- (4) The piping shall be purged with fuel gas that is discharged to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas detector in accordance with 8.3.2.2. Purging shall be stopped when fuel gas is detected.
- (5) The piping shall be purged by the gas supplier in accordance with written procedures.

A combustible gas detector is required for purging systems that are permitted to be purged indoors. Combustible gas detectors simply indicate the presence of fuel gas, as opposed to combustible gas indicators required for outdoor purging that indicate fuel gas levels as a percentage by volume in air or inert gas. A combustible gas indicator could also be used for systems being purged indoors, but a combustible gas detector is adequate for small-volume systems. The term *listed* is defined in Chapter 3 and basically requires a testing and quality control program by a recognized third party.

A.8.3.2.1 Where small piping systems contain air and are purged to either the indoors or outdoors with fuel gas, a rapid and uninterrupted flow of fuel gas must be introduced into one end of the piping system and vented out of the other end so as to prevent the development of a combustible fuel–air mixture. Purging these systems can be done either using a source of ignition to ignite the fuel gas or by using a listed combustible gas detector that can detect the presence of fuel gas.

8.3.2.2 Combustible Gas Detector. Combustible gas detectors shall be listed and calibrated or tested in accordance with the manufacturer's instructions. Combustible gas detectors shall be capable of indicating the presence of fuel gas.

Many combustible gas detectors are capable of detecting gas concentrations well below the lower explosible limit (LEL) of the gas sensed. Use caution if the piping system was purged with inert gases prior to being filled with gas because this may render some technologies inoperative.

8.3.3 Purging Appliances and Equipment. After the piping system has been placed in operation, appliances and equipment shall be purged before being placed into operation.

Follow the manufacturer's instructions for startup of appliances and equipment.

References Cited in Commentary

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471, (800) 344-3555, www.nfpa.org.

NFPA 560, Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems, 2017 edition.

Appliance, Equipment, and Accessory Installation

Chapter 9 of the code covers requirements for appliance installation and applies to all gas appliances. Chapter 10 also covers requirements for appliance installation, but provides additional requirements for specific types of appliances that are used primarily in residential and commercial installations. Chapter 9 includes references to Chapter 12 that remind the installer that appliances must be properly vented.

Chapter 9 provides requirements on the following:

- *General:* Requirements covering many appliances and installations, including the following:
 - Approval of appliances and accessories
 - Addition or conversion of appliances to existing systems
 - Types of gas being used
 - Safety shutoff devices for LP-Gas appliances used indoors
 - Use of air or oxygen under pressure
 - Protection of appliances from fumes or gases other than products of combustion
 - Process air requirements
 - Building structural members
 - Flammable vapors
 - Installation in residential garages, commercial garages, and aircraft hangars
 - Physical protection of appliances
 - Venting of flue gases
 - Extra devices or attachments
 - Adequacy of pipe sizing and prevention of strain on piping
 - Installation and venting of appliance pressure regulators and bleed lines for diaphragm valves
 - Combination of appliances and equipment
 - Installation instructions
 - Protection of outdoor appliances
 - Inspection of an existing appliance installation after major building envelope modifications
- Accessibility and Clearance: Provides requirements for installers to allow for access to appliances for maintenance and for clearance to combustible construction
- Air for Combustion and Ventilation: Provides requirements for determining and providing sufficient air for gas to burn properly, dilution of products of combustion, and ventilation of appliance rooms and spaces

CHAPTER

- Appliances on Roofs: Provides requirements for roof installations
- Appliances in Attics: Provides requirements for appliances in attics
- Appliance and Equipment Connections to Building Piping: Provides requirements for connection of appliances to the piping system
- Electrical: Includes requirements for electrical connections, ignition and control devices, control circuits, and continuous power for electrically controlled appliances
- Room Temperature Thermostats: Provides requirements for the location of thermostats for thermostatically controlled space conditioning appliances

9.1 General

9.1.1* Appliances, Equipment, and Accessories to Be Approved. Appliances, equipment, and accessories shall be approved.

A.9.1.1 The American Gas Association, American National Standards Institute, Inc., and the National Fire Protection Association do not approve, inspect, or certify any installations, procedures, appliances, equipment, or materials; nor do they approve or evaluate testing laboratories. In determining acceptability of installations, procedures, appliances, equipment, or materials, the authority having jurisdiction can base acceptance on compliance with AGA, ANSI, CSA, or NFPA, or other appropriate standards. In the absence of such standards, said authority can require evidence of proper installation, procedure, or use. The authority having jurisdiction can also refer to the listings or labeling practices of an organization concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

9.1.1.1 Approved shall mean "acceptable to the authority having jurisdiction."

The authority having jurisdiction — which may be the local building or fire official, insurer, property owner, or commanding officer (in the military) — approves the materials, equipment, appliances, and method of construction as the result of investigations and tests or by reason of accepted principles or tests by national authorities, technical organizations, and scientific organizations.

FAQ How can the authority having jurisdiction determine whether a specific appliance or piece of equipment is approved?

The authority having jurisdiction often has lists of acceptable organizations that provide listing services. These services provide details on the terms of the listing and labeling, identifying the equipment and appliances that meet the standards appropriate to its use. A label carrying the identifying mark of the listing agency affixed to the appliance, or inclusion of the identifying mark in the installation manual, provides the authority having jurisdiction with a fast way of approving equipment and appliances. See Exhibit 10.4 for an example of an appliance label with an agency logo. See also the definitions of the terms *labeled*, defined in 3.2.4, and *listed*, defined in 3.2.5.

