NFPA® 37

Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines

2024 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA® 37

Standard for the

Installation and Use of Stationary Combustion Engines and Gas Turbines

2024 Edition

This edition of NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, was prepared by the Technical Committee on Internal Combustion Engines. It was issued by the Standards Council on December 1, 2023, with an effective date of December 21, 2023, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See "Codes & Standards" at www.nfpa.org for more information.

This edition of NFPA 37 was approved as an American National Standard on December 21, 2023.

Origin and Development of NFPA 37

This document was created in 1904 as the "Rules and Requirements for the Construction and Installation of Gas and Gasolene *[sic]* Engines" by the Committee of Consulting Engineers of the National Board of Fire Underwriters. Editions of NBFU No. 37 were published in 1905 and 1910.

The document was then turned over to the NFPA Committee on Explosives and Combustibles, who produced the 1915 edition by combining the 1910 edition of NFPA 37 with the 1908 edition of NBFU No. 37A, "Rules and Requirements for the Construction, Installation and Use of Coal Gas Producers (Pressure and Suction Systems)." The 1915 edition was designated NFPA 37 – 37A, *Installation and Use of Internal Combustion Engines (Gas, Gasolene [sic], Kerosene, Fuel Oil) also Coal Gas Producers (Pressure and Suction Systems)*. Responsibility for the document was later transferred to the Committee of Gases, which produced revised editions of NFPA 37 – 37A in 1922 and 1934.

In 1955, responsibility for the standard was transferred to the Committee on Internal Combustion Engines, which eliminated the provisions addressing coal gas producers. Revised editions of the document were issued in 1959, 1963, 1967, 1970, 1975, 1979, 1984, 1990, 1994, 1998, 2002, 2006, 2010, 2015, 2018, and 2021.

The 1998 edition was reorganized. The 7500-horsepower limitation in the scope was removed, guidance for installing gas trains for gaseous-fueled engines was added, and requirements for engine exhaust systems were added.

The 2002 edition was revised and restructured to comply with the *NFPA Manual of Style*. New requirements were added for the containment of fuel spills. Additional requirements were added for spill prevention and containment through provisions for glass sight gauges or sight feeds for lubricating oil.

Revisions for the 2006 edition included new requirements for detached structures used specifically for housing engines or turbines and their appurtenances. A comprehensive section describing the required components of a gas train was added. Comprehensive requirements for gas regulators and manual shutoff valves were also added.

The 2010 edition incorporated enhanced and new definitions for *automatic safety shutoff valve*, *automatic safety vent valve*, *vent valve*, and *secondary containment tank*. A new subsection was added to establish specific safety component requirements for automatic safety shutoff valves as applied to gas turbines compared to those for internal combustion engines. A requirement for a double block valve arrangement in liquid fuel lines was added. The Control and Instrumentation chapter was completely revised to establish the minimum required protective control devices for engines and turbines. Changes to the chapter also included provisions to identify devices that can be replaced by alarms and new operator response procedures.

Revisions to the 2015 edition included requirements for engines and turbines to comply with wind and seismic design criteria. A requirement for a vent valve or valve proving system for a gas train was added. Requirements for a flame arrester when biogas fuels are used and for a filter or strainer in the fuel line were added. A requirement was also added to allow the use of a proof-of-closure switch or a valve proving system as alternatives to a vent valve between the two automatic safety shutoff valves. The annexes were expanded to address fire suppression system design for thin-walled gas turbines (based on aircraft engine designs). The performance criteria for total flooding gaseous agent suppression systems and local application gaseous agent suppression systems were also revised. A new subsection was added to address retrofitting existing fire suppression systems.

Revisions to the 2018 edition included adding provisions related to the proximity of engines and weatherproof enclosures to combustible construction. A new subsection addressing proper anchoring of flexible connectors was added. The allowable operating time for automatic safety shutoff valves (ASSVs) was revised from 1 second to 2 seconds to be consistent with ANSI Z21.21, *Automatic Valves for Gas Appliances*. The Overpressure Protection section was extensively revised to include requirements for protection of gas trains that operate between 2 psi and 125 psi. A requirement was also added for the investigation of any situation resulting in a trip of the high-pressure limit control prior to a manual reset. The annex text was extensively revised to address the concerns of products of combustion in the exhaust of stationary engines, particularly carbon monoxide.

The 2021 edition included revisions to fire test criteria to establish clearance distances for locating engines on roofs and outdoors. In addition, allowing a calculation under engineering supervision was added as an option for locating engines. A new annex on inspection, testing, and monitoring was added, and annex language was added clarifying that engine rooms, enclosures, or other locations are not classified based on *NFPA 70*®. Other new requirements included automatic safety shutoff valves being listed or specified by the engine or turbine manufacturer for an application. Chapter 8, on engine exhaust systems, was reorganized to include listings for factory-built chimneys. Finally, a new section on hybrid fire extinguishing systems was added.

Revisions to the 2024 edition include the introduction of new requirements on manifolding atmospheric vent lines and atmospheric vent line discharges. A new UL standard has been added to the references to assist AHJs in regulating vent terminations near combustible materials. In addition, new requirements on hydrogen-enriched fuels have been added to Chapters 5 and 11, and a new annex on the subject has been added to assist design engineers. Requirements for fire testing to demonstrate that an engine can be closer than 5 feet from a combustible structure have been revised. Requirements for pipe flanges and a definition for *proof-of-closure switch* have also been added. Finally, to align with *NFPA 70*®, *National Electrical Code*®, a requirement has been added to clarify that rooms do not require electrical classification solely due to the installation of an engine fuel system that includes either a belly tank or day tank.

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

Committee Scope: This Committee shall have primary responsibility for documents on the fire safety of the installation, operation, and control of internal combustion engines, including gas turbine engines, using all types of fuel, within structures or immediately exposing structures.

Contents

NFPA 37

Standard for the

Installation and Use of Stationary Combustion Engines and Gas Turbines

2024 Edition

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text should 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. This standard establishes criteria for minimizing the hazards of fire during the installation and operation of stationary combustion engines and gas turbines.

1.2 Purpose. This standard provides minimum fire safety requirements for the installation and operation of stationary combustion engines and gas turbines.

1.3 Application.

1.3.1* This standard applies to stationary combustion engines and gas turbines. This standard also applies to portable engines that remain connected for use in the same location for a period of one week or more.

1.3.2 This standard applies to new installations and to those portions of existing equipment and installations that are modified.

1.3.3 The effective date of application of this standard is not determined by NFPA. All questions related to applicability shall be directed to the authority having jurisdiction.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction and only where it is clearly evident that a reasonable degree of safety is provided.

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

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2* In determining the suitability of the equipment or component for use, the authority having jurisdiction shall consider the following:

(1) The equipment or component is listed for the intended use.
(2) The equipment or component meets the requirements of applicable standards through stamping or certification.
(3) The equipment or component displays the mechanical strength and durability for the intended application.
(4) The equipment or component is used in the same or a similar application as in this document.

1.6 Units and Formulas.

1.6.1* Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). These units are listed in Table 1.6.1 with conversion factors. Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection.

1.6.2 If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value shall be considered to be approximate.

Table 1.6.1 Units of Measurement

Name of Unit	Unit Symbol	Conversion Factor
meter	m	1 ft = 0.3048 m
millimeter	mm	1 in. = 25.4 mm
liter	L	1 gal = 3.785 L
kilopascal	kPa	1 psi = 6.89 kPa
kilowatt	kW	1 hp = 0.75 kW
watt	W	1 Btu/hr = 0.3 W
pascal	Pa	1 psi = 6894.757 Pa
bar	bar	1 psi = 0.0689 bar
bar	bar	1 bar = 10^5 Pa

1.6.3 All pressures expressed in this document shall be gauge pressures unless specifically noted otherwise.

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 2, *Hydrogen Technologies Code,* 2023 edition.
NFPA 10, *Standard for Portable Fire Extinguishers,* 2022 edition.
NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2024 edition.
NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2022 edition.
NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2022 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2022 edition.
NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2022 edition.
NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2024 edition.
NFPA 30, *Flammable and Combustible Liquids Code,* 2024 edition.
NFPA 54, *National Fuel Gas Code,* 2024 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2024 edition.
NFPA 70®, National Electrical Code®, 2023 edition.
NFPA 72®, National Fire Alarm and Signaling Code®, 2022 edition.
NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2024 edition.
NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2023 edition.
NFPA 770, *Standard on Hybrid (Water and Inert Gas) Fire-Extinguishing Systems,* 2021 edition.
NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2022 edition.

2.3 Other Publications.

Δ **2.3.1 ANSI Publications.** American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z21.21/CSA 6.5, *Automatic Valves for Gas Appliances,* 2019.

Δ **2.3.2 API Publications.** American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 2013, with Addendum 1 (2014), Addendum 2 (2018), and Addendum 3 (2021).

API STD 650, *Welded Tanks for Oil Storage,* 2020, with Errata 1 (2021).

Δ **2.3.3 ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250,* 2020.

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard,* 2020.

ASME B31.1, *Power Piping,* 2022.

ASME B31.3, *Process Piping,* 2020.

Boiler and Pressure Vessel Code, 2021.

N **2.3.4 ISO Publications.** International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO 7005, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems,* 2011.

ISO 7005, *Metallic flanges — Part 2: Cast iron flanges,* 1998.

ISO 7005, *Metallic flanges — Part 3:Copper alloy and composite flanges,* 1998.

2.3.5 MSS Publications. Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street, NE, Vienna, VA 22180-4602.

MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation,* 2018.

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

UL 103, *Factory-Built Chimneys for Residential Type and Building Heating Appliances,* 2010, revised 2021.

UL 429, *Electrically Operated Valves,* 2013, revised 2021.

UL 900, *Air Filter Units,* 2015.

UL 959, *Medium Heat Appliance Factory-Built Chimneys,* 2010, revised 2019.

UL 2200, *Stationary Engine Generator Assemblies,* 2020.

2.3.7 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

2.4 References for Extracts in Mandatory Sections.

NFPA 30, *Flammable and Combustible Liquids Code,* 2024 edition.
NFPA 54, *National Fuel Gas Code,* 2024 edition.
NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2023 edition.
NFPA 86, *Standard for Ovens and Furnaces,* 2023 edition.
NFPA *101®, Life Safety Code®,* 2024 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 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 phrases "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 Class I Fuel. For the purpose of this standard, any liquid fuel having a flash point below 37.8°C (100°F).

Δ **3.3.2 Combustible (Material).** A material that, in the form in which it is used and under the conditions anticipated, will ignite and burn; a material that does not meet the definition of noncombustible or limited-combustible. [***101***, 2024]

3.3.3* Enclosure. A cover or housing intended to protect an engine and related equipment.

3.3.4 Engines. Prime movers such as internal combustion engines, external combustion engines, gas turbine engines, rotary engines, and free piston engines using either gaseous fuels or liquid fuels or combinations thereof.

3.3.4.1 *Combustion Gas Turbine Engines.* An engine that produces shaft power utilizing the Brayton (joule) cycle, where atmospheric air is drawn in and compressed and the compressed air then flows into a combustion chamber where fuel is injected and continuous combustion occurs, resulting in high-pressure hot gas to the expansion section (turbine) where the heat energy is converted to rotating, mechanical energy.

3.3.4.2* *Engines for Emergency Use.* Engines that operate under limited-use conditions to support critical operations in the protection of life, property, or both.

3.3.4.3 *Portable Engines.* Engines mounted on skids, wheels, or otherwise arranged so that they can be moved from place to place as the required service dictates.

3.3.4.4* *Reciprocating Engines.* An engine that uses a spark plug to ignite a fuel–air mixture (e.g., Otto cycle engine) or an engine in which high-pressure compression raises the air temperature to the ignition temperature of the injected fuel (e.g., diesel cycle engine).

N **3.3.5 Flare System.** A gas combustion device used to provide for the safe disposal of flammable gases; also referred to as a gas flare or flare stack.

3.3.6 Flue Gas Temperature. The temperature of the flue products at the point or points of passing close to or through combustible materials or at the entrance to a chimney, whichever is applicable.

3.3.7 Gas Train. The portion of the fuel gas supply piping starting with and including the equipment isolation valve and extending to the point at which the fuel enters the prime mover.

3.3.8 Hazardous Location. An area where flammable or combustible gases or liquids or combustible dusts or flyings usually exist.

3.3.9* Horsepower Rating (Reciprocating Engines). The power of an engine measured at the flywheel or output shaft at standard SAE conditions of 752.1 mm Hg (29.61 in. Hg) barometer and at 25°C (77°F) inlet air temperature.

N **3.3.10* Hydrogen-Enriched Fuel.** A gas fuel that contains a hydrogen concentration greater than 25 percent by volume.

3.3.11 Inlet Gas Pressure. The pressure at the outlet of the equipment isolation valve.

3.3.12 Line Pressure Regulator. A pressure regulator placed in a gas line between the service regulator and the appliance shutoff valve. [**54,** 2024]

3.3.13 Overpressure Protection Device. A pressure-limiting or pressure-relieving device that prevents the downstream pressure from exceeding its set point.

N **3.3.14 Proof-of-Closure Switch.** A switch installed in a safety shutoff valve that activates only after the valve is fully closed. [**86,** 2023]

3.3.15 Rated Pressure. The maximum internal and external pressures that the materials, devices, or components are designed to contain or control, whichever is less.

3.3.16 Remote Location. A location suitably separated from the engine installation so as to be accessible during an engine fire.

3.3.17 Service Regulator. A pressure regulator installed by the serving gas supplier to reduce and limit the service line gas pressure to delivery pressure. [**54,** 2024]

3.3.18 Spark Protected. Electrical equipment enclosed in a tight case or protected by shields, screens, or insulation that contains sparks or prevents their emission.

3.3.19 Tank.

3.3.19.1 ***Engine-Mounted Tank.*** A fuel tank furnished and mounted on the engine or engine-frame by the engine manufacturer.

3.3.19.2* ***Fuel Tank.*** A tank containing fuel for an engine(s).

3.3.19.3 ***Secondary Containment Tank.*** A tank that has an inner and outer wall with an interstitial space (annulus) between the walls and that has a means for monitoring the interstitial space for a leak. [**30,** 2024]

3.3.20 Valve.

3.3.20.1* ***Automatic Safety Shutoff Valve (ASSV).*** A valve that, upon shutdown conditions, will automatically stop the flow of gas to the engine or turbine. *(See 5.5.4 and 5.5.5.)*

3.3.20.2 ***Automatic Safety Vent Valve.*** A valve that, upon closing of the automatic safety shutoff valves (ASSVs), automatically vents the volume of gas between the two ASSVs to atmosphere.

