72:29.5.10]

9.4.2.4.1.1* Mild to Severe Hearing Loss. Notification appliances provided for those with mild to severe hearing loss shall comply with the following:

- (1) An audible notification appliance producing a low frequency alarm signal shall be installed in the following situations:
 - (a) Where required by governing laws, codes, or standards for people with hearing loss
 - (b) Where provided voluntarily for those with hearing loss
- (2) The low frequency alarm signal output shall have a waveform with a fundamental frequency of 520 Hz ± 10 percent.

9.4.2.4.1.2* Moderately Severe to Profound Hearing Loss. Visual notification appliances in accordance with the requirements of 6.5.5.8 and tactile notification appliances in accordance with the requirements of Section 6.10 shall be required for those with moderately severe to profound hearing loss in the following situations:

- (1) *Where required by governing laws, codes, or standards for people with hearing loss
- (2) Where provided voluntarily for those with hearing loss [72:29.5.10.2]

9.4.2.4.2 Where visual appliances are provided, they shall meet the requirements of Section 6.5. [72:29.5.8]

9.4.2.4.3 Since hearing deficits are often not apparent, the responsibility for advising the appropriate person(s) of the existence of this deficit shall be that of the party with hearing loss. [72:29.5.9]

9.4.2.4.4 Visible notification appliances used with single- or multiple-station fuel gas alarms shall be permitted to operate in accordance with 9.5.5.

9.5 Power Supplies.

9.5.1 General.

9.5.1.1 Power supplies shall have the capacity to continuously operate the alarm signal(s) for not less than 12 hours.

9.5.1.2 Electrically powered fuel gas warning equipment shall be provided with a primary ac power source in accordance with 9.5.2.1 and a secondary power source in accordance with 9.5.4, unless otherwise permitted by the following:

- (1) Detectors shall be permitted to be powered by a monitored dc circuit of a control unit where power for the control unit meets the requirements of Section 9.5 and the circuit remains operable upon loss of primary ac power.
- (2) A detector and a wireless transmitter that serves only that detector shall be permitted to be powered from a monitored battery primary source where part of a listed, monitored, low-power radio wireless system.
- (3) In existing construction, a monitored battery primary power source, in accordance with 9.5.3, shall be permitted.

9.5.2 Primary Power Supply—ac.

9.5.2.1 An ac primary power source shall be a commercial light and power supply or other dependable source.

9.5.2.2 A visible “power on” indicator shall be provided.

9.5.2.3 Primary ac power shall be supplied from either a dedicated branch circuit or the unswitched portion of a branch circuit also used for power and lighting.

9.5.2.4 Electrical systems designed to be installed by other than a qualified electrician shall be powered from a source not in excess of 30 volts that meets the requirements for Class 2 circuits as defined in Article 725 of NFPA 70.

9.5.2.5* A restraining means shall be provided for the plug of any cord-and-plug-connected installation.

9.5.2.6 Loss of Power.

9.5.2.6.1 Operation of a switch, other than a circuit breaker, ground fault circuit interrupter (GFCI), or arc-fault circuit interrupter (AFCI), shall not cause loss of primary ac power alarms powered by branch circuits protected by arc-fault circuit interrupters or ground-fault circuit-interrupters.

9.5.2.6.2 Primary ac power alarms powered by branch circuits protected by arc-fault circuit interrupters or ground-fault circuit-interrupters shall have a secondary power source.

9.5.2.7 The requirement of 9.5.2.6 shall not apply to branch circuit overcurrent devices of other than GFCI and AFCI types.

9.5.2.8 Neither loss nor restoration of primary ac power shall cause an alarm signal exceeding 2 seconds.

9.5.2.9 The primary ac power supply shall be of sufficient capacity to operate the system under all conditions of loading with any secondary battery disconnected or fully discharged.

9.5.3 Primary Power Supply—Monitored Battery.

9.5.3.1 Fuel gas warning equipment shall be permitted to be powered by a battery, provided that the battery is monitored to ensure all of the following conditions are met:

- (1) The power requirements are met for not less than 1 year of battery life, including monthly testing.
- (2) A distinctive audible trouble signal sounds before the battery is incapable of operating the device(s) for alarm purposes due to aging or terminal corrosion.

- (3) Automatic transfer is provided from the alarm to a trouble condition for a unit employing a lock-in alarm feature.
- (4) The unit is capable of producing an alarm signal for no less than 12 hours at the battery voltage at which a trouble signal is normally obtained, followed by no less than 7 days of trouble signal operation.
- (5) The alarm persists for the entire time the gas alarm or detector is in the presence of a detectable concentration of gas.
- (6) After 4 minutes of continuous or temporal alarm, an alarm signal pause for up to 60 seconds is permitted before resuming the audible alarm.
- (7) The audible trouble signal is produced not less than once every minute for 7 consecutive days.
- (8) Acceptable replacement batteries are identified by the manufacturer's name and model number on the unit near the battery compartment.
- (9) A visible indication is displayed when a primary battery is removed from the unit.
- (10) A visible "power on" indicator is provided.

9.5.3.2 If an alarm uses a nonrechargeable, nonreplaceable battery as a primary power supply, both of the following shall apply:

- (1) The battery shall be capable of powering the unit for its service life, including testing.
- (2) The battery shall meet the requirements of 9.5.3.1.

9.5.4 Secondary Power Supply.

9.5.4.1 A secondary power supply shall have the capacity to power the unit for 24 hours, followed by not less than 12 hours of alarm, followed by not less than 7 consecutive days of trouble signals.

9.5.4.2 The alarm signal shall persist for the entire time the gas alarm or detector is in the presence of a detectable concentration of gas.

9.5.4.3 After 4 minutes of continuous or temporal alarm, an alarm signal pause for up to 60 seconds shall be permitted before resuming the audible alarm.

9.5.4.4 Removal or disconnection of a battery used as a secondary power source shall cause an audible or visual trouble signal.

9.5.4.5 Replacement batteries shall be specified by the manufacturer's name and model number on the unit near the battery compartment.

9.5.4.6 Where required by law for disposal reasons, rechargeable batteries shall be removable.

9.5.4.7 An audible trouble signal shall sound before the battery is incapable of operating the device(s) for alarm purposes from causes such as aging, discharge, or terminal corrosion.

9.5.4.8 Automatic recharging shall be provided where a rechargeable battery is used as a secondary supply.

9.5.4.9 Where automatic recharging is provided, the battery shall be recharged within one of the following time periods:

- (1) Within 4 hours where power is provided from a circuit that can be switched on or off by means other than a circuit breaker

- (2) Within 48 hours where power is provided from a circuit that cannot be switched on or off by means other than a circuit breaker

9.5.5* Visible notification appliances used with single- or multiple-station fuel gases alarms shall not be required to operate upon loss of primary ac power.

9.6 Equipment Performance.

9.6.1 Fuel Gas Alarms and Detectors.

9.6.1.1 Each fuel gas alarm shall be in compliance with UL 1484, *Residential Gas Detectors*.

9.6.1.2* Alarm Threshold.

9.6.1.2.1* Fuel gas alarms and detectors shall be designed to alarm at a concentration at or below 25 percent LEL.

9.6.1.2.2 Fuel gas detectors that are part of a household gas detection system shall be listed in accordance with UL 2075, *Gas and Vapor Detectors and Sensors*.

9.6.1.2.3 Fuel gas alarms shall be listed in accordance with UL 1484, *Residential Gas Detectors*.

9.6.1.2.4 Fuel gas alarms and detectors shall be marked in accordance with their listing.

9.6.1.3* Fuel gas alarms or detectors shall not exhibit false alarms in the presence of acetone and ethanol at a concentration resulting from a spill in a typical household room.

9.6.1.4 All signals produced from periodic testing of fuel gas alarms or detectors shall be identical to the signal produced when the unit is in alarm.

9.6.1.5 Trouble signals shall be distinctive from alarm signals. [72:29.10.3.4]

9.6.1.6 Unless otherwise recommended by the manufacturer's published instructions, fuel gas alarms and detectors shall be replaced when they fail to respond to tests.

9.6.1.7 Fuel gas alarms shall be replaced when either the end-of-life signal is actuated or the manufacturer's replacement date is reached.

9.6.1.8* Combination fuel gas, smoke, or carbon monoxide alarms shall be replaced when the end-of-life signal activates or 10 years from the date of manufacture, whichever comes first.

9.6.1.9 Combination fuel gas, smoke, or carbon monoxide alarms shall be replaced when either the end-of-life signal is actuated or the manufacturer's replacement date is reached, whichever comes first.

9.6.2 Audible Alarm Signals.

9.6.2.1 All alarm-sounding appliances shall have a minimum rating of 85 dBA at 10 ft (3 m).

9.6.2.2 The audible alarm signal for fuel gas alarms shall comply with the requirements of 5.8.6.5.1.

9.6.3 Multiple-Purpose Alarms.

9.6.3.1 A fire alarm signal shall take precedence and be recognizable over any other signal, even when the nonfire signal is initiated first.

9.6.3.2 Different audible alarm signals shall be provided for each of the following:

- (1) Fire alarms
- (2) Fuel gas alarms
- (3) Carbon monoxide alarms
- (4) Other alarms

9.6.4 Interconnection of Alarms. Where two or more alarms are installed within a dwelling unit, suite of rooms, or similar area, they shall be arranged so that the operation of any alarm causes all alarms within these locations to sound.

9.6.4.1 In existing occupancies, alarms shall not be required to cause all alarms to sound.

9.6.4.2* The interconnection of alarms shall comply with the following:

- (1) Alarms shall not be interconnected in numbers that exceed the manufacturer's published instructions.
- (2) In no case shall more than 18 initiating devices be interconnected (of which 12 can be smoke alarms) where the interconnecting means is not supervised.
- (3) In no case shall more than 64 initiating devices be interconnected (of which 42 can be smoke alarms) where the interconnecting means is supervised.
- (4) Alarms of different manufacturers shall not be interconnected unless listed as being compatible with the specific model.
- (5) When alarms of different types are interconnected, all interconnected alarms shall produce the appropriate audible response for the phenomena being detected or remain silent.

[72:29.11.2.1]

9.6.4.3 Auxiliary components, such as, but not limited to, relay modules or notification appliances, listed for use with fuel gas alarms shall be permitted, provided that an open or short circuit of the wiring leading to these components does not prevent normal operation of the interconnected alarm.

9.6.4.4 Fuel gas alarms shall not be interconnected with alarms from other manufacturers unless listed as being compatible with those specific models.

9.6.4.5 A single fault on the wiring connecting the alarms shall not prevent the independent operation of any of the interconnected alarms.

9.6.4.6 The test feature on any alarm device shall cause all interconnected alarms to activate the alarm signal.

9.6.5 Control Equipment.

9.6.5.1 Control equipment shall be automatically restored upon restoration of electrical power.

9.6.5.2 The control equipment shall be of a type that latches on an alarm condition.

9.6.5.3 Where a reset switch is provided, it shall be of a self-restoring type.

9.6.5.4 An alarm-silencing switch shall not be provided unless one of the following criteria applies:

- (1) The silenced position is indicated by a distinctive signal.
- (2) The switch is a momentary or self-restoring switch.

9.6.5.5 Each electrical fuel gas detection system shall have an integral test means to allow testing of the system operation.

9.6.6 Combination Systems.

9.6.6.1 Where common wiring is employed for a combination system, the equipment for other than a fire warning signaling system shall be permitted to be connected to the common wiring of the system provided that the following conditions are met:

- (1) Short circuits, open circuits, or any other ground fault in equipment or interconnection between this equipment and the fire warning system does not interfere with the monitoring for integrity of the fire warning system.
- (2) Short circuits, open circuits, or any other ground fault in this equipment or interconnection between this equipment and the fire warning system does not prevent alarm or trouble signal transmissions.

9.6.6.2 In a combination system, the operation shall be as follows:

- (1) A fire alarm signal shall take precedence or be annunciated over any other signal, even when the nonfire or fuel gas signal is initiated first.
- (2) Different audible alarm signals shall be provided for each of the following:
 - (a) Fire alarms
 - (b) Fuel gas alarms
 - (c) Carbon monoxide alarms
 - (d) Other alarms
- (3) The use of a common audible notification appliance shall be permitted if distinctive signals are obtained.

9.6.6.3 Single- or multiple-station fuel gas alarms shall be permitted to be connected to system control equipment located within the dwelling unit.

9.6.6.4 When connected, the actuation of a single- or multiple-station fuel gas alarm shall initiate an alarm signal at the system control equipment located within the dwelling unit.

9.6.7 Interconnection to Fire Alarm or Combination Control Units.

9.6.7.1 Operation of fuel gas alarms or detectors shall not cause fire alarm or combination control units to activate either protected premises or supervising station fuel gas signals.

9.6.7.2 Where fuel gas warning equipment is connected to a protected premises fire alarm system, receipt of signals shall initiate the signal required by 9.6.2.

9.6.8 Supervising Station Systems.

9.6.8.1* Unless as permitted by 9.6.8.2, fuel gas warning equipment signals that are transmitted off-premises shall comply with the requirements of Chapter 7 and the following:

- (1) Where required, immediately retransmit indication of the fuel gas alarm signal to the communications center
- (2) Contact the responsible party(s) in accordance with the notification plan

9.6.8.2 The immediate retransmission of the signals described in 9.6.8.1 shall be permitted to be delayed by not more than 90 seconds where the jurisdiction permits the supervising station to first contact the protected premises to determine if the alarm was initiated by the activation of a test.

9.6.8.3 Once contacted, the subscriber shall be one of the following:

- (1) Informed to take action in accordance with the manufacturer's published instructions
- (2) Advised to take the following actions where manufacturer's published instructions are not available:
 - (a) **SMELL GAS ACT FAST**, leave the building immediately. If an odor is present or gas alarm is activated, take others with you. If you are outside when you smell the gas, leave the area immediately.
 - (b) Avoid causing a spark or operating any electrical system component, which might cause the gas to ignite, such as the following:
 - (i) Do not create a source of flames, including matches and lighters, and do not smoke or vape
 - (ii) Do not turn on/off anything electrically powered, appliances or lights
 - (iii) Do not use a flashlight
 - (iv) Do not start a car or any vehicle
 - (v) Do not use a telephone, cell phone, or other communication device
 - (vi) Do not ring doorbells
 - (c) Use a phone/cellphone or other communication device away from the area and immediately call 911 or your gas utility. Always call to report the gas odor or alarm. Do not assume someone else will do it.
 - (d) Do not reenter the area until the area is deemed to be safe. Follow directions from utility employees or emergency responders who are on site.

9.6.8.4 Supervising Stations.

9.6.8.4.1 Transmission of signals from single- and multiple station alarms to a constantly attended supervising station shall be processed by a household alarm system or as permitted by 7.1.2.

9.6.8.4.2 Where a digital alarm communicator transmitter (DACT) is used, the DACT serving the protected premises shall only require a single telephone line and shall only require a call to a single digital alarm communicator receiver (DACR) number. [72:29.10.9.10.1]

9.6.8.4.3 Where a DACT is used, the DACT test signals shall be transmitted at least monthly. [72:29.10.9.10.2]

9.6.8.4.4* Requirements for indication of central station service shall not be required.

9.6.8.4.5 Where a communication or transmission means other than DACT is used, only a single communication technology and path shall be required to serve the protected premises. [72:29.10.9.10.3]

9.6.8.4.6 Where a communication or transmission means other than DACT is used, all equipment necessary to transmit an alarm signal shall be provided with a minimum of 24 hours of secondary power capacity and shall report a trouble condition indicating loss of primary power. [72:29.10.9.10.4]

9.6.8.4.7 Failure of the communication path referenced in 9.6.8.4.5 shall be annunciated at the supervising station and at the protected premises within not more than 7 days of the failure. [72:29.10.9.10.5]

9.6.8.4.8 A dedicated cellular telephone connection shall be permitted to be used as a single means to transmit alarms to a constantly attended remote monitoring location. [72:29.10.9.10.6]

9.6.8.5 Household alarm systems shall be programmed by the manufacturer to generate at least a monthly test of the communication or transmission means.

9.6.9 Low-Power Wireless Systems.

9.6.9.1 Low-power radio (i.e., wireless) systems shall comply with the requirements of Section 5.12.

9.6.9.2 The requirements of 5.12.4.5 shall not apply to dwelling units.

9.6.10 Nonsupervised Wireless Interconnected Alarms.

9.6.10.1 Fire alarm signals shall have priority over all other signals. [72:29.10.8.2.2]

9.6.10.2 The maximum allowable response delay from activation of an initiating device to receipt and alarm/display by the receiver/control unit shall be 20 seconds. [72:29.10.8.2.3]

9.6.10.3* Wireless interconnected fuel gas alarms—in receive mode—shall remain in alarm as long as the originating unit (i.e., transmitter) remains in alarm.

9.6.10.4 The occurrence of any single fault that disables a transceiver shall not prevent other transceivers in the system from operating. [72:29.10.8.2.5]

9.7 Installation.

9.7.1 General Provisions.

9.7.1.1 All fuel gas alarms or detectors shall be installed in accordance with the manufacturer's published instructions.

9.7.1.2 All fuel gas alarms or detectors shall be located and mounted so that accidental operation will not be caused by jarring or vibration.

9.7.1.3 All fuel gas alarms or detectors shall be supported independently of their attachment to wires.

9.7.1.4 All fuel gas alarms or detectors shall be tested in accordance with the instructions provided by the supplier or installing contractor to ensure operation after installation. (See 9.9.2 and 9.9.3.)

9.7.1.5 The supplier or installing contractor shall provide the owner with the instructions required in 9.9.3.

9.7.2 Multiple-Station Alarms.

9.7.2.1* Interconnection that causes the other multiple-station alarms or the fuel gas notification signal of multiple-purpose alarms within an individual dwelling unit to produce an alarm signal shall be permitted.

9.7.2.2 Remote annunciation from single- and multiple-station alarms shall be permitted provided the devices comply with 9.4.2 and 9.6.4.

9.7.2.3 Remote annunciation shall be permitted provided the signal is identifiable for the hazard it annunciates.

9.8 Inspection, Testing, and Maintenance.

9.8.1 Single- and multiple-station fuel gas alarms shall be maintained and tested in accordance with Section 8.7.

9.8.2 All fuel gas alarms or detectors shall be restored to their normal mode of operation after each alarm or test.

9.8.3 Household fuel gas detection systems shall be maintained and tested in accordance with Section 8.8.

9.9 Markings and Instructions.

9.9.1 General. Fuel gas alarms or detectors shall be provided with the information specified in 9.9.2 and 9.9.3.

9.9.2 Markings. The following markings on alarms and detectors shall include the following:

- (1) Mark or certification that the unit has been listed by a nationally recognized testing laboratory
- (2) If gas odor is detected by smell or alarm is activated, evacuate immediately

9.9.3 Instructions. The following information shall be included in the printed instructions provided with fuel gas alarms and detectors:

- (1) Installation instructions
- (2) Operating instructions
- (3) Testing instructions
- (4) Maintenance instructions
- (5) Replacement and service instructions
- (6) Statement indicating that odor might not be present during a fuel gas alarm condition
- (7)* Information on the actions to be taken in case of an alarm or a gas odor
- (8) Minimum and recommended distances from fuel-gas-burning appliances

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 This document does not attempt to cover all equipment, methods, and requirements that might be necessary or advantageous for the protection of life and property from fuel gas releases.

A.1.1.2 The requirements in this standard specifically address fuel gas alarm and fuel gas detection systems in residential and commercial mixed occupancies. The requirements also apply to other occupancies (e.g., industrial facilities, power plants) if deemed necessary by applicable laws, codes, and standards for a specific type of occupancy.

Additionally, see NFPA 1192 for equipment for use in recreational vehicles.

See UL 2075, *Gas and Vapor Detectors and Sensors*, and UL 1484, *Residential Gas Detectors*.

UL 2075 addresses toxic and combustible gas and vapor detectors and sensors, that include an assembly of electrical components coupled with a sensing means inside a chamber, or by separate components, to detect toxic or combustible gases or vapors. Detectors in UL 2075 cover a broad spectrum of applications, including residential, industrial, and commercial.

Detectors are intended for monitoring environments for open-area protection and for connection to a compatible power supply or control unit for operation as part of gas detection or emergency signaling systems. In addition, UL 2075 addresses detectors solely for control of ventilation or shutoff devices, such as fans or control valves, as provided by the listing. UL 2075 also covers equipment intended for use in hazardous locations.

The scope of UL 1484 specifically addresses requirements for electrically operated gas alarms intended for residential and recreational vehicle occupancies to detect fuel gases such as liquefied petroleum gas (LP-Gas) and natural gas. Devices are intended to be factory-built as a complete assembly of components functioning as a self-contained alarm device, including an element to detect gas concentration, an alarm-sounding appliance, and provision for connection to a power supply source. Devices are specifically not intended for use in hazardous locations as defined in NFPA 70, for industrial or commercial use, or for use as smoke and fire detectors or alarms.

Although UL 2075 does not cover self-contained and single- and multiple-station residential fuel gas alarms otherwise covered in UL 1484, those sensors, detectors, and alarms that are covered in UL 2075 must operate within the sensitivity parameters defined by the manufacturer and must not exceed alarm limits defined in UL 1484.

A.1.2 Fuel gas alarms and detectors are intended to alarm at fuel gas concentrations below those that are known to be dangerous or explosive. (See also Table B.1.)

A.1.3.2 Although fuel gas detection and warning equipment might respond to gases produced by unwanted fires or carbon monoxide releases, it is not intended to be a substitute for fire or carbon monoxide detection or warning equipment.

A.1.6.7 Where dimensions are expressed in inches, it is intended that the precision of the measurement be 1 in., thus plus or minus ½ in. The conversion and presentation of dimensions in millimeters would then have a precision of 25 mm, thus plus or minus 13 mm.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department

ment, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Acoustically Distinguishable Space (ADS). All parts of a building or area intended to have occupant notification are subdivided into ADSs as defined. Some ADSs might be designated to have voice communications capability and require that those communications be intelligible. Other spaces might not require voice intelligibility or might not be capable of reliable voice intelligibility. An ADS might have acoustical design features that are conducive for voice intelligibility, or it might be a space where voice intelligibility could be difficult or impossible to achieve. Each is still referred to as an ADS. [72, 2022]

In smaller areas, such as those under 400 ft² (37 m²), walls alone will define the ADS. In larger areas, other factors might have to be considered. In spaces that might be subdivided by temporary or movable partitions, such as ballrooms and meeting rooms, each individual configuration should be considered a separate ADS. Physical characteristics, such as a change in ceiling height of more than 20 percent, or a change in acoustical finish, such as carpet in one area and tile in another, would require those areas to be treated as separate ADSs. In larger areas, there might be noise sources that require a section to be treated as a separate ADS. Any significant change in ambient noise level or frequency might necessitate an area be considered a separate ADS.

