

NFPA®

715

Standard for the
Installation of Fuel Gases Detection
and Warning Equipment

2023



NFPA® 715

Standard for the Installation of Fuel Gases Detection and Warning Equipment

2023 Edition



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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 705

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.



Technical Committee on Fuel Gases Warning Equipment

Stephen M. Olenick, Chair

Combustion Science & Engineering, Inc., MD [SE]

Jay Avanesian, CNIGuard, NY [M]

Mark S. Boone, AEGIS Insurance Services Limited, NJ [I]

Karen Crippen, Gas Technology Institute, IL [U]

Nick Dearing, CenterPoint Energy, IN [IM]

Luis Romeo Escobar, American Gas Association (AGA), DC [U]

Murtaza I. Gandhi, BakerRisk Engineering & Risk Consultants, Inc., TX [SE]

Rick Heffernan, SDi, NJ [M]

Rep. National Electrical Manufacturers Association

Fatima Gamal Ibrahim, JENSEN HUGHES, CA [SE]

Renee M. Lani, American Public Gas Association, DC [U]

Ron Lazarus, New Cosmos USA, IL [M]

Jim Loftus, Siemens, NJ [M]

Rep. Automatic Fire Alarm Association, Inc.

James Andrew Lynch, The Fire Solutions Group, PA [SE]

David E. Mills, UL LLC, IL [RT]

Larry Ratzlaff, Carrier/UTC/Kidde Safety, IL [M]

Richard Jay Roberts, Honeywell Fire Safety, IL [M]

Noah Ryder, Fire & Risk Alliance, MD [SE]

De L. San, SoCalGas, CA [IM]

Joel E. Sipe, Exponent, Inc., CA [SE]

Bruce J. Swiecicki, National Propane Gas Association, IL [U]
Rep. National Propane Gas Association

Robert Torbin, Omega Flex, Inc., MA [M]

Rick Trieste, Consolidated Edison Company of NY, NY [IM]

Christopher Wagner, AmeriGas Propane, PA [IM]

Ted A. Williams, Natural Gas Direct, LLC., VA [SE]

Robert D. Wilson, Northeast Gas Association, NY [IM]

Mike Woznicki, USI Electric, IL [M]

Alternates

Wayne J. Aho, Jr., Siemens, Industry Inc., NJ [M]

(Alt. to Rick Heffernan)

Christopher Creamer, DynaFire, FL [M]

(Alt. to Jim Loftus)

Howard Hopper, UL LLC, CA [RT]

(Alt. to David E. Mills)

Nasir Hussain, Combustion Science & Engineering, Inc., MD [SE]

(Alt. to Stephen M. Olenick)

Stephen J. Jordan, Fire And Risk Alliance LLC, MD [SE]

(Alt. to Noah Ryder)

Scott R. Lang, Honeywell International, IL [M]

(Alt. to Richard Jay Roberts)

Stuart Saulters, American Public Gas Association, DC [U]

(Alt. to Renee M. Lani)

Kazuaki Watanabe, Figaro USA Inc., IL [M]

(Alt. to Ron Lazarus)

Chad Duffy, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

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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2023 Edition

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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 evaluation.

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 $\frac{1}{2}$ 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☐ This system does not have monitoring modules.

Number of devices: _____

5.1.3 Other Initiating Devices☐ This system does have other initiating devices.

Describe: _____

6. SUPERVISORY SIGNAL-INITIATING DEVICES**6.1 Supervisory Devices**☐ This system does not have supervisory devices.

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

Describe: _____

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 OPERATONAL 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 of faults 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.