3.3.20.3 ***Carburetion Valve.*** A control valve that meets the functional requirements of an automatic safety shutoff valve (ASSV) by being capable of automatically stopping the flow of gas to the engine.

3.3.20.4* ***Equipment Isolation Valve.*** The manually operated valve that isolates the balance of the gas train and the prime mover from the gas supply.

3.3.20.5 ***Vent Valve.*** A valve used to allow venting of air or gas from the system to the atmosphere. [**85,** 2023]

3.3.21 Zero Governor Regulator. A gas pressure regulator equipped with a counter spring beneath the valve that requires an external impulse signal such as top loading with pressure or generating vacuum in the downstream piping.

Chapter 4 Engines — General Requirements

4.1 Engine Locations.

4.1.1 General Requirements.

4.1.1.1 Engines shall be situated so that they are readily accessible for maintenance, repair, and firefighting.

4.1.1.2* The air supply shall be designed to meet at least the minimum requirements for combustion, cooling, and ventilation and to prevent flue gas products from being drawn from stacks or flues of boilers or other combustion devices.

4.1.1.3* Combustible materials shall not be stored in rooms or enclosures housing engines, other than those combustible materials required for day-to-day operations/maintenance. Such materials shall be stored properly.

4.1.1.4 Engines fueled by a Class I fuel or by liquid-phase LP-Gas shall not be installed in rooms containing fired equipment or open flames.

Δ **4.1.1.5** Combustion air filters mounted directly on engines or turbines shall be listed in accordance with UL 900, *Air Filter Units.*

4.1.2 Engines Located in Structures.

4.1.2.1* Engine Rooms.

4.1.2.1.1 Engine rooms located within structures shall have interior walls, floors, and ceilings of at least 1-hour fire resistance rating, unless otherwise permitted by 4.1.2.1.2.

4.1.2.1.2 The ceiling of rooms located on the top floor of a structure shall be permitted to be noncombustible or protected with an automatic fire suppression system.

4.1.2.1.3* Engine rooms shall have ventilation that is adequate to prevent a hazardous accumulation of vapors, gases, or heat, both when the engine is operating and when it is shut down.

4.1.2.1.4 Engine rooms attached to structures shall comply with 4.1.2.2.1 and 4.1.2.2.3 except that the common wall shall have a fire resistance rating of at least 1 hour.

4.1.2.1.5* Openings from an engine room to other sections of the structure shall be provided with automatic or self-closing fire doors or dampers corresponding to the rating of the walls in which they are located.

4.1.2.1.6 Rooms containing engines utilizing a Class I fuel shall be located on an exterior wall, the construction of which shall provide ready accessibility for firefighting operations through the provision of doors, access openings, windows, louvers, or lightweight, noncombustible wall panels.

4.1.2.2 Dedicated Detached Structures.

4.1.2.2.1* Dedicated detached structures shall be of noncombustible or fire-resistive construction.

4.1.2.2.2 Dedicated detached structures shall be located at least 1.5 m (5 ft) from openings in walls and at least 1.5 m (5 ft) from structures having combustible walls. A minimum separation shall not be required where any of the following conditions exist:

(1) The exposing wall of the detached structure has a fire resistance rating of at least 1 hour.
(2) The exposed wall of the adjacent structure has a fire resistance rating of at least 1 hour.
(3) The detached structure is protected by an automatic fire protection system.

4.1.2.2.3* Dedicated detached structures shall have ventilation designed to prevent a hazardous accumulation of vapors, gases, or heat, both when the engine is operating and when it is shut down.

4.1.3 Engines Located on Roofs.

4.1.3.1 Engines and, if provided, their enclosures that are installed on roofs of structures shall be located at least 1.5 m (5 ft) from any openings in the walls of structures.

4.1.3.2 Engines and, if provided, their enclosures that are installed on roofs or structures shall be located at least 1.5 m (5 ft) from structures having combustible walls, except as permitted in 4.1.3.2.1, 4.1.3.2.2, or 4.1.3.2.3.

4.1.3.2.1 A clearance less than 1.5 m (5 ft) shall be permitted where all portions of the structure that are closer than 1.5 m (5 ft) from the engine enclosure have a fire resistance rating of at least 1 hour.

Δ **4.1.3.2.2*** A clearance less than 1.5 m (5 ft) shall be permitted where a fire test demonstrates that a fire originating at the engine will not ignite combustible structures.

N **4.1.3.2.2.1** Enclosures supplied with the engine or intended to be installed on the engine shall be included in the fire test.

4.1.3.2.2.2 If an engine assembly includes a nonrated fuel tank, the testing in 4.1.3.2.2 shall include the fuel tank.

4.1.3.2.3 A clearance less than 1.5 m (5 ft) shall be permitted where calculations performed under engineering supervision demonstrate that a fire originating at the engine or within its enclosure will not ignite combustible structures.

4.1.3.3* An oil containment system consisting of a curb or dike having a capacity at least equal to the total capacity of the lubricating oil system or the liquid fuel system, whichever is greater, shall be provided.

4.1.3.3.1 This system shall also comply with applicable requirements of Chapter 6.

4.1.3.4* The surface beneath the engine and beyond the engine and the oil containment dike shall be noncombustible to a minimum distance of 300 mm (12 in.).

4.1.4 Engines Located Outdoors.

4.1.4.1 Engines and, if provided, their enclosures that are installed outdoors shall be located at least 1.5 m (5 ft) from any openings in the walls of structures.

4.1.4.2* Engines and, if provided, their enclosures that are installed outdoors shall be located at least 1.5 m (5 ft) from structures having combustible walls, except as permitted in 4.1.4.2.1, 4.1.4.2.2, or 4.1.4.2.3.

4.1.4.2.1 A clearance less than 1.5 m (5 ft) shall be permitted where all portions of structures that are closer than 1.5 m (5 ft) from the engine enclosure have a fire resistance rating of at least 1 hour.

Δ **4.1.4.2.2** A clearance less than 1.5 m (5 ft) shall be permitted where a fire test demonstrates that a fire originating at the engine will not ignite combustible structures.

N **4.1.4.2.2.1** Enclosures supplied with the engine or intended to be installed on the engine shall be included in the fire test.

4.1.4.2.2.2 If an engine assembly includes a nonrated fuel tank, the testing in 4.1.4.2.2 shall include the fuel tank.

4.1.4.2.3 A clearance less than 1.5 m (5 ft) shall be permitted where calculations performed under engineering supervision demonstrate that a fire originating at the engine or within its enclosure will not ignite combustible structures.

4.2* Support of Engines. Engines shall be supported in accordance with the manufacturer's instructions.

4.3* Hazardous Locations. In hazardous locations, engines that neither compress a flammable gas nor pump a flammable liquid shall meet the following three criteria:

(1) They shall be installed in an enclosure or room of fire-resistive construction.
(2) They shall be ventilated from a nonhazardous outside area.
(3) They shall have a defined emergency egress path(s) acceptable to the authority having jurisdiction.

4.4 Engines Handling Hazardous Materials (Other Than Their Own Fuel Supply).

4.4.1 The use of an engine-driven unit to compress a flammable gas or to pump a flammable liquid shall be permitted provided the combination unit or groups of such combined units are isolated from areas not having a similar hazard.

4.4.2* Isolation shall be permitted to be achieved by either locating the unit outdoors or employing indoor structural separation in accordance with 4.1.2, except as modified by all of the following:

(1) Provision shall be made for the venting of an explosion.
(2) Rooms containing combustion engines located within structures shall have interior walls, floors, and ceilings of at least 2-hour fire resistance rating.
(3) The rooms or structures described in 4.4.2(2) shall be ventilated in an approved manner from a nonhazardous area.

4.4.3 Engine Accessories for Hazardous Locations.

4.4.3.1 Each spark-ignition engine comprising part of a unit that compresses a flammable gas or pumps a flammable liquid shall have magnetos or distributors and coils of the spark-protected type. All leads shall be positively attached.

4.4.3.2 Ventilation openings in such devices shall be protected by a fire screen unless the device is purged, pressurized, or otherwise protected in an approved manner.

4.4.3.3 Ignition wires shall be positively attached at each end by use of the outer sheath of the insulation.

4.4.3.4 Spark plugs shall be fully shielded against flashover. Fully radio-shielded spark plugs or spark plugs provided with insulating boots shall be permitted.

4.4.3.5 Flame-arresting equipment shall be attached to the engine air intake to avoid blowoff or rupture. A mechanically attached air filter shall be permitted to meet this requirement.

4.4.3.6 Starter, generator, and associated electrical equipment attached to engines shall be of the spark-protected type.

4.4.3.7 Fan belts shall be electrically conductive (nonsparking).

4.5 Electrical Installations.

4.5.1 Electrical installations shall comply with *NFPA 70*.

4.5.2* Engine rooms, enclosures, or other locations shall not be classified as hazardous locations as defined in Article 500 or 505 of *NFPA 70* solely by reason of the engine fuel system or a supply that consists of either a belly tank or a day tank associated with the engine fuel system, lubricating oil, or hydraulic fluid.

4.5.3 Engine Wiring. Wire and insulation materials shall have all of the following characteristics:

(1) Capacity to remain flexible over typical engine operating temperature ranges
(2) Capacity to have the minimum possible absorption of oils, fuels, and other fluids commonly found on or near the engine
(3) Rated for continuous use at the maximum range of temperatures that will occur where installed

4.5.3.1 Wiring shall be protected by either fuses or circuit breakers in accordance with its ampacity.

4.5.3.2 The wire shall be stranded annealed copper.

4.5.3.3 The ground circuits on engine wiring shall be permitted to be any of the following:

(1) Green
(2) Green with yellow trace
(3) Braided uninsulated cable

4.5.3.4* Electrical control circuits on engines not for emergency use shall be designed to shut down the engine automatically in the event of breaking, disconnecting, or cutting of the control wire.

4.5.3.5 The requirements of 4.5.3 shall not apply to ignition wiring, thermocouples, or microprocessor wiring.

4.5.4 Batteries, wiring, and electrical devices shall be protected against arcing and accidental shorting.

4.6* General Installation Requirements. Engines and their appurtenances shall be installed in accordance with the following:

(1) Applicable NFPA codes and standards
(2) Industry standards
(3) User requirements
(4) Manufacturer's installation instructions
(5)* Applicable local building codes with respect to wind and seismic design requirements.

Chapter 5 Fuel Supply — Gaseous

5.1* Gas Piping.

Δ **5.1.1** Gas piping shall be installed in accordance with the following methods:

(1) All fuel gas systems at service pressures equal to or less than a gauge pressure of 860 kPa (gauge pressure of 125 psi) shall be installed and tested in accordance with NFPA 54.
(2) All fuel gas systems at service pressures in excess of a gauge pressure of 860 kPa (gauge pressure of 125 psi), other than LP-Gas systems, shall be installed and tested in accordance with ASME B31.3, *Process Piping*.
(3) LP-Gas systems, whether liquid or vapor phase, shall be installed and tested in accordance with NFPA 58.
(4)* Hydrogen systems (95 percent or greater), whether liquid or gas phase, shall be installed and tested in accordance with NFPA 2.

5.1.2* Plastic pipe shall not be used to carry fuel within a room housing an engine(s).

5.1.3 Approved metallic flexible connectors shall be permitted for protection against damage caused by settlement, vibration, expansion, contraction, or corrosion.

5.1.4 Approved nonmetallic connectors shall be permitted for protection against damage caused by settlement, vibration, expansion, contraction, or corrosion except for LP-Gas in the liquid phase.

5.1.5 Flanged connections shall comply with the applicable requirements of ASME B16 or ASME B31 standards for pipe flanges, fittings, and gaskets or ISO 7005 standards for pipe flanges and fittings.

5.1.5.1 Raised-face flanges shall not be joined to flat-faced flanges.

N **5.1.5.2*** Aluminum raised-face flanges shall be permitted in the gas train.

5.1.6* Connectors used for vibration dampening shall be properly anchored and installed according to manufacturer's instructions.

5.2* Gas Trains.

Δ **5.2.1** Gas trains, as defined in 3.3.7, shall contain at least the following safety components:

(1) An equipment isolation valve
(2) A gas pressure regulator, if the prime mover does not operate at the gas supply pressure
(3) Two automatic safety shutoff valves (ASSVs)
(4) A manual leak test valve for each ASSV or an alternative means of proving the full closure of the ASSV
(5)* A low-pressure limit control for engines with a 732 kW (2.5 million Btu/hr) full-load input or greater
(6)* A high-pressure limit control that requires a manual reset as specified in 9.1.2 for engines with a 732 kW (2.5 million Btu/hr) full-load input or greater
(7) A flame arrester where biogases are used and there is risk of having oxygen in the biogas
(8) A flame arrester where a hydrogen-enriched fuel is used
(9) A gas filter or strainer
(10) Any other components or equipment that the manufacturer requires for safe operation

Δ **5.2.2** For gas trains for engines rated for or operating at more than a gauge pressure of 14 kPa (2 psi) inlet gas pressure to the equipment isolation valve, one of the following shall be provided:

(1) An automatic safety vent valve located between the two automatic safety shutoff valves that fails open without an externally applied source of power and discharges outdoors
(2) At least one safety valve fitted with a proof-of-closure switch
(3) A listed valve proving system (VPS) to prove the two automatic safety shutoff valves upon each startup or after each shutdown

5.3 Regulators.

5.3.1 Except as provided for in 5.3.1.1, a gas pressure regulator shall vent to the atmosphere outside the structure at a point at least 1.5 m (5 ft) away from any structure opening.