In areas of 85 dBA or greater ambient sound pressure level, meeting the pass/fail criteria for intelligibility might not be possible, and other means of communications might be necessary. So, for example, the space immediately surrounding a printing press or other high-noise machine might be designated as a separate ADS, and the design might call for some form of effective notification but not necessarily require the ability to have intelligible voice communications. The aisles or operator's control stations might be separate ADSs where intelligible voice communication might be desired. [72, 2022]

Significant differences in furnishings — for example, an area with tables, desks, or low dividers adjacent to an area with high shelving — would require separate consideration. The entire desk area could be a single acoustic zone, whereas each area between shelving could be a unique zone. Essentially, any noteworthy change in the acoustical environment within an area will mandate consideration of that portion of the area to be treated as an acoustic zone. Hallways and stairwells will typically be considered as individual acoustic zones. [72, 2022]

Spaces confined by walls with carpeting and acoustical ceilings can be deemed to be one ADS. An ADS should be an area of consistent size and material. A change of materials from carpet to hard tile, the existence of sound sources, such as decorative waterfalls, large expanses of glass, and changes in ceiling height, are all factors that might separate one ADS from another. [72, 2022]

Each ADS might require different components and design features to achieve intelligible voice communication. For example, two ADSs with similar acoustical treatments and noise levels might have different ceiling heights. The ADS with the lower ceiling height might require more ceiling-mounted loudspeakers to ensure that all listeners are in a direct sound field (see Figure A.3.3.1). Other ADSs might benefit from the use of alternate loudspeaker technologies, such as line arrays, to achieve intelligibility. [72, 2022]

An ADS that differs from another because of the frequency and level of ambient noise might require the use of loudspeakers and system components that have a wider frequency bandwidth than conventional emergency communications equipment. However, designers should not use higher bandwidth loudspeakers in all locations, unless needed to overcome certain acoustic and ambient conditions. This is because the higher bandwidth appliance will require more energy to perform properly. This increases amplifier and wire size and power supply requirements. [72, 2022]

In some spaces, it might be impractical to achieve intelligibility, and, in such a case, alternatives to voice evacuation might be required within such areas. [72, 2022]

There might be some areas of a facility where there are several spaces of the same approximate size and the same acoustic properties. For example, there might be an office space with multiple individual offices, each with one loudspeaker. If one or two are satisfactorily tested, there is no need to test all of them for speech intelligibility. [72, 2022]

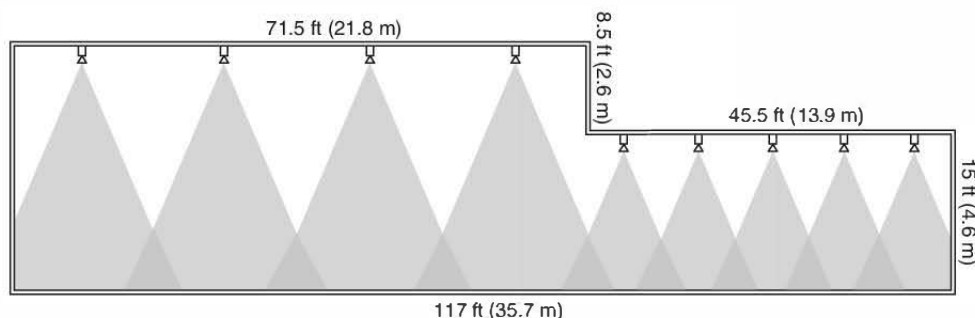


FIGURE A.3.3.1 Illustration Demonstrating the Effect of Ceiling Height. (Source: R. P. Schiffliti Associates, Inc.) [72, 2022]

A.3.3.4 Communications Center. Examples of functions of a communications center are as follows:

- (1) Communications between the public and the communications center
- (2) Communications between the communications centers, the emergency response agency (ERA), and emergency response facilities (ERFs)
- (3) Communications within the ERA and between different ERAs

[1221, 2022]

A.3.3.5 Device (Class N). Class N devices include components connected to a Class N network that monitor the environment (e.g., smoke, heat, contact closure, manual “in case of fire” pull) and/or provide some output(s) (e.g., dry contact, audible/visual alert/notification, addressable loudspeaker) that are required to provide the real-time functionality necessary for the protection of life and property. In this way, a component connected to the network used for noncritical functions (i.e., maintenance) can be differentiated and excluded from the monitoring for integrity requirements of Class N. [72, 2022]

Also in this way, transport equipment (e.g., switches, routers, hubs, media converters) and other equipment (e.g., printers, storage devices) can be differentiated from the requirements applied to Class N devices if they do not provide life safety-specific environmental monitoring, inputs, or outputs for the life safety system. This is not to say that this equipment is not important to the overall operation of the system, just that this equipment is not considered a “device” in the context of Class N. Equipment that does not meet the definition of a device cannot be specifically supervised but rather generally supervised as they are part of the supervised pathways that service the Class N devices themselves. [72, 2022]

A.3.3.7 Emergency Response Agency (ERA). An ERA includes any public, governmental, private, industrial, or military organization that engages in the operations specified in the definition. [1225, 2022]

A.3.3.12 Fuel Gas. Examples of fuel gases include, but are not limited to, natural gas, methane, or liquefied petroleum gases (LP-Gas) such as propane and butane.

A.3.3.13 Fuel-Gas-Burning Appliance. Fuel-gas-burning appliances include, but are not limited to, devices used for cooking, heating, lighting, or decorative purposes. Examples are stoves, portable space heaters, ranges, furnaces, water heaters, clothes dryers, gas refrigerators, gas lamps, and fuel-gas-burning fireplaces.

A.3.3.14 Fuel Gas Control Function Interface Device. The fuel gas control function interface device is a listed relay or other listed appliance that is part of the fuel gas detection system. An example of a fuel gas control function interface device is the fuel gas detection system control relay that removes power to a fan control unit (i.e., closes a valve shutting off the supply gas).

A.3.3.16 Fuel Gas Detection Control Unit. In addition to the functions identified in the definition, a fuel gas control unit might have an integral operator interface, and supply power to detection devices, notification appliances, transponder(s), or off-premises transmitter(s) or any combination of these. The control unit might also provide transfer of condition to relay or devices connected to the control unit. There can be multiple fuel gas control units in a fuel gas alarm system.

A.3.3.20 Lower Explosive Limit (LEL). The LEL of fuel gas mixtures is often estimated to be the LEL of the primary fuel gas constituent, for example, with natural gas the LEL is based on methane (5 percent by volume gas in air). However, the actual LEL for natural gas depends on the gas composition and is generally less than 5 percent gas in air considering other mixed gas components such as ethane and other hydrocarbons that might be present. The actual LEL of a combustible gas mixture (LEL_{MIX}) can be calculated using the Le Chatelier’s mixing rule. LEL_{MIX} is calculated using the gas composition (in mol percent) from a complete gas analysis of the combustible gas and the LELs of the constituents as follows:

[A.3.3.20a]

$$LEL_{MIX} = \frac{100}{\left(\sum x_i / LEL_i\right)}$$

where:

x_i = mole percentage hydrocarbon component i in the gas mixture

LEL_i = component i ’s LEL

The gas composition is typically determined with gas chromatography, per analytical methods per ASTM D1945, *Standard Test Method for Analysis of Natural Gas by Gas Chromatography*, GPA 2261, *Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography*, or GPA 2286, *Method for the Extended Analysis of Hydrocarbon Liquid Mixtures Containing Nitrogen and Carbon Dioxide by Temperature Programmed Gas Chromatography*. These methods provide the composition of natural gas in mol percent, which is equivalent to volume percent.

For example, calculate the LEL of a mixture of 90 percent methane (LEL 5 percent per Table B.1) and 10 percent ethane (LEL 3 percent per Table B.1):

[A.3.3.20b]

$$LEL_{MIX} = \frac{100}{\left(\frac{90}{5} + \frac{10}{3}\right)} = 4.7\% \text{ gas in air}$$

A.3.3.21 Nonrequired. There are situations where the applicable building or fuel gas code does not require the installation of a fuel gas detection system or specific fuel gas detection system components, but the building owner wants to install a fuel gas detection system or component to meet site-specific needs or objectives. A building owner always has the option of installing protection that is above the minimum requirements of the standard. It is the intent of the standard that any fuel gas detection system, or fuel gas detection system components installed voluntarily by a building owner, meet the requirements of the applicable portions of the standard. However, it is not the intent of the standard that the installation of a nonrequired fuel gas detection system, or fuel gas detection system components, trigger requirements for the installation of additional fuel gas detection system components or features. For example, the installation of a fuel gas detection control unit and fuel gas detectors to service a specific area, such as a computer room or flammable liquid storage room, does not trigger a requirement for audible or visual notification appliances, manual alarm boxes, or other fuel gas detection system features in other parts of the building.

A.3.3.25 Off-Premises Monitoring. Examples of supervising station service are central station, proprietary supervising station, and remote supervising station monitoring.

A.3.3.28 Sleeping Area. Bedrooms (or sleeping rooms) separated by other use areas, such as kitchens or living rooms (but not bathrooms), are considered separate sleeping areas. [72, 2022]

A.3.3.29.3 Trouble Signal. Examples include off-normal outputs from integrity monitoring circuits, the light and sound from activated trouble notification appliances, trouble data transmission to a supervising station, and so forth. [72, 2022]

A.3.3.31.2 Combination System. Examples of non-fire systems are security, card access control, closed circuit television, sound reinforcement, background music, paging, sound masking, building automation, time, and attendance. [72, 2022]

A.4.3.2 The manufacturer's published instructions are intended to provide device- or system-specific installation, operation, and maintenance requirements. These requirements could vary based on the fuel gas or gases the detector/system is intended to detect, the sensor technology utilized, and other device- or system-specific installation, operation, and maintenance variables.

A.4.3.3 This requirement does not apply to notification appliance circuits. [72:A.10.3.3]

A.4.3.4 A relay used for fuel gas safety functions is one possible example of such a situation.

A.4.4.3 It is not the intent to require personnel performing simple inspections or operational tests of initiating devices to require factory training or special certification, provided such personnel can demonstrate knowledge in these areas. [72:A.10.5.3]

A.4.4.3.1 The requirements for inspection personnel can vary depending on the type of inspection being performed. The purpose for initial and reacceptance inspections is to ensure compliance with approved design documents and to ensure installation in accordance with this standard and other required installation standards. Therefore, the acceptance inspection should be performed by someone who is familiar with the specific requirements, the design documents, and the applicable codes and standards. This implies that acceptance inspections should be performed by the persons or entities responsible for the system design and by authorities having jurisdiction. [72:A.10.5.3.1]

Once a system or a change to a system has been accepted, the inspection needs also change. The purpose for periodic inspections is to assure that obvious damages or changes that might affect the system operability are visually identified. Those persons performing periodic system inspections might or might not be familiar with all the specific system design goals and requirements. While many periodic inspections could uncover design faults, the intent of this standard is for such problems to be discovered at the acceptance inspection. The standard does not intend to require persons performing periodic inspections necessarily to be knowledgeable or qualified for inspecting and verifying the design of a system. [72:A.10.5.3.1]

A.4.4.3.2 Testing personnel knowledge should include equipment selection, placement, and installation requirements of

this standard and the manufacturer's published documentation. [72:A.10.5.3.2]

A.4.4.3.4(1) Factory training and certification is intended to allow an individual to service equipment only for which he or she has specific brand and model training. [72:A.10.5.3.4(1)]

A.4.4.3.4(2) Nationally recognized certification programs might include those programs offered by the International Municipal Signal Association (IMSA), National Institute for Certification in Engineering Technologies (NICET), and the Electronic Security Association (ESA). NOTE: These organizations and the products or services offered by them have not been independently verified by the NFPA, nor have the products or services been endorsed or certified by the NFPA or any of its technical committees.

A.4.4.3.4(3) Licenses and certifications offered at a state or local level are intended to recognize those individuals who have demonstrated a minimum level of technical competency in the area of fuel gas alarm servicing.

A.4.4.3.5 This is not intended to require certification where it is not offered or required by the manufacturer. [72:A.10.5.3.5]

A.4.5.5.2 Multiple pieces of system equipment can be connected to a branch circuit, subject to the current capacity of the circuit. It is not intended that a branch circuit be limited to a single piece of equipment. It is not intended that the circuit supply power to other than system equipment. For example, a branch circuit could power both an alarm control unit and an NAC power supply, but it could not power both an alarm control unit and a sprinkler system air compressor.

A.4.5.6.1 The secondary power supply is not required to supply power to the fuel gas detection system through parallel distribution paths. Automatic transfer switches are commonly used to allow secondary power to be supplied over the same distribution system as the primary power.

The generator does not need to be dedicated to the fuel gas detection system.

A.4.5.6.2.1 A combination system is a fire alarm system and is required to comply with NFPA 72.

A.4.5.6.2.2 An example of another standard is NFPA 731.

A.4.5.6.2.3.1 Correction factors are intended to address normal aging effects on battery capacity. As a lead-acid battery ages, rated capacity will decrease to 80 percent, which is considered the end of service life. As a minimum, a correction factor of 1.25 should be applied for aging to ensure the battery can meet its current demand at the end of service life. At initial installation, lead-acid battery capacity can be as low as 90 percent and should gradually increase when it is subjected to several deep discharge/charging cycles or when it remains on float-charge for several weeks. [72:A.10.6.7.2.14]

Battery calculations should include correction factors established for the battery technology to ensure that the required calculated amp-hour capacity remains available during the service life of the batteries and to compensate for changes in capacity where the batteries will be operated outside their nominal temperature range. [72:A.10.6.7.2.14]

Temperature also affects lead-acid batteries. For additional information on lead-acid battery sizing considerations refer to

IEEE 485, *Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications*. [72:A.10.6.7.2.14]

Different battery technologies will require different correction factors.

A.4.5.7 Where a computer system of any kind is used to receive and process alarm or supervisory signals, an ESS with sufficient capacity to operate the system until the secondary supply is capable of operating the fuel gas detection system might be required in order to prevent signal loss or a greater than 10-second signal delay.

ESS equipment often contains an internal bypass arrangement to supply the load directly from the line. These internal bypass arrangements are a potential source of failure. ESS equipment also requires periodic maintenance. It is, therefore, necessary to provide a means of promptly and safely bypassing and isolating the ESS equipment from all power sources while maintaining continuity of power supply to the equipment normally supplied by the ESS. [72:A.10.6.6]

A.4.5.8.1 Examples include the following:

- (1) A notification appliance circuit power supply located remotely
- (2) A power supply for transmitter required to transmit signals off premises
- (3) Power over ethernet (PoE), where provided for control units, circuit interfaces, or other equipment essential to system operation, and located remotely from the main control unit

A.4.5.9.3.4 The circuitry and methods for charging batteries of various types are to be evaluated by a nationally recognized testing laboratory to ensure they are appropriate for the purpose. During primary power use, batteries are trickle charged if they are off-line and waiting to be put under load in the event of a loss of power. [72:A.10.6.10.3.4]

Float-charged batteries are fully charged and connected across the output of the rectifiers to smooth the output and to serve as a standby source of power in the event of a loss of line power. Other charging methods are used to restore capacity to a battery after it has been utilized during a loss of primary power. [72:A.10.6.10.3.4]

A.4.6.3 Control unit signals can be audible, visual, or both for any particular function. Some older systems used only audible indicators that had to be coded for users to know what the signal meant. Where a control unit uses both audible and visual indicators, the purpose of the audible signal is to get someone's attention. In large system configurations, there might be multiple control units with audible signals. Also, there might be several different functions requiring an audible alert as a part of the whole signal. Thus, there could be several different audible signals. It is not the intent of this standard to have separate and distinct audible signals where clear visual distinction provides the user with the needed information. Visual signals, whether a lamp with a text label, an LCD screen, a computer monitor, or other textual visual appliances, are better forms of human interface. [72:A.10.10.4]

A.4.6.4 A valve supervisory, a low-pressure switch, or another device intended to cause a supervisory signal when activated should not be connected in series with the end-of-line supervisory device of initiating device circuits, unless a distinctive

signal, different from a trouble signal, is indicated. [72:A.10.10.5]

A.4.7.3.1 Where it is desired to deactivate the notification appliances for fire service operations inside the building and signal evacuated occupants that an alarm is still present, it is recommended that a separate non-silenceable notification zone be provided on the exterior of the building. The audible and visual notification appliances located at the building entrances could serve as a warning to prevent occupant reentry. [72:A.10.12.2]

A.4.7.3.6 Resetting of alarm signals should not require the simultaneous operation of multiple reset switches or the disconnection of any wiring or equipment to reset the alarm condition. [72:A.10.11.6]

A.4.9.8.1 The purpose of automatic trouble re-sound is to remind owners, or those responsible for the system, that the system remains in a fault condition. A secondary benefit is to possibly alert occupants of the building that the fuel gas detection system is in a fault condition.

A.4.9.9.7 In large, campus-style arrangements with proprietary supervising stations monitoring protected premises systems, and in other situations where off-premises monitoring achieves the desired result, the authority having jurisdiction is permitted to allow the reactivation to occur only at the supervising station. Approval by the authority having jurisdiction is required so it can consider all fuel gas safety issues and make a determination that there are procedures in place to ensure that the intent is met; in other words, someone is available to take action to correct the problem.

A.4.10.2 The operability of controlled mechanical equipment should be verified by periodic testing. Failure to test and properly maintain controlled mechanical equipment can result in operational failure during an emergency, with potential consequences up to and including loss of life.

A.4.11.1.1 An indoor conditioned space is one that includes heating or air conditioning equipment that will prevent temperature extremes from being present in the space. All fuel-gas detectors and alarms listed in accordance with UL 1484, *Residential Gas Detectors*, and UL 2075, *Gas and Vapor Detectors and Sensors*, have been tested at ambient temperatures of 32°F (0°C) and 120°F (49°C).

A.4.11.1.2 Unconditioned indoor spaces include areas that are not served by heating or air conditioning equipment, such as those typically found in attached and detached garages, sheds, attics, and some basements. For low-temperature extremes, the AHJ should consider ambient temperatures likely to occur during a typical cold season. For high-temperature extremes, the AHJ should consider ambient temperatures likely to occur during a typical hot season. In addition, some locations such as unconditioned attic spaces might exceed outdoor ambient temperatures, and consideration should be given to adding a safety factor to the anticipated high ambient temperature.

The equipment manufacturer can choose the temperature extremes used to test and list their equipment. Some equipment has been tested and listed for temperatures as low as -40°F (-40°C) and as high as 150°F (66°C).

Battery performance can be affected at temperature extremes, and only the batteries recommended in the manu-

facturer's instruction should be used since they have been tested for use at the rated operating temperatures.

A.4.11.2.1 Fuel gas alarm specifications can include some or all of the following:

- (1) Address of the protected premises
- (2) Owner of the protected premises
- (3) Authority having jurisdiction
- (4) Applicable codes, standards, and other design criteria to which the system is required to comply
- (5) Type of building construction and occupancy
- (6) Emergency forces response point(s) and annunciator location(s)
- (7) Type of fuel gas detection system to be provided
- (8) Calculations (e.g., secondary supply and voltage drop calculations)
- (9) Type(s) of fuel gas alarm-initiating devices, supervisory alarm-initiating devices, and notification appliances to be provided
- (10) Intended area(s) of coverage
- (11) Complete list of detection, signaling, and annunciator zones
- (12) Complete list of fuel gas safety control functions
- (13) Complete sequence of operations detailing all inputs and outputs

A.4.12.3 The primary purpose of annunciation is to enable responding personnel to quickly and accurately determine the status of equipment or fuel gas control functions that might affect the safety of occupants.

A.4.13 The provision of a double loop or other multiple path conductor or circuit to avoid electrical monitoring is not acceptable. [72:A.12.6]

A.4.13.7 This standard does not have jurisdiction over the monitoring integrity of conductors within equipment, devices, or appliances. [72:A.12.6.8]

A.4.13.16.2 Because digital alarm communicator systems establish communications channels between the protected premises and the central station via the public switched telephone network, the requirement to supervise circuits between the protected premises and the central station (*see 4.13.1 and 4.13.2*) is considered to be met if the communications channel is periodically tested in accordance with 26.6.4.2.5 of *NFPA 72*. [72:A.10.6.9.2]

A.4.13.16.4 This requirement is intended to prevent all of the supervising station alarm systems in a given geographic area from transmitting simultaneous trouble signals (and overwhelming the associated supervising stations) in the event of a widespread power failure. A trouble signal is not intended to be transmitted if primary power is restored within the time delay. [72:A.10.6.9.3]

A.4.14.1.4 Fuel gas detection systems are often installed under construction or remodeling contracts and subsequently connected to a supervising station alarm system under a separate contract. All contractors should complete the portions of the record of completion documentation for the portions of the connected systems for which they are responsible. Several partially completed documents might be accepted by the authority having jurisdiction provided that all portions of the connected systems are covered in the set of documents.

A.4.14.1.5 Protected premises fuel gas detection systems are often installed under construction or remodeling contracts and subsequently connected to a supervising station alarm system under a separate contract. All contractors should complete the portions of the record of completion documentation for the portions of the connected systems for which they are responsible. Several partially completed documents might be accepted by the AHJ provided that all portions of the connected systems are covered in the set of documents.

A.4.14.2.2 It is important to note that shop drawings and particularly the word "sheets" do not necessarily mean physical paper sheets, but could be on electronic media. [72:A.7.4.2]

A.4.14.3.1.1 The requirements of 8 should be used to perform the installation wiring and operational acceptance tests required when completing the record of completion. [72:A.7.5.6.3]

The record of completion form is permitted to be used to record decisions reached prior to installation regarding intended system type(s), circuit designations, device types, notification appliance type, power sources, and the means of transmission to the supervising station.

A.4.14.4.3.1(1) An owner's manual should contain the following documentation:

- (1) A detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, intended sequence of operations, expansion capability, application considerations, and limitations
- (2) A written sequence of operation in matrix or narrative form
- (3) Operator instructions for basic system operations, including alarm acknowledgment, system reset, interpretation of system output (LEDs, CRT display, and printout), ancillary function controls, and change of printer paper
- (4) A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including testing and maintenance instructions for each type of device installed. This information should include the following:
 - (a) Listing of the individual system components that require periodic testing and maintenance
 - (b) Step-by-step instructions detailing the requisite testing and maintenance procedures, and the intervals at which these procedures are to be performed, for each type of device installed
 - (c) A schedule that correlates the testing and maintenance procedures
- (5) A service directory, including a list of names and telephone numbers of those who provide service for the system.

A.5.2.2.1.1 Compatibility between software systems is necessary to ensure that the systems can communicate correctly and that the overall system can function as intended. Unfortunately, software that is compatible can become incompatible when the software is updated. Newer revisions of software might not maintain compatibility with older revisions. This paragraph requires that the fuel gas detection software or firmware that interfaces with software or firmware in another system is compatible. The term "required" indicates that this compatibility requirement is intended for required functions and not for supplemental functions that are not part of the required operation of the system. An example of a supplemental function

might be an RS-232 port that connects to a terminal emulator program used for maintenance purposes. The term “functionally” is intended to ensure that the intended functionality is maintained by the software. It is trying to avoid a situation where a change in software revision might still be compatible but changes the available functionality so that the two systems no longer perform the intended functions, even though the software communicates correctly.

A.5.2.2.1.2 Compatibility between systems will be documented in one or the other (or both) of the manufacturer’s installation documents for the compatible products and controlled by the listings agencies. This documentation will be referenced in the marking on the product. The documentation might be paper copy or electronic media (disk, web site, etc.). When a software revision changes, the documentation can be consulted to ensure that it is still compatible with the software or firmware on the other side of the interface. [72:A.23.2.2.1.2]

A.5.2.2.2 A commonly used method of protecting against unauthorized changes can be described as follows (in ascending levels of access):

- (1) *Access Level 1.* Access by persons who have a general responsibility for safety supervision, and who might be expected to investigate and initially respond to a fuel gas alarm or trouble signal
- (2) *Access Level 2.* Access by persons who have a specific responsibility for safety, and who are trained to operate the control unit
- (3) *Access Level 3.* Access by persons who are trained and authorized to do the following:
 - (a) Reconfigure the site-specific data held within the control unit, or controlled by it
 - (b) Maintain the control unit in accordance with the manufacturer’s published instructions and data
- (4) *Access Level 4.* Access by persons who are trained and authorized either to repair the control unit or to alter its site-specific data or operating system program, thereby changing its basic mode of operation

A.5.3.2 Nonrequired fuel gas detection features are defined in 3.3.21. These are fuel gas detection systems or components that are not required by the building codes and are installed voluntarily by a building owner to meet site-specific fuel gas detection safety objectives. There is a need to properly document the nonrequired system and components. Nonrequired components must be operationally compatible in harmony with other required components and must not be detrimental to the overall system performance. It is for this reason that 5.3.2.1 mandates that nonrequired (voluntary) systems and components meet the applicable installation, testing, and maintenance requirements of this standard. It is not the intent of the standard to have the installation of nonrequired (voluntary) systems or components trigger a requirement for the installation of additional fuel gas detection components or features in the building. For example, if a building owner voluntarily installs a fuel gas detection control unit, that does not trigger a requirement to install other fuel gas detection system components or features. See also A.5.8.5.5 and A.6.1.5.

A.5.4.3 The intent of the circuit designations is not to create a hierarchical ranking; rather it is to provide guidance on the levels of performance.

A.5.4.3.1 Fiber-optic or wireless pathways are examples of Class A circuitry not impaired by earth ground connection or

short-circuits and therefore do not annunciate those conditions as a fault. [72:A.12.3.1]

A.5.4.3.3 Class C is intended to describe technologies that supervise the communication pathway by polling or continuous communication “handshaking,” such as the following:

- (1) Fuel gas detection control unit or supervising station connections to a wired LAN, WAN, or Internet
- (2) Fuel gas detection control unit or supervising station connections to a wireless LAN, WAN, and Internet
- (3) Fuel gas detection control unit digital alarm communicator transmitter or supervising station digital alarm communicator receiver connections to the public switched telephone network

Individual pathway segments are not required to be monitored. Supervision is accomplished by end-to-end communications. [72:A.12.3.3]

A.5.4.3.4 Class D is intended to describe pathways that are not supervised but have a fail-safe operation that performs the intended function when the connection is lost. Examples of such pathways include the following:

- (1) Power to door holders where interruption of the power results in the door closing
- (2) Power to locking hardware that release upon an open circuit or fuel gas detection operation

A.5.4.3.5 Class E is intended to describe pathways that do not require supervision as described in Section 4.13. [72:A.12.3.5]

A.5.4.3.6(1) The Class N pathway designation is added to specifically address the use of modern network infrastructure when used in fire alarm or fuel gas detection and emergency communication systems.