5.3.1.1 The following devices, when used with fuel gases containing less than 25 percent hydrogen, shall not be required to be vented to the outside when installed in accordance with their listing:

(1) Any regulator or zero governor that operates with gas pressure on both sides of the diaphragm
(2)* A full lock-up regulator
(3) A listed regulator incorporating a vent-limiting device
(4) A regulator incorporating a safety diaphragm that contains a vent-limiting device with an orifice sized for 0.07 m^3/hr (2.5 ft^3/hr) or less, based on natural gas
(5) A pressure switch incorporating a vent limiter or a safety diaphragm that contains a vent limiter with an orifice sized for 0.07 m^3/hr (2.5 ft^3/hr) or less, based on natural gas

N **5.4 Atmospheric Vent Lines.**

N **5.4.1*** Atmospheric vent lines shall comply with the following:

(1) The vent line(s) must be sized to prevent a backpressure or backflow that could cause improper operation of the device(s) or system(s) being vented.
(2) The discharge must be located away from and directed away from occupied areas.
(3) The discharge must be located away from sources of ignition, combustion air intakes, building ventilation systems, and the windows of an engine or combustion turbine room or adjacent buildings and is extended above the engine or combustion turbine room and adjacent structures so that gaseous discharge does not present a hazard.
(4) Terminations must be designed to prevent the entry of water, insects, or other foreign materials that could cause blockage.

N **5.4.2*** Where atmospheric vent lines are manifolded, the vent lines shall comply with all of the following:

(1) Vent lines from multiple engines or turbines are not permitted to be manifolded.
(2) Vent lines from the same engine or turbine serving similar devices are manifolded.
(3) Vent lines from devices operating at the compatible inlet pressures are manifolded.
(4) Vents from systems containing different fuels are not permitted to be manifolded.
(5) When vents are manifolded, the cross-sectional area of the manifold line must be not less than the greater of the following:
    (a) The cross-sectional area of the largest vent plus 50 percent of the sum of the cross-sectional areas of the additional vent lines
    (b) The sum of the cross-sectional areas of the two largest vent lines

5.5 Valves.

5.5.1* Manual Shutoff Valves.

5.5.1.1 Multiple manual shutoff valves shall be permitted in the gas train to allow additional isolation for maintenance reasons.

5.5.1.2 If the shutoff valve is locked open, the key shall be secured in a well-marked, accessible location near the valve.

5.5.1.3* A manual shutoff valve in a remote location shall be provided to isolate the fuel supply.

5.5.2* Equipment Isolation Valves. In multiple-engine installations, the equipment isolation valve shall be located no further from the engine than the first takeoff or branch pipe that serves only that engine.

5.5.3 Automatic Safety Shutoff Valves (ASSVs). The ASSVs, where required, shall be listed in accordance with ANSI Z21.21/CSA 6.5, *Automatic Valves for Gas Appliances*, or UL 429, *Electrically Operated Valves*, or be specified by the engine or turbine manufacturer for the particular application.

5.5.4* Automatic Safety Shutoff Valves (ASSVs) for Engines Other Than Gas Turbines. The ASSVs shall stop the flow of fuel within 2 seconds in the event the engine stops from any cause. The ASSV shall fail closed without an externally applied source of power.

5.5.4.1* When the fuel gas is supplied at a gauge pressure of 14 kPa (gauge pressure of 2 psi) or less, it shall be permissible to replace one of the ASSVs required by Section 5.2 with one of the following devices, provided the device is mounted downstream of an ASSV and the device will automatically shut off the flow of fuel within 2 seconds if the engine stops from any cause:

(1) Carburetion valve
(2) Zero governor–type regulating valve
(3) Auxiliary valve

5.5.4.1.1 The ASSV shall be permitted to be located downstream from one of the three devices listed in 5.5.4.1 if that device is vented outside the structure at a point at least 1.5 m (5 ft) away from any structure opening.

5.5.4.2* Where a carburetion valve or zero governor–type regulating valve is used as one of the required ASSVs, the downstream manual leak test valve shall not be required.

5.5.5 Automatic Safety Shutoff Valves (ASSVs) for Gas Turbines. The two ASSVs required by Section 5.2 shall operate as follows:

(1) One of the ASSVs shall stop the flow of fuel when the engine is shut down under normal conditions.
(2) Both ASSVs shall stop the flow of fuel if the engine must be shut down due to abnormal or emergency operating conditions as specified by the manufacturer.

5.5.5.1 The ASSV shall stop flow of fuel to the engine as follows:

(1) For combustion turbines supplied by piping 150 mm (6 in.) diameter or less, within 3 seconds
(2) For combustion turbines supplied by piping greater than 150 mm (6 in.) diameter, within 5 seconds

5.5.5.2 The ASSV shall fail closed without an externally supplied source of power.

5.5.5.3* It shall be permissible to replace one of the ASSVs with a control valve, provided the device will automatically shut off the flow of fuel within the time limits specified in 5.5.5.1(1) and 5.5.5.1(2), whichever is applicable.

5.5.5.4* If the engine is shut down for abnormal or emergency operating conditions as specified by the manufacturer, the automatic safety vent valve shall open automatically to depressurize the included piping.

N **5.5.5.4.1** The vent shall fail open without an externally supplied source of power and discharge outdoors.

5.5.5.5* One ASSV shall be located external to the combustion turbine package and any associated building.

5.6 Pressure-Boosting Equipment.

5.6.1 Boosters or compressors, if used, shall be approved for the service intended.

Δ **5.6.2** Receivers, if used, shall be certified with a stamp that they have been designed, constructed, and tested as required by Section VIII, Division 1, "Pressure Vessels," of the ASME *Boiler and Pressure Vessel Code*.

5.7 Overpressure Protection.

5.7.1 Overpressure protection shall be required for any fuel gas train subject to either of the following conditions:

(1) The inlet gas pressure exceeds both 14 kPa (2 psi) and the rated pressure of any downstream component
(2) The failure of a single upstream line pressure regulator results in an inlet gas pressure exceeding the rated pressure of any downstream component

5.7.1.1* When an overpressure protection device is required in 5.7.1, it shall be set to not exceed the following pressures:

(1) The set point of the device shall not exceed 150 percent of the rated pressure of the lowest rated component when the rated pressure of any component is less than 83 kPa (12 psi).
(2) The set point of the device shall not exceed 41 kPa (6 psi) above the rated pressure of the lowest rated component when the rated pressure of any component is equal to or greater than 83 kPa (12 psi) but less than 414 kPa (60 psi).
(3) The set point of the device shall not exceed 110 percent of the rated pressure of the lowest rated component when the rated pressure of any component is equal to or greater than 414 kPa (60 psi).

5.7.1.1.1 The overpressure protection device required in 5.7.1.1(3) shall also comply with the following:

(1) The overpressure protection device shall be any one device permitted in Section 5.9 of NFPA 54.
(2)* There shall be an active or passive means by which the activation of the overpressure protection device is detectable.
(3) Where a pressure relief valve(s) is used as the overpressure protection device, the relief valve and all connected vent piping shall be sized to accommodate the maximum anticipated flow due to the failure of the nearest upstream line pressure regulator.

N **5.7.2** Relief valves shall vent to the outside of the structure at a point at least 1.5 m (5 ft) away from any structure opening.

Chapter 6 Fuel Supply — Liquid

Δ **6.1* Design and Construction of Liquid Fuel Tanks.** Fuel tanks other than those mounted on the engine by the manufacturer for gravity feed to a carburetor shall meet one of the following criteria:

(1) Constructed in accordance with the applicable requirements of NFPA 30
(2) Listed as "Steel-Inside Tanks for Oil Burner Fuel"
(3) Listed as "Underground Tanks for Flammable Liquids"
(4) Listed as "Aboveground Tanks for Flammable Liquids"
(5) Constructed in accordance with API STD 650, *Welded Tanks for Oil Storage*
(6) Constructed in accordance with API STD 620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*

6.1.1 Metallic tanks shall be liquidtight with welded or brazed joints.

6.1.2 Nonmetallic tanks shall be of liquidtight, one-piece construction.

6.2* Installation Criteria for Fuel Tanks Containing Class I Fuels.

6.2.1 Tanks for Class I fuels shall be located underground or aboveground outside of structures.

6.2.2* Fuel tanks shall be installed in accordance with NFPA 30.

6.3* Installation Criteria for Fuel Tanks Containing Liquid Fuels Other Than Class I Fuels.

6.3.1 General. Engine-mounted tanks shall be securely mounted on the engine assembly and protected against all of the following:

(1) Vibration
(2) Physical damage
(3) Engine heat
(4) Exhaust piping heat

6.3.2 Fuel Tanks Inside Structures.

6.3.2.1 Fuel tanks inside structures shall be securely mounted on noncombustible supports.

Δ **6.3.2.2** Fuel tanks not in a room by themselves shall not exceed 2500 L (660 gal) capacity. Fuel tanks larger than 2500 L (660 gal) capacity shall be enclosed in a room in accordance with 6.3.5 or 6.3.6. Not more than one 2500 L (660 gal) capacity tank, or two or more tanks with an aggregate capacity of not more than 2500 L (660 gal), shall be connected to any one engine.

N **6.3.2.2.1*** Fuel tanks of any size shall be permitted within engine rooms or mechanical spaces if the engine or mechanical room is designed using recognized engineering practices with suitable fire detection, fire suppression, and containment means to prevent the spread of fire beyond the room of origin.

Δ **6.3.2.3** The aggregate capacity of all fuel tanks in a structure shall not exceed 5000 L (1320 gal) unless that portion exceeding 5000 L (1320 gal) is enclosed in a room in accordance with 6.3.5 or 6.3.6.

N **6.3.2.3.1** Fuel tanks of any size shall be permitted within engine rooms or mechanical spaces if the engine or mechanical room is designed using recognized engineering practices with suitable fire detection, fire suppression, and containment means to prevent the spread of fire beyond the room of origin. *(See A.6.3.2.2.1.)*.

Δ **6.3.2.4** Fuel tanks within structures shall be provided with spill containment consisting of either a wall, a curb, or a dike having a capacity at least equal to that of the largest tank enclosed.

N **6.3.2.4.1** A spill containment system of lesser capacity shall be permitted for fuel tanks within structures if equipped with an overflow or drainage system that is adequate in size and location to convey any spillage of fuel to a tank (inside or outside) or to a safe area outside the structure.

N **6.3.2.4.2** Listed or approved secondary containment tanks shall be considered as meeting the requirement of 6.3.2.4 if piping between the fuel tank(s) and the engine(s) is double-wall and protected from physical damage.

6.3.3 Fuel Tanks Outdoors (Aboveground or Underground) or Beneath a Structure. Fuel tanks located outside, either aboveground or underground, or located beneath a structure shall comply with the applicable provisions of NFPA 30.

6.3.4 Fuel Tanks on Roofs.

6.3.4.1 Fuel tanks on roofs shall be mounted securely on noncombustible supports.

Δ **6.3.4.2** Fuel tanks located on roofs shall be provided with spill containment consisting of a wall, a curb, or a dike having a capacity at least equal to that of the largest tank enclosed.

N **6.3.4.2.1** A spill containment system of lesser capacity shall be permitted for fuel tanks on roofs if equipped with an overflow or drainage system that is adequate in size and location to convey any spillage of fuel to a tank (inside or outside) or to a safe area outside the structure.

N **6.3.4.2.2** Listed or approved secondary containment tanks shall be considered as meeting the requirement of 6.3.4.2.

6.3.5* Rooms Housing Only Fuel Tanks with an Aggregate Capacity of 5000 L (1320 gal) or Less.

6.3.5.1 Rooms containing only fuel tanks with an aggregate capacity of 5000 L (1320 gal) or less shall be constructed of walls, floor, and ceiling having a fire resistance rating of not less than 1 hour with the walls bonded to the floor.

6.3.5.1.1 If the walls of such rooms extend to and are bonded to the underside of a concrete floor or roof above that has a fire resistance rating of not less than 1 hour, a separate ceiling shall not be required for the room.

6.3.5.1.2 At least 380 mm (15 in.) clearance shall be left around each tank for the purpose of inspection and repair.

6.3.5.2 Each tank room shall be provided with an opening that is protected by a self-closing 1-hour–rated fire door if it opens inside a building.

6.3.5.2.1 If an exterior door is provided, it shall be listed for fire exposures.

Δ **6.3.5.3** Each tank room shall be provided with spill containment consisting of either a wall, a curb, or a dike having a capacity at least equal to that of the largest tank.

N **6.3.5.3.1** A spill containment system of lesser capacity shall be permitted for tank rooms if equipped with an overflow or drainage system that is adequate in size and location to convey any spillage of fuel to a tank (inside or outside) or to a safe area outside the structure.

N **6.3.5.3.2** Listed or approved secondary containment tanks shall be considered as meeting the requirement of 6.3.5.3 if piping between the fuel tank(s) and the engine(s) is double-wall and protected from physical damage.

6.3.5.4* Ventilation.

6.3.5.4.1 Ventilation for tank rooms shall be sufficient to maintain the concentration of vapors within the room at or below 25 percent of the lower flammable limit (LFL) of the fuel used.

6.3.5.4.2 Ventilation shall be accomplished by mechanical or natural means and shall discharge to a safe location outside the building, without recirculation of the exhaust air.

6.3.5.4.3 Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation and shall be arranged to include all floor areas or pits where flammable vapors can collect.

6.3.6* Rooms Housing Only Fuel Tanks with an Aggregate Capacity of More Than 5000 L (1320 gal).

6.3.6.1 Rooms containing only fuel tanks shall be constructed of walls, floor, and ceiling having a fire resistance rating of not less than 3 hours with the walls bonded to the floor.

6.3.6.1.1 If the walls of such rooms extend to and are bonded to the underside of a concrete floor or roof above that has a fire resistance rating of not less than 3 hours, a separate ceiling shall not be required for the room.

6.3.6.1.2 At least 380 mm (15 in.) clearance shall be left around each tank for the purpose of inspection and repair.

6.3.6.2 Any opening of a tank room shall be protected by a self-closing 3-hour fire-rated door or damper assembly as applicable.

Δ **6.3.6.3** Each tank room shall be provided with spill containment consisting of either a wall, a curb, or a dike having a capacity at least equal to that of the largest tank.

N **6.3.6.3.1** A spill containment system of lesser capacity shall be permitted for tank rooms if equipped with an overflow or drainage system that is adequate in size and location to convey any spillage of fuel to a tank (inside or outside) or to a safe area outside the structure.

N **6.3.6.3.2** Listed or approved secondary containment tanks shall be considered as meeting the requirement of 6.3.6.3 if piping between the fuel tank(s) and the engine(s) is double-wall and protected from physical damage.

6.3.6.4 Floor openings shall be protected by a ramp or curb of sufficient height to contain the entire contents of the tank within the walls to the height corresponding to the level of fuel that will be retained.

Δ **6.3.6.4.1** The curb shall be built to withstand the lateral pressure due to the liquid head, and the walls and floor shall be liquidtight.

N **6.3.6.4.2** A spill containment system of lesser capacity shall be permitted for tank rooms if it is adequate in size and location to convey any spillage of fuel to a tank (inside or outside) or to a safe area outside the room.

6.3.6.5* Ventilation.

6.3.6.5.1 Ventilation for tank rooms shall be sufficient to maintain the concentration of vapors within the room at or below 25 percent of the LFL of the fuel used.

6.3.6.5.2 Ventilation shall be accomplished by mechanical or natural means and shall discharge to a safe location outside the building, without recirculation of the exhaust air.

6.3.6.5.3 Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation. That introduction of make-up air shall be arranged to include all floor areas or pits where flammable vapors can collect.

6.4 Installation Criteria for Fuel Tanks Containing Liquefied Petroleum Gases. LP-Gas systems in the liquid phase shall be installed in accordance with the provisions of NFPA 58.

6.5 Fuel Flow Control.

6.5.1 Liquid fuel supply systems, including drains from carburetors, shall be designed and installed to minimize, as far as practicable, the accidental discharge of fuel into the engine room or structure.

6.5.2 Alarms, float-controlled valves, or mechanical or remote-reading level gauges or protected sight glass gauges shall be installed to aid personnel in properly operating the fuel system.

6.5.3 Stationary-powered fuel pumps supplying fuel tanks shall have “stop” controls sensitive to a tank's high liquid level.

6.5.4 Fuel tanks supplied by pumps shall be provided with all of the following:

(1) An overflow line
(2) A high-level alarm
(3) A high-level automatic shutoff

6.5.4.1 The overflow line shall be continuous piping, without valves or traps, back to the source tank or to a collection system.

6.5.4.2 The capacity of the overflow line shall exceed the delivery capacity of the supply lines to the fuel tank.

6.5.5 Overflows, vents, fuel piping, and fuel tanks shall not be located at or near engine air intake, exhaust piping, mufflers, or filters.

6.5.6 Pressure relief valves and relief piping shall be provided where the potential exists to overpressurize the fuel system piping.

6.5.6.1 Relief piping shall be routed, without valves or traps, back to the source tank or to a collection system.

6.5.7* Fuels That Require Heating.

6.5.7.1 Fuel shall be constantly recirculated from the fuel tanks through heaters regardless of engine fuel demand.

6.5.7.2 Fuel-heating systems shall include thermostatic controls and suitable pressure and temperature gauges.

6.6 Filling.

6.6.1 Engine-mounted tanks for Class I fuels shall be filled by a closed piping system.

6.6.1.1 Filling by approved safety cans shall be permitted when the engine is shut down and engine surface temperature is below the autoignition temperature of the fuel.

6.6.2 Engine-mounted tanks for liquid fuels other than Class I fuels shall be filled by a closed piping system.

6.6.2.1 Filling from a container shall be permitted when the engine is shut down and engine surface temperature is below the autoignition temperature of the fuel.

6.6.3 Piping for fuel tanks, other than engine-mounted tanks, shall be in accordance with the provisions of 6.6.3.1 through 6.6.3.3, except as provided for in 6.6.3.4.

6.6.3.1 Piping for fuel tanks shall meet the applicable requirements of Chapters 21 and 27 of NFPA 30.

6.6.3.2 Tanks shall be filled by a closed piping system.

6.6.3.3 The fill pipe for each tank shall be provided on an exterior wall of the room or structure enclosing the tank at a point at least 600 mm (24 in.) from any building opening at the same or lower level.

6.6.3.4 A fill pipe terminating in accordance with 6.6.3.3 shall not be required for tanks that are filled manually at the fill connection on the tank, provided that the tank and its fill connection are located within the spill containment required by 6.3.2.4, 6.3.5.3, or 6.3.6.3 and the filling operation is constantly attended.

6.7 Vent Piping.

6.7.1 Vent piping shall be installed in accordance with Chapter 27 of NFPA 30.

6.7.1.1 The vent pipe shall terminate outside the building at a point at least 600 mm (24 in.) from any building opening at the same or lower level.

6.8 Fuel Piping, Valves, and Fittings.

6.8.1* Piping shall be in accordance with Chapter 27 of NFPA 30, except that piping shall be steel or other metal and the provisions of 6.8.2 shall apply.

6.8.2 Piping systems shall be supported and protected against physical damage and excessive stresses in accordance with MSS SP-58, *Pipe Hangers and Supports — Materials, Design, Manufacture, Selection, Application, and Installation.*

6.8.2.1* Approved metallic or nonmetallic flexible connectors shall be permitted to protect the piping system against damage caused by settlement, vibration, expansion, contraction, or corrosion.

6.8.3* Valves shall be provided to control the flow of liquid fuel in normal operation and to shut off the flow of fuel in the event of a pipe break.

6.8.3.1 The liquid fuel supply for a gas turbine shall include two stop valves or equivalent valves in series, with proof of closure, in the fuel line to each combustion turbine.

6.8.3.1.1 These valves shall operate automatically to stop the flow of fuel in the event the engine stops for any reason.

6.8.3.1.2 Means shall be provided to prevent or relieve excess pressure between these valves.

6.8.4 Piping to aboveground supply tanks filled from tank cars or tank vehicles by centrifugal pumps shall be provided with check valves to prevent backflow.

6.9 Transfer of Liquid Fuel to Engines. Liquid fuel shall feed to engines by pumps.

6.9.1 Fuel tanks mounted on the engine by the engine manufacturer for fuel feed to a carburetor shall be permitted.

Chapter 7 Lubricating Systems

7.1 General Requirements.

7.1.1 Lubricating oil reservoirs shall include the following protective devices:

(1) A flame arrester on the vent pipe, if the vent terminates in the exhaust gas path
(2) A high-oil-level alarm if the reservoir is filled automatically
(3) A remote shutdown switch for auxiliary lubricating oil pumps, if provided

7.1.2 The vent pipe specified in 7.1.1(1) shall not terminate in a location where the vapors can be drawn into the engine combustion air supply.

7.2 Combustion Gas Turbines.

7.2.1 Lubricating oil reservoirs provided with heaters shall be provided with a low-oil-level heater shutdown switch set to shut off the heater before the oil level falls to a level below the top of the heater element.

7.2.2 Lubricating oil reservoirs provided with a positive displacement lubricating oil pump shall be provided with a pressure relief valve.

7.2.3 Lubricating oil reservoir vent piping for combustion gas turbines driving compressors that handle flammable gases and utilize a combined lubricating oil and seal oil system shall not terminate in the exhaust gas path.

7.2.4 Lubricating oil reservoirs for combustion gas turbines driving compressors that handle flammable gases and utilize a combined lubricating oil and seal oil system shall be provided with a connection for an inert gas blanket.

7.3* Lubricating Oil Piping. Lubricating oil piping shall be in accordance with the provisions of 6.8.1, 6.8.2, and 6.8.3.

7.4 Reciprocating Engines.

7.4.1 On engines where crankcase explosions can be a hazard, explosion venting shall be provided or means shall be used to maintain a nonflammable atmosphere in the crankcase.

7.4.2 Auxiliary reservoir oil supply chambers, if used, shall be vented through either separate vents or a common venting system.

7.4.3 Engines designed to operate with a negative pressure in the crankcase and equipped with a separate lubricating oil sump shall be provided with check valves in the venting system from the sump.

7.5 Safeguards for Gauging Devices. Sight gauges or feeds for lubricating oil shall be protected against physical damage to prevent the escape of oil.

Chapter 8 Engine Exhaust Systems

8.1 Design and Construction.

8.1.1* Engines installed in structures shall have exhaust systems designed and constructed such that the system can withstand the anticipated exhaust gas temperatures.

8.1.2* Exhaust systems shall be designed and constructed to withstand the intended service.

8.1.2.1 Exhaust systems shall consist of metal, masonry, or factory-built chimneys where they pass through a floor, ceiling, attic, or concealed space.

8.1.2.1.1 Field fabricated or unlisted metal and masonry chimneys shall be designed and constructed in accordance with NFPA 211 or an engineered design.

8.1.2.1.2 Factory-built chimneys shall be listed in accordance with UL 103, *Factory-Built Chimneys for Residential Type and Building Heating Appliances*, for positive pressure applications or UL 959, *Medium Heat Appliance Factory-Built Chimneys*, and follow the requirements of NFPA 211.

8.1.3* If an engine exhaust system connects to the same flue as other fuel-burning appliances, the engine exhaust shall enter the flue a distance of at least 1½ times the equivalent diameter of the exhaust pipe or duct above or below the level of the other appliance vent(s).

8.1.3.1* An engine exhaust system that will discharge at positive pressure (greater than atmospheric pressure) shall not enter the same flue as an appliance that relies on natural draft to vent.

8.1.3.2 Common venting shall be permitted where appropriate calculations demonstrate that the exhaust from the engine does not reduce the performance of the other appliance(s).

8.1.4* Exhaust systems shall be designed and constructed to withstand forces caused by the ignition of unburned fuel or shall have provisions to relieve those forces without damaging the exhaust system.

8.1.5* Low points in exhaust systems shall have drains.

8.2 Installation.

8.2.1 Exhaust systems shall be connected to the engine to prevent the escape of sparks, flame, or flue gas within the structure.

8.2.2 Engine exhaust systems shall have one or more flexible connectors if necessary to minimize the risk of a leak in the engine exhaust system because of engine vibration or thermal expansion.

8.2.3 Exhaust System Termination.

8.2.3.1* Exhaust systems shall terminate outside the structure at a point where hot gases, sparks, or products of combustion will discharge to a safe location.

8.2.3.2 Exhaust system terminations shall not be directed toward combustible materials or structures or into atmospheres containing flammable gases, flammable vapors, or combustible dusts unless the engine generator assembly and exhaust system are listed to UL 2200, *Stationary Engine Generator Assemblies*, and the installation meets the manufacturer's minimum offset distances.

8.2.3.3 Exhaust systems equipped with spark-arresting mufflers shall be permitted to terminate in Division 2 locations or Zone 2 locations, as defined in Article 500 and Article 505 of *NFPA 70*.

8.2.4 Where necessary to prevent personnel burns, exhaust systems shall be guarded.

8.3 Clearance from Exhaust Systems with Exhaust Gas Temperatures of Less Than 760°C (1400°F). Exhaust systems with exhaust gas temperatures of 760°C (1400°F) or less shall comply with NFPA 211.

8.3.1 Unlisted exhaust pipes and ducts shall have clearances of at least 457 mm (18 in.) to adjacent combustible materials, except as specified in 8.3.2 and 8.3.3. The clearance shall be measured from the outside surface of the exhaust pipe or duct and not from any insulation that might be present.

8.3.2 Unlisted exhaust pipes and ducts passing directly through combustible roofs shall be guarded at the point of passage by ventilated metal thimbles that extend not less than 229 mm (9 in.) on each side (above and below) of roof construction and are at least 229 mm (9 in.) in diameter larger than the exhaust pipe or duct.

8.3.3 Unlisted exhaust pipes and ducts passing directly through combustible walls or partitions shall be guarded at the point of passage by one of the following methods:

(1) Metal ventilated thimbles not less than 300 mm (12 in.) larger in diameter than the exhaust pipe or duct
(2) Metal or burned fire clay thimbles constructed of brickwork or other approved fireproofing materials providing not less than 200 mm (8 in.) of insulation between the thimble and combustible material

8.4* Clearance from Exhaust Systems with Exhaust Gas Temperatures of 760°C (1400°F) or Greater. Exhaust systems with exhaust gas temperatures of 760°C (1400°F) or greater shall comply with NFPA 211.

Chapter 9 Control and Instrumentation

9.1 All Engines.

Δ **9.1.1** Each engine shall be equipped with an automatic engine speed control.

Δ **9.1.2*** Where a high-pressure limit control is required by 5.2.1(6), the conditions that result in a tripping of the control shall be investigated before a manual reset of the safety function is performed.

9.2 Reciprocating Engines.

9.2.1* Reciprocating Engines — 7.5 kW (10 hp) or More. Engines of 7.5 kW (10 hp) or more shall be equipped with protective devices or with equivalent provisions to shut down the engine when any of the following conditions occur:

(1) Engine overspeed
(2) High jacket water temperature or high cylinder temperature
(3) Low lubricating oil pressure or, in the case of a splash-lubricated engine, low oil level
(4) High lubricating oil temperature

Δ **9.2.1.1** Each engine shall also have provision for shutting down the engine at the engine and from a remote location.

Δ **9.2.1.2** Engines that have lubricating oil pumps that are not directly driven by the engine shall also have provision for shutting down the lubricating pump from a remote location.

Δ **9.2.1.3** For engines intended for emergency use or that are constantly attended, the protective devices for conditions specified in 9.2.1(2), 9.2.1(3), and 9.2.1(4) shall be permitted to be configured as alarms where written procedures exist and operators are trained in established actions to take if any of the stated events occur.

9.2.2* Diesel Engines. Diesel engines installed in hazardous locations shall also have provisions for shutting down the engine by shutting off both the fuel supply and the combustion air supply.

9.3 Combustion Gas Turbines.

Δ **9.3.1*** Combustion gas turbine engines shall be equipped with protective devices or with equivalent provisions to shut down the engine when any of the following conditions occur:

(1) Overspeed. Each engine shall have a primary overspeed shutdown control and a backup means for overspeed shutdown independent of the primary overspeed shutdown.
(2) Low lubricating oil pressure.
(3) High lubricating oil temperature.
(4) Excessive vibration.
(5) Flame failure.
(6) High exhaust temperature.

Δ **9.3.1.1** For combustion gas turbine engines that are intended for emergency use or that are constantly attended, the protective devices for conditions specified in 9.3.1(1), 9.3.1(2), and 9.3.1(5) shall be permitted to be configured as alarms where written procedures exist and operators are trained in established actions to take if any of the stated events occur.

Δ **9.3.2*** Combustion gas turbine engines shall also have the following controls:

(1) Main speed control
(2) Provisions for shutting down the engine from a remote location
(3) Provisions for shutting down, from a remote location, lubricating oil pumps not directly driven by the engine
(4) Means to automatically shut off the fuel supply in the event of engine shutdown

Δ **9.3.3** The combustion gas turbine starting sequence shall include a purge cycle that will result in a nonignitible atmosphere in the turbine and its exhaust system prior to the start of the ignition sequence and the introduction of fuel.