Class N networks can be specified for ancillary functions but are not required for supplemental reporting described in 5.10.4. [See Figure A.5.10.4.] [72:A.12.3.6(1)]

Ethernet network devices are addressable but with an important distinction from device addresses on a traditional SLC multi-drop loop. A device with an Ethernet address is, in most cases, a physical endpoint connected to a dedicated cable. Traditional SLC devices are all wired on the same communication line (in parallel), similar to an old party-line telephone system. By comparison, Ethernet’s network switches direct each data packet to its intended recipient device like our modern phone systems. [72:A.12.3.6(1)]

Class N uses redundant paths as a means to compensate for Ethernet wiring that does not report a single connection to ground, a basic requirement of Class B. Thus, the physical separation of Class A and Class X, and equipment redundancy described in 5.4.3.7, is not inherently required of Class N. In other words, failure of a single switch is permitted take down a class N segment and is only required to report the loss of communication. Where redundant path segments are intended to have survivability similar to Class A or Class X, the physical separation requirements and overall equipment redundancy must be specified in addition to the Class N designation. [72:A.12.3.6(1)]

As a visual model, Class N could be likened to a redundant pathway backbone, allowed to have Class C branch paths to single endpoint devices. Therefore, every effort is made in this section to clearly distinguish the single endpoint device from

the transport equipment required to have redundant paths. [72:A.12.3.6(1)]

Class N requires redundant, monitored pathway segments to and from control equipment (fire or fuel gas alarm control units, ACUs, or ECCUs) where any interruption in communications could potentially affect multiple endpoint devices. Typically, interconnected communications equipment such as Ethernet switches, wireless repeaters, or media converters are used in combination to create pathways. 5 describes the required behavior of Class N pathways. All equipment must meet the requirements of other chapters in NFPA 715 (such as, but not limited to, requirements pertaining to secondary power supplies, equipment listings, and environment conditions).

Redundant pathways, isolated from ground, are actually common practice in robust Ethernet designs. Managed network switches commonly have specific uplink ports that are intended for load sharing and allow two parallel connections. For compliance with Class N, a trouble must be reported if either of these connections fails. [See Figure A.5.4.3.6(1)(a) and Figure A.5.4.3.6(1)(b).] [72:A.12.3.6(1)]

Class N pathways can use metallic conductor communications cable, such as a 100 ohm balanced twisted pair (e.g., Category 5E), including single-pair or multi-pair cable, or other communications media, such as optical fiber cable or wireless transmission, or a combination of two or more such transport mediums. [72:A.12.3.6(1)]

Where a conductor-based media is used for Class N, the intention is not to monitor faults on individual conductors but rather to monitor the operational capability and performance of the pathway as a whole. Similar to Class C, end-to-end verification is used in Class N. [72:A.12.3.6(1)]

Primary and required redundant pathways are independently and continuously verified for their ability to support end-to-end communications to and from each endpoint device and its associated control equipment. Pathway segments that service more than one device must have at least one verified redundant pathway segment. Should any primary pathway segment fail, communication is supported by the redundant pathway segment(s). Failure of either a primary or redundant pathway will indicate a trouble. [72:A.12.3.6(1)]

Redundant pathway segments are generally independent and do not normally share media with the primary pathways. However, there are exceptions, such as different frequencies for wireless components, or ring topologies. [See Figure A.5.4.3.6(5).] [72:A.12.3.6(1)]

A Class N network can be made more reliable with physically distinct pathway segments (i.e., an alternate conduit, or cable tray route, or wireless transmission frequency range, or a combination of distinct media). In addition to the required primary segments and redundant segments, a Class N pathway is permitted to have nonrequired segments. [See Figure A.5.4.3.6(1)(c)] Additional nonrequired pathway segments are allowed to be connected and not independently monitored for integrity as long as two paths are monitored to meet the redundancy requirement of Class N. [72:A.12.3.6(1)]

Traditionally, NFPA has used the word *device* for input components and the term *appliance* for components used in notification. With respect to Class N, the term *device* includes appliances and other intelligent, addressable components that perform a programmable input or output function. Examples of Class N devices include the following:

- (1) Input components such as alarm initiating modules switches and sensors
- (2) Output components such as output modules, Ethernet loudspeakers (i.e., IEEE 802.3af PoE loudspeakers), intelligent visual notification appliances (strobes), textual signage, and intelligent audio amplifiers

[72:A.12.3.6(1)]

Transmission equipment components (e.g., media converters, Ethernet switches, patch panels, cross-connects) are connected to the Class N pathway merely to transport instructions between other equipment. As such, they are not considered devices with respect to Class N pathways. [72:A.12.3.6(1)]

The audio amplifier listed above is an example of an addressable device that can receive a digital audio input from the Class N pathway and then provide a notification appliance circuit (NAC) output with Class A, B, or X pathways. Other endpoint devices can similarly provide alternate class pathways for visual notification appliances (strobes) (NACs) or initiating devices (IDCs). From the perspective of the Class N pathway, communications terminate at this endpoint device. However, since these types of endpoints can support multiple notification appliance devices or initiating devices, path segments are subject to the redundant pathway requirement unless protected in an enclosure or raceway less than 20 ft (6 m) in length. (See 4.13.8.) [See Figure A.5.4.3.6(1)(c).] [72:A.12.3.6(1)]

Class N connections between control equipment are required to have redundant monitored pathway segments if a failure of a primary pathway segment in between control equipment could impair the operation of the control equipment. [See Figure A.5.4.3.6(1)(d).] [72:A.12.3.6(1)]

Class N is also permitted to include dual port devices that provide both transmission and input/output functions. Endpoint devices can have multiple connection ports and support dual pathway segment connections; thus the term *endpoint device* is not intended to prohibit more than one connection to a device. Even with dual connections, where other devices depend on the path, primary and redundant paths are required. But, where an endpoint device has two connection ports, and when a secondary nonrequired connection is added, there is no requirement to separately supervise the nonrequired redundant pathway segment. [See Figure A.5.4.3.6(1)(e).] [72:A.12.3.6(1)]

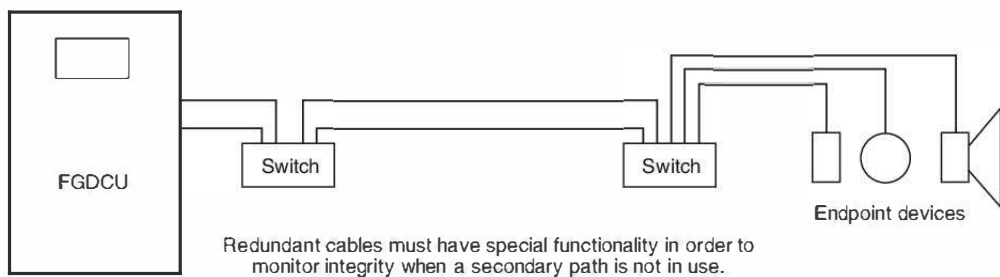


FIGURE A.5.4.3.6(1)(a) Class N Pathway Block Diagram – Example 1. [72:Figure A.12.3.6(1)(a)]

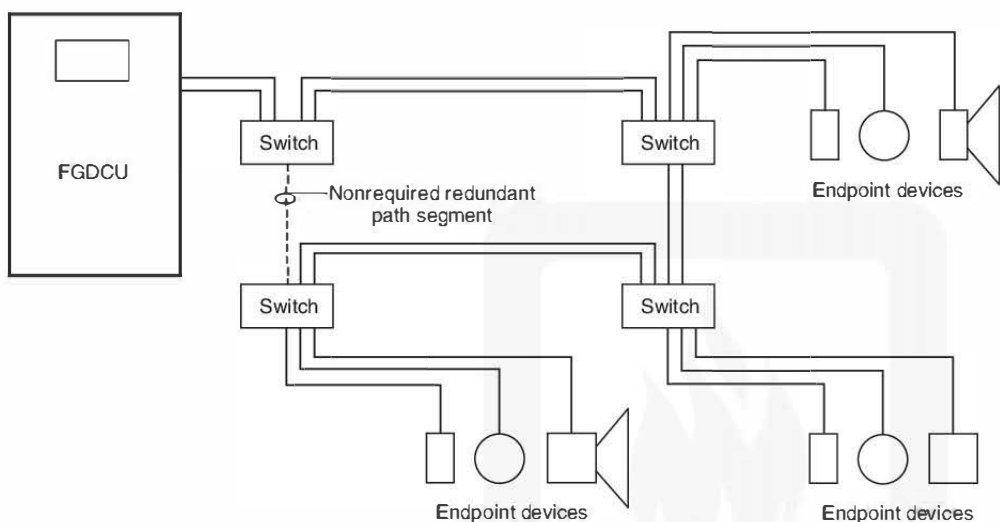


FIGURE A.5.4.3.6(1)(b) Class N Pathway Block Diagram – Example 2. [72:Figure A.12.3.6(1)(b)]

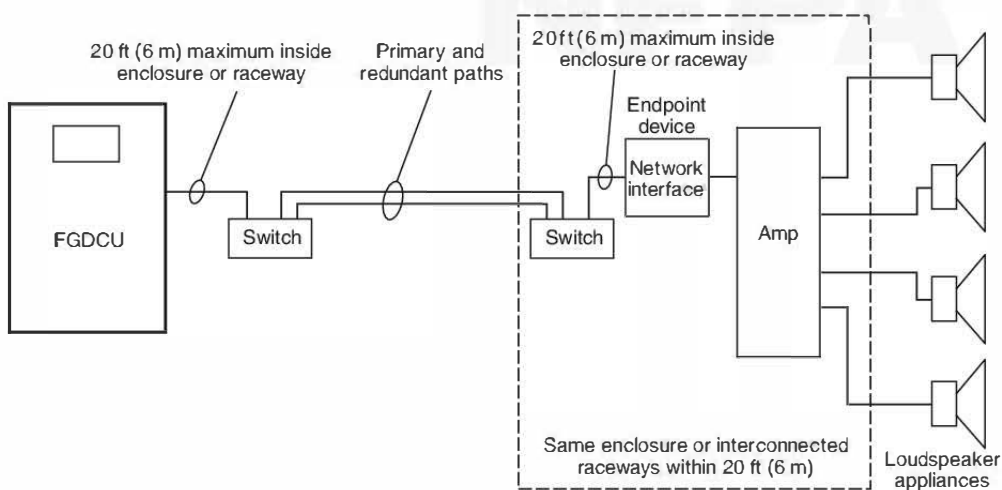


FIGURE A.5.4.3.6(1)(c) Class N Pathway to Endpoint with Multiple Devices. [72:Figure A.12.3.6(1)(c)]

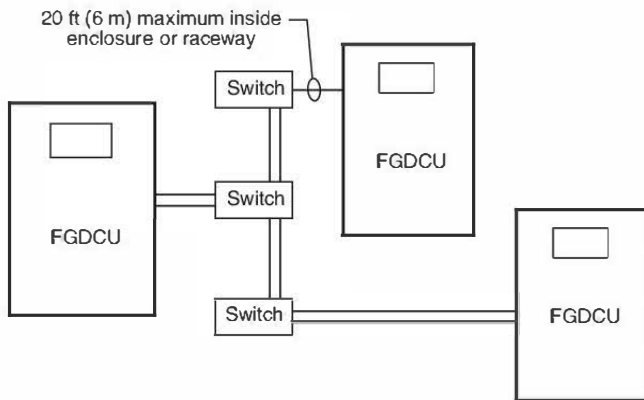


FIGURE A.5.4.3.6(1)(d) Class N Pathway Block Diagram with Multiple Control Units. [72:Figure A.12.3.6(1)(d)]

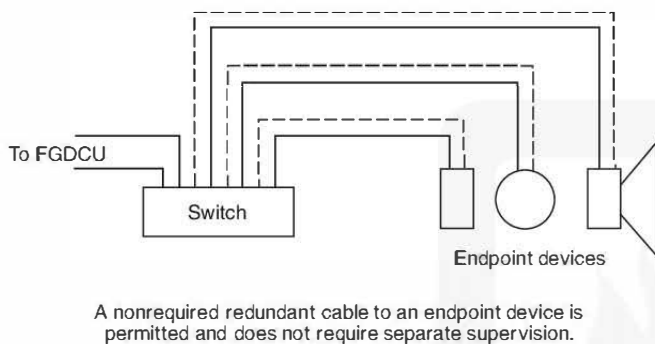


FIGURE A.5.4.3.6(1)(e) Class N Pathway Block Diagram with Device with Dual Pathway Connection. [72:Figure A.12.3.6(1)(e)]

A.5.4.3.6(4) Operational conditions of the pathway include factors such as latency, throughput, response time, arrival rate, utilization, bandwidth, and loss. Life and property safety equipment connected to a Class N network actively monitors some or all of the pathway's operational conditions so that an improperly installed or configured pathway or a subsequently degraded pathway or segment is detected by the life and property safety equipment and reported as a trouble. The trouble condition is reported when operational conditions of the pathway(s) have deteriorated to the point where the equipment is no longer capable of meeting its minimum performance requirements, even if some level of communication to devices is still maintained. Performance requirements include the activation of an alarm within 10 seconds, the reporting of a trouble signal within 200 seconds, and delivery of audio messages with required intelligibility. End-to-end communications might be operational under system idle conditions, but in the event of an alarm, the increased load on a degraded pathway could cause a partial or complete failure to deliver required life safety signals. Such predictable failure must be actively detected and reported.

A.5.4.3.6(5) Devices with dual path connections are permitted to be connected in a daisy-chain of devices on a ring. Again, where Class N pathway segments support multiple devices, verified redundant pathway segment(s) are required. This can be accomplished with a ring topology, as long as each segment of the ring is verified as functional, and the failure of any one

segment does not result in the loss of functionality of more than one device. In this arrangement, primary and redundant pathway segments share the same media, and provide two possible directions of communications in a ring topology [see Figure A.5.4.3.6(5)]. This daisy-chain configuration is also permitted between multiple control units that require verified primary and redundant pathway segments. [72:A.12.3.6(5)]

A.5.4.4.2 The intent of this paragraph is to prevent situations where the signaling line circuit to a device is required to be one class of operation, while the power circuits, running in the same raceways and subject to the same threats, are wired to a lower class of operation. This means that it is possible to have power wiring connected to a device that is of a different class than the signaling line or initiating device circuits. One example of where meeting the same minimum performance requirements would still allow different classes of wiring is where the performance requirements are based on distance or the number of devices attached to the wires. For example, if the signaling line circuit supplies 200 devices and the performance requirement is that not more than 10 devices be lost to a wiring fault, then the class of wiring on the signaling line circuit will be Class A, with isolators to protect against shorts. Where the power wires never supply more than 10 devices, the power wires could be wired as Class B. [72:A.23.4.2.2]

A.5.4.4.3 A goal of 5.4.4.3 is to provide adequate separation between the outgoing and return cables. This separation is required to help ensure protection of the cables from physical damage. The recommended minimum separation to prevent physical damage is 12 in. (305 mm) where the cable is installed vertically and 48 in. (1.22 m) where the cable is installed horizontally.

A.5.6.1 The intent of 5.6.1 applies to both short-circuit faults and open-circuit faults. [72:A.23.6.1]

Fuel gas detection technologies have evolved to the point that SLCs are now the prevalent means of monitoring initiation devices, controlling output devices, and communicating between panels, annunciators, and controllers.

The extent of coverage of traditional IDCs is inherently limited based on the quantity of powered initiation devices or code limitations. Similarly, the extent and coverage of NACs also are limited by the power required to operate the devices. SLCs, unlike IDCs and NACs, have few limitations, and it is now common that a single SLC can monitor and control more than 250 devices. In addition, a single SLC can be the only pathway by which alarms are initiated, emergency control functions are controlled, and audible and visual notification appliances are actuated. [72:A.23.6.1]

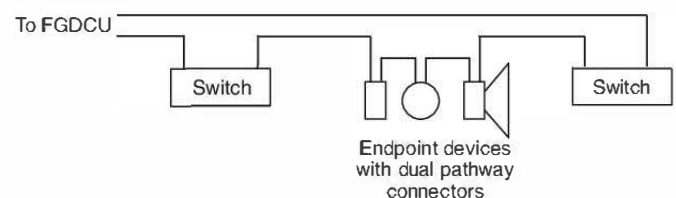


FIGURE A.5.4.3.6(5) Class N Pathway Block Diagram with Daisy-Chained Devices with Dual Pathway Connection. [72:Figure A.12.3.6(5)]

A total catastrophic failure of a fuel gas detection system due to a single open or short on an SLC can negate most, if not all, of this standard's requirements for specifying an acceptable minimum level of performance and reliability for the protection of life and property from fuel gas leak.

Designers should carefully consider the potential that a single SLC short or open caused by a fire or inadvertent damage to the SLC could disable an entire SLC prior to the activation of an alarm condition along with the subsequent alarm signaling and emergency control functions. [72:A.23.6.1]

With traditional IDCs and NACs, a single open, ground, or short fault on one circuit could not affect the performance of other IDCs, NACs, and emergency control circuits. As such, the occurrence of a single short or open could limit the extent of the failure to a particular zone or area. [72:A.23.6.1]

One method for providing an acceptable level of performance and reliability of SLCs is to limit the potential catastrophic failure to one zone, in a way similar to how traditional IDCs and NACs have been and are now required to do. [72:A.23.6.1]

A single zone could be designated in the following ways:

- (1) By floor where an SLC would not span multiple floors
- (2) By floor area, where a large floor would be split into multiple zones based on a maximum floor area size (e.g., 22,500 ft²)
- (3) By fire barrier or smoke barrier compartment boundaries, which an SLC would not cross
- (4) By maximum length or circuit, where an SLC would not be longer than a predetermined length (e.g., 300 ft)

[72:A.23.6.1]

See the definition of zone (3.3.32) and Figure A.5.6.1(a) through Figure A.5.6.1(d) for additional clarification. [72:A.23.6.1]

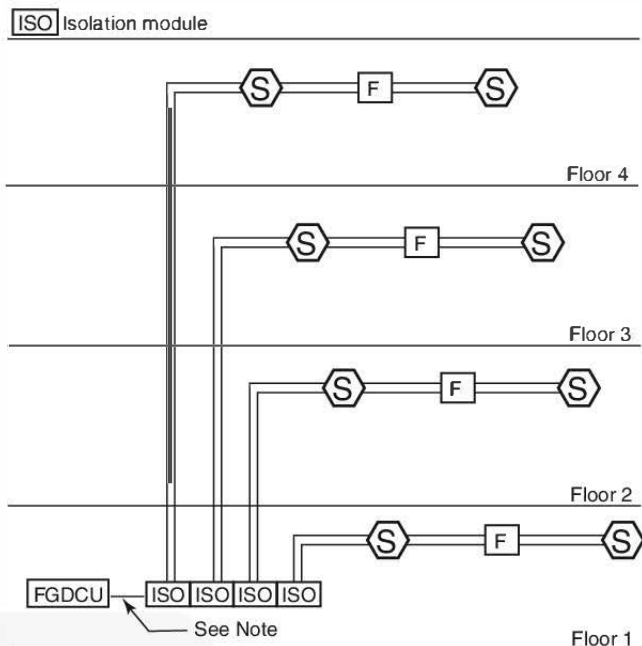
Figure A.5.6.1(a) depicts a Class B SLC with four zones. Wiring of more zones would require one isolator for each additional zone. The isolator can be integrated into the device or a separate component. If a single short or open occurs beyond the isolators, only one zone will be affected. [72:A.23.6.1]

Figure A.5.6.1(b) depicts a Class A SLC with four zones. Wiring of more zones would require one isolator for each additional zone. The isolator can be integrated into the device or a separate component. If a single short or open occurs, only one zone will be affected. If a single open occurs, no devices will be affected. [72:A.23.6.1]

Figure A.5.6.1(c) depicts a hybrid Class A SLC loop with Class B SLC branches serving four zones that is designated as a Class B SLC. Wiring of more zones would require one isolator for each additional zone. The isolator can be integrated into the device or a separate component. If a single short occurs, only one zone will be affected. If a single open occurs, it might affect only one zone. [72:A.23.6.1]

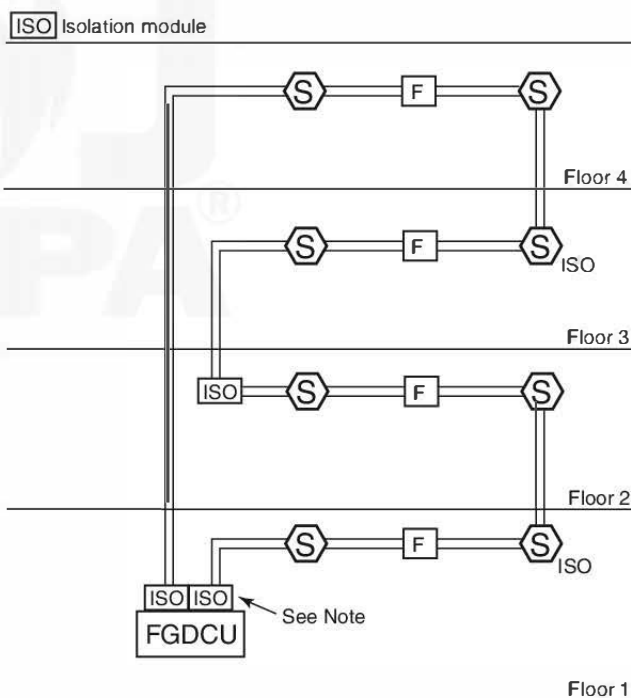
Figure A.5.6.1(d) depicts an incorrect Class B SLC configuration with four zones. If a single short or open occurs, one or more zones could be affected depending on the location of the single short. [72:A.23.6.1]

A.5.6.1.3 The intent is to clarify that the requirement identified in 5.6.1 applies only to SLCs that connect to addressable devices and not to SLCs that interconnect fire alarm control units (FACU) or transponders. [72:A.23.6.1.3]



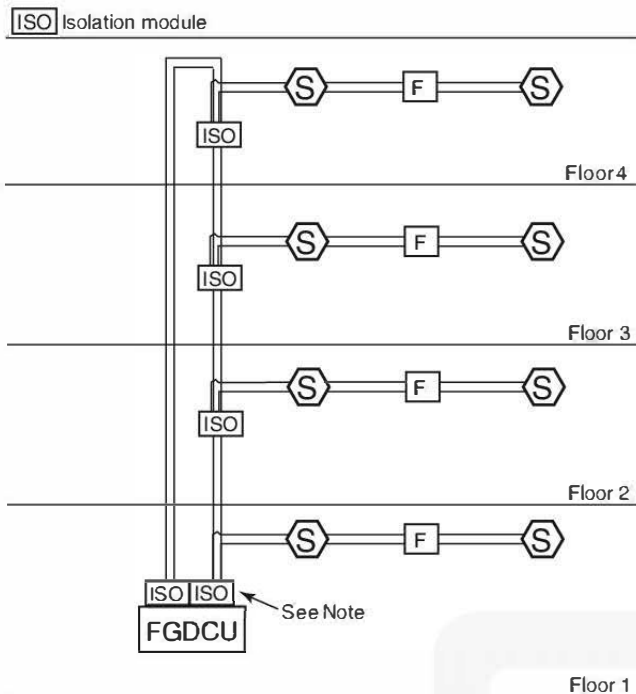
Note: Paragraph 5.6.1.3(2) allows an un-isolated circuit in metallic raceway or other equivalently protected method that does not exceed 3 ft (914 mm) in length.

FIGURE A.5.6.1(a) Class B Isolation Method.



Note: The two isolation modules shown at the FGDCU are not required if the panel SLC controller is internally isolated from shorts between outgoing and return termination points.

FIGURE A.5.6.1(b) Class A Isolation Method. [72:Figure A.23.6.1(b)]



Note: The two isolation modules shown at the FGDCU are not required if the panel SLC controller is internally isolated from shorts between outgoing and return termination points.