Chapter 10 Instructions

10.1 Operating Instructions.

10.1.1 At least one set of engine operating and maintenance instructions shall be supplied with each installation and shall contain the following:

(1) A detailed explanation of the operation of the engine
(2) Instructions for routine maintenance
(3) Detailed instructions for repair of the engine
(4) Pictorial parts list and parts numbers
(5) Pictorial and schematic electrical drawings of wiring systems, including all of the following:
  (a) Operating and safety devices
  (b) Control panels
  (c) Instrumentation
  (d) Annunciators
(6) Instructions on the operation of the fire safety features of the engine

10.1.2 Operating and maintenance procedures shall be developed and implemented for the engines and its auxiliaries based on the manufacturer's instructions and on generally accepted engineering principles and procedures.

10.1.3 One set of operating and maintenance procedures shall be located where they are readily accessible to personnel operating or maintaining the engine.

10.2* Emergency Instructions.

10.2.1* Emergency shutdown procedures shall be developed and provided for the engine.

10.2.2 A diagram shall be posted conspicuously near the engine, indicating the location of the fuel shutoff valve(s). Diagrams shall not be required for installations with clearly identified fuel shutoff valves.

10.2.3 Emergency operating procedures shall be located where they are readily accessible to personnel operating or maintaining the engine.

10.3* Training. Individuals responsible for the operation and maintenance of the engine shall be trained in operating and maintenance procedures, including emergency shutdown procedures. *(See Chapter 11 for fire protection features.)*

Chapter 11 Fire Protection Features

11.1* General. A fire risk evaluation shall be performed for each engine installation, including engine auxiliary equipment, with respect to the following:

(1) Design
(2) Layout
(3) Operating requirements

11.2 Portable Fire Extinguishers.

11.2.1* Portable fire extinguishers, where provided, shall comply with NFPA 10.

11.3 Fire Detection and Alarm Systems.

11.3.1* Automatic fire detection and alarm systems, where provided, shall comply with *NFPA 72.*

11.3.2 The electrical installation and required rating of system components shall comply with *NFPA 70.*

11.3.3 Automatic fuel stop valves, where required by other sections of this standard, shall be arranged to close upon activation of the fire detection system within the fire alarm zone that covers the engine installation, including auxiliary equipment.

11.3.3.1 Where written procedures are in place to direct operator actions upon activation of the detection system, automatic fuel stop valves for engines that are used for emergency use or for engines that are constantly attended shall be permitted to remain open.

11.3.4 Mechanical ventilation systems, where provided, shall be arranged to shut down upon activation of the fire detection system within the engine enclosure.

11.3.4.1 Where procedures are in place to direct operator actions, mechanical ventilation systems for engines that are used for emergency use or for engines that are constantly attended shall be permitted to remain in operation.

11.4 Fire Suppression Systems and Equipment.

11.4.1 Fixed Fire Suppression Systems.

11.4.1.1* Fixed fire suppression systems, where provided, shall comply with the following standards, as appropriate, unless specifically noted otherwise in this standard:

(1) NFPA 11
(2) NFPA 12
(3) NFPA 12A
(4) NFPA 13
(5) NFPA 15
(6) NFPA 17
(7) NFPA 750
(8) NFPA 770
(9) NFPA 2001

11.4.1.2 Fixed fire suppression systems shall be designed to protect all areas where fuel or oil might spray, flow, or collect.

11.4.2 General.

11.4.2.1* Automatic fuel stop valves, where required by other sections of this standard, shall be arranged to close upon activation of the fire suppression system that covers the engine installation, including auxiliary equipment.

11.4.2.1.1* Where procedures are in place to direct operator actions upon activation of the fire suppression system that covers the engine installation, automatic fuel stop valves for engines that are for emergency use or for engines that are constantly attended shall be permitted to remain open.

11.4.2.2 Mechanical ventilation systems, where provided, shall be arranged to shut down upon activation of the fire suppression system within the engine enclosure.

11.4.2.3* Where procedures are in place to direct operator actions upon activation of the fire suppression system within the engine installation, mechanical ventilation systems for engines that are for emergency use or engines that are constantly attended shall be permitted to remain in operation.

11.4.2.4 The positioning of the fire suppression systems and equipment shall be such that maintenance access to the engine is maintained.

11.4.3* Foam Fire Suppression Systems. Foam fire suppression systems shall be designed to provide a foam blanket or foam submergence until it can be demonstrated that the engine has cooled to below the autoignition temperature of combustible material present.

11.4.4* Gaseous Agent Fire Systems.

N **11.4.4.1*** The design of fire suppression systems for hydrogen-enriched fuels shall comply with the applicable standard listed in 11.4.1.1.

11.4.4.2* Total flooding gaseous agent systems shall be designed to take into consideration both of the following factors:

(1) The agent concentrations required for the specific combustible materials involved
(2) The specific configuration of the equipment and enclosure

11.4.4.2.1* Total flooding gaseous suppression systems shall be designed to maintain the design concentration within the enclosure for a time sufficient to ensure that the fire is extinguished and that surface temperatures of the engine or turbine have cooled to below the autoignition temperature of combustible material present. In lieu of manufacturer or laboratory fire test data demonstrating the actual time to achieve extinguishment and cool-down, the concentration shall be maintained for a minimum of 20 minutes.

11.4.4.3* Local application gaseous agent suppression systems shall be designed to operate for a time sufficient to ensure that the fire is extinguished and that surface temperatures of the engine or turbine have cooled to below the autoignition temperature of combustible material present. In lieu of manufacturer or laboratory fire test data demonstrating the actual time to achieve extinguishment and cool-down, the discharge duration shall be maintained for a minimum of 20 minutes.

11.4.5 Automatic Sprinkler and Water Spray Systems.

11.4.5.1* Automatic sprinkler systems shall be designed to provide a density of 12.2 mm/min (0.3 gpm/ft^2) over the most remote 230 m^2 (2500 ft^2).

11.4.5.1.1 Sprinklers and spray nozzles shall be spaced at a 9 m^2 (100 ft^2) maximum area of coverage per sprinkler or spray nozzle.

11.4.5.1.2 Sprinkler and water spray system coverage shall be provided to all areas within the enclosure located within 6 m (20 ft) of the following:

(1) The engine
(2) The lubricating oil system
(3) The fuel system

11.4.5.2 Sprinklers and water spray nozzles shall not be directed at engine components that are susceptible to thermal shock or deformation.

11.4.6 Dry Chemical Fire Suppression Systems. Dry chemical fire suppression systems shall be designed to operate for a minimum of 20 minutes or until it can be demonstrated that the engine has cooled to below the autoignition temperature of combustible material present.

11.4.7* Water Mist Suppression Systems. Water mist suppression systems shall be designed and installed in accordance with their listing for the specific hazards and protection objectives specified in the listing.

11.4.8 Hybrid Fire Extinguishing Systems. Hybrid fire extinguishing systems shall be designed and installed in accordance with their listing unless the manufacturer or laboratory fire test data demonstrate that a different discharge duration ensures extinguishment and prevents reignition of the combustible materials present.

11.4.9 Retrofit of Fire Suppression Systems. Where retrofit of a fire suppression system is undertaken, the minimum discharge duration shall be 20 minutes, unless manufacturer or laboratory fire test data demonstrate that a different discharge duration ensures extinguishment and cool-down to below the autoignition temperature of combustible materials present.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

Δ **A.1.3.1** For engines used to drive fire pumps, see also NFPA 20.

For engines used in essential electrical systems in health care facilities, see also NFPA 99.

For engines used in emergency power supplies, see also NFPA 110.

This standard might be useful for engines other than propulsion that are installed on marine vessels. This standard is not intended to apply to engines used to propel mobile equipment.

A.1.5.2 Many items or components commonly used in engine installations might not be listed for that specific use. Therefore, users of this standard, including authorities having jurisdiction, need a basis for determining when components are suitable for use. While the items in 1.5.2 are not necessarily all-inclusive, they provide a minimum checklist of factors that should be considered in making this determination. The emphasis should be on the evaluation process, which should consider all relevant factors. A component might not meet one or more of the criteria in subparagraphs (1) through (4) yet still be suitable for use considering all aspects of the design.

Δ **A.1.6.1** For additional conversions and information, see IEEE/ASTM SI 10, *American National Standard for Metric Practice*.

Δ **A.3.2.1 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment, or materials, the "authority having jurisdiction" may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The "authority having jurisdiction" may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA standards in a broad manner because jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Δ **A.3.3.3 Enclosure.** An enclosure is not considered to be a structure or a room.

An enclosure can be a simple weather protection cover or housing (as typically provided for a small outdoor generator set) that cannot be entered by a person. UL 2200, *Stationary Engine Generator Assemblies*, is often applied for the design of these enclosures.

An enclosure can also be a purpose-designed housing provided with an engine or a turbine which might have provisions for personnel entry to facilitate inspection or maintenance. Some generator sets and turbines are provided in a fully self-contained "package" that might be in the form of a purpose-designed housing or a standard shipping container. Although purpose-designed housings and packages might be placed within a building, they are not an integral part of the building and, therefore, do not constitute an "engine room" as used in NFPA 37.

These enclosures might provide, but are not limited to, one or more of the following functions:

(1) Environmental protection
(2) Noise containment
(3) Fire protection
(4) Heat rejection/ventilation
(5) Human protection
(6) Hazardous area classification

A.3.3.4.2 Engines for Emergency Use. These engines operate to support critical operations such as the following:

(1) Support of building evacuation
(2) Fire suppression
(3) Communications for fire, police, or medical services
(4) Support of the protection of life

A.3.3.4.4 Reciprocating Engines. Engines considered reciprocating engines for the purpose of this standard include the following:

(1) Internal combustion engines
(2) External combustion engines
(3) Rotary engines
(4) Free piston engines

A.3.3.9 Horsepower Rating (Reciprocating Engines). See SAE J1349, *Engine Power Test Code, Spark Ignition and Compression Ignition.*

N **A.3.3.10 Hydrogen-Enriched Fuel.** The 25 percent threshold is based on the minimum public domain (e.g., NFPA, IEC) guidance regarding a hydrogen content in natural gas where the flammability properties of the mixture are considered the same as natural gas. IEC 60079-20-1, *Explosive atmospheres — Part 20-1: Material characteristics for gas and vapour classification — Test methods and data*, indicates that industrial methane (e.g., natural gas) is classified as Group IIA if it does not contain more than 25 percent by volume of hydrogen. The upper limit for a hydrogen-enriched fuel is 95 percent, at which point it is considered "pure" hydrogen as defined in NFPA 2.

A.3.3.19.2 Fuel Tank. This definition includes tanks located in the following places:

(1) Indoors
(2) Outdoors
(3) Aboveground
(4) Underground
(5) Mounted on or below the engine or engine assembly

A.3.3.20.1 Automatic Safety Shutoff Valve (ASSV). A valve that meets the requirements of ANSI Z21.21/CSA 6.5, *Automatic Valves for Gas Appliances*, or a valve that is specified by the engine or turbine manufacturer for this particular application will meet this definition.

A.3.3.20.4 Equipment Isolation Valve. The equipment isolation valve should be located as near the prime mover as practical to minimize the length of the gas train. See Figure A.5.2 for an example of a typical piping arrangement of a gas train.

A.4.1.1.2 Requirements for air vary with any of the following factors:

(1) The types and sizes of engines
(2) The driven equipment
(3) Other air-consuming equipment in the room
(4) The nature of the engine room

A.4.1.1.3 Proper storage entails separating combustible materials from ignition sources. For example, instruction manuals and log sheets should be stored on or in a metal desk or bookshelf detached from the engine, and maintenance materials, such as rags, should be stored in metal containers.

A.4.1.2.1 NFPA 37 does not require engines to be installed in enclosed spaces or engine rooms. There are applications where there is no fire protection need to enclose the engine in a room. For example, a gas engine-driven air compressor that might be on a large manufacturing floor need not be enclosed in a separate room. Likewise, there is no fire protection need to enclose an engine-driven generator in a parking garage. If an engine is enclosed within a room, 4.1.2.1 establishes requirements for the enclosure.

A.4.1.2.1.3 Ventilation can be natural, mechanical, or both. Explosion venting for a fuel explosion should be considered for large engine installations.

A.4.1.2.1.5 Openings in the engine room should be in the outside walls.

A.4.1.2.2.1 For information regarding noncombustible and fire-resistive building construction, refer to NFPA 220. The question of whether a factory-built generator enclosure is treated as a building, with respect to additional separation and protection requirements, depends on local zoning and building code requirements.

Δ **A.4.1.2.2.3** Explosion venting for a fuel explosion should be considered for large engine installations. In some installations where it might not be practical for the normal constantly operating ventilation to prevent the accumulation of flammable vapors or gases from leakage, a hazardous vapor detection system can be installed. The system is often set up to detect the hazardous vapors at two concentration levels [percentage of the lower explosive limit (LEL)].

If the first (lower) level is reached, the ventilation volume is increased by use of a purge fan to remove the vapors. If the second (higher) level is reached, the operation is shut down and the enclosure inerted as the ventilation is stopped. The inerting is normally done quickly and maintained until the leak is stopped, after which the entire hazard volume is purged while operations are resumed.

Δ **A.4.1.3.2.2** When conducting a fire test, the test should expose all the combustibles associated with the engine to fire unless the engine has been designed specifically to protect a combustible component from exposure to fire. ASTM E603, *Standard Guide for Room Fire Experiments*, contains guidance for conducting fire tests. A recognized fire test protocol is specified in UL 2200A, *Outline of Investigation for Fire Containment Testing of Stationary Engine Generator Enclosures*. See also A.4.1.4.2.

A.4.1.3.3 The weatherproof housing might have the available capacity to contain the contents of the oil lubricating system or liquid fuel system.

A.4.1.3.4 Examples of means of satisfying this requirement can include, but are not limited to, concrete pavers commonly used as ballast on loose-laid membrane roofs or sheet metal over noncombustible insulation.

Δ **A.4.1.4.2** It has been shown that combustible materials exhibit different levels of combustibility, ignitibility, and fire performance. Therefore, fire tests should be conducted in the presence of combustible materials that adequately represent the expected potential fire hazard at the location where the engine is to be placed. ASTM E603, *Standard Guide for Room Fire Experiments*, contains guidance for conducting such fire tests. *(See also NFPA 555).*

An example of a test method that provides data for installations with less than the required spacing to combustible structures in accordance with 4.1.4.1 is UL 2200A, *Outline of Investigation for Fire Containment Testing of Stationary Engine Generator Enclosures*. The fire condition represented by this test simulates the ignition of combustibles and assemblies within the generator enclosure.

For liquid-fueled engines that include a fuel tank within the enclosure, the maximum quantity of fuel should be considered as part of the fire test.

The calculation procedures in Chapter 10 of NFPA 555 contain a procedure similar to the “Radiant Ignition of a Near Fuel” algorithm in NIST’s Fire Protection Engineering Tools for Hazard Estimation (FPETool) for calculating ignition from a nearby fire. It is a sound, engineering-based method of predicting radiative ignition of a material not in direct contact with a flame.

The values in 4.1.4 and the reference to the NFPA 555 calculation method are the result of the calculations presented to the technical committee in 1996. The calculations treated an engine fire as a vertical cylinder. The values in 4.1.4 changed somewhat in the 1998 edition of NFPA 37 based on those calculations. They are reasonably consistent with the requirements of the *BOCA National Building Code*, which was in effect at the time. The technical committee wanted to include a performance alternative in NFPA 37. The reference to the NFPA 555 method in this annex provides guidance on how to evaluate proposed alternatives.

A.4.2 Siting requirements should be in accordance with local codes. Factors to consider might include, but are not limited to, flood plains, terrain slopes, and seismic activity.

A.4.3 Hazardous vapor detection can be appropriate where vapor leaks might be expected. This type of detector can identify the need for engine fuel system shutdown and possible inerting of the engine enclosure via a fire suppression system discharge.

A.4.4.2 See NFPA 68.

A.4.5.2 Unless otherwise required by the local environment, stationary combustion engines and gas turbines and the surrounding area are not classified as a hazardous (classified) location. The primary source of ignition associated with these installations is the external hot surfaces such as exhaust system and combustion system hardware. Because these other ignition sources are present, the inclusion of non-hazard-rated wiring does not increase the likelihood of ignition. Refer to NFPA 497 regarding equipment with open flames or other ignition sources.

A.4.5.3.4 Engines for emergency use are intended to support critical operations in the protection of life, property, or both. To require an engine used in this manner to shut down automatically in the event of a control wire break might defeat this purpose. Therefore, engines for emergency use are not required to shut down in case of control wire break, disconnect, or cutting, but they are not prevented from doing so based on actual application.

A.4.6 Manufacturer's instructions are recognized as minimum requirements. Any deviations in installation should be reviewed with the manufacturer.

A.4.6(5) Design provisions that address other natural hazards and perils, such as storm surges and floods, should also be considered.

Δ **A.5.1** Gaseous-fueled engines are those engines in which the fuel supply is delivered to the engine in vapor form, including, but not limited to, the following:

(1) Natural gas
(2) Compressed natural gas (CNG)
(3) Propane
(4) LP-Gas
(5) Hydrogen (see ANSI/ASME B31.12, *Hydrogen Piping and Pipelines*)
(6) Mixed gas (including mixtures containing less than 95 percent hydrogen)
(7) Manufactured gas and syngas
(8) Biogas (e.g., landfill and digester gas) (for biogas applications, see ANSI/CSA B149.6, *Code for Digester Gas, Landfill Gas, and Biogas Generation and Utilization*)

Liquefied natural gas (LNG), for the purpose of Chapter 5, can be considered a gaseous fuel for engines.

Piping systems supplying gaseous fuels should be designed to minimize piping failure. Several examples of methods for minimizing piping failure are as follows:

(1) Welded pipe joints should be used where practical. Threaded couplings and bolted flanges should be assembled in accordance with the manufacturer's requirements.
(2) If rigid metal piping is used, it should be designed to deflect with the engine in any direction. Properly designed flexible connectors are an alternative in high-vibration areas, such as between rigid pipe supply lines and manifolds or other points of connection to the engine.
(3) Rigid piping connected directly to the engine should be supported so that failures will not occur due to the natural frequency of the piping coinciding with the rotational speed of the engine. Care should be taken in the design of pipe supports to avoid vibrations.

For guidance on the evacuation/purging, charging, and commissioning of the combustible gas supply in the piping upstream of the equipment isolation valve, refer to NFPA 56.

During commissioning, the gas train should be inspected for leaks. Typically, inspection and leak tests of a gas train is performed at a pressure not less than their normal operating pressure using the test method detailed in NFPA 54.

N **A.5.1.1(4)** NFPA 2 is specific to hydrogen at 95 percent or greater purity by volume. See C.5.2 for mixtures that contain less than 95 percent hydrogen.

A.5.1.2 Plastic pipe is not permitted by 5.1.2 because of the risk of damage from heat, physical contact, and vibration (many plastic pipe products are relatively brittle).

A.5.1.5.2 NFPA 54 does not allow the use of aluminum raised-face flange components, and it is recognized that aluminum valve components used in the gas train are often supplied with raised-face flanges. Raised-face flanges are permitted above 860 kPa (125 psi) in accordance with ASME B31.3, *Process Piping.*

A.5.1.6 The following items should be considered when using connectors for vibration dampening:

(1) Since most machinery vibrates in a radial direction from the main shaft, the connector should be installed parallel to the shaft (i.e., in line with the engine).
(2) Install the connector in a pre-stress condition (i.e., with minimum offset/displacement).
(3) Do not install the connector in a gas line and then attempt to pull, compress, or torque it in order to align the connector into position.
(4) Piping and the connector should be lined up within a maximum of 3 mm (⅛ in.). If a connector is being used to accommodate misalignments, an additional or longer hose might be needed to dampen the vibration.
(5) In order for the connector to absorb movement, it needs to be properly anchored. Installing an anchor near the hose at the opposite end of the source of motion is a fundamental rule because a connector increases flexibility. This added flexibility can potentially result in extreme deflection applied to both the pipe and the metal hose, and can add a large amount of force similar to oscillations or a "whipping" action.
(6) Piping must be supported by hangers or anchors so that its weight is not carried by the connector. For hoses that might be used for this application, excessive weight can compress the hose and relax the braid tension.
(7) A rigid anchor should be installed within 4 pipe diameters and a second within 10 pipe diameters of the connector to prevent oscillations or "whipping” of the upstream components.

A.5.2 The requirements in this section state the minimum requirements for compliance with this standard. These controls and valves are required as part of the prime mover installation and are to be dedicated solely to the single individual prime mover. These components of the gas train might or might not be supplied by the manufacturer of the prime mover. Authorities having jurisdiction and manufacturer’s data sheets for gas train components might have additional requirements. Prior editions of this standard required an automatic control valve, which is an operating component to control the engine under load and not a safety device. Therefore, the requirement for an automatic control valve is no longer within the scope of NFPA 37.

For calculations, the fuel input rating is to be based on the higher heating value (HHV), also called total heating value, which is the number of British thermal units produced by the combustion, at constant pressure, of 0.028 m^3 (1 ft^3) of gas when the products of combustion are cooled to the initial temperature of the gas and air, when the water vapor formed during combustion is condensed, and when all necessary corrections have been applied.

The following paragraphs describe the basis for the requirements in this standard that are applicable to each component of the gas train:

(1) The equipment isolation valve is installed to allow the gas supply to a single prime mover to be shut off without affecting other equipment. This valve could be used in an emergency, but the primary application is the isolation of the prime mover for maintenance of the prime mover and/or the gas train without a danger of a gas leak.
(2) The regulator provides steady gas pressure to the engine for stable operation. With its own regulator, the prime mover will be less affected by pressure spikes or dips caused by the operation of other loads in the plant or on the same gas supply system.
(3) The automatic safety shutoff valves (ASSVs) ensure the automatic shutoff of the fuel supply to the prime mover in the event the prime mover stops for any reason or there is a serious fuel or control problem.
(4) The manual leak test valve is for periodic testing of the ASSV. An ASSV requires periodic testing (proofing) to verify complete blockage of the gas flow. The ASSV manual leak test valve must be installed downstream of but prior to any other device that can block the flow of gas. Some manufacturers build in proofing provisions for this valve as part of the ASSV; it is permissible to use this provision for the manual leak test valve if it is located on the downstream side of the ASSV. A manual leak test valve can consist of a shutoff valve, suitable for the specific fuel, that is capped or plugged when not being used to conduct a leak test.

(5) The low-pressure switch shuts down the engine if the gas pressure to the engine falls below the level where the engine can operate properly, thereby reducing the risk of unburned gas discharge through the exhaust. Either a manual or automatic resettable switch is acceptable.
(6) The high-pressure switch (with manual reset) protects against high pressure in the gas supply. A high-pressure condition is usually caused by failure of a component, such as a regulator.

Figure A.5.2 illustrates the typical arrangement of components of a gas train.

A.5.2.1(5) The limit control required by this item can take the form of a dedicated switch, sensor, or other device that converts pressure into an analog or digital signal for action by a programmable logic controller (PLC) or active control system.

A.5.2.1(6) The limit control required by this item can take the form of a dedicated switch, sensor, or other device that converts pressure into an analog or digital signal for action by a PLC or active control system.

A.5.3.1.1(2) Lock-up is a feature of some pressure regulators where, under no-flow conditions, there is a maximum pressure increase downstream of the regulator (i.e., "lock-up pressure"). This lock-up pressure should be significantly less than the inlet pressure to the regulator. A lock-up regulator generally permits not more than 150 percent of the outlet pressure setting or 1244 pascals (5 in. w.c.), whichever is greater, though this can vary for any given regulator design and application. In addition, there are variables for each regulator design that affect the lock-up pressure including, but not limited to, the following:

(1) Ambient temperature
(2) Condition of the regulator disc, after some use
(3) Flow
(4) Inlet pressure
(5) Outlet pressure setting
(6) Volume between the regulator and the first downstream safety shutoff valve
(7) Whether or not the regulator incorporates internal relief
(8) Sizing of the regulator
(9) Length of the atmospheric vent connection, if vented

N **A.5.4.1** The expectation is that gas will be diluted below its lower flammable limit (LFL) before coming into contact with an ignition source or re-entering a building or enclosure.

External points of discharge for the vent line should be in accordance with all of the following:

(1) Gas should not impinge on equipment, supports, buildings, windows, or materials, as it could ignite and create a fire hazard.
(2) Gas should not impinge on personnel at work (e.g., roofers or other maintenance professionals) in the area or in the vicinity of the exit of the vent line, as it could ignite and create a fire hazard.
(3) Gas should not be vented in the vicinity of air intakes, compressor inlets, or other devices that utilize ambient air. See NFPA 54 for acceptable clearances.

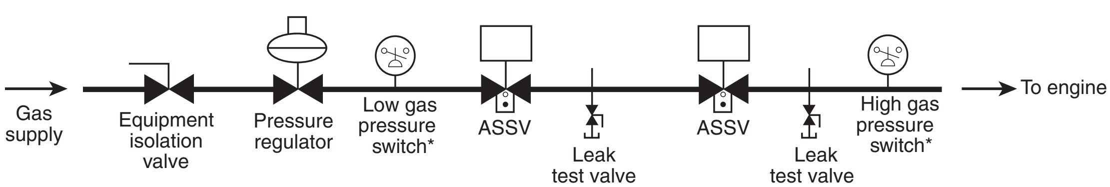
N **A.5.4.2** The design of manifolded vent lines should consider the effect of controls operating at different pressures and the potential for crossflow or backflow between different portions of the system or different units. Compatible inlet pressures depend on the design of the system itself, which requires engineering judgment for a specific application to determine when manifolding will not cause improper operation of the device(s) or system(s) being vented.

A.5.5.1 Manual shutoff valves provide positive shutoff of fuel to the prime mover at any point in the gas train selected by the manufacturer. Manual shutoff valves should be quick acting and plainly marked to show open and closed positions. Ball or butterfly valves are typically found in this application.

A.5.5.1.3 At least one of the manual shutoff valves should be located in a remote location outside the fire hazard area of the prime mover for emergency shutdown purposes.

A.5.5.2 Equipment isolation valves are placed near the prime mover as a preventative measure. Such a valve is to be used whenever maintenance is to be performed on the prime mover and/or associated gas train, in cases where there is a suspected leak in the gas train and fuel needs to be immediately shut off, and whenever lockout/tagout is required for safe operation. This valve should shut down fuel supply to only the one prime mover, isolating it from the gas supply and allowing other appliances to continue operating. If located outside the prime mover fire hazard area, this valve can also provide the emergency shutdown capability required in 5.5.1.3.

A.5.5.4 ASSVs are quick-acting valves that shut off fuel when the prime mover stops or when the prime mover needs to be automatically stopped based on some other criteria such as an activated fire alarm or sprinkler system alarm.



ASSV = Automatic safety shutoff valve

*Required for engines of 732 kW (2.5 million Btu/hr) full-load input or greater.

FIGURE A.5.2 Typical Piping Arrangement of a Gas Train.

A.5.5.4.1 It is permissible, but less desirable, to replace one of the ASSVs with one of the following valves if it will automatically shut off the flow of fuel within 2 seconds of the engine stopping:

(1) *Carburetion valve.* The carburetion valve is often referred to as the mixer or air/gas valve. The carburetion valve controls the air–fuel mixture by metering the fuel inlet based on the velocity of the air coming into the valve. If there is no air flow, the carburetion valve shuts off the fuel.
(2) *Zero governor–type regulating valve.* Also referred to as a “zero pressure regulator” or “zero governor.” In the case of a venturi mixer, a zero governor–type regulating valve is used. When used as a shutoff valve, it must be adjusted to provide zero fuel flow in the standby condition. Prime mover vacuum draws against a diaphragm, which opens the spring-loaded fuel inlet valve, causing fuel to flow.
(3) *Auxiliary valve.* This category would include any other types of valves that suit the purpose of providing positive fuel shutoff within 2 seconds of the prime mover stopping.

A.5.5.4.2 Paragraph 5.5.4.1 allows the use of a carburetion valve or zero governor–type regulating valve if the device automatically shuts off the flow of gas. If one of those is used, there is no need to install a manual leak test valve since the engine side is vented to atmosphere.