FIGURE A.5.6.1(c) Hybrid Isolation Method. [72:Figure A.23.6.1(c)]

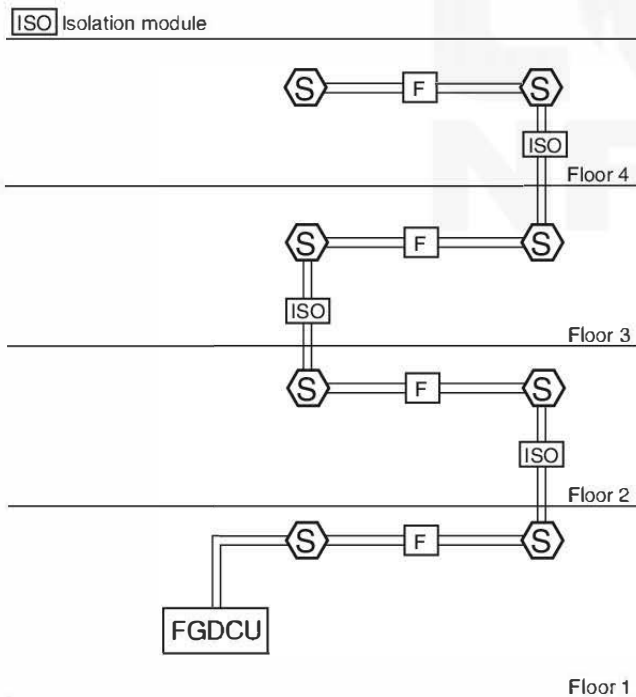


FIGURE A.5.6.1(d) Incorrect Use of Isolators on an SLC. [72:Figure A.23.6.1(d)]

A.5.6.1.3(3) In many cases, existing systems are partially modified with addressable devices being added as a part of the scope of work. In this case the SLC might not have been installed in a manner that could be easily modified to accommodate isolation modules and/or keep a single SLC loop confined to a single zone. This condition makes it clear that the requirements of SLC zones do not apply to existing systems that were not required to meet the zoning requirements of 5.6.1 when originally installed. [72:A.23.6.1.3(3)]

A.5.6.1.5 Possible scenarios in which a designer might choose to permit loss of more than one zone include a multistory building with a small floor plan footprint where a limited number of addressable devices are located on the floor (e.g., two fuel gas detection devices). In this scenario, the designer might choose to include multiple floors of devices on the same signaling line circuit because the loss of such devices due to a single SLC short or open would disable a limited number of devices.

Another scenario could include buildings with a small vestibule at the top of a stair that exits onto the roof of a building. The vestibule might contain one fuel gas detection device that could be connected to the signaling line circuit on the floor below and considered the same zone.

Designers providing documents for upgrades to an existing building where the control units and all fuel gas detection devices are being replaced but some portion of the existing circuits are being reused might, because of constructability reasons, opt for combining zones and the associated risk of the loss of those devices due to a single SLC short or open.

The intent of 5.6.1.5 is not to impose an unnecessary burden on building owners with existing systems undergoing renovations, upgrades, or replacements. In these scenarios as well as others, the designer would be required to provide a documented, performance-based design approach to justify why the loss of more than one zone is acceptable. Documentation must be composed in accordance with 5.6.2.4 and be submitted in accordance with 5.6.1.6. [72:A.23.6.1.5]

A.5.6.2 Class N systems should mitigate risk that could be present when a zone or area is serviced by a single Class N device. However, 5.6.2 is not intended to automatically require the installation of twice as many (or more) Class N devices as compared to a design based on Class A, B, or X pathways. The risks inherent to Class N are different from the risks inherent to Class A, B, or X. [72:A.23.6.2]

Class A and B pathways are permitted to lose devices in a zone (see Section 5.6) upon a multiple ground-fault pathway failure. Class A and B pathways require a single ground to be annunciated as a trouble signal. The requirement is to annunciate the first ground fault and alert the user so that the ground fault can be addressed before a possible second ground fault occurs. Note that a second ground fault is also annunciated at the systems operator interface because communication is lost. [72:A.23.6.2]

Class X pathways are not permitted to lose devices in a zone (see Section 5.6) upon a multiple ground-fault pathway failure that results in a short circuit across the pathway. Class X pathways require a single ground to be annunciated as a trouble signal. The requirement is to annunciate the first ground fault and alert the user so that the ground fault can be addressed before a possible second ground fault occurs. [72:A.23.6.2]

By contrast, Class N is not required to report a trouble condition at the occurrence of the first ground fault because it limits the loss to a single device if another ground occurs. A second ground fault in the Class N pathway, like Class A and B pathways, announces a trouble condition at the systems operator interface because communication is lost. [72:A.23.6.2]

In summary, the potential risk of a loss of fire alarm function in an area must be considered in Class N network design. Multiple ground faults might cause such a loss in an area, especially after no one was alerted of a trouble condition at the first ground fault. [72:A.23.6.2]

The term “device” in this context should be understood in conjunction with the definition of Device (Class N) 3.3.5 and the associated annex material A.3.3.5. An area is a separated space within a zone where initiating devices or notification appliances are required. Examples include an office, conference rooms, or temporary partitioned banquet rooms where alarm notification is required. Factors to consider when determining the need for multiple Class N devices within an area or zone include the following: whether the space is acoustically and/or visually isolated; specific audible and visual indication of trouble to the occupants in that area for a related ground fault pathway failure of any device/appliance in that area; the pathways to devices in the area are not susceptible to ground faults such as fiber-optic or wireless pathways. [72:A.23.6.2]

Also, multiple devices are not required when devices/appliances are connected by redundant pathways. For example, consider the dual port devices deployed as per A.5.4.3.6(5). For example, the failure of a sole Class N initiating device might delay or prevent the timely initiation of an alarm. [72:A.23.6.2]

Depending on the facility and the risks for that occupancy, areas serviced by single devices, without redundant pathways, that are susceptible to ground faults should be established by the system designer and approved by the authority having jurisdiction. [72:A.23.6.2]

A.5.6.2.3 This requirement is to ensure that devices without redundant pathways are not used to terminate additional equipment such that a loss of the pathway would result in more than one device failure to communicate and operate as intended. This stipulation does not apply to dual port devices as described in A.5.4.3.6(5), because these devices support redundant pathways. A dual port device that is used to daisy-chain additional devices without a redundant pathway would be prohibited. [72:A.23.6.2.3]

The term “device” in this context should be understood in conjunction with the definition of Device (Class N) 3.3.5 and the associated annex material A.3.3.5. [72:A.23.6.2.3]

A network-based audio amplifier is an example of an addressable device that can receive a digital audio input from the Class N pathway and then provide a notification appliance circuit (NAC) output with Class A, B, or X pathways. Other endpoint devices can similarly provide alternate class pathways for visual notification appliances (strobes) (NACs) or initiating devices (IDCs). From the perspective of the Class N pathway, communication terminates at this endpoint device. However, since these types of endpoints can support multiple notification appliance devices or initiating devices, Class N path segments are still subject to the redundant pathway requirement unless protected in an enclosure or raceway less than 20 ft (6 m) in length. [See Figure A.5.4.3.6(1)(c).] [72:A.23.6.2.3]

A.5.6.2.4 This clause is a consequence of the definition of Class N, which permits a single pathway to be used when only one device is served. [See 5.4.3.6(1).] This exception to the requirement of redundant pathways allows for the loss of operational capability to a single device. Unplugging, grounding, or cutting any single Ethernet cable or conductor cannot affect more than one Ethernet device and cannot affect additional devices, Ethernet or otherwise, in the system. [72:A.23.6.2.4]

A.5.6.3.3 All shared pathways defined as Class N should be documented, including all equipment connected to the shared pathways, interconnecting methods identifying required redundant communication pathways, end points, techniques used for proper supervision, and possible risk due to shared pathway failures. As an example, for wired Ethernet, the designer might want to use cabling techniques identified in standards such as ISO/IEC 14763-3, *Information technology — Implementation and operation of customer premises cabling — Part 3: Testing of optical fibre cabling*, to satisfy the requirements of the authority having jurisdiction. [72:A.23.6.3.3]

A.5.6.3.3.1.2 Cable installations should be tested with appropriate field test measurement equipment in accordance with applicable standards such as TIA 526, *Standard Test Procedures for Fiber Optic Systems*, or other standards acceptable to the authority having jurisdiction. For example, testing requirements for Category 5 or higher balanced twisted-pair cabling should include the following:

- (1) Wire map (e.g., continuity, pairing)
- (2) Length
- (3) Insertion loss
- (4) NEXT loss
- (5) ACR-F (formerly called *ELFEXT*)
- (6) Propagation delay and delay skew
- (7) Return loss
- (8) Power sum near-end crosstalk (PSNEXT) loss
- (9) PSACR-F (formerly called *PSELFEXT*)

[72:A.23.6.3.3.1.2]

Testing requirements for optical fiber cabling should include the following:

- (1) Attenuation
- (2) Optical bandwidth
- (3) Length

[72:A.23.6.3.3.1.2]

A.5.6.3.3.2 All ports need to be properly identified and labeled. For example, Class N switches should be permanently labeled “LIFE SAFETY EQUIPMENT – NO UNAUTHORIZED USE,” or plugs should be used to prevent access. [72:A.23.6.3.3.2]

A.5.6.3.3.3.2 Life safety Class N network cabling, equipment, and infrastructure might include (but is not limited to) Ethernet switches, media converters, uninterruptible power supplies, separate life safety network dedicated branch circuit power, cabling cross connects, and both copper and optical fiber cabling. [72:A.23.6.3.3.3.2]

A.5.6.3.5.1 Regular inspection, testing, and maintenance are conducted on life safety systems. In traditional systems a single certified entity was typically capable of servicing the fire alarm control unit, transport equipment, and/or wiring associated with it. Class N systems will often use modern network infra-

structure that might fall outside the expertise of the life safety-certified entity, or other building systems could share the infrastructure used to create the Class N network. The property or building or system owner or the owner's designated representative has responsibility to maintain a list of certified entities that are capable of servicing and maintaining the life safety system and the Class N network. This is what *NFPA 72* refers to as a *management organization*. For example, if the Class N network runs through Ethernet switches and routers, the premises IT infrastructure should be maintained by service personnel as referenced in 4.4.3.3. [72:A.23.6.3.5.1]

A.5.6.3.5.2 During inspection, testing, or maintenance it could be necessary to temporarily disable or test part of a life safety system. The *management organization* is responsible to ensure that other affected entities are notified and action plans put in place to ensure appropriate life safety coverage is maintained and appropriate notification is given to other entities such as the fire or security monitoring services. [72:A.23.6.3.5.2]

A.5.6.3.6.1 When shared pathway Level 1 or Level 2 is employed, care should be taken to ensure that the life safety system(s) traffic has priority over other systems sharing the Class N network to maintain the required bandwidth. Other systems might have unspecified or unpredictable bandwidth usage (such as a manually controlled security camera); therefore, the analysis should specify the method(s) used to ensure the required life safety bandwidth is maintained under all circumstances. The network design analysis should show this and be signed by the property or building or system owner or the owner's designated representative responsible for the design for the authority having jurisdiction to review. [72:A.23.6.3.6.1]

A.5.6.3.6.2 Primary and backup power should meet the requirements of NFPA 715. Life safety equipment and their connected equipment (Class N transport devices when not powered by the FGDCU) should utilize dedicated branch circuits for primary power. This is to prevent other loads from tripping a circuit breaker connected to the FGDCU and to prevent inadvertent disconnecting of primary power to the FGDCU.

The branch circuit disconnecting means (circuit breakers) should be clearly labeled and made only accessible to authorized personnel. [72:A.23.6.3.6.2]

FGDCUs are required to have a secondary power source that must last for 24 hours of standby (nonalarm) power followed by either 5 (non-voice systems) or 15 (voice systems) minutes of alarm power. This is typically accomplished by backup batteries or by an emergency generator. All transport equipment not powered by the FGDCU has the same requirement. The analysis should document the calculation of all power requirements (standby and alarm) of the FGDCU and transport equipment to ensure that the system can meet this requirement. To meet this requirement, non-life safety systems could be disconnected from the secondary power source.

A.5.6.3.7.1 Maintenance is a critical aspect of fuel gas detection systems, and a plan needs to be in place to empower continued operation of the fuel gas detection system. Shared Class N pathways present a unique concern in that non-fuel gas detection technicians could perform maintenance or changes to the Class N equipment or pathways. For example, routine updates to software in the routers and switches or

upgrades to address new non-fuel gas detection needs. This could result in outages of the portions of the fuel gas detection system or affect the subsequent operation of the fuel gas detection system. It is crucial that the maintenance plan address policy and procedure to monitor, maintain, and test per 8 and control change of the shared pathways to contribute to continued intended operation of the fuel gas detection system. For example, 8.4.2.5 states that changes to system executive software require a 10 percent functional test of the system, including typical network infrastructure such as routers and switches that now need consideration as part of the life safety network maintenance plan.

A.5.6.3.7.2 Written procedures should address who can access the Class N network; how the procedures will be implemented; the level of retesting of the system needed when software updates to the Class N network infrastructure such as routers and switches are made; and the effect of changes on system response times to ensure required time limits are maintained. [72:A.23.6.3.7.2]

A.5.6.3.7.2(3) The planned impairment process is used to control change in the system and inform stakeholders. Any activities that can affect the performance of the network or impact conclusions of a risk analysis should be presented to the organization referred to in 5.6.3.5 for approval. The organization should have a name (e.g., Life Safety Network Management Group). All stakeholders who could be affected by network outages should have representation in the organization. [72:A.23.6.3.7.2(3)]

A committee made up of members of the organization should meet on a regular basis and report to the organization. All planned impairments should have 7 days' notice. An emergency impairment (one with less than 7 days' notice) should meet very stringent standards for urgency. Outages and repair operations are dealt with on a case by case basis with the fire marshal's office, and the Department of Public Safety is included based on the operational impact. [72:A.23.6.3.7.2(3)]

All proposed changes and outages are to be presented to the organization for authorization, scheduling, and coordination. Once a change has been authorized and scheduled, an impairment notification is issued notifying all affected users. If specific mitigation actions, such as fire watch, are required, they are to be included in the impairment notification. [72:A.23.6.3.7.2(3)]

Impairment notifications are issued through the fire marshal's office, the Department of Public Safety, the Power Outages Group, or other groups depending on the systems affected. [72:A.23.6.3.7.2(3)]

A "login banner" is a programmable option for network switches and routers. This banner is the first thing that comes up on the screen when you log into the equipment. Where practical, network equipment used in life safety systems should have a login banner to notify service personnel that the network is a part of an active life safety system and any impairment should be coordinated with the named organization. [72:A.23.6.3.7.2(3)]

A.5.6.3.8 Although this section outlines some specific criteria and/or limitations, each application should be based on recognized performance-based design practices and the emergency response plan developed for the specific facility. Here are the general categories of questions that might be presented to the

stakeholders responsible for Class N shared network design decisions. The actual questions for each project must be tailored to the area, the building, the campus, and the culture of the user organization and the nature of how the network is being shared. The requirements for the life safety network should be evaluated with respect to the types of emergency events and emergency response plan. The potential impact of these events upon the life safety network also should be evaluated. [72:A.23.6.3.8]

- (1) What types of emergency events could affect the life safety network (e.g., fire, security, safety, health, environmental, geological, meteorological, utility service disruption, or other types of events)?
- (2) What is the anticipated or expected severity of the emergency events, that is, how will they impact the facility and its functions? Are they expected to be extreme, severe, and so forth?
- (3) What is the certainty of the emergency event, that is, is it happening now, is it very likely to occur, is it likely to occur, is it possible that it will occur in the future, is it unlikely to occur, or is its occurrence unknown?
- (4) Natural hazards: What are the network risks to the implementation of the emergency response plan in response to natural hazard events? What are the types of emergency events that could be predicted to result from natural hazard events? For example, if flooding is possible in the surrounding area, how would a flood affect the life safety network while operating in its normal, monitored state? What would happen if a fire alarm occurred during a flood? How likely is it that a flood could damage the life safety network? What related events might impact the life safety network and equipment, such as a power outage?
- (5) Human caused: What are the network risks to the implementation of the emergency response plan in response to accidents or intentional acts? What are the types of emergency events that could be predicted from both within and outside the protected premises? What type of related damage might be expected to impact the life safety network and equipment, such as explosions?
- (6) Technological caused: What are the network risks to the implementation of the emergency response plan in response to technologically caused events or failures and the types of emergency events that could be predicted to result from a technologically caused event both within and outside the protected premises. What type of related damage might be expected to impact the life safety network and equipment, such as a network attack?
- (7) Network maintenance risks: What are the network risks to the implementation of the emergency response plan in response to a degradation of network software performance (e.g., an unintended degradation of performance due to software updates) or a degradation of physical network performance or implementation (e.g., physical damage, system modifications)? What types of emergency events could be predicted to result from a degradation of the life safety network? What type of related impairments might be expected to impact the components of the life safety network and equipment, such as environmental controls?

[72:A.23.6.3.8]

The questions suggested in items (1) through (7) are offered for consideration, and not all of them might be appropriate for every life safety network installation. [72:A.23.6.3.8]

A.5.6.3.9 Shared pathway designations propose a list of shared pathways, some of which are only allowable for nonrequired functions. Other sections of this standard determine which of the shared pathways are allowed to be used as paths for required fire alarm signaling. Refer to 5.8.2.5 for shared communications requirements. [72:A.12.5]

A.5.8.1 Actuation of an initiating device is usually the instant at which a complete digital signal is achieved at the device, such as a contact closure. Some initiating devices involve signal processing and analysis by the device or by the control unit software. In these cases, actuation means the instant when the signal analysis requirements are completed by the device or control unit software.

It is not the intent of 5.8.1 to dictate the time frame for the local safety devices to complete their function.

A.5.8.2 This standard addresses field installations that interconnect two or more listed control units, possibly from different manufacturers, that together fulfill the requirements of this standard. [72:A.23.8.2]

Such an arrangement should preserve the reliability, adequacy, and integrity of all alarm, supervisory, and trouble signals and interconnecting circuits intended to be in accordance with the provisions of this standard. [72:A.23.8.2]

Where interconnected control units are in separate buildings, consideration should be given to protecting the interconnecting wiring from electrical and radio frequency interference. [72:A.23.8.2]

A.5.8.4.1 The provisions of 5.8.4.1 apply to types of equipment used in common with fuel gas detection systems, such as burglar alarm or coded paging systems, and to methods of circuit wiring common to both types of systems.

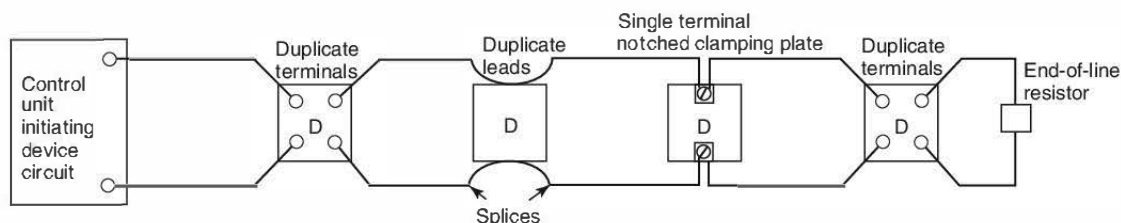
A.5.8.4.6 A combination fuel gas detection system, defined in 3.3.31.1, excludes fire alarm and mass notification systems. Priority requirements for fire alarm and mass notification systems, including combination fire alarm systems that incorporate fuel gas detection, are established in *NFPA 72*.

A.5.8.5.1.5 The monitoring of circuit integrity relies on the interruption of the wiring continuity when the connection to the initiating device is lost. Terminals and leads, as illustrated in Figure A.5.8.5.1.5(a) and Figure A.5.8.5.1.5(b), monitor the presence of the device on the initiating device circuit. [72:A.17.4.6]

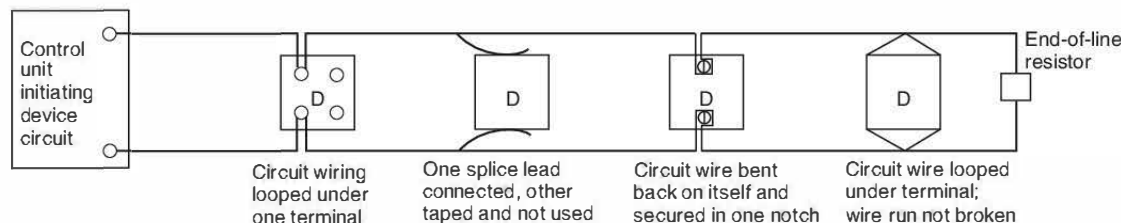
A.5.8.5.2.3 Where power is supplied separately to the individual initiating device(s), multiple initiating circuits are not prohibited from being monitored for integrity by a single power supervision device. [72:A.23.8.5.3.2]

A.5.8.5.3.1(1) For natural gas, detectors located on a wall should be located as close as practicable to the ceiling in the same room as permanently installed fuel-gas-burning appliances.

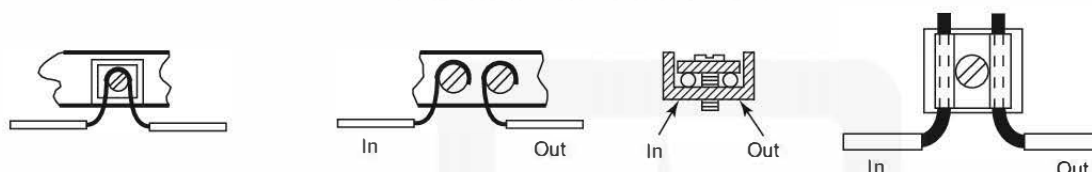
A.5.8.5.3.1(2) For liquefied petroleum gas (LP-Gas), detectors located on a wall should be located no more than 18 in. (457 mm) from but as close as practicable to the floor in the same room as permanently installed fuel-gas-burning appliances.



Correct wiring method — two-wire detectors



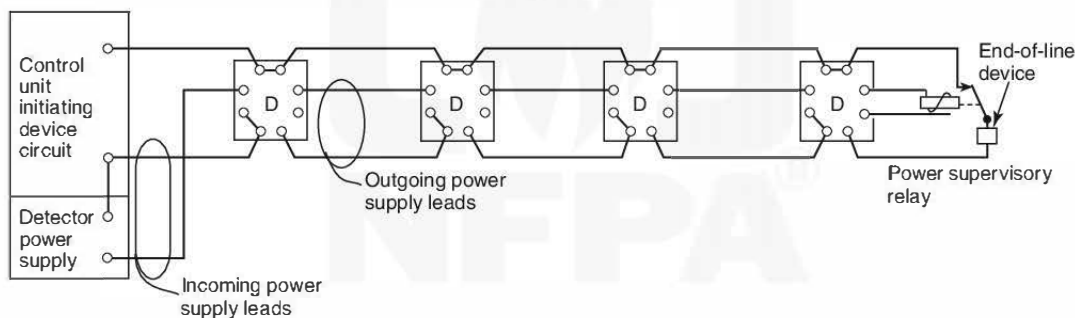
Incorrect wiring method — two-wire detectors



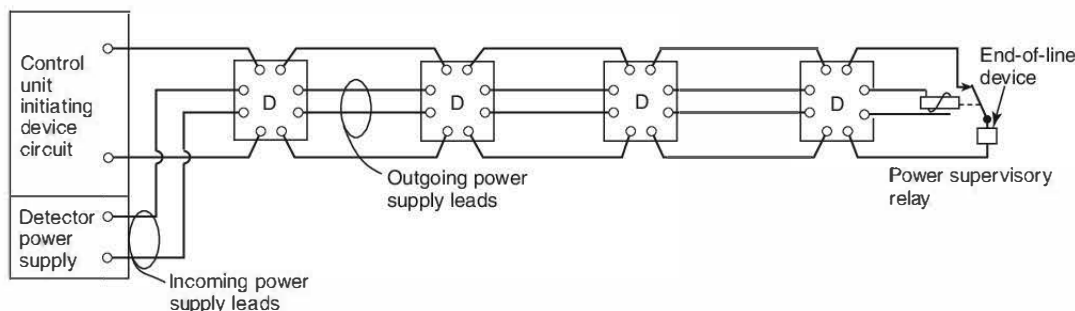
Incorrect

Correct — separate incoming and outgoing conductors

FIGURE A.5.8.5.1.5(a) Correct (and Incorrect) Wiring Methods. [72:Figure A.17.4.6(a)]



Illustrates four-wire detector employing a three-wire connecting arrangement. One side of power supply is connected to one side of initiating device circuit. Wire run broken at each connection to detector to provide supervision.



Illustrates four-wire detector employing a four-wire connecting arrangement. Incoming and outgoing leads or terminals for both initiating device and power supply connections. Wire run broken at each connection to provide supervision.

D = Detector

FIGURE A.5.8.5.1.5(b) Wiring Arrangements for Four-Wire Detectors. [72:Figure A.17.4.6(b)]

A.5.8.5.3.1(3) Detectors should be located as close as practicable, but no closer than 3 ft (914 mm), to permanently installed fuel-gas-burning appliances and should not be placed in obstructed pathways, which is consistent with considerations of detector accessibility, sources of detector contamination, and nuisance sources. Siting considerations can include locations where gas pockets or layers of gas are likely to accumulate, where transient back-drafting spillage of flue gases during startup could occur, and near ventilation supply or exhaust vents.

A.5.8.5.3.1(5) The purpose of detectors in basements or other subgrade rooms with foundation penetrations that might convey migrating fuel gas leaks from outside the occupancy is to detect fuel gases from sources outside the structure migrating to and through the subgrade outer surfaces. Detector location and spacing should be based on an engineering evaluation that considers potential sources and migration of fuel gases. Fuel gas lines outside the structure should be considered in the evaluation since damaged pipelines are a potential source of the migrating fuel gas. Other considerations when locating fuel gas detectors are the permeability of the wall, permeability of the floor, manmade penetrations (e.g., pipe passthroughs), and naturally occurring penetrations such as cracks.