A.5.5.5.3 It is permissible, but less desirable, to replace one of the ASSVs with a control valve, provided the valve can automatically shut off the flow of fuel within the time limits specified in 5.5.5.1. The manufacturer’s decision to use a control valve as an ASSV should be a function of trapped gas volume downstream of the last ASSV. Where large volumes of trapped gas exist, engine shutdown time is increased and the potential for increased equipment damage from an extended shutdown time becomes a primary factor in deciding between a dedicated ASSV and a substitute ASSV control valve.

A.5.5.5.4 The vent valve is used to depressurize the gas trapped between two ASSVs and thereby minimize the risk from any leaks that might occur in the gas train. Consequently, the valve should be sized to depressurize the trapped volume quickly. Additional guidance for venting hydrogen-enriched fuels is provided in Section C.8.

A.5.5.5.5 Gas turbines are typically installed in a dedicated enclosure that provides acoustic isolation from the rest of the plant and incorporates high volume forced ventilation to manage the very high heat rates from the turbine casings [some portions of which can exceed 540°C (1000°F)]. Additionally, facilities that have multiple turbines can include a large building to provide weather protection for the equipment and personnel. The ability to isolate the fuel supply external to these enclosed spaces mitigates potentially catastrophic flammable atmospheres within the enclosed spaces.

A.5.7.1.1 The pressure limits in this section are consistent with 49 CFR 192.201, “Required Capacity of Pressure Relieving and Limiting Stations.”

A.5.7.1.1.1(2) An example of *active means* is an alarm or light notification. An example of *passive means* is a manual reset.

A.6.1 Liquid-fueled engines are those where fuel is delivered to the engine in liquid form. This chapter does not apply to propane stored as a liquid and utilized as a vapor. *(See 4.1.1.4 and Chapter 5.)*

A.6.2 Examples of Class I fuels are gasoline, gasohol, and alcohol.

A.6.2.2 Installation requirements in NFPA 30 that are applicable to NFPA 37 include minimum distance from adjoining property lines, spacing, dikes, foundations, supports, depth and cover, anchorage, normal and emergency vents, and testing.

A.6.3 Examples of liquid fuels other than Class I fuels are diesel fuel, fuel oils, jet fuel, and kerosene.

Δ **A.6.3.2.2.1** Fire codes have the following two principal objectives: to prevent fire and, when fire does occur, to limit the spread of smoke and fire to limit damage to life and property. One commonly accepted fire protection goal is to extinguish or control the fire before it reaches flashover or full room involvement. In other words, the philosophy is that the worst case should be to sacrifice the room or compartment where the fire occurs to protect the rest of the structure.

The provisions of this paragraph do not address the likelihood of a fire. Rather, they address limiting the spread of fire to limit damage in the event of a fire. There are many sound fire protection engineering methods and techniques to evaluate equivalent protection. Some are computer-based and require many inputs, while others offer a method of understanding, evaluating, presenting, and comparing risks graphically.

A.6.3.5 Aboveground storage tanks designed and constructed in accordance with UL 2080, *Fire Resistant Tanks for Flammable and Combustible Liquids*, or UL 2085, *Protected Aboveground Tanks for Flammable and Combustible Liquids*, are not considered by NFPA 37 to be equivalent to the rooms described in 6.3.5 and 6.3.6.

The reason tanks listed to UL 2080 and UL 2085 are not equivalent to the rooms described in 6.3.5 and 6.3.6 is that the UL listings and the construction of these tanks are directed at protecting the tank from exposure to an external fire. The enclosure requirements in 6.3.5 and 6.3.6 are designed to protect the building from a fire in the fuel tank room.

A.6.3.5.4 See Section 18.6 on ventilation in NFPA 30.

A.6.3.6 Aboveground storage tanks designed and constructed in accordance with UL 2080, *Fire Resistant Tanks for Flammable and Combustible Liquids*, or UL 2085, *Protected Aboveground Tanks for Flammable and Combustible Liquids*, are not considered by NFPA 37 to be equivalent to the rooms described in 6.3.5 and 6.3.6.

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A.6.3.6.5 See NFPA 30 section on ventilation.

A.6.5.7 Where crude or residual oils are utilized as engine fuel, it is sometimes necessary to heat the fuel above the flashpoint of certain light fractions within the fuel for satisfactory handling and injection into the engine. This condition necessitates special storage, purifying, and heating systems.

A.6.8.1 Piping systems supplying liquid fuels should be designed to minimize piping failure. Several examples of methods for minimizing piping failure are as follows:

(1) Welded pipe joints should be used where practical. Threaded couplings and bolted flanges should be assembled in accordance with the manufacturer's requirements.
(2) If rigid metal piping is used, it should be designed to deflect with the engine in any direction. Properly designed flexible connectors are an alternative in high-vibration areas, such as between rigid pipe supply lines and manifolds or other points of engine interface.
(3) Rigid piping connected directly to the engine should be supported so that failures will not occur due to the natural frequency of the piping coinciding with the rotational speed of the engine. Care should be taken in the design of pipe supports to avoid vibrations.

A.6.8.2.1 Flexible connectors can fail under fire exposure. This factor should be considered in the design of piping systems.

A.6.8.3 There are several ways to meet the requirements of this section. Shutoff mechanisms can be either manual or automatic.

Manual valves located away from the engine or outside of the engine room can be used as emergency shutoff devices. Solenoid valves interlocked with other controls can also be used to shut off fuel supplies.

In the event of a fire, automatic valves utilizing fusible links have been used to shut off fuel supplies. The fusible element might be in the valve handwheel or attached to a flexible wire and spring of a lever-operated valve. These valves are normally closed. They are held open when the fusible element is intact.

An oil safety valve or antisiphon valve could be utilized to shut off the fuel supplies where the possibility of continued, undesirable flow of fuel by gravity or siphoning exists due to a pipe break. An oil safety valve requires a vacuum on its outlet to open and permit oil flow, thereby automatically stopping flow in the event of a pipe break. An oil safety valve will also stop oil flow in the event of a gasket leak on a basket-type oil filter or strainer that prevents the oil pump on the engine from pulling a vacuum.

A.7.3 Piping systems supplying lubricating or hydraulic oil should be designed to minimize piping failure. Several examples of methods for minimizing piping failure are as follows:

(1) Welded pipe joints should be used where practical. Threaded couplings and bolted flanges should be assembled in accordance with the manufacturer's requirements.
(2) Where practical, lubricating oil lines should use guard pipe construction, with the pressurized supply line located inside the return line.
(3) If rigid metal piping is used, it should be designed to deflect with the engine in any direction. Properly designed flexible connectors are an alternative in high-vibration areas.
(4) Rigid piping connected directly to the engine should be supported so that failures will not occur due to the natural frequency of the piping coinciding with the rotational speed of the engine.

A.8.1.1 The exhaust gas flow, engine manufacturer's recommendations, and user requirements should also be considered in the design and construction of engine exhaust systems.

Δ **A.8.1.2** The "service" of an exhaust system includes any of the following:

(1) Exposure to heat (short-term and sustained high-temperature)
(2) Corrosive atmospheres (internal or external)
(3) Internal pressure, including possible explosion of unburned fuel (pressure rise for hydrogen-enriched fuel can be significantly higher than for natural gas and other hydrocarbon fuels)
(4) External forces (e.g., wind, weight of snow, dust or dirt accumulation, seismic event)

A.8.1.3 Calculations for exhausting engines and other appliances into the same flue can be complex and should only be performed by qualified persons. Factors that affect calculations include the uniqueness of the installation, the number of devices venting into the flue, the exhaust gas flow and temperature, and the size and height of the flue.

A.8.1.3.1 See A.8.1.3.

A.8.1.4 Normally, this provision is met by the built-in strength of the system. However, it can also be accomplished by use of devices such as relief valves, rupture discs, or their equivalent.

A.8.1.5 Low points are needed to provide a means of draining liquids that can accumulate in the exhaust system, including condensate, rainwater, or melted snow.

A.8.2.3.1 Exhaust systems should not terminate under structures (including loading platforms) or where exhaust gas entrainment into ventilation intakes might occur. Products of combustion, carbon monoxide in particular, present a life safety hazard. It is recommended that engine exhausts discharge as far away as is practical from any structural opening, such as a window, door, crawl space access at or below grade level, or ventilation opening, in order to minimize this hazard. As a further precaution, consideration should be given to installing carbon monoxide detectors in any structures that might be subject to carbon monoxide accumulation from the exhaust.

Additional information regarding the separation of exhaust system termination from openings into a structure is available in NIST Technical Note 1637, *Modeling the Effects of Outdoor Gasoline Powered Generator Use on Indoor Carbon Monoxide Exposures*, and NIST Technical Note 1666, *Modeling the Effects of Outdoor Gasoline Powered Generator Use on Indoor Carbon Monoxide Exposures — Phase II.*

A.8.4 Exhaust systems with temperatures in this range might require special consideration as to the following:

(1) Choice of materials
(2) Provision for thermal expansion
(3) Clearances from combustible materials
(4) Other design details

A.9.1.2 A manual reset feature within the safety circuitry is required by 9.1.2 so that all high gas conditions can be identified before other components, such as diaphragms for sensing and control, are damaged by repeated high-pressure conditions. The manual reset function can be integrated into the high gas switch or be integrated within the engine controller.

A.9.2.1 In many installations, it is advisable to have a lower alarm point for parameters such as engine overspeed, high jacket water temperature or high cylinder temperature, low oil level or pressure, and high oil temperature to alert operators of deteriorating operating conditions prior to the automatic shutdown of the engine.

A.9.2.2 Hazardous locations might contain flammable or combustible vapors that could be of sufficient concentration to cause the engine to continue to run if the vapors are drawn into the engine through its intake.

A.9.3.1 In many installations it is advisable to have a lower alarm point for parameters such as engine overspeed, engine vibration, low lubricating oil pressure, and high exhaust temperatures to alert operators of deteriorating operating conditions prior to the automatic shutdown of the engine. See ISO 21789, *Gas Turbine Applications — Safety*.

One method of shutting down a combustion gas turbine is by means of an emergency stop button provided at a remote location, in addition to the normal remote stop button. The purpose of the emergency stop button is to shut off the fuel supply and electrical power to the unit, leaving only essential lubricating oil and fire suppression services operational. The emergency stop button is usually colored red and conspicuously identified.

An emergency stop might differ from a normal remote stop by avoiding some shutdown sequences, such as a cool-down period.

A.9.3.2 While 9.3.1 provides a list of devices required to shut down the engine in case of an emergency, 9.3.2 provides a list of control features needed to ensure the safety of the engine.

A.10.2 Emergency instructions should be established for all operations involved with engines. At a minimum, a written fire emergency plan should be developed that includes the following:

(1) Response to the fire alarms and fire system supervisory alarms
(2) Notification of personnel identified in the plan
(3) Evacuation of employees not directly involved in firefighting activities for the fire area
(4) Coordination with security forces or other designated personnel to admit public fire department
(5) Fire extinguishment activities
(6) Periodic drills to verify viability of the plan
(7) Control room operators' activities during fire emergencies

A.10.2.1 Procedures for the operation of the engine during abnormal operating conditions should be developed also.

A.10.3 Training for operating and maintenance procedures will vary by system type, size, and complexity. The manufacturer's recommendations for training will prevail as a minimum requirement, as amended by the owner or the authority having jurisdiction.

Training can range from reading and understanding an instruction manual for very small systems to undergoing formalized classroom and hands-on training for larger systems. Of particular importance is training on emergency shutdown procedures. Operating personnel should be knowledgeable of and capable of operation of all emergency shutdown procedures.

A.11.1 The fire risk evaluation should include, but not be limited to, the following:

(1) Characteristics of the engine
(2) Characteristics of the fuel
(3) Layout of the engine installation, including engine auxiliary equipment
(4) Adjacent exposures, including structures, operations, and other engine installations

The fire risk evaluation should also consider operating requirements, such as whether the engine installation is for emergency use.

The fire risk evaluation should result in a list of recommended fire protection features, separation or control of common and special hazards, and the detection and suppression of fires. The fire risk evaluation should at least consider the following:

(1) Life safety requirements
(2) The type and quantity of combustible materials involved, including engine fuel, lubricating oil, and insulating materials
(3) Potential ignition sources, including electrical components and hot metal surfaces
(4) Oxygen and ventilation sources
(5) The location of the engine
(6) Operational considerations, including expected maximum and minimum ambient conditions
(7) The method of fuel transfer
(8) The importance of the engine to operations
(9) Response time and capabilities of the local fire department or fire brigade
(10) Fire experience

A.11.2.1 Where portable extinguishers are provided, personnel involved in the installation and operation of engines should be trained in their use.

A.11.3.1 For each enclosure requiring fire protection, fire detectors are intended to provide timely detection of a fire and might allow early intervention that can limit damage. Selection of the type of fire detector to be used should be based on the application and engine equipment arrangement. For example, the use of smoke detection might be a problem due to false actuations caused by exhaust gases during engine operation. If heat-activated fire detectors are used, temperature ratings should be based on the maximum ambient temperatures of the enclosure that can be expected under normal operating conditions, so that fire detectors do not actuate due solely to the heat produced when the engine is operating. Typically, detectors are selected to actuate at about 28°C (50°F) above the maximum expected temperature in the enclosure.

For more rapid detection of fires, the use of flame detectors can be considered for early warning, engine shutdown, or fire suppression system activation. The installation of these detectors should be evenly distributed across the hazard to allow for proper detection throughout the enclosure.

Where hydrogen concentration is dominant, rapid detection is necessary and an optical detector should be considered based on the specific mixture of gases. The selection of the detection technology should be based on the operating parameters of the sensor. Consultation with the equipment manufacturer or supplier is recommended.

In all installations, the detectors should be strategically positioned near specific hazards but away from high-ventilation flow paths that could disperse heat and delay detection of a fire and away from heat-producing devices, such as heaters, that could unnecessarily set off detectors. The detectors should be mounted firmly to rigid structures and in areas where minimum vibration is present.

Where a fire suppression system is also being used and inadvertent actuation of the suppression system is a concern, consideration should be given to cross-zoning the detectors such that at least two detectors that are installed in different detection zones have to trip in order for the suppression system to activate.

In addition to the detectors, the installation of the other components of the fire detection and alarm system also need to be addressed. Visual and audible notification devices should be located where they will be easily seen and heard. Depending on the installation, this might be both inside and outside of the engine enclosure.

Hazardous vapor detection can be appropriate where vapor leaks might be expected. This type of detector can identify the need for engine fuel system shutdown and possible inerting of the engine enclosure via a fire suppression system discharge.

Components that should be considered when installing a fire detection and alarm system, especially when used in conjunction with a fire suppression system, should include at least the following:

(1) Fire alarm strobe and horns positioned in highly visible and audible areas of the engine enclosure on the inside and outside of the enclosure, where applicable
(2) Warning signs positioned on enclosure access doors where a fire suppression system has been installed
(3) Manual discharge stations positioned near enclosure access doors where a fire suppression system has been installed
(4) Manual lockout stations for engine maintenance purposes positioned near enclosure access doors where a fire suppression system has been installed
(5) Where required for the fire suppressant being used, predischarge timers, located in the fire control panel, that allow a time delay of at least 30 seconds between fire alarm strobe and horn annunciation and fire suppression system discharge

A.11.4.1.1 Upon installation, all fire suppression systems, including any associated fire detection and alarm system, should be fully tested in accordance with the applicable NFPA standards. Applicable NFPA standards might require a full discharge or concentration test to ensure the fire suppression system operates properly or might allow for some other means, such as a room pressurization test, to prove the capabilities of the system.

A.11.4.2.1 The following factors should be considered in determining whether to provide an automatic fuel shutdown valve that stops the flow of fuel when the engine enclosure fire suppression system activates:

(1) Whether the engine is running.
(2) Whether the engine is constantly attended.
(3) If more than one source of emergency power is available, whether it is possible to shut down one source without adversely affecting the supply of emergency power. In this case, the automatic valve should be provided.
(4) If more than one source of emergency power is available, the likelihood that a fire involving one source will spread to the other sources. If the fire is likely to spread to other sources or exposures, an automatic stop valve should be provided.
(5) If the engine is for emergency use, whether the following could cause accidental operation of the fire suppression system. If the fire detection system is tied to the fire suppression system, shutdown of the emergency use engine could occur at a time when shutdown would be unacceptable. Provisions should be considered to prevent the following:
    (a) Accidental activation of the fire detection system.
    (b) Prolonged operation of the engine during a power outage, which can produce extreme temperatures or conditions not found during system commissioning, testing, and inspection. For example, heat detectors might activate if placed too close to exhaust manifolds, smoke detectors might activate after animal nests are built touching exhaust piping, and optical flame detectors might detect lightning or other phenomenon not present during system commissioning.
    (c) Electrical voltage irregularities or transients in the outside power supply system, which might necessitate emergency power and might cause unpredictable operation of the fire detection system.
(6) Even though an engine is for emergency use and it might be desirable to maintain emergency power during a fire, whether it might not be possible to keep the engine running even if the fuel line is not closed because of one or more of the following:
    (a) Gaseous fire suppression systems that require the closure of all vents, doors, and dampers, the closure of which can prevent the engine from receiving radiator cooling air, combustion air, or both, and subsequently can cause the engine to stop running or become damaged
    (b) Fires involving motor fuel that can generally cause high temperatures in the engine enclosure that are likely to damage or destroy electrical distribution cabling intended to distribute emergency power
    (c) Fires involving motor fuel that are likely to damage or destroy the fuel line, preventing the engine from having an adequate supply of fuel and resulting in loss of emergency power
(7) Whether the location of the engine can affect the risk of spread of fire or smoke to, or within, the rest of the building. An engine on a roof would present a different hazard from an engine in a basement. The need for automatic fuel shutoff is greater in an installation that poses an increased risk to the building or its contents.
(8) Whether a fire during routine testing can cause damage that will take months to repair. Most operation of engines for emergency use occurs during routine testing, when normal power is also available. During such repair time, emergency power might not be available to some or all of the critical equipment or facilities. Even if an automatic fuel stop valve is determined to present an unacceptable risk to an emergency-use engine, arrangements should be considered that would provide automatic fuel shutdown in the event of a fire during routine testing.

A.11.4.2.1.1 The option for emergency and constantly attended engines is whether to have the fire suppression system close the automatic valve, not whether to install the valve. The automatic valve is required to meet other requirements of this standard, regardless of whether the fire suppression system closes it.

Δ **A.11.4.2.3** After the fire suppression system has extinguished the fire, the suppression agent and potentially toxic products of combustion should be removed from the engine enclosure and the atmosphere sampled before personnel without air-breathing apparatus enter for inspection or repairs. Removal is usually accomplished by dilution ventilation, using a combination of exhaust and make-up air. Removal can be accomplished by using either normal or mechanical ventilation.

Normal ventilation is natural movement of air through the enclosure or room by opening doors or windows. In instances where rooms or enclosures are inside larger structures, care should be taken to avoid introducing contaminants into other building areas.

Mechanical ventilation systems can consist of the normal ventilation system for the room or enclosure or a dedicated purge system. Exhaust air should discharge outside the structure, away from operable windows and outside air intakes.

In locating the exhaust air discharge, consideration should be given to both the engine enclosure and nearby structures. Chapter 24, "Airflow Around Buildings," of the ASHRAE *Handbook — Fundamentals* can be consulted for guidelines on exhaust air stack height and distance from other structures, as well as air intakes needed to provide adequate dilution and to avoid detrimental effects of downdrafts.

Make-up air and exhaust openings in the enclosure should be sized and located to minimize short-circuiting. Short-circuiting occurs when make-up air flows directly from the inlet to the outlet without adequately sweeping through the enclosure. For suppression agents heavier than air, make-up air should enter high and exhaust should leave low. For suppression agents lighter than air, make-up air should enter low and exhaust should leave high. In either case, inlets and outlets should ideally be on opposite sides of the enclosure.

Make-up air openings in the enclosure should be sized for relatively low velocities. With sufficiently low velocity, the incoming make-up air tends toward "plug flow," pushing contaminated air toward the exhaust. High-velocity incoming air would mix the make-up and contaminated airstreams, reducing the contaminant concentration of the exhausted air.

Exhaust air openings should likewise be sized for low velocities. Higher velocities tend to create a funnel effect, leaving dead zones of contaminated air that is slow to be exhausted.

For guidance on calculating the time required to achieve a suitable atmosphere within the room or enclosure, refer to NFPA 92 or the ASHRAE *Handbook of Smoke Control Engineering*. For guidance in determining allowable concentrations of contaminant, refer to safety data sheets (SDS) and permissible exposure limits (PEL) from OSHA.

A.11.4.3 Fire suppression system discharge durations should be held as long as the hazards of hot metal surfaces above the autoignition temperature and uncontrollable combustible fluid flow exist (consult manufacturer for applicable engine cool-down times). Testing has shown this time requirement to be approximately 20 minutes for many areas, but it can be substantially longer. It has been shown that the initial discharge will not usually hold for a 20-minute time period in most engine enclosures, and, under these circumstances, an added extended discharge is necessary to prevent potential fire reignition due to smoldering and heat soak. Where design concentrations still cannot be maintained effectively, an alternative system should be provided.

When foam suppression systems are used, full discharge tests should be completed to determine if the engine will be submerged. Fencing with a maximum opening of 1300 mm^2 (2 $in.^2$) or other barriers should be used when openings in the protected engine enclosure are present.

A.11.4.4 Gaseous agent fire suppression systems can be used to extinguish engine equipment fires in either of the following two ways:

(1) Total flooding systems are used where there is a permanent enclosure around the fire hazard that is adequate to enable the design concentration to be built up and to be maintained for the period of time required to ensure the complete and permanent extinguishment of a fire for the specific combustible materials involved. For total flooding systems, potential leakage sources should be included in the gaseous agent design quantities, which should include leakage through ventilation dampers. Usually ventilation dampers are either gravity actuated (i.e., close when the ventilation fans automatically shut down upon gaseous agent discharge) or pressure actuated (i.e., close by means of counterweight and a pressure-operated latch that is activated by the gaseous agent). Leakage from the interface between the enclosure walls and the foundation should also be taken into consideration. For engine enclosures where the normal temperature of the enclosure exceeds 93°C (200°F) or is below −18°C (0°F), gaseous agent levels should be adjusted as required by the appropriate NFPA standard or the manufacturer's instruction manual.
(2) Local application systems are used for the extinguishment of surface fires of combustible gases, liquids, or solids, where the fire hazard is not enclosed or where the enclosure does not conform to the requirements for a total flooding system. For local application systems, it is imperative that the entire fire hazard be protected. The hazard area should include all areas that are subject to spillage, leakage, splashing, condensation, and so forth, and are of combustible materials that might extend a fire outside the protected area or lead a fire into the protected area. This type of hazard could necessitate dikes, drains, or trenches to contain any combustible material leakage. When multiple engine equipment fire hazards are in an area such that they are interexposing, provisions should be made to ensure that the hazards can be protected simultaneously, which could involve subdividing the hazards into sections and providing independent protection to each section.

Gaseous agent fire suppression systems should generally be designed to have the capacity to supply two full discharges to avoid having to keep the engine shut down until the gaseous agent reservoir can be replenished, particularly after a minor fire or accidental discharge. Two full discharges should use 90 percent of the total gaseous agent reservoir capacity as an optimum design; however, up to 95 percent is acceptable. For applications where ambient temperatures are above the normal operating conditions of the gaseous agent reservoir, a shelter with ventilation openings or an equivalent alternative should be used. Where ambient temperatures are below the normal operating conditions of the gaseous agent reservoir, reservoir heaters (such as immersion heaters) and instrument line heaters should be used or, where applicable, the reservoir can be superpressurized with nitrogen to maintain the required flows and pressures in a low-temperature environment.

Warning signs and safety instructions are required on some types of gaseous agent systems. The user should refer to the appropriate NFPA standards for those systems for detailed requirements.

N **A.11.4.4.1** Hydrogen-enriched fuels usually require a significantly higher suppressant concentration than other fuels. For example, consider carbon dioxide (CO_2); methane requires a 34 percent minimum initial suppressant concentration and ethane requires a 40 percent minimum initial suppressant concentration to ensure suppression of a fire. The other primary constituents of natural gas and alternative hydrocarbon fuels, such as propane and butane, fall between those values. A pure hydrogen fire requires a 75 percent CO_2 concentration to extinguish the combustion. The activation of the upstream ASSVs and vents to quickly halt and isolate the flow of the hydrogen-enriched fuel supply can reduce the required concentration since the gaseous hydrogen-enriched fuel will quickly burn off and the residual fire fed by leaked lubrication oil, liquid fuels, or other combustible material in the protected space will be suppressed by the lower required concentration. See C.5.3 for further information.

A.11.4.4.2 Where total flooding gaseous systems are used, the engine enclosure should be arranged for minimum leakage by automatic shutdown of fans and automatic closing of doors, ventilation dampers, and other openings. During operation of an engine, there is a need for substantial amounts of cooling and ventilation air. This air flow will not stop immediately upon engine shutdown and should be considered in the extinguishing system design.

A.11.4.4.2.1 Fire suppression system design concentrations and discharge durations should be held as long as the hazards of hot metal surfaces above the autoignition temperature and uncontrollable combustible fluid flow exist. The manufacturer should be consulted for applicable engine cool-down times. Testing has shown this time requirement to be approximately 20 minutes, but for many heavy-duty industrial engines, it can be substantially longer. Conversely, thin-walled turbines based on aircraft engine designs cool very quickly, once fuel flow terminates. Just as discharge time might need to be increased for some heavy-duty designs, it is appropriate to reduce the discharge duration for aircraft engine–based turbines to less than 20 minutes, based on discharge tests. Information on fire tests that demonstrate the extinguishment time for a turbine design should also be considered in determining the minimum discharge time. It is recommended that the minimum discharge time be no less than twice the time demonstrated to achieve fire extinguishment for the suppressant used. It has been shown that the initial concentration usually will not hold for a 20-minute time period in most engine enclosures and under these circumstances an extended discharge time is necessary to prevent potential fire reignition due to smoldering and heat soak. Where design concentrations still cannot be maintained effectively, an alternative system should be provided.

A.11.4.4.3 Fire suppression system discharge durations should be held as long as the hazards of hot metal surfaces above the autoignition temperature and uncontrollable combustible fluid flow exist. The manufacturer should be consulted for applicable engine cool-down times. Testing has shown this time requirement to be approximately 20 minutes, but for industrial turbines it can be substantially longer. Conversely, thin-walled turbines based on aircraft engine design cool very quickly, once fuel flow terminates. Just as discharge time might need to be increased for industrial turbine designs, it is appropriate to reduce the discharge duration for aircraft engine–based designs to less than 20 minutes, based on discharge tests. Information on fire tests that demonstrate the extinguishment time for a turbine design should also be considered in determining the minimum discharge time. It is recommended that the minimum discharge time be no less than twice the time demonstrated to achieve fire extinguishment for the suppressant used. An extended discharge time is necessary to prevent potential fire reignition due to smoldering and heat soak.

A.11.4.5.1 Automatic sprinkler systems are considered to be effective in controlling lubricating oil fires. Sprinkler densities provided in this standard are based on Extra Hazard, Group 1 occupancy as defined in NFPA 13. Automatic sprinkler protection designed as local protection for the engine in many cases provides better protection than sprinkler protection installed only at the ceiling level, particularly in the case of pressurized lubricating oil fires.

Consideration should be given to providing local protection when the protected engine equipment is located in a high bay area. Delayed activation time or lack of water penetration could delay fire suppression from a ceiling system.

Local protection for engines can be accomplished using either a wet system or a single interlock preaction deluge system with heat detection. Detectors for actuation of a preaction system should be located above the engine and around the system piping.

For diesel engine installations, the system piping should loop the engine at the height of the cylinder heads.

Because of the tight radial clearances on combustion gas turbines and the potential for rubbing of rotating parts and increased damage, it is advisable to use great care if using a sprinkler or water spray suppression system. Water from a ceiling or spot protection system could effectively control a fire; however, gaseous suppression agents could be just as effective without the potential for equipment damage when the system activates.

A.11.4.7 Water mist fire suppression systems need to be designed specifically for use with the size and configuration of the specific engine installation or enclosure being protected. Currently there is no generic design method recognized for water mist systems. System features such as nozzle spacing, flow rate, drop size distribution, cone angle, and other characteristics need to be determined for each manufacturer's system through full-scale fire testing to obtain a listing for each specific application and must be designed, installed, and tested in accordance with NFPA 750.