A.5.8.5.3.3 Subparagraph 5.8.5.3.3 requires a maximum fuel gas detection threshold of 25 percent LEL, but also will accept listed detectors with lower detection thresholds, including 10 percent LEL detectors. Using detectors with lower LEL detection thresholds should provide faster detection response. Currently, natural gas detectors are commercially available that are listed with a 10 percent LEL detection threshold. Listed liquefied petroleum gas (LP-Gas) gas detectors with a detectable level at 10 percent LEL are not as readily available to the public market as natural gas detectors.

Due to the current listing standards, there is not uniform adoption of 10 percent LEL detection for all fuel gas detectors. Until manufacturers are required by the test standard to meet this higher level of sensitivity to obtain a listing, up to 25 percent LEL detection is allowed. Based on the scientific studies, it is recommended that a 10 percent LEL detector is used when available.

A.5.8.5.3.3.1 UL 2075, *Gas and Vapor Detectors and Sensors*, addresses toxic and combustible gas and vapor detectors as well as sensors that include an assembly of electrical components coupled with a sensing means inside a chamber, or by separate components, to detect toxic or combustible gases or vapors. Detectors in UL 2075 cover a broad spectrum of applications, including residential, industrial, and commercial. Detectors are intended for monitoring environments for open-area protection and for connection to a compatible power supply or control unit for operation as part of gas detection or emergency signaling systems. In addition, UL 2075 addresses detectors solely for control of ventilation or shutoff devices, such as fans or control valves, as provided by the listing. UL 2075 also covers equipment intended for use in hazardous locations.

A.5.8.5.3.3.2 The scope of UL 1484, *Residential Gas Detectors*, specifically addresses requirements for electrically operated fuel gas alarms intended for residential and recreational vehicle occupancies to detect fuel gases such as liquefied petroleum gas (LP-Gas) and natural gas. Devices are intended to be factory-built as a complete assembly of components functioning as a self-contained alarm device, including an element to detect gas concentration, an alarm-sounding appliance, and provision

for connection to a power supply source. Devices are specifically not intended for use in hazardous locations as defined in *NFPA 70*, for industrial or commercial use, or for use as smoke and fire detectors or alarms.

Although UL 2075, *Gas and Vapor Detectors and Sensors*, does not cover self-contained and single- and multiple-station residential fuel gas alarms otherwise covered in UL 1484, those sensors, detectors, and alarms that are covered in UL 2075 must operate within the sensitivity parameters defined by the manufacturer and must not exceed alarm limits defined in UL 1484.

A.5.8.5.3.7 Fuel gas detectors can be affected by electrical, chemical, and mechanical influences and by household chemicals, aerosols, and particulate matter found in protected spaces. The location of detectors should be such that the influences of household chemicals, aerosols and particulate matter from sources such as those in Table A.5.8.5.3.8(a) are minimized. Some of these sources could cause a false alarm on the sensor, such as acetone or ethanol, or other light hydrocarbons found in industrial cleaning solutions. Others such as humidity and particulates might not cause a false alarm but could be detrimental to the detector's life span and ability to reliably detect a fuel gas. Similarly, the influences of electrical and mechanical factors shown in Table A.5.8.5.3.7(b) should be minimized. While it might not be possible to isolate environmental factors totally, an awareness of these factors during system layout and design favorably affects detector performance. Fuel gas detectors should not be installed in environments outside the manufacturers published instructions.

A.5.8.5.5 The requirement of 5.8.5.5 recognizes there will be instances where, for example, a facility owner would want to apply detection to meet certain performance goals and to address a particular hazard or need, but that detection is not required. Once installed, of course, acceptance testing, annual testing, and ongoing maintenance in accordance with this [standard] is expected.

A.5.8.6.3.2 The building's emergency response plan might specify occupant notification only in the area(s) of initiation and at the control panel. Whole building evacuation might not be specified in the emergency response plan. [72:A.23.8.6.3.3]

A.5.8.6.5.1 A distinct continuous or temporal pattern signal is required to avoid the confusion of occupants and first responders, considering Temporal 3 and Temporal 4 signals already exist with similar devices (i.e., smoke, fire, carbon monoxide). The distinct signal must persist while the gas detector is in the presence of a detectable gas concentration; however, after 4 minutes of continuous or temporal pattern audible signal, a 60-second time "off" between cycles is permitted to conserve battery life. Since fuel gases contain other leak detection warning agents (i.e., gas odorants) which allow for detection typically below alarm detection thresholds, this audible alarm pause option provides a reasonable, balanced approach to power conservation without compromising occupant or first responder awareness of the potential presence of fuel gas.

A.5.8.6.5.1(1) Examples of this type of signal include a single frequency (e.g., tone) or a combination of two or more frequencies when actuated.

Table A.5.8.5.3.7(a) Common Sources of Aerosols and Particulate Matter Moisture

Moisture	Humid outside air Humidifiers, including ultrasonic humidifiers Live steam Showers Slop sink Steam tables Water spray
Chemical products and fumes	Aroma oil diffusers Chemical fumes Cleaning fluids Cooking equipment Curing Cutting, welding, and brazing Dryers Exhaust hoods Fireplaces Household chemicals Machining Ovens Paint spray
Atmospheric contaminants	Corrosive atmospheres Dust or lint Excessive tobacco smoke Heat treating Linen and bedding handling Pneumatic transport Sawing, drilling, and grinding Sea salt particles (alkalis) Silicone vapors Textile and agricultural processing Volatile organic compounds
Engine exhaust	Diesel trucks and locomotives Engines not vented to the outside Gasoline forklift trucks
Heating element with abnormal conditions	Cooking fumes Dust accumulations Improper exhaust Incomplete combustion

Table A.5.8.5.3.7(b) Sources of Electrical and Mechanical Influences on Fuel Gas Detectors

Electrical Noise and Transients	Airflow
Vibration or shock	Gusts
Radiation	Excessive velocity
Radio frequency	
Intense light	
Lightning	
Electrostatic discharge	
Power supply	

[72:Table A.17.7.1.10(b)]

A.5.8.6.5.2 Coordination or synchronization of the audible signal within a notification zone is needed to preserve the temporal pattern. It is unlikely that the audible signal in one evacuation/notification zone will be heard in another at a level that will destroy the temporal pattern. Thus, it would not normally be necessary to provide coordination or synchronization for an entire system. Caution should be used in spaces such as atriums, where the sounds produced in one notification zone can be sufficient to cause confusion regarding the temporal pattern. [72:A.18.4.2.5]

A.5.9.2 Embossed plastic tape, pencil, ink, or crayon should not be considered to be a permanently attached placard. [72:A.17.4.7.1]

A.5.10.4 Off-site logging of fuel gas alarm data can be useful to preserve information in the face of building failure to facilitate accurate reconstruction of the event. It can also be beneficial to send data off-premises to incident command personnel to enhance situational awareness and response decisions and to maintain safe and efficient operations. Figure A.5.10.4 shows an example of a network to accomplish these goals.

A.5.11.2 Fuel gas control function interface devices can be located far from the device to be activated, such as air-handling units and exhaust fans located on the roof. The requirement for monitoring installation wiring for integrity only applies to the wiring between the fuel gas control unit and the fuel gas control function interface device. For example, it does not apply to the wiring between the fuel gas control function interface device and a motor stop/start control relay, or between the fuel gas control function interface device and the equipment to be controlled (e.g., air-handling units and exhaust fans). The location of the fuel gas control function interface device within 3 ft (914 mm) applies to the point of interface and not to remotely located equipment.

A.5.12 The term *wireless* has been replaced with the term *low-power radio* to eliminate potential confusion with other transmission media such as fiber optics. [72:A.23.16]

Low-power radio devices are required to comply with the applicable *low-power* requirements of Title 47, Code of Federal Regulations, Part 15. [72:A.23.16]

A.5.12.1 Equipment listed solely for dwelling unit use would not comply with this requirement. [72:A.23.16.1]

A.5.12.2 This requirement is intended to limit the impact from the failure of a battery-operated receiver/transmitter in a given space. This requirement is not intended to prevent a single device that contains multiple function elements, such as a combination carbon monoxide, fuel gas and smoke detector, a detector with an independently controllable sounder, a notification appliance with visible and audible elements, and so forth. This requirement is intended to limit the number of functional elements to one of each independent type. For example, two manual fire alarm boxes could not rely on a single battery.

A.5.12.3.1 This requirement is not intended to preclude verification and local test intervals prior to fuel gas alarm transmission.

A.5.12.3.1.3 This requirement ensures that an alarm is received in the rare event that the RF channel experiences interference. [72:A.23.16.3.1.3]

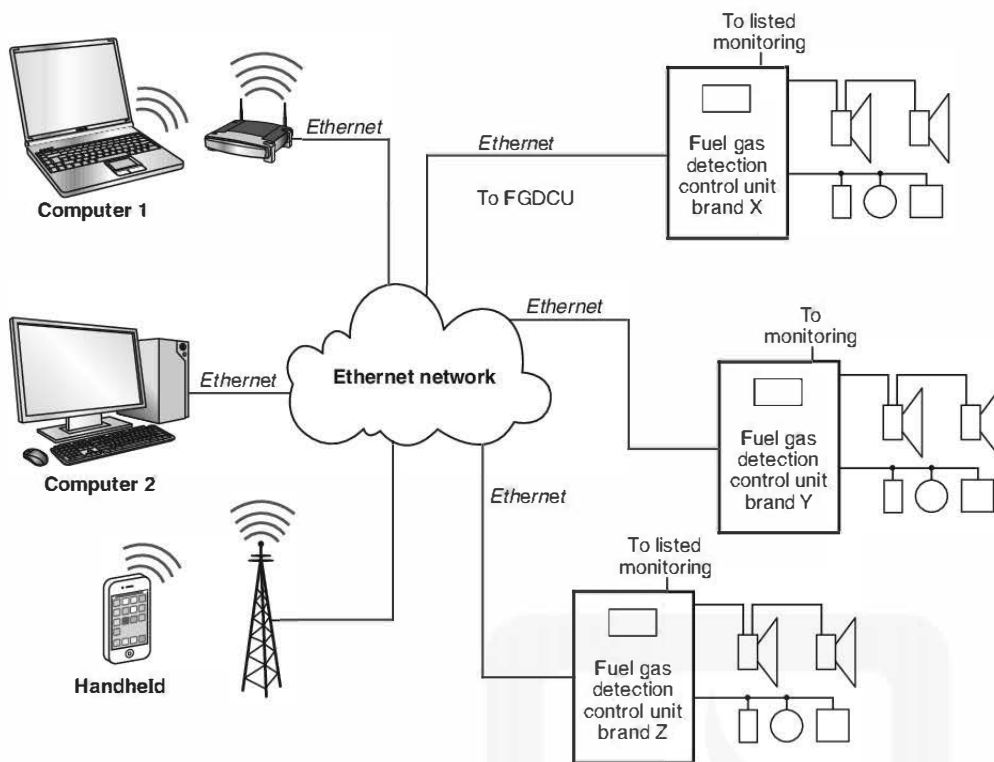


FIGURE A.5.10.4 Supplemental Reporting Network. [72:Figure A.23.12.4]

A.5.12.3.2 Trouble and supervisory signals are not required to latch. Self-restoring trouble and supervisory signals are acceptable. [72:A.23.16.3.1.5]

A.6.1 Notification appliances should be sufficient in quantity, audibility, intelligibility, and visibility so as to reliably convey the intended information to the intended personnel during an emergency. [72:A.18.1]

Notification appliances in conventional commercial and industrial applications should be installed in accordance with the specific requirements of Sections 6.4 and 6.5. [72:A.18.1]

The standard recognizes that it is not possible to identify specific criteria sufficient to ensure effective occupant notification in every conceivable application. If the specific criteria of Sections 6.4 and 6.5 are determined to be inadequate or inappropriate to provide the performance recommended, approved alternative approaches or methods are permitted to be used. [72:A.18.1]

Designers and AHJs are advised to consider alternative means in occupancies that have individuals with cognitive disabilities. In addition, persons responsible for evacuation planning should consider specific training for individuals with cognitive disabilities to familiarize them with audible and visual signals and what responses are necessary based on their capabilities. [72:A.18.1]

A.6.1.5 Chapter 6 establishes the means, methods, and performance requirements of notification appliances and systems. Chapter 6 does not require the installation of notification appliances or identify where notification signaling is required. Authorities having jurisdiction, other codes, other standards, and chapters of this standard require notification

signaling and might specify areas or intended audiences. [72:A.18.1.5]

For example, Chapter 4 requires audible and visible trouble signals at specific locations. A building or fire code might require audible and visual notification throughout all occupiable areas. In contrast, a building or fire code might require complete coverage with audible signaling, but might only require specific areas or spaces to have visual signaling. It is also possible that a referring code or standard might require compliance with mounting and notification appliance performance requirements without requiring complete notification signaling system performance. An example might be where an appliance is specifically located to provide information or notification to a person at a specific desk within a larger room. [72:A.18.1.5]

A.6.3.3.2 The intent is to prohibit labeling that could give an incorrect message. Wording such as “Emergency” would be acceptable for labeling because it is generic enough not to cause confusion. Fuel gas detection systems are often used as emergency notification systems, and therefore attention should be given to this detail.

Combination audible and visual notification appliances are permitted to have multiple visual elements each labeled differently or not labeled at all. [72:A.18.3.3.2]

A.6.3.4 Situations exist where supplemental enclosures are necessary to protect the physical integrity of a notification appliance. Protective enclosures should not interfere with the performance characteristics of the appliance. If the enclosure degrades the performance, methods should be detailed in the manufacturer's published instructions of the enclosure that

clearly identify the degradation. For example, where the appliance signal is attenuated, it might be necessary to adjust the appliance spacings or appliance output. [72:A.18.3.4]

A.6.3.6 For hardwired appliances, terminals or leads, as described in 6.3.6, are necessary to ensure that the wire run is broken and that the individual connections are made to the leads or other terminals for signaling and power [72:A.18.3.6]

A common terminal can be used for connection of incoming and outgoing wires. However, the design and construction of the terminal should not permit an uninsulated section of a single conductor to be looped around the terminal and to serve as two separate connections. For example, a notched clamping plate under a single securing screw is acceptable only if separate conductors of a notification circuit are intended to be inserted in each notch. [See Figure A.5.8.5.1.5(a).] [72:A.18.3.6]

Another means to monitor the integrity of a connection is to establish communication between the fuel gas detection control unit. The integrity of the connection is verified by the presence of communication. Monitoring integrity in this fashion might not require multiple terminals or leads, as previously described.

It should be noted that monitoring the integrity of the installation conductors and their connection to an appliance does not guarantee the integrity of the appliance or that it is operational. Appliances can be damaged and become inoperable or a circuit can be overloaded, resulting in failure when the appliances are called upon to work. Presently, only testing can establish the integrity of an appliance. [72:A.18.3.6]

A.6.4.1.3 In determining maximum ambient sound levels, sound sources that should be considered include air-handling equipment and background music in a typical office environment, office cleaning equipment (vacuum cleaner), noisy children in a school auditorium, car engines in an auto shop, conveyor belts in a warehouse, and a running shower and fan in a hotel bathroom. Temporary or abnormal sound sources that can be excluded would include internal or external construction activities (i.e., office rearrangements and construction equipment). [72:A.18.4.1.3]

A.6.4.1.5.1 Audibility of a signal might not be required in all rooms and spaces. For example, a system that is used for general occupant notification should not require audibility of the signal in closets and other spaces that are not considered as occupiable spaces. However, a space of the same size used as a file room would be considered occupiable and should have coverage by notification appliances. Also, signaling intended only for staff or emergency forces might only have to be effective in very specific locations.

A.6.4.2 The typical average ambient sound level for the occupancies specified in Table A.6.4.2 are intended only for design guidance purposes. The typical average ambient sound levels specified should not be used in lieu of actual sound level measurements. [72:A.18.4.4]

Sound levels can be significantly reduced due to distance and losses through building elements. Every time the distance from the source doubles, the sound level decreases by about 6 decibels (dB). Audible notification appliances are typically rated by manufacturers' and testing agencies at 10 ft (3 m) from the appliance. Subsequently, at a distance of 20 ft (6.1 m) from an audible appliance rated at 84 dBA, the sound level

might be reduced to 78 dBA. At a closed door, the loss might be about 10 dB to 24 dB or more depending on construction. If the opening around the door is sealed, this might result in a loss of 22 dB to 34 dB or more. [72:A.18.4.4]

A.6.4.3.2 For example, in critical care patient areas, it is often desirable to not have an audible notification even at reduced private mode levels. Each case requires consideration by the governing authority. Another example would be high noise work areas where an audible signal needed to overcome background noise at one time of day would be excessively loud and potentially dangerous at another time of lower ambient noise. A sudden increase of more than 30 dB over 0.5 seconds is considered to cause sudden and potentially dangerous fright. [72:A.18.4.5.2]

A.6.4.4.3 The intent of this section is to require the use of the low frequency signal in areas intended for sleeping and in areas that might reasonably be used for sleeping. For example, this section requires a low frequency audible signal in a bedroom of an apartment and also in the living room area of an apartment as it might have sleeping occupants. However, it would not be required to use the low frequency signal in the hallways, lobby, and other tenantless spaces. In hotels, the guest rooms would require use of the low frequency signals, but other spaces that might require audible signals could use any listed audible appliances regardless of the frequency content of the signal being produced. This chapter of the standard addresses notification appliances connected to and controlled by a system. This chapter does not address dwelling unit protection such as fuel gas alarms and their audible signal characteristics. Requirements for single and multiple-station alarms and household fuel gas alarm systems can be found in Chapter 9.

Table A.6.4.2 Average Ambient Sound Level According to Location

Location	Average Ambient Sound Level (dBA)
Business occupancies	54
Educational occupancies	45
Industrial occupancies	88
Institutional occupancies	50
Mercantile occupancies	40
Mechanical rooms	91
Piers and water-surrounded structures	40
Places of assembly	60
Residential occupancies	35
Storage occupancies	30
Thoroughfares, high-density urban	70
Thoroughfares, medium-density urban	55
Thoroughfares, rural and suburban	40
Tower occupancies	35
Underground structures and windowless buildings	40
Vehicles and vessels	50

[72:Table A.18.4.4]

It is not the intent of this section to preclude devices that have been demonstrated through peer-reviewed research to awaken occupants with hearing loss as effectively as those using the frequency and amplitude specified in this section. [72:A.18.4.6.3]

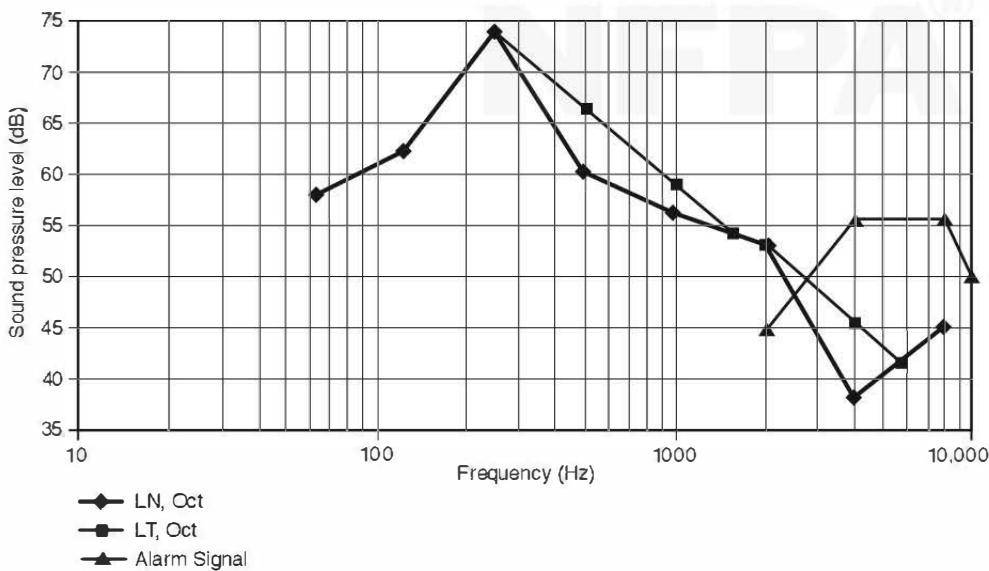
Non-voice (e.g., horns) notification appliances should be listed as a “low frequency alarm” alarm appliance. Voice appliances and systems should be capable of 520 Hz ± 10 percent with the appropriate harmonics [72:A.18.4.6.3]

For increased protection in the sleeping area, tactile notification in accordance with Section 6.10 might be an effective means of awakening those who have normal hearing, as well as those who are hearing impaired. [72:A.18.4.6.3]

A.6.4.4.3(2) For the purposes of awakening, the low frequency signal can be produced by a listed stand-alone appliance or by a listed system consisting of a recorded waveform delivered through an amplifier and loudspeaker. [72:18.4.6.3(2)]

A.6.4.5 This subsection permits a more rigorous analysis and design for audible signaling. Acoustic design practice and psychoacoustic research have long recognized that for a signal to be audible, it need only penetrate the background noise in a one-third or a one octave band. The averaging resulting from A-weighted analysis and design is a simplification that often results in systems being overdesigned. This overdesign is not dangerous but can be costly and is certainly not needed for effective system performance. [72:A.18.4.7]

A.6.4.5.2 Noise at a lower frequency can mask a signal at an adjacent higher frequency. Thus, it is necessary to calculate the effective masked level of the noise in accordance with established procedures. Figure A.6.4.5.2 shows an example of an octave band analysis of noise along with the calculated effective masked threshold and the proposed alarm signal. [72:A.18.4.7.2]



At the first octave band center frequency, the masked threshold of hearing, LT, Oct is equal to the noise level. For each subsequent center frequency, LT, Oct is the greater of either the noise level at that octave band, LN, Oct, or the masked threshold of the previous band less 7.5 dB.

FIGURE A.6.4.5.2 Threshold Masking Level Example. [72:Figure A.18.4.7.2]

A.6.4.6.2 Consideration must be given to the location of notification appliances relative to the location of the fuel gas detector. Where practicable, notification appliances should be located further away than the detector from fuel gas leak sources. For heavier-than-air fuel gases, the detector must be located lower than the notification appliance horizontal plane location.

A.6.4.8 See Annex D, Speech Intelligibility, of NFPA 72. [72:A.18.4.11]

A.6.4.8.1 See the definition of acoustically distinguishable space in 3.3.1. [72:A.18.4.11.1]

A.6.4.8.3 For example, based on the system design the following locations might not require intelligibility.

- (1) Private bathrooms, shower rooms, saunas, and similar rooms/areas
- (2) Mechanical, electrical, elevator equipment rooms, and similar rooms/areas
- (3) Elevator cars
- (4) Individual offices
- (5) Kitchens
- (6) Storage rooms
- (7) Closets
- (8) Rooms/areas where intelligibility cannot reasonably be predicted

A.6.4.8.4 ADS assignments should be a part of the original design process. See the discussion in A.3.3.1. The design drawings should be used to plan and show the limits of each ADS where there is more than one. [72:A.18.4.11.4]

All areas that are intended to have audible occupant notification, whether by tone only or by voice should be designated as one or more ADSs. Drawings or a table listing all ADSs should be used to indicate which ADSs will require intelligible voice communications and those that will not. The same draw-

ings or table could be used to list audibility requirements where tones are used and to list any forms of visual or other notification or communications methods being employed in the ADS. [72:A.18.4.11.4]

A.6.5 The mounting height of the appliances affects the distribution pattern and level of illumination produced by an appliance on adjacent surfaces. It is this pattern, or effect, that provides occupant notification by visual appliances. If mounted too high, the pattern is larger but at a lower level of illumination (measured in lumens per square foot or foot-candles). If mounted too low, the illumination is greater (brighter) but the pattern is smaller and might not overlap correctly with that of adjacent appliances. [72:A.18.5]

A qualified designer could choose to present calculations to an authority having jurisdiction showing that it is possible to use a mounting height greater than 96 in. (2.44 m) or less than 80 in. (2.03 m), provided that an equivalent level of illumination is achieved on the adjacent surfaces. This can be accomplished by using listed higher intensity appliances or closer spacing, or both. [72:A.18.5]

Engineering calculations should be prepared by qualified persons and should be submitted to the authority having jurisdiction, showing how the proposed variation achieves the same or greater level of illumination provided by the prescriptive requirements of Section 6.5. [72:A.18.5]

The calculations require knowledge of calculation methods for high-intensity visual notification appliances. In addition, the calculations require knowledge of the test standards used to evaluate and list the appliance. [72:A.18.5]

A.6.5.1 There are two methods of visual signaling. These are methods in which notification of an emergency condition is conveyed by direct viewing of the illuminating appliance or by means of illumination of the surrounding area. [72:A.18.5.1]

Visual notification appliances used in the public mode must be located and must be of a type, size, intensity, and number so that the operating effect of the appliance is seen by the intended viewers regardless of the viewer's orientation. [72:A.18.5.1]

A.6.5.1.2 Visual notification for emergency signaling might not be required in all rooms or spaces. For example, a system that is used for general occupant notification should not require visual signaling in closets and other spaces that are not considered as occupiable areas. However, a space of the same size used as a file room could be considered occupiable and should have coverage by notification appliances. Also, signaling intended only for staff or emergency forces might only have to be effective in very specific locations.

A.6.5.2.2 Occupant notification by visual signaling is not required by NFPA 715 except in high noise areas (*see* 6.4.1.1). Just as with audible occupant notification, the requirement to have such signaling originates from other governing laws, codes, or standards. Those other governing laws, codes, or standards specify the areas or spaces that require either audible, visual, or both types of occupant notification. NFPA 715 then provides the standards for those systems. [72:A.18.5.2.2]

A.6.5.5.4 Visual notification appliances must be listed for either wall mounting or ceiling mounting. The effectiveness of ceiling-mounted appliances does not depend on them being mounted on a surface. Therefore, the standard permits them to be suspended below the ceiling using proper electrical

installation methods. Appliances mounted parallel to the floor, whether on a ceiling or suspended, can sometimes significantly reduce installation costs and provide better coverage. [72:18.5.5.4]

In convention spaces and areas with racking and shelving, wall-mounted appliances are frequently obstructed or subjected to mechanical damage. Ceiling mounting (or suspending) the appliances can prevent problems and increases the ability for the appliance to cover the floor area through direct and indirect signaling.

A.6.5.5.5 The visual notification appliance intensities listed in Table 6.5.5.5.1 (a) or Table 6.5.5.5.1 (b), 6.5.5.6, or determined in accordance with the performance requirements of 6.5.5.7 are the minimum required intensities. It is acceptable to use a higher intensity visual notification appliance in lieu of the minimum required intensity.

Areas large enough to exceed the rectangular dimensions given in Figure A.6.5.5.5(a) through Figure A.6.5.5.5(c) require additional appliances. Often, proper placement of appliances can be facilitated by breaking down the area into multiple squares and dimensions that fit most appropriately [*see* Figure A.6.5.5.5(a) through Figure A.6.5.5.5(d)]. An area that is 40 ft (12.2 m) wide and 80 ft (24.4 m) long can be covered with two 60 cd appliances. Irregular areas and areas with dividers or partitions need more careful planning to make certain that at least one 15 cd appliance is installed for each 20 ft × 20 ft (6.1 m × 6.1 m) area and that light from the appliance is not blocked. [72:A.18.5.5.7]

A.6.5.5.5.6 This subsection is also intended to permit ceiling mounted visual notification appliances to be suspended below the ceiling, provided the visual notification appliance height is not below the viewing plane for any ceiling height. [72:18.5.5.7.6]

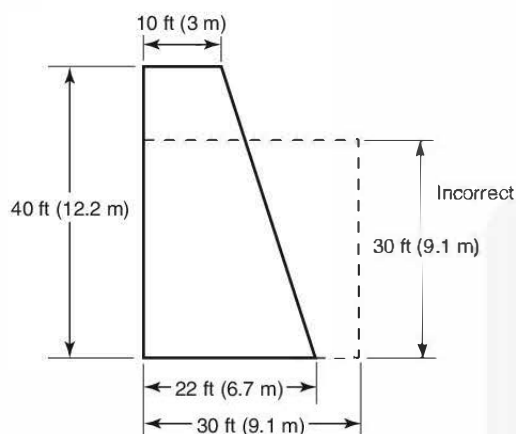
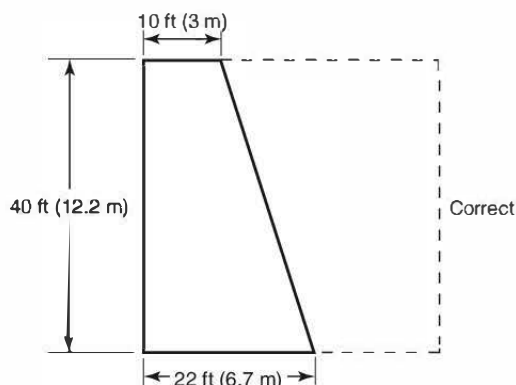
A.6.5.5.6 Because the occupants are usually alert and moving, and because their vision is focused by the narrowness of the space, corridor signaling is permitted to be by direct viewing of lower-intensity (15 cd) appliances. That is, the alerting is intended to be done by direct viewing of the visual notification appliance, not necessarily by its reflection off of surfaces (indirect viewing) as required for rooms in 6.5.5.5. [72:A.18.5.5.8]

Note that it is acceptable to use 6.5.5.5 (Spacing in Rooms) to determine the number and location of visual notification appliances in corridors. If 6.5.5.5 is used, it is not necessary to have a corridor visual notification appliance within 15 ft (4.6 m) of the end of the corridor. [72:A.18.5.5.8]

See Figure A.6.5.5.6 for corridor spacing for visual notification appliances. [72:A.18.5.5.8]

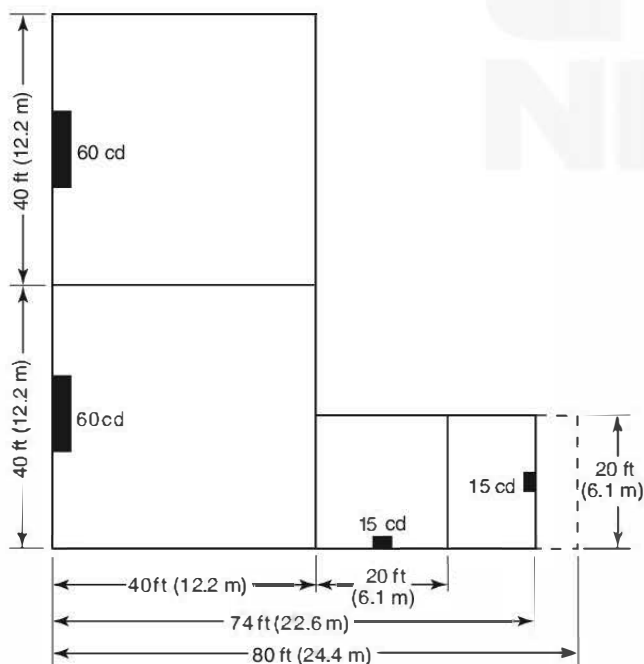
A.6.5.5.6.5 Visual notification appliances in corridors are permitted to be mounted on walls or on ceilings in accordance with 6.5.5.6. Where there are more than two appliances in a field of view, they need to be synchronized. [72:A.18.5.5.8.5]

Note that it is acceptable to use 6.5.5.5 (Spacing in Rooms) to determine the number and location of visual notification appliances in corridors. If 6.5.5.5 is used, it is not necessary to have a corridor visual notification appliance within 15 ft (4.6 m) of the end of the corridor. It is not the intent of this section to require visual notification appliances at or near every exit or exit access from a corridor. [72:A.18.5.5.8.5]



Note: Broken lines represent imaginary walls.

FIGURE A.6.5.5.5(a) Irregular Area Spacing.



Note: Broken lines represent imaginary walls.

FIGURE A.6.5.5.5(b) Spacing of Wall-Mounted Visual Notification Appliances in Rooms. [72:Figure A.18.5.5.7(b)]

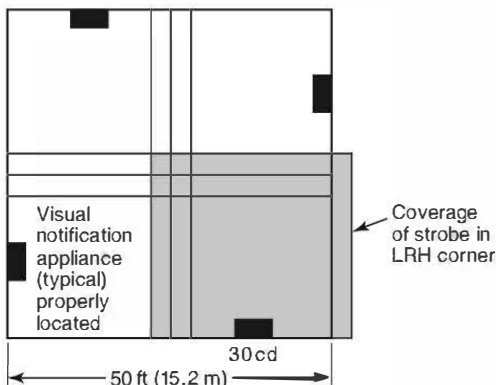


FIGURE A.6.5.5.5(c) Room Spacing Allocation — Correct. [72:Figure A.18.5.5.7(c)]

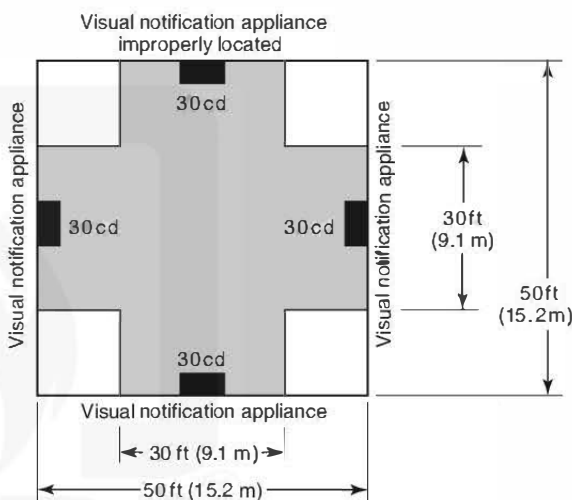


FIGURE A.6.5.5.5(d) Room Spacing Allocation — Incorrect. [72:Figure A.18.5.5.7(d)]

A.6.6 Though the number of visual notification appliances might be reduced in private operating mode settings, visual notification appliances might still need to be considered in spaces occupied by the public or the hearing impaired or subject to other laws or codes. [72:A.18.6]

A.6.8.2 The tone signal is used to evaluate the sound pressure level produced by loudspeaker appliances because of the fluctuating sound pressure level of voice or recorded messages. [72:A.18.8.1.2]

A.6.9 Textual and graphical visual appliances are selected and installed to provide temporary text, permanent text, or symbols. Textual and graphical visual appliances are most commonly used in the private mode for fuel gas alarm systems. The use of microprocessors with computer monitors and printers has resulted in the ability to provide detailed information in the form of text and graphics to persons charged with directing emergency response and evacuation. Textual and graphical visual appliances are also used in the public mode to communicate emergency response and evacuation information directly to the occupants or inhabitants of the area protected by the system. For both private mode and public mode signaling, text

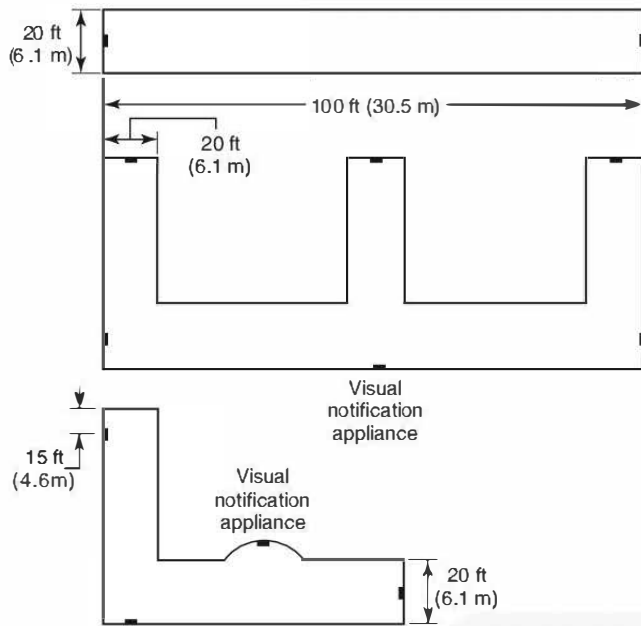


FIGURE A.6.5.5.6 Corridor Spacing for Visual Notification.
[72:Figure A.18.5.5.8]

and graphic annunciators can provide information about pre-alarm, alarm, trouble, and supervisory conditions. Because textual and graphical visual appliances do not necessarily have the ability to alert, they should only be used to supplement audible or visual notification appliances.

Textual and graphical visual information should be of a size and visual quality that is easily read. Many factors influence the readability of textual visual appliances, including the following:

- (1) Size and color of the text or graphic
- (2) Distance from the point of observation
- (3) Observation time
- (4) Contrast
- (5) Background luminance
- (6) Lighting
- (7) Stray lighting (glare)
- (8) Shadows
- (9) Physiological factors

[72:A.18.9]

While many of these factors can be influenced by the equipment manufacturer and by the building designers, there is no readily available method to measure legibility. [72:A.18.9]

A.6.9.4 Parts of this section on text characteristics are based on Section 703.5 of the updated accessibility guidelines in the US Access Board's ADA-ABA-AG. [72:A.18.9.4]

A.6.9.4.2 Signs are more legible for persons with low vision when characters contrast as much as possible with their background. Additional factors affecting the ease with which the text can be distinguished from its background include shadows cast by lighting sources, surface glare, and the uniformity of the text and its background colors and textures. [72:A.18.9.4.2]

Stroke width-to-height ratios are an important part of character legibility and are affected by contrast. Ratios for light characters on a dark background and dark characters on a light

background differ because light characters or symbols tend to spread or bleed into the adjacent dark background. To accommodate these differences, recommendations for symbol stroke width-to-character height ratios are as follows:

- (1) Positive image — Dark characters on a light background, ratio of 1:6 to 1:8
- (2) Negative image — Light characters on a dark background, ratio of 1:8 to 1:10

[72:A.18.9.4.2]

Source: Federal Aviation Administration (FAA) Human Factors Awareness Course available at <http://www.hf.faa.gov/webtraining/Intro/Intro1.htm>. [72:A.18.9.4.2]

A.6.9.4.4 The use of all uppercase characters in messages should be avoided as it decreases legibility. The exception is one- or two-word commands or statements such as stop, go, or exit stair. [72:A.18.9.4.4]

A.6.9.4.7 Paragraph 6.9.4.7 and the associated table does not apply to text and graphics displayed on desktop monitors. The standard does not list any specific sizing requirements for desktop monitors. However, 6.9.3 does require them to be clear and legible at the intended viewing distance. Other requirements in 6.9.4 such as contrast, sans serif fonts, and so forth should still apply to desktop displays. The specific requirements of Table 6.9.4.7 are taken directly from Section 703.5 of the updated accessibility guidelines in the US Access Board's ADA-ABA-AG. The table has been reformatted to be consistent with other parts of NFPA 715. [72:A.18.9.4.7]

A.6.9.4.8 The minimum height for textual and graphic visual appliances is given as 40 in. (1.02 m) above the ground or finished floor. However, the character or symbol sizes should be based on the height of the highest character or symbol displayed by the appliance. [72:18.9.4.8]

A.6.10.2 Notification appliances are available for the deaf and hard of hearing. These appliances include, but are not limited to, supplemental tactical notification appliances. Such tactile notification appliances can be capable of awakening people. Tactile appliances can initiate in response to the activation of an audible fuel gas alarm, through hard wiring into the fuel gas alarm system or by wireless methods.

Some tests show that visual notification appliances might not be effective in awakening some sleeping individuals during an emergency. Some tactile devices can be more effective in awakening individuals, regardless of hearing levels, from sleep. [72:A.18.10.2]

A.6.11 Emergency Services Interfaces. Annunciators, information display systems, and controls for portions of a system provided for use by emergency service personnel should be designed, arranged, and located in accordance with the needs of the organizations intended to use the equipment. [72:A.10.18.6]

Where annunciators, information display systems, and controls for portions of the system are provided for use by emergency service personnel, these should have a common design and operation to avoid confusion of users.

A.7.1.2 Some fuel gas utilities utilize remote metering equipment that enables monitoring and communication of gas consumption and other fuel gas delivery variables. In some cases, fuel gas utilities perform operational monitoring of jurisdictional piping systems by use of integrated gas sensors as part

of their overall gas safety pipeline integrity management program. In these cases, fuel gas utilities typically monitor these variables remotely. If an indication of a potential fuel gas release or leak is communicated to the utility, the utility will respond and investigate as part of their emergency response plan. Response actions are similar to a situation where a consumer notifies a utility of a potential fuel gas release or leak by detection of a gas odor.

A.7.2.1.1.2 If a fuel gas detector cannot be reset in accordance with Chapter 8, that could indicate that fuel gas is still present in the premises. Until such time that fuel gas can be excluded as the source of the alarm, the assumption should be that fuel gas is present and appropriate life safety precautions should be followed.

A.7.2.2 The supervising station should have a notification plan on file, the manufacturer's published instructions, and multiple points of contact with the subscriber when the account is added to their system. Once contacted, supervising station personnel should inform the subscriber to take action in accordance with the manufacturer's published instructions. If the manufacturer's published instructions are not available, supervising station personnel should inform the subscriber to take action in accordance with 9.6.8.3.

A.7.2.3 The communications center should have a notification plan on file, the manufacturer's published instructions, and multiple points of contact for the subscriber when the account is added to their system. Once contacted, the communications center should inform the subscriber of the action to take.

A.8.2.1.5 Service personnel should be able to do the following:

- (1) Understand the requirements contained in this standard, in *NFPA 72*, and the relevant requirements contained in *NFPA 70*
- (2) Understand basic job site safety laws and requirements
- (3) Apply troubleshooting techniques, and determine the cause of fuel gas detection system trouble conditions
- (4) Understand equipment specific requirements, such as programming, application, and compatibility
- (5) Read and interpret fuel gas detection system design documentation and manufacturer's inspection, testing, and maintenance guidelines
- (6) Properly use tools and test equipment required for testing and maintenance of fuel gas detection systems and their components
- (7) Properly apply the test methods required by this standard

A.8.2.2 Prior to any scheduled inspection or testing, the service company should consult with the building or system owner or the owner's designated representative. Issues of advance notification in certain occupancies, including advance notification time, building posting, systems interruption and restoration, evacuation procedures, accommodation for evacuees, and other related issues, should be agreed upon by all parties prior to any inspection or testing. [72:A.14.2.4]

A.8.2.4 The test plan is intended to clarify exactly what is to be tested and how it is to be tested. Testing of fuel gas alarm and signaling systems is often done in a segmented fashion to accommodate the availability of testing or other personnel or to minimize the interruption of building operations. Where a building owner has contracted the performance of inspection, testing, and maintenance activities to outside entities, the test plan, what will and will not be tested, should be reviewed by

those parties. Building operations can be affected by testing of the fuel gas alarm or signaling system itself and by the operation of emergency control functions actuated by the fuel gas alarm or signaling system. The boundary of the fuel gas alarm or signaling system extends up to and includes the emergency control function interface device. The testing requirements prescribed in NFPA 715 for fuel gas alarm and signaling systems end at the emergency control function interface device. The purpose of the test plan is to document what devices will and will not actually be tested.

The testing of emergency control functions, releasing systems, or interfaced equipment is outside the scope of NFPA 715. Requirements for testing other systems are found in other governing laws, codes, or standards. Requirements for integrated testing of combined systems also fall under the authority of other governing laws, codes, standards, or authority having jurisdiction.

Further information on testing associated with emergency control functions can be found in Table 8.4.3, Item 18 and its related annex material in A.8.4.3. [72:A.14.2.10]

A.8.3.1 Equipment performance can be affected by building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, improper installation, degree of cleanliness, or other obvious problems that might not be indicated through electrical supervision. [72:A.14.3.1]

The intent of 8.3.1 is to prevent an inspection being made at intervals exceeding those allowed by Table 8.3.1. Annual inspections should be made every 12 months; monthly inspections should be made every 30 days, and so forth. For example, it is not acceptable to conduct an annual inspection in January of year one, and December of year two (23 month frequency) just because Table 8.3.1 requires an inspection once each year. [72:A.14.3.1]

A.8.4.2 Reacceptance testing is performed to verify the proper operation of added or replaced devices, appliances, [fuel gas safety] control function devices, control units, and so forth. It is not the intent of the committee to unduly burden the system owner with increased costs for repeated testing of devices not directly affected by the replacement of devices with like devices. [72:A.14.4.2]

For example, if a 2 amp fuse is replaced with another 2 amp fuse in the fuel gas detection control unit, verification of the circuit(s) served by the fused supply is required, but it would not be necessary to test 10 percent of initiating devices not directly affected by replacing the fuse. Likewise, it is not necessary to test all these initiating devices whenever a fuel gas detector is replaced with a like fuel gas detector.

When wiring changes are made to correct improperly supervised circuits, a test of the affected device or appliance is required, but not a test of 10 percent of initiating devices not directly affected. [72:A.14.4.2]

A.8.4.2.4(2) The choice of devices chosen for this testing should allow for different locations/units/areas or other appropriate divisions to ensure it can discover any systematic software faults. If these tests discover any systematic software errors, appropriate changes should be made and the entire system should be tested end to end.

A.8.4.2.5 The functional test should be commensurate with the change made and can range from checking part of the system (only portions affected by the change if the change is limited and cannot affect operations of other portions of the overall system) up to the full system.

A.8.4.3 Table 8.4.3, Item 8(4). Ohmic testing is a means to determine the state of health of a VRLA battery's cells by measuring some form of a cell's internal resistance. Typically ohmic testing equipment uses one of three techniques—conductance, impedance, or resistance—to make these measurements. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

In simplest technical terms, ohmic technology is based on Ohm's Law, which expresses the relationship between volts, amperes, and ohms in an electrical circuit. Ohmic testing attempts to use voltage and current to determine the resistive characteristic of a battery's cells. As the cells in a battery age and start to lose capacity, the internal components of the battery are undergoing a degradation process. The degradation of these components (plates, grids, internal connection straps) within the battery's cells causes an increased resistance in the conduction paths of the cell, which in turn causes a change in the internal ohmic values. A measured increase in impedance or resistance, or a decrease in conductance, indicates the battery is losing its ability to produce the energy it was designed to deliver when called upon to support the connected loads. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

The key to effective application of ohmic testing is the appropriate trending of test results over time compared to a baseline or reference value. Studies have demonstrated that an individual battery produces a unique ohmic "signature" and the use of ohmic testing equipment to trend changes in this signature from installation through the life of the battery is the most effective use of the technology. A program that involves ohmic testing on a regular interval to note changes in the battery is a good maintenance practice. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

An ohmic baseline reference value is a benchmark value based on data collected from known good batteries. Reference values can be determined from site-specific measurement, or from testing a sample of new healthy batteries, or by using a generic baseline value to get started. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

- (1) The best baseline is one established on the installed battery within three to six months after installation and trend accordingly using good record keeping. Ideally the individual ohmic value should be measured at installation and again after the battery has been on float charge for at least 72 hours in order for it to reach a high state of stabilization. These initial "site-specific" values should be recorded and permanently affixed to the battery as a baseline for subsequent tests over the life of the battery. The ohmic value will typically increase for conductance and decrease for resistance and impedance between the initial installation and after being on float-charge for 90 to 180 days (10 percent to 15 percent depending on battery type and size). Six months after installation measure and compare the ohmic readings to the readings taken at installation. Use whichever value is greater for conductance or lower for resistance and impedance as the baseline for that particular battery at that site going forward. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

- (2) A sample of new healthy batteries in a fully charged state can be tested to obtain a baseline value representative of a new battery. A sample size of at least 30 batteries from one manufacturer with the same make, model, amp-hour rating, age (within 6 months), and manufacturing lot is recommended. Record the following information for the batteries:

- (a) Battery manufacturer
- (b) Model number
- (c) Date of manufacture
- (d) Manufacturing lot number (if available)
- (e) Battery temperature
- (f) Whether or not the battery has had a freshening charge
- (g) Battery voltage
- (h) Ohmic test value

[72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

Calculate the average ohmic value of the batteries. Do not include batteries that deviate more than 30 percent from the average because they could be outside of an acceptable range. Use the average value as a baseline starting point for this model battery. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

- (1) A generic baseline value for a specific battery model can often be found by contacting the ohmic test equipment manufacturer or from the battery manufacturer. While it is important to note that the use of generic reference values might not be as accurate, it is still possible to identify grossly failed batteries and significant changes in battery condition by applying this method. Generic baseline values are typical averages to be used as general guidelines and should only be used when no other data is available. When testing older batteries for which no initial site-specific ohmic value is available, reference values can be obtained in the following ways:

- (a) Contact the equipment or battery manufacturer for assistance.
- (b) Consult your company documentation to see if reference values were created for the battery you are testing.
- (c) Using ohmic readings of recently installed batteries of the same manufacturer and model of the battery, manufacturer and model of the alarm panel/system, charging circuit, and temperature at time of measurements, calculate the average ohmic value of the best 8 to 10 batteries and use this value as a baseline reference.

[72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

As a battery ages and loses capacity, the internal ohmic values change. Although the change might not be perfectly consistent over all battery models and sizes, experience and extensive test data shows that a deviation of ohmic values from the established baseline by 30 percent or more for conductance and 40 percent more for resistance or impedance indicates that the actual battery capacity has dropped to 80 percent or lower. (For lead-acid batteries, capacity drops off rapidly once the 80 percent capacity point is reached in the lifetime curve, so this is known as the "knee" of the capacity vs. lifetime curve). This 80 percent capacity is the level at which battery manufacturers recommend battery replacement. Figure A.8.4.3 illustrates an ohmic trend of a 5-year design life battery with an actual expected service life of 3 years. Note that while battery

Unit #1 still has good ohmic readings, semiannual measurements show Unit #2 failing prematurely. For this case, it is desirable to replace both units at the same time. If one unit fails at 2½ years, it is likely the second unit will fail in one of the next semiannual tests. Full replacement ensures that all units will “float” together. One exception might be when a unit fails in the first year. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

Ohmic testing can be a safe, simple, accurate, and reliable means of determining the state of health of VRLA batteries. It is important however to understand the following basic guidelines in order to maximize the benefits and avoid possible misleading test results:

- (1) Follow safety regulations: wear eye protection and remove metal jewelry, and so forth prior to working with batteries.
- (2) Conduct a visual inspection prior to testing. A cracked case, leaking terminal or post, or bulging battery should be replaced, not tested.
- (3) Temperature changes affect measured ohmic values and battery capacity. Ohmic measurements should be taken at 77°F (25°C) ±13°F (7°C).
- (4) For maximum accuracy and consistency, batteries should be tested when in a fully charged state.
- (5) Check the battery charging current prior to test. The charging current should be stable and be within the normal float current recommendations of the battery manufacturer for the battery model. If it is not, it is likely that the batteries have recently been discharged and a test is not appropriate until this float current stabilizes.
- (6) Whenever possible, ohmic readings should be taken each time with the same instrument, but as a minimum with the same model. Changing models will skew the data and require re-establishing the baseline.
- (7) When test equipment is provided with an alert, set the ohmic baseline and/or thresholds prior to beginning the test to provide an indication of any deviations from baseline.
- (8) It is essential to take ohmic measurements at the battery terminal or post. For consistency and accuracy, subsequent tests should always have probes or clamps placed at the same point while avoiding battery hardware such as bolt heads or washers. Connecting on the hardware will influence the readings and could cause replacement of a healthy battery.
- (9) Maintain good contact at the test point for the duration of the test. If the probe or clamp slips off during the test, an incorrect reading will result.
- (10) For batteries with fully insulated quick disconnect connectors, the battery should be taken offline by removing the quick disconnects from the battery terminals and then measuring and recording the internal ohmic value of the battery.
- (11) Do not condemn a battery based upon results of a single test without any trending data or an established baseline for that specific battery.
- (12) When one or more units in a battery falls outside the acceptable range from baseline, replace the entire string.
- (13) While testing online is the preferred method, it should be noted that the capability of ohmic meters varies. As such, the test equipment manufacturer might provide instructions to disconnect the battery and test offline. A battery tested online can display a different value than

when tested offline due to the charger circuit and load being across the battery. Always test the same way, either online or offline, to have consistent and meaningful results. When ohmic testing is performed online, a change in current occurs due to the ohmic test set signal that could impact battery voltage readings. Because battery float voltage is directly tied to float current, the sum of the voltages of each battery cell/unit have to equal the charger float voltage of the battery string. If a load is applied from the ohmic test set that depresses one cell/unit, then the others have to rise somewhat to offset it. As ohmic testing progresses through the battery string, each cell/unit gets pulled down by the ohmic test set somewhat, and the charger must boost the string current to maintain the voltage, raising the voltage of the cells/units that have not yet been tested. For this reason, voltage readings should be taken with a voltmeter prior to performing ohmic testing online.

[72:A.14.4.3.2 Table 14.4.3.2 Item 9(4)]

Table 8.4.3.2, Item 8(5).

Battery capacity is determined by the mass of active material contained in the battery and is a measure of the battery's stored energy. The rated capacity of small VRLA batteries used in fire alarm and signaling system applications is typically measured in ampere-hours (Ah) where the ampere-hour rating is based on the battery's capability to provide a constant current at the nominal battery voltage for 20 hours. The rated capacity might vary from manufacturer to manufacturer. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(5)]

The actual battery capacity during service life, often referred to as the state of charge (SOC), can vary significantly from rated capacity due to aging, charge and discharge cycles, temperature, and other factors. The unique failure modes of VRLA batteries due to aging and internal degradation are attributed for a high failure rate where the actual battery capacity has degraded to 80 percent of the manufacturer's rated capacity. As a result, battery manufacturers often recommend replacement much sooner than the rated design life for critical systems. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(5)]

A test of battery capacity is designed to determine if the battery is capable of continuing to deliver the voltage level specified by the manufacturer. The results of a capacity test can also be used to estimate where the battery is in its service life. A test of capacity is performed by applying a constant current load to the battery based on the manufacturer's published discharge rates until voltage falls to specified levels. Although discharging the battery for capacity testing concerns some, VRLA batteries are designed to handle numerous discharges within the limits established by the battery manufacturer. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(5)]

The discharge rate selected for testing should be representative of the battery duty cycle. At shorter test times, the test duration has a greater effect on the capacity calculation. For example, a 1-minute difference in actual test time for a 5-minute discharge rate compared to a 3-hour discharge rate will result in a greater deviation of the calculated capacity. The battery is also operating less efficiently at shorter discharge rates and the effects of aging and degradation might not be as prevalent during shorter discharges. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(5)]

Fuel gas detection and signaling system loading is typically insufficient for the practical application of a battery load test because the system load cannot be varied to maintain a constant current equal to the battery manufacturer's published discharge rates. The fixed load applied by the system will result in final voltage levels that are deceptively high. Battery sizing is also a factor. The calculated system loads for the battery duty cycle (e.g., 24 hours standby followed by 5 minutes in an alarm) will rarely align with published discharge rates necessary for load testing. In many applications where the battery size is large in comparison to the required system current, the system loading could be too small to accurately determine battery capacity. In these cases, a battery near failure could conceivably satisfy the low discharge rate applied by the fire alarm or signaling system.

In order to satisfy the load test requirements of Table 8.4.3, battery capacity testing can be performed in the following manner or in accordance with other methods such as those identified in IEEE 1188, *Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*.

- (1) Referring to the battery manufacturer's specifications, determine the load current for the 3-hour battery rating to the selected end voltage, typically 1.67 volts per cell (10.2 volts for a 12-volt system or 20.4 volts for a 24-volt system).
- (2) Record the battery temperature at the negative terminal.
- (3) Disconnect the charger and connect a load bank to the battery terminals.
- (4) Apply the constant current specified for the 3-hour rate to the battery. Once the constant current is applied, continue the test until the battery terminal voltage decreases to the specified end voltage.
- (5) Stop the test when the selected end voltage is reached.
- (6) Record the actual test duration in minutes.
- (7) Disconnect the load bank and reconnect the charger.
- (8) Calculate percent battery capacity as follows:

$$\% \text{ Capacity} = [T_{\text{actual}} / (180 \times K_T)] \times 100$$

where:

T_{actual} = the test duration in minutes

K_T = the temperature correction factor for the actual battery temperature at the start of the test from Table 8.4.3. Additional temperature correction factors can be obtained from IEEE 1188.

- (9) Replace the battery if the battery capacity is less than or equal to 80 percent. Replace the battery at the next scheduled test interval if the battery capacity is less than 85 percent.

[72:A.14.4.3.2 Table 14.4.3.2 Item 9(5)]

As a good practice, a new battery should be fully charged and then load tested following the battery manufacturer's recommendations prior to installation. A new fully charged battery should have a capacity of at least 90 percent. [72:A.14.4.3.2 Table 14.4.3.2 Item 9(5)]

Table 8.4.3, Item 18.

The extent of testing of a fire alarm or signaling system, including devices that were not tested, should be documented in accordance with the test plan in 8.2.4. NFPA 72 does not require testing of an emergency control function, such as eleva-

tor recall, but does require testing of the emergency control function interface device, such as the relay powered by the fire alarm or signaling system. Where the emergency control function is not being tested concurrent with the fire alarm or signaling system testing, measurement of the emergency control function interface device output should be verified using the proper test devices. This might require reading or observing the condition of a relay, a voltage measurement, or the use of another type of test instrument. Once testing is complete, verification that any disabled or disconnected interface devices have been restored to normal is essential, and this verification should be documented in the testing results. [72:Table 8.4.3, Item 24]

Testing of the emergency control functions themselves is outside of the scope of NFPA 715. A complete end-to-end test that demonstrates the performance of emergency control functions actuated by the fire alarm or signaling system might be required by some other governing laws, codes, or standards, or the authority having jurisdiction. In that situation, other applicable installation standards and design documents, not NFPA 715, would address testing and performance of the emergency control functions. [72:Table 8.4.3, Item 24]

Table A.8.4.3 Temperature Correction Factors

Temperature		
°F	(°C)	K_T
65	18.3	0.92
66	18.9	0.927
67	19.4	0.935
68	20	0.942
69	20.6	0.948
70	21.1	0.955
71	21.7	0.96
72	22.2	0.97
73	22.8	0.975
74	23.4	0.98
75	23.9	0.985
76	24.5	0.99
77	25	1
78	25.6	1.002
79	26.1	1.007
80	26.7	1.011
81	27.2	1.017
82	27.8	1.023
83	28.3	1.03
84	28.9	1.035
85	29.4	1.04
86	30	1.045
87	30.6	1.05
88	31.1	1.055
89	31.6	1.06
90	32.2	1.065
95	35	1.09
100	37.8	1.112

[72:Table A.14.4.3.2]

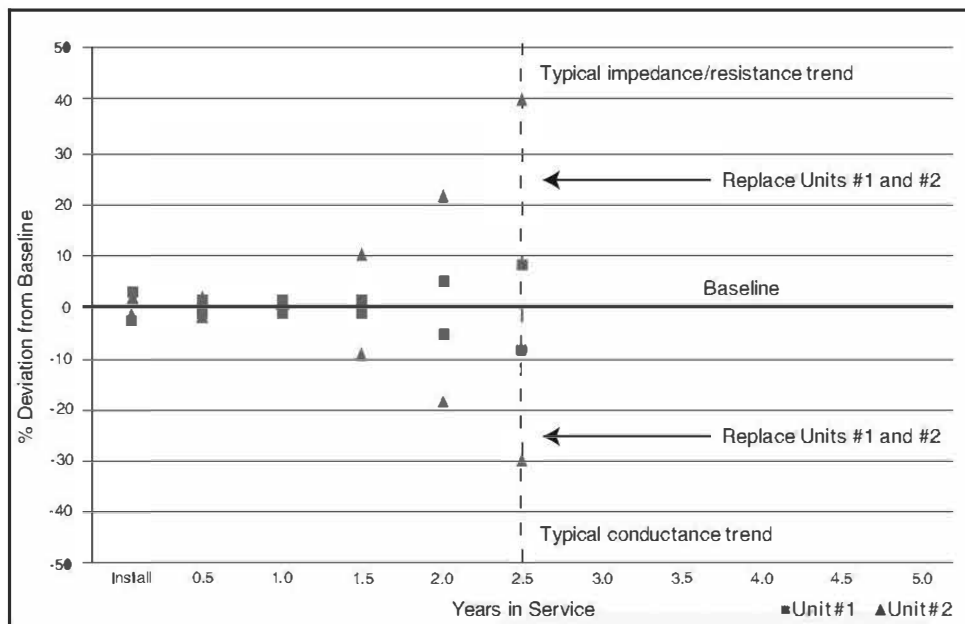


FIGURE A.8.4.3 Ohmic Trend Analysis for a 24-Volt Battery Made Up of Two 12-Volt Units.
[72:Figure A.14.4.3.2]

A.8.4.4 It is suggested that the annual test be conducted in segments so that all devices are tested annually. [72:A.14.4.4]

The intent of 8.4.4 is to prevent a test from being made at intervals exceeding those allowed by Table 8.4.3. Annual tests should be made every 12 months; monthly tests should be made every 30 days, and so forth. For example, it is not acceptable to conduct an annual test in January of year one, and December of year two (23-month frequency), just because Table 8.4.3 requires a test once each year. See the definition of frequency in 3.3.11 for minimum and maximum time between testing events. [72:A.14.4.4]

A.8.4.4.1 Examples of inaccessibility due to safety concerns include continuous process operations, energized electrical equipment, radiation risk, and excessive height.

A.8.4.5.4 Examples of indication at the detector or the control unit include, but are not limited to, an LED indication or analog output or display.

A.8.7.5 Permanent occupants, whether renters or owners, of a dwelling unit should be provided with training and information sufficient to operate, inspect, test, and maintain their own alarms. The information should cover basic maintenance requirements, testing, and troubleshooting procedures, and contact information for further support. It is not intended that occupants be trained to a level similar to that of a factory-trained technician or to qualify them to redesign, program, or extend their alarms without further training.

A.8.8.1.1 Unlike single- and multiple-station fuel gas alarms, fuel gas detection systems often do not have simple test buttons and have an added level of complexity for testing the system. It is considered an industry best practice to have a fuel gas detec-

tion system tested every 3 years to ensure proper operating conditions. Due to the added complexity of the system including the presence of the control panel, this requires a qualified service technician.

A.8.8.3 Permanent occupants, whether renters or owners, of a dwelling unit should be provided with training and information sufficient to operate, inspect, test, and maintain their own household alarm system. The information should cover basic maintenance requirements, testing and troubleshooting procedures, and contact information for further support. It is not intended that occupants be trained to a level similar to that of a factory-trained technician or to qualify them to redesign, program, or extend their systems without further training.

A.9.1.1 The manufacturer's published instructions are intended to provide device- or system-specific installation, operation, and maintenance requirements. These requirements could vary based on the fuel gas or gases the detector/system is intended to detect, the sensor technology utilized, and other device- or system-specific installation, operation, and maintenance variables.

A.9.3.3 This standard establishes minimum standards for the use of fuel gas warning equipment. The use of additional alarms or detectors over and above the minimum standard is encouraged. The use of additional devices can result in a combination of equipment (e.g., a combination of single- and multiple-station alarms or a combination of fuel gas alarms or fuel gas detectors that are part of a security/fuel gas detection system and existing multiple-station alarms). Though a combination is allowed, one type of equipment must independently meet the requirements of the standard. Compliance with the

requirements of the standard cannot rely on the combination of the following fuel gas warning equipment:

- (1) Single-station alarms
- (2) Multiple-station alarms
- (3) Household fuel gas detection system (includes a security/fuel gas system with fuel gas alarms or fuel gas detectors)

It is encouraged that the highest level of protection be used where possible. For example, if multiple-station alarms are added to an occupancy with compliant single-station alarms, the multiple-station alarms should be installed to replace all of the single-station alarms. Similarly, if a monitored household fuel gas detection system is added to a house that has compliant multiple-station alarms, monitored fuel gas alarms or fuel gas detectors should be installed to replace the multiple-station alarms or be installed to provide the same required coverage.

A.9.4.1 Hazardous concentrations of fuel gas can accumulate in a residence due to leaking or defective piping systems or connections to end-use devices of malfunctioning equipment such as boilers, water heaters, and cooking appliances.

While fuel gas is typically odorized by use of fuel gas odorants to impart a gassy odor, individuals that do not have a normal sense of smell might not detect a leak. Fuel gas alarms meeting the requirements of UL 1484, *Residential Gas Detectors*, or fuel gas detection systems meeting UL 2075, *Standard for Gas and Vapor Detectors and Sensors*, and installed in accordance with the applicable standard(s) should provide a significant additional level of protection against fuel-gas-related incidents.

The installation of fuel gas alarms or detection systems could result in a greater degree of protection in addition to gas odorants. Adding alarms to rooms where fuel-burning appliances are located could provide earlier warning of fuel gas hazards caused by those sources. Additional alarms located in rooms normally closed off from the required alarms could increase the escape time, since the fuel gas concentration needed to force the fuel gas out of the closed rooms to the alarms would not be necessary. As a consequence, the installation of additional fuel gas alarms should be considered.

Fuel gas alarms or detectors are not substitutes for properly odorized fuel gases, and proper maintenance, inspection, and testing of fuel-burning equipment. Fuel gas piping systems and fuel-gas-burning equipment and appliances should be used, maintained, tested, and inspected according to the manufacturers' instructions and all applicable standards.

Fuel gas alarms or detectors are cross-sensitive to hydrogen, a combustible gas that can be given off by recharging lead acid batteries. Where households include recharging stations (e.g., for golf carts), the alarm should be located away from the recharging location.

A.9.4.1.1 Where sleeping areas are separated and the audibility of the alarm or detector to occupants within each sleeping area could be seriously impaired, more than one unit could be needed. [72:A.29.7.1.1]

At times, depending on conditions, the audibility of notification appliances could be seriously impaired when occupants are in the bedroom area. For instance, there might be a noisy window air conditioner or room humidifier generating an ambient noise level of 55 dBA or higher. The detection device alarms need to penetrate through the closed doors and be heard over the bedroom's noise levels with sufficient intensity

to awaken sleeping occupants. Test data indicate that alarms with ratings of 85 dBA at 10 ft (3 m) that are installed outside the bedrooms can produce about 15 dBA over ambient noise levels of 55 dBA in the bedrooms. This sound pressure is likely to be sufficient to awaken the average sleeping person. [72:A.29.7.1.1]

Alarms or detectors located remote from the bedroom area might not be loud enough to awaken the average person. In such cases, it is recommended that units be interconnected in such a way that the operation of the remotely located detector or alarm causes an alarm of sufficient intensity to penetrate the bedrooms. The interconnection can be accomplished by the following:

- (1) Installation of a system
- (2) Wiring together of multiple-station alarms
- (3) Use of line carrier or radio frequency transmitters/receivers
- (4) Adding supplemental notification appliances

[72:A.29.7.1.1]

Examples of ancillary buildings are maintenance sheds, detached garages, summer kitchens, pool pump rooms, and structures other than important buildings as defined in NFPA 58.

A.9.4.1.1(1) Alarms or detectors should be located as close as practicable, but no closer than 3 ft (914 mm), to permanently installed fuel-gas-burning appliances and should not be placed in obstructed pathways, which is consistent with considerations of alarm or detector accessibility, sources of alarm or detector contamination, and nuisance sources. Siting considerations can include locations where gas pockets or layers of gas are likely to accumulate, where transient back-drafting spillage of flue gases during startup could occur, and near ventilation supply or exhaust vents.

A.9.4.1.1(3) As explained in NFPA 54/ANSI Z223.1, the "point of delivery," for other than undiluted liquefied petroleum gas (LP-Gas) systems, is the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted LP-Gas systems, the point of delivery is considered to be the outlet of the final pressure regulator, exclusive of line gas regulators where no meter is installed. Where a fuel gas meter is installed, the point of delivery is the outlet of the meter.

A.9.4.1.1(4) The requirements of 9.4.1.1(4) do not pertain to fuel gas detectors.

A.9.4.1.2(1) For natural gas, alarms or detectors located on a wall should be located as close as practicable to the ceiling in the same room as permanently installed fuel-gas-burning appliances.

A.9.4.1.2(2) For liquefied petroleum gas (LP-Gas), alarms or detectors located on a wall should be no more than 18 in. (457 mm) from but as close as practicable to the floor, in the same room as permanently installed fuel-gas-burning appliances.

A.9.4.2.3 A distinct continuous or temporal pattern signal is required to avoid the confusion of occupants and first responders, considering Temporal 3 and Temporal 4 signals already exist with similar devices (i.e., smoke, fire, carbon monoxide). The distinct signal must persist while the gas detector or alarm is in the presence of a detectable gas concentration; however,

after 4 minutes of continuous or temporal pattern audible signal, a 60-second time “off” between cycles is permitted to conserve battery life. Since fuel gases contain other leak detection warning agents (i.e., gas odorants) which allow for detection typically below alarm detection thresholds, this audible alarm pause option provides a reasonable, balanced approach to power conservation without compromising occupant or first responder awareness of the potential presence of fuel gas.

A.9.4.2.3(1) Examples of this type of signal include a single frequency (e.g., tone) or a combination of two or more frequencies when actuated.

A.9.4.2.4 Since hearing deficits are often not apparent, the responsibility for advising the appropriate person(s) of the existence of this deficit should be that of the hearing-impaired party.

A.9.4.2.4.1.1 As an example, governing laws, codes, or standards might require a certain number of accommodations be equipped for those with hearing loss or other disability. [72:A.29.5.10.1]

A.9.4.2.4.1.1(2) It is not the intent of this section to preclude devices that have been demonstrated through peer reviewed research to awaken occupants with hearing loss as effectively as those using the frequency and amplitude specified in this section. [72:A.29.5.10.1(2)]

A.9.4.2.4.1.2 Tactile notification appliances such as bed shakers have been shown to be effective in waking those with normal hearing to profound hearing loss (Ashley, et al. 2005, UL 1971, 2018). Tactile signaling has been studied and found to be an effective way to alert and notify sleeping persons. However, there are many variables that have not been tested that might affect the reliability of their performance. Some of the appliance variables include the mass of the appliance, frequency of vibration, and the throw or displacement of the vibrating mass. Occupant variables that might affect the reporting of test results and the effectiveness of the appliance include the person's age, how long a person has lived with their hearing loss, and what sleep stage the person is experiencing when the appliance operates. The type of mattress might also have an effect of the performance of certain tactile appliances. Mattress variables can include thickness, firmness, memory foam, pillow tops, water beds, air beds, and motion isolation mattresses. Users of tactile appliances should be cautioned to test how well they might sense the effect of the appliance. [72:A.29.5.10.2]

The standard requires both visual notification appliances and tactile appliances. Visual notification appliances can awaken sleeping persons, provide verification that there is a fuel gas alarm condition, and serve to alert persons when they are not in contact with a tactile appliance.

A.9.4.2.4.1.2(1) As an example, governing laws, codes, or standards might require a certain number of accommodations be equipped for those with hearing loss or other disability. [72:A.29.5.10.2(1)]

A.9.5.2.5 Restraining means are not intended to be used where the detector or alarm is designated to be plugged directly into a receptacle without a cord. [72:A.29.9.4(3)]

A.9.5.5 When visible signaling is to be provided, consideration should be given to the use of a household fuel gas detection system that has sufficient secondary (battery) power to support the proper operation of visible notification appliances.

A.9.6.1.2 Paragraph 9.6.1.2 requires a maximum fuel gas detection threshold of 25 percent LEL, but also will accept listed detectors and alarms with lower detection thresholds, including 10 percent LEL detectors and alarms. Using detectors and alarms with lower LEL detection thresholds should provide faster detection response. Currently, natural gas detection equipment is commercially available that is listed with a 10 percent LEL detection threshold. Listed liquefied petroleum gas (LP-Gas) detection equipment with a detectable level at 10 percent LEL is not as readily available to the public market as natural gas detection equipment.

Due to the current listing standards, there is not uniform adoption of 10 percent LEL detection for all fuel gas detectors and alarms. Until manufacturers are required by the test standard to meet this higher level of sensitivity to obtain a listing, up to 25 percent LEL detection is allowed. Based on the scientific studies, it is recommended that a 10 percent LEL detector or alarm is used when available.

A.9.6.1.2.1 UL 2075, *Gas and Vapor Detectors and Sensors*, addresses toxic and combustible gas and vapor detectors as well as sensors that include an assembly of electrical components coupled with a sensing means inside a chamber, or by separate components, to detect toxic or combustible gases or vapors. Detectors in UL 2075 cover a broad spectrum of applications, including residential, industrial, and commercial. Detectors are intended for monitoring environments for open-area protection and for connection to a compatible power supply or control unit for operation as part of gas detection or emergency signaling systems. In addition, UL 2075 addresses detectors solely for control of ventilation or shutoff devices, such as fans or control valves, as provided by the listing. UL 2075 also covers equipment intended for use in hazardous locations.

The scope of UL 1484, *Residential Gas Detectors*, addresses requirements for electrically operated fuel gas alarms intended for residential and recreational vehicle occupancies to detect fuel gases such as liquefied petroleum gas (LP-Gas) and natural gas. Devices are intended to be factory-built as a complete assembly of components functioning as a self-contained alarm device, including an element to detect gas concentration, an alarm-sounding appliance, and provision for connection to a power supply source. Devices are specifically not intended for use in hazardous locations as defined in NFPA 70, for industrial or commercial use, or for use as smoke and fire detectors or alarms.

Although UL 2075 does not cover self-contained and single- and multiple-station residential fuel gas alarms otherwise covered in UL 1484, those sensors, detectors, and alarms that are covered in UL 2075 must operate within the sensitivity parameters defined by the manufacturer and must not exceed alarm limits defined in UL 1484.

A.9.6.1.3 Fuel gas alarms or detectors could exhibit a positive response when acetone or ethanol are present. Laboratory interference tests on samples submitted for product performance testing will demonstrate that the alarm or detector does not respond to acetone or ethanol. Laboratory interference tests should consider the following:

- (1) Typical household spill levels can be estimated from a chemical spill scenario of 20 ml (0.7 oz) in an 810 ft³ (22.9 m³) room (9 ft x 12 ft x 7½ ft) (2.7 m x 3.7 m x 2.3 m).

- (2) The actual volume of acetone and ethanol tested should be ratioed to the test chamber size. The calculated volume of acetone or ethanol is placed in a shallow pan, 0.5 in. (13 mm) petri dish, or watch glass inside the test chamber.
- (3) A means to provide air movement in the test chamber to mix the chemical vapors with air must be included in the test setup. For example, a fan should be placed to blow over the liquid volume.
- (4) The fuel gas detectors should be energized during the exposure testing.
- (5) The exposure time for each chemical should be 15 minutes.
- (6) Fuel gas detection threshold measurements are to be made before and after the exposure.
- (7) Testing conditions are to be (68–77°F (20–25°C) and 40–60 percent relative humidity.
- (8) All other testing criteria should conform to that specified in UL 1484, *Residential Gas Detectors*.

A.9.6.1.8 When combined with smoke or carbon monoxide sensing functionality, fuel gas alarms are required to be replaced after a maximum of 10 years. Smoke alarms are required by NFPA 72 to be replaced after 10 years. This requirement is outlined in a reliability estimation in UL 217, *Smoke Alarms*, which is based on a specification of 4 failures per million hours from MIL-HDBK 217F, *Military Standardization Handbook*. The specification of 4 failures per million hours is also contained in UL 1484, *Residential Gas Detectors*, for residential fuel gas alarms. The 10-year replacement period in NFPA 72 balances the number of failures in smoke sensing alarms in the field and the cost and effort necessary to replace smoke sensing alarms.

A.9.6.4.2 Once these limits have been exceeded, a household fuel gas detection system should be installed.

A.9.6.8.1 A means of providing emergency access to all areas of the premises should be considered.

A.9.6.8.4.4 Refer to 26.3.4 of NFPA 72 for requirements for indication of central station service.

A.9.6.10.3 Receiving units that stay in alarm for 30 seconds or 1 minute longer than the transmitting alarm would provide additional protection if the first alarm is damaged. The persisting alarm signal would provide additional notification to occupants. This option needs to be considered in light of the potential for the longer alarm signals on receiving fuel gas alarms being a potential nuisance to occupants during test and other nuisance alarm events.

A.9.7.2.1 Fuel gas alarms or detectors could be susceptible to unwanted alarm signals triggered by vapors from petroleum, alcohols, or aerosols. Refer to the manufacturer's installation instructions for additional information. An alarm for such a condition might be anticipated and tolerated by the occupant of a dwelling unit through routine living experience. An alarm would not be acceptable if it also triggered detectors in other dwelling units or resulted in an alarm of detectors located in common-use areas. Unwanted alarms can occur, and inspection authorities should be aware of the ramifications that could result if the coverage is extended beyond the limits of a single dwelling unit.

A.9.9.3(7) The information should provide examples of organizations to be contacted for assistance.

Annex B Dangers and Properties of Fuel Gases

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Fuel Gases. A fuel gas is any gas intended to be burned to produce thermal energy. If the gas is released and the concentration is allowed to exceed the lower explosive limit (LEL), also called the lower flammable limit (LFL), an explosion risk will exist. If the gas is above the LEL and in the presence of an ignition source and an oxidizer, such as air, a fire or explosion could occur. As a result, it is important to warn occupants of the presence of fuel gas before the concentration reaches the LEL. The LEL of fuel gas mixtures is often estimated to be the LEL of the primary fuel gas constituent; for example, with natural gas, the LEL is based on methane (i.e., 5 percent by volume gas-in-air). However, the actual LEL for natural gas depends on the gas composition and is generally less than 5 percent gas-in-air when considering other mixed gas components such as ethane and other hydrocarbons that might be present. The actual LEL of a combustible gas mixture (LEL_{MIX}) can be calculated using the Le Chatelier's mixing rule and is calculated using the gas composition (in mol percent) from a complete gas analysis of the combustible gas and the LELs of the constituents as follows:

[B.1a]

$$LEL_{MIX} = \frac{100}{\left(\sum x_i / LEL_i\right)}$$

where:

x_i = mol percentage hydrocarbon component

i = gas mixture

LEL_i = component i 's LEL

The gas composition is typically determined with gas chromatography, in accordance with analytical methods in ASTM D1945, *Standard Test Method for Analysis of Natural Gas by Gas Chromatography*; GPA 2261, *Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography*; or GPA 2286, *Method for the Extended Analysis of Hydrocarbon Liquid Mixtures Containing Nitrogen and Carbon Dioxide by Temperature Programmed Gas Chromatography*. These methods provide the composition of natural gas in mol percent, which is equivalent to volume percent.

For example, calculate the LEL of a mixture of 90 percent methane (i.e., LEL 5 percent according to Table B.1) and 10 percent ethane (LEL 3 percent according to Table B.1):

[B.1b]

$$LEL_{MIX} = \frac{100}{\left(\frac{90}{5} + \frac{10}{3}\right)} = 4.7\% \text{ gas in air}$$

The requirements of this standard will not mitigate the release of gas and keep the concentration below the LEL; they will only serve to warn the occupants of the presence of fuel gas in the building. Gases also have an upper explosive limit (UEL), that, when exceeded, renders the mixture nonflammable. However, it is important to note that although a mixture below the LEL cannot ignite, a mixture above the UEL can be diluted and fall within the flammable range (i.e., between LEL and UEL). Since many gases do not have an odor and thus

might not be readily detected by smell, an odorant is often added to aid in detection. Although it is rare 1 in 1000, individuals are insensitive to the odorant added.

Gases will behave differently depending on their specific gravity (SG), which is the ratio of gas density to air:

Table B.1 shows the LEL, UEL, and SG of typical fuel gases.

B.1.1 Gas Density and Temperature Effects. Gases that have an SG less than 1 are less dense than air and will naturally rise within a space, thus detector placement must account for the tendency of the gas to rise. Gases that have an SG greater than 1 are denser than air and, absent air movement or thermal convection, will tend to naturally sink within a space, thus detector placement must account for the tendency of the gas to sink and concentrate in low areas.

The temperature of the released gas will also play a part—if a gas temperature is substantially warmer than the ambient air, the released mixture can rise initially, even if the relative density of the mixture at the ambient temperature is higher than that of the air. The converse could also be the case.

B.1.2 Gas Mixing. When a gas is released it will mix with the other gases in the volume, typically air, and the concentration of the gas will decrease. The mixing process occurs most quickly through natural or mechanical ventilation; however, some mixing will also occur through diffusion. Once the gas is mixed it will remain mixed unless it is removed through a chemical process, however continued dilution is possible and will decrease the concentration.

B.2 Gas Odorants as Fuel Gas Leak Warning Agents. The addition of odorants (i.e., sulfur containing compounds) to fuel gases as warning agents in case of leaks capitalizes on the ability of the human nose and olfactory system (i.e., sense of smell) to detect and recognize low parts per billion amounts of mercaptans. Fuel gas odorants are usually two or more sulfur-containing compounds that are classified into three groups: mercaptans, cyclic sulfides, and alkyl sulfides. Liquefied petroleum fuel gas, such as liquefied petroleum gas (LP-Gas), is typically odorized with ethyl mercaptan while pipeline natural gas systems use a variety of mercaptan compounds/blends with the most common being a tertiary-butyl-mercaptan (TBM) blend. The AGA Odorization Manual describes the chemical properties of fuel gas odorants and is referenced in Annex D.

Current federal code 49 CFR § 192.625 requires fuel gas to either contain a natural odorant or be odorized such that a person with an average sense of smell can readily detect it at a concentration in air of one-fifth of the lower explosive limit or

20 percent LEL (i.e., for pipeline natural gas approximately 1 percent gas-in-air and for liquefied petroleum gas (LP-Gas) approximately 0.42 percent gas-in-air). Some state jurisdictional requirements are more conservative requiring a 10 percent LEL minimum detectable threshold and lower (for example, in MA, the detection threshold is 0.15 percent gas-in-air).

However, as a practical matter, fuel gases are typically odorized to more conservative, higher levels, to enable detection while accounting for many variables affecting olfactory response. This typically results in olfactory detection thresholds less than 10 percent LEL. For example, the common natural gas odorant tertiary-butyl mercaptan is typically injected at a rate of 0.5 lb/MMSCF (8g/10³m³), resulting in an olfactory detection threshold typically less than 10 percent LEL. Similarly, for liquefied petroleum gas (LP-Gas), the amount of odorant injected (e.g., ethyl mercaptan is between 1 and 1.5 lb/10,000 gallons) exceeds the amount of odorant needed to meet the minimum detection threshold of 0.42 percent gas-in-air concentration.

In practice, fuel gas detectors should alarm at or below the practical odorization olfactory detection threshold based on current industry odorant injection practices. The consistency in approach between odor detection (typically less than 10 percent) and alarm activation will drive consistent behavior of consumers to act on an alert condition by odor detection and alarm activation.

Ideally, every person should be able to detect the odorant in fuel gas well before the concentration approaches the lower explosive limit. However, the fact is that there are some people whose olfactory response system is not able to detect the odorant. This could be due to age, a medical condition (e.g., a common cold), or the effects of medication, alcohol, tobacco, or drugs. In households having any of these conditions, the installation of a fuel gas detector can provide an additional measure of security.

Annex C Guidelines for Emergency Responders

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Guidelines for Occupants. How occupants respond to a fuel gas incident is essential for their safety.

Information on how occupants should respond to a fuel gas incident can be found through fuel gas industry sources. References include, but are not limited to, the following:

- (1) www.propane.com/newsroom/can-do-journal/what-to-do-if-you-smell-gas-in-the-home
- (2) www.aga.org/natural-gas/safe/smell-gas

It is important to note that the primary safety indicator for the presence of fuel gas and the potential of a fuel gas leak is the presence of a “gassy odor.” Odorants are sulfur compounds that impart a gassy odor, typically associated with the smell of a rotten egg, that are added to fuel gases for detection by an average sense of smell because fuel gases in their natural state are usually odorless. Gas odor detection by a person with an average sense of smell could precede fuel gas alarm activation; as a result, either a gas odor or a gas alarm should trigger identical response actions.

Table B.1 Properties of Common Fuel Gases

Fuel Gas*	LEL (% vol)	UEL (% vol)	Specific Gravity (@ STP)
Biomethane†	Varies	Varies	Varies
Ethane	3.0	12.4	1.065
Hydrogen	4.0	75.0	0.070
Iso-butane	1.8	8.4	2.006
Methane	5.0	15.0	0.554
Propane	2.1	9.5	1.522

*This table includes a broad list of gases that might require special consideration beyond detection requirements detailed in this standard.
†This is sometimes referred to as renewable natural gas.

Occupants are advised to act immediately if a gas odor is detected and an alarm is not activated. Do not wait for an alarm to activate!

Occupants are advised to act immediately if an alarm is activated and a gassy odor is not present. Do not wait for a gas odor to be present!

C.2 Guidelines for First Responders. How public emergency response organizations respond to fuel gas incident calls is essential for the safety of the building occupants and the emergency responders.

The following sources could provide further guidance for first responders:

- (1) <https://www.we-energies.com/firstresponders/electric-natgas-hazards-first-responder.pdf>
- (2) <https://Ngafirstresponder.com>

Emergency response organizations should contact the specific utilities in their area.

It is imperative for dispatchers answering a call for a gas odor or gas alarm to inform the fire department and appropriate utility operator as soon as possible. Clear and accurate information must be relayed. Where a utility has both electric and fuel gas service, the proper emergency contact(s) must be made.

Refer to 9.6.8.3 for specific guidance.

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

D.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 54, *National Fuel Gas Code*, 2021 edition.

NFPA 70®, *National Electrical Code®*, 2023 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2022 edition.

NFPA 731, *Standard for the Installation of Premises Security Systems*, 2023 edition.

NFPA 1192, *Standard on Recreational Vehicles*, 2021 edition.

“Combustible Gas Distribution in Residential Occupancies and Detector Location Analysis,” Fire Protection Research Foundation and Gexcon US, Inc., August 2020.

D.1.2 Other Publications.

D.1.2.1 AGA Publications. American Gas Association, 400 North Capitol Street, NW, Washington, DC 20001.

AGA XQ1702, *Odorization Manual*, 2017.

D.1.2.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D1945, *Standard Test Method for Analysis of Natural Gas by Gas Chromatography*, 2014, reapproved 2019.

D.1.2.3 GPA Publications. GPA Midstream Association 6060 American Plaza, Suite 700, Tulsa, OK 74135. <https://gпамidstream.org>

GPA 2261, *Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography*, 2000.

GPA 2286, *Method for the Extended Analysis of Hydrocarbon Liquid Mixtures Containing Nitrogen and Carbon Dioxide by Temperature Programmed Gas Chromatography*, 2014.

D.1.2.4 IEEE Publications. IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141.

IEEE 485, *Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications*, 2010.

IEEE 802.3af, *Standard for Information Technology — Telecommunications and Information Exchange Between Systems — Local and Metropolitan Area Networks — Specific Requirements — Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications — Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI)*, 2003.

IEEE 1188, *Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*, 2005.

D.1.2.5 ISO Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401 - 1214 Vernier, Geneva, Switzerland, www.iso.org

ISO/IEC 14763-3, *Information technology — Implementation and operation of customer premises cabling — Part 3: Testing of optical fibre cabling*, 2014.

D.1.2.6 Military Specifications. US Department of Defense Single Stock Point, Document Automation and Production Service, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-HDBK 217F, *Military Standardization Handbook*, 1974.

D.1.2.7 TIA Publications. Telecommunications Industry Association, 1310 North Courthouse Road, Suite 890, Arlington, VA 22201.

TIA 526, *Standard Test Procedures for Fiber Optic Systems*, 1992.

D.1.2.8 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 217, *Smoke Alarms*, 2020.

UL 1484, *Residential Gas Detectors*, 2016.

UL 2075, *Gas and Vapor Detectors and Sensors*, 2017.

D.1.2.9 US Government Publications. US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

ADA-ABA-AG, *Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines*, 2010.

Title 47, Code of Federal Regulations, Part 15, "Radio Frequency Devices."

Title 49, Code of Federal Regulations, Part 192.625, "Odorization of Gas."

D.1.2.10 Other Publications.

Ashley, E., DuBois, J., "Waking Effectiveness of Audible, Visual, and Vibratory Emergency Alarms Across All Hearing Levels," Fire Suppression and Detection Research Symposium, Orlando, FL 2005.

Report of research on emergency signaling devices for use by the hearing impaired (Subject 1971), Underwriters Laboratories, 1991.

D.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

An Experimental Study of the Buildup and Dispersal of Natural Gas in a House, Contract Research Report 169, BG Technology for the Health and Safety Executive, Leicestershire, England, 1988.

Bruck, D. and Thomas, I., "Smoke alarms for sleeping adults who are hard-of-hearing: comparison of auditory, visual, and

tactile signals," *Ear and Hearing*, 30(1), February 2009, pp. 73–80.

Bruck, D., Thomas, I., and Ball, M., "Optimizing Fire Alarm Notification for High Risk Groups Research Project — Waking effectiveness of alarms (auditory, visual and tactile) for the alcohol impaired," Report to the Fire Protection Research Foundation, June 2007.

"NYSEARCH Study for Natural Gas Dispersion and Detection in Residential Environments," Fire & Risk Alliance, LLC, Derwood, MD, March 2020.

"Natural Gas Dispersion Testing Report," Consolidated Edison Company of New York, Fire & Risk Alliance LLC, Derwood, MD, February 2018.

"Odorization Manual," American Gas Association (AGA), Washington, DC, April 2017.

Roby, R., "Smoke Detector Alert for the Deaf," Phase II SBIR, Final Report, NIH Grant No. 2R44 DC004254-2, May 27, 2005.

D.3 References for Extracts in Informational Sections.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2022 edition.

NFPA 1225, *Standard for Emergency Services Communications*, 2022 edition.

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Sequence of Events for the Standards Development Process

Once the current edition is published, a Standard is opened for Public Input.

Step 1 – Input Stage

- Input accepted from the public or other committees for consideration to develop the First Draft
- Technical Committee holds First Draft Meeting to revise Standard (23 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Technical Committee ballots on First Draft (12 weeks); Technical Committee(s) with Correlating Committee (11 weeks)
- Correlating Committee First Draft Meeting (9 weeks)
- Correlating Committee ballots on First Draft (5 weeks)
- First Draft Report posted on the document information page

Step 2 – Comment Stage

- Public Comments accepted on First Draft (10 weeks) following posting of First Draft Report
- If Standard does not receive Public Comments and the Technical Committee chooses not to hold a Second Draft meeting, the Standard becomes a Consent Standard and is sent directly to the Standards Council for issuance (see Step 4) or
- Technical Committee holds Second Draft Meeting (21 weeks); Technical Committee(s) with Correlating Committee (7 weeks)
- Technical Committee ballots on Second Draft (11 weeks); Technical Committee(s) with Correlating Committee (10 weeks)
- Correlating Committee Second Draft Meeting (9 weeks)
- Correlating Committee ballots on Second Draft (8 weeks)
- Second Draft Report posted on the document information page

Step 3 – NFPA Technical Meeting

- Notice of Intent to Make a Motion (NITMAM) accepted (5 weeks) following the posting of Second Draft Report
- NITMAMs are reviewed and valid motions are certified by the Motions Committee for presentation at the NFPA Technical Meeting
- NFPA membership meets each June at the NFPA Technical Meeting to act on Standards with “Certified Amending Motions” (certified NITMAMs)
- Committee(s) vote on any successful amendments to the Technical Committee Reports made by the NFPA membership at the NFPA Technical Meeting

Step 4 – Council Appeals and Issuance of Standard

- Notification of intent to file an appeal to the Standards Council on Technical Meeting action must be filed within 20 days of the NFPA Technical Meeting
- Standards Council decides, based on all evidence, whether to issue the standard or to take other action

Notes:

1. Time periods are approximate; refer to published schedules for actual dates.
2. Annual revision cycle documents with certified amending motions take approximately 101 weeks to complete.
3. Fall revision cycle documents receiving certified amending motions take approximately 141 weeks to complete.

Committee Membership Classifications^{1,2,3,4}

The following classifications apply to Committee members and represent their principal interest in the activity of the Committee.

1. M *Manufacturer*: A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
2. U *User*: A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
3. IM *Installer/Maintainer*: A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
4. L *Labor*: A labor representative or employee concerned with safety in the workplace.
5. RT *Applied Research/Testing Laboratory*: A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
6. E *Enforcing Authority*: A representative of an agency or an organization that promulgates and/or enforces standards.
7. I *Insurance*: A representative of an insurance company, broker, agent, bureau, or inspection agency.
8. C *Consumer*: A person who is or represents the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in (2).
9. SE *Special Expert*: A person not representing (1) through (8) and who has special expertise in the scope of the standard or portion thereof.

NOTE 1: “Standard” connotes code, standard, recommended practice, or guide.

NOTE 2: A representative includes an employee.

NOTE 3: While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of member or unique interests need representation in order to foster the best possible Committee deliberations on any project. In this connection, the Standards Council may make such appointments as it deems appropriate in the public interest, such as the classification of “Utilities” in the National Electrical Code Committee.

NOTE 4: Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

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Submit a Public Comment

Once the First Draft Report becomes available there is a Public Comment period. Any objections or further related changes to the content of the First Draft must be submitted at the Comment Stage. To submit a Public Comment follow the same steps as previously explained for the submission of Public Input.

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Header: View document title and scope, access to our codes and standards or NFCSS subscription, and sign up to receive email alerts.

 Current & Prior Editions	Research current and previous edition information.
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Information on the NFPA Standards Development Process

I. Applicable Regulations. The primary rules governing the processing of NFPA standards (codes, standards, recommended practices, and guides) are the NFPA *Regulations Governing the Development of NFPA Standards (Regs)*. Other applicable rules include NFPA *Bylaws*, NFPA *Technical Meeting Convention Rules*, NFPA *Guide for the Conduct of Participants in the NFPA Standards Development Process*, and the NFPA *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council*. Most of these rules and regulations are contained in the *NFPA Standards Directory*. For copies of the *Directory*, contact Codes and Standards Administration at NFPA headquarters; all these documents are also available on the NFPA website at “www.nfpa.org/regs.”

The following is general information on the NFPA process. All participants, however, should refer to the actual rules and regulations for a full understanding of this process and for the criteria that govern participation.

II. Technical Committee Report. The Technical Committee Report is defined as “the Report of the responsible Committee(s), in accordance with the Regulations, in preparation of a new or revised NFPA Standard.” The Technical Committee Report is in two parts and consists of the First Draft Report and the Second Draft Report. (See *Regs* at Section 1.4.)

III. Step 1: First Draft Report. The First Draft Report is defined as “Part one of the Technical Committee Report, which documents the Input Stage.” The First Draft Report consists of the First Draft, Public Input, Committee Input, Committee and Correlating Committee Statements, Correlating Notes, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.3.) Any objection to an action in the First Draft Report must be raised through the filing of an appropriate Comment for consideration in the Second Draft Report or the objection will be considered resolved. [See *Regs* at 4.3.1(b).]

IV. Step 2: Second Draft Report. The Second Draft Report is defined as “Part two of the Technical Committee Report, which documents the Comment Stage.” The Second Draft Report consists of the Second Draft, Public Comments with corresponding Committee Actions and Committee Statements, Correlating Notes and their respective Committee Statements, Committee Comments, Correlating Revisions, and Ballot Statements. (See *Regs* at 4.2.5.2 and Section 4.4.) The First Draft Report and the Second Draft Report together constitute the Technical Committee Report. Any outstanding objection following the Second Draft Report must be raised through an appropriate Amending Motion at the NFPA Technical Meeting or the objection will be considered resolved. [See *Regs* at 4.4.1(b).]

V. Step 3a: Action at NFPA Technical Meeting. Following the publication of the Second Draft Report, there is a period during which those wishing to make proper Amending Motions on the Technical Committee Reports must signal their intention by submitting a Notice of Intent to Make a Motion (NITMAM). (See *Regs* at 4.5.2.) Standards that receive notice of proper Amending Motions (Certified Amending Motions) will be presented for action at the annual June NFPA Technical Meeting. At the meeting, the NFPA membership can consider and act on these Certified Amending Motions as well as Follow-up Amending Motions, that is, motions that become necessary as a result of a previous successful Amending Motion. (See 4.5.3.2 through 4.5.3.6 and Table 1, Columns 1-3 of *Regs* for a summary of the available Amending Motions and who may make them.) Any outstanding objection following action at an NFPA Technical Meeting (and any further Technical Committee consideration following successful Amending Motions, see *Regs* at 4.5.3.7 through 4.6.5) must be raised through an appeal to the Standards Council or it will be considered to be resolved.

VI. Step 3b: Documents Forwarded Directly to the Council. Where no NITMAM is received and certified in accordance with the *Technical Meeting Convention Rules*, the standard is forwarded directly to the Standards Council for action on issuance. Objections are deemed to be resolved for these documents. (See *Regs* at 4.5.2.5.)

VII. Step 4a: Council Appeals. Anyone can appeal to the Standards Council concerning procedural or substantive matters related to the development, content, or issuance of any document of the NFPA or on matters within the purview of the authority of the Council, as established by the *Bylaws* and as determined by the Board of Directors. Such appeals must be in written form and filed with the Secretary of the Standards Council (see *Regs* at Section 1.6). Time constraints for filing an appeal must be in accordance with 1.6.2 of the *Regs*. Objections are deemed to be resolved if not pursued at this level.

VIII. Step 4b: Document Issuance. The Standards Council is the issuer of all documents (see Article 8 of *Bylaws*). The Council acts on the issuance of a document presented for action at an NFPA Technical Meeting within 75 days from the date of the recommendation from the NFPA Technical Meeting, unless this period is extended by the Council (see *Regs* at 4.7.2). For documents forwarded directly to the Standards Council, the Council acts on the issuance of the document at its next scheduled meeting, or at such other meeting as the Council may determine (see *Regs* at 4.5.2.5 and 4.7.4).

IX. Petitions to the Board of Directors. The Standards Council has been delegated the responsibility for the administration of the codes and standards development process and the issuance of documents. However, where extraordinary circumstances requiring the intervention of the Board of Directors exist, the Board of Directors may take any action necessary to fulfill its obligations to preserve the integrity of the codes and standards development process and to protect the interests of the NFPA. The rules for petitioning the Board of Directors can be found in the *Regulations Governing Petitions to the Board of Directors from Decisions of the Standards Council* and in Section 1.7 of the *Regs*.

X. For More Information. The program for the NFPA Technical Meeting (as well as the NFPA website as information becomes available) should be consulted for the date on which each report scheduled for consideration at the meeting will be presented. To view the First Draft Report and Second Draft Report as well as information on NFPA rules and for up-to-date information on schedules and deadlines for processing NFPA documents, check the NFPA website (www.nfpa.org/docinfo) or contact NFPA Codes & Standards Administration at (617) 984-7246.



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