Subsection 9.1.1 provides criteria for approving unlisted equipment and appliances and provides three criteria for acceptance.

△ 9.1.1.2 Listed appliances, equipment, and accessories shall be installed in accordance with Chapter 9 and the manufacturers' installation instructions.

9.1.1.3 Acceptance of unlisted appliances, equipment, and accessories shall be on the basis of a sound engineering evaluation.

9.1.1.4 The unlisted appliance, equipment, or accessory shall be safe and suitable for the proposed service and shall be recommended for the service by the manufacturer.

9.1.2 Added or Converted Appliances. When additional or replacement appliances or equipment is installed or an appliance is converted to gas from another fuel, the location in which the appliances or equipment is to be operated shall be checked to verify the following:

- (1) Air for combustion and ventilation is provided where required, in accordance with the provisions of Section 9.3. Where existing facilities are not adequate, they shall be upgraded to meet Section 9.3 specifications.
- (2) The installation components and appliances meet the clearances to combustible material provisions of 9.2.2. It shall be determined that the installation and operation of the additional or replacement appliances do not render the remaining appliances unsafe for continued operation.
- (3) The venting system is constructed and sized in accordance with the provisions of Chapter 12. Where the existing venting system is not adequate, it shall be upgraded to comply with Chapter 12.

Installation procedures must be thoroughly reviewed when an appliance is installed, replaced, or converted to gas from another fuel. The references to Chapter 12 specify the need to verify that air for combustion and ventilation is adequate, that the clearance to combustible material is sufficient, and that the venting system meets the most recent requirements. If any of these specifications are not met, the portion not meeting code requirements must be upgraded to present code standards.

Paragraph 9.1.2(3) emphasizes that venting is not "grandfathered" when the appliance is replaced or converted. In many instances, the location has undergone renovation since the original installation. In the case of new appliances, the design and operation of the new appliance may be different from the existing appliance. New, more energy-efficient appliances have installation requirements that can vary substantially from those for the replaced appliance.

9.1.3 Type of Gas(es). The appliance shall be connected to the fuel gas for which it was designed. No attempt shall be made to convert the appliance from the gas specified on the rating plate for use with a different gas without consulting the installation instructions, the serving gas supplier, or the appliance manufacturer for complete instructions.

FAQ The existing furnace uses propane; natural gas is now available. Can the appliance be converted to natural gas?

Subsection 9.1.3 highlights an important safety concern: that the proper gas is supplied to appliances. Appliance rating plates identify the gas for which a particular appliance is specifically designed. Some appliances are not designed to be converted, whereas others include parts and installation instructions for conversion from one gas to another that stipulate a specific conversion kit part number. If there are no such instructions, the manufacturer or serving gas supplier should be contacted to determine whether the unit can be converted safely and how to make the conversion. If the burners are satisfactory for use with both gases, it should only be necessary to change the gas orifice(s) and regulator. In appliances that have a pilot burner, the pilot burner orifice must also be changed. [Natural gas appliances usually operate at 3.5 in. w.c. to 7 in. w.c. (2.5 kPa to 2.7 kPa) manifold pressure.] Refer to Annex E for additional information on orifice sizing.

See Annex E for more information on orifice sizing.

9.1.4 Safety Shutoff Devices for Unlisted LP-Gas Appliances Used Indoors. Unlisted appliances for use with undiluted LP-Gases and installed indoors, except attended laboratory equipment, shall be equipped with safety shutoff devices of the complete shutoff type.

All appliances must have controls to protect against flame failure. Listed appliances are required by their product standard to have a safety shutoff device. Unlisted LP-Gas appliances with pilot burners must have a complete (100 percent) shutoff-type safety device. A safety shutoff device of the complete shutoff type is one that will stop the flow of gas to both the main burner(s) and the pilot burner in the event of pilot failure.

▲ 9.1.5 Use of Air or Oxygen Under Pressure. Where air or oxygen under pressure is used in connection with the gas supply, effective means such as a back pressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. Where oxygen is used, installation shall be in accordance with NFPA 51.

In many applications, air or oxygen is used at a greater pressure than the fuel gas. If the air or oxygen enters the gas supply, the air or oxygen could travel all the way back to the gas supply source. A backup of air or oxygen into a gas pipe can result in a flammable mixture in the pipe, which can be extremely dangerous and must be avoided to prevent an explosion within the gas pipe.

Installations where the use of air or oxygen combined with natural gas or propane is likely to be found include jewelry stores that do repairs, muffler shops, and other metalworking facilities.

9.1.6* Protection of Appliances from Fumes or Gases Other than Products of Combustion.

A.9.1.6 Halogenated hydrocarbons are particularly injurious and corrosive after contact with flames or hot surfaces.

9.1.6.1 Where corrosive or flammable process fumes or gases, such as carbon monoxide, hydrogen sulfide, ammonia, chlorine, and halogenated hydrocarbons, as are present, means for their safe disposal shall be provided.

9.1.6.2 Non-direct-vent appliances installed in beauty shops, barber shops, or other facilities where chemicals that generate corrosive or flammable products such as aerosol sprays are routinely used shall be located in a mechanical room separate or partitioned off from other areas with provisions for combustion and dilution air from outdoors. Direct vent appliances in such facilities shall be in accordance with the appliance manufacturer's installation instructions.

Corrosive or flammable process fumes or gases can be disposed of safely only by a separate exhaust system and an adequate supply of fresh make-up air. Providing a system of isolation for the gas-fired appliance may be necessary to ensure that uncontaminated air is available for its combustion process.

FAQ

Why might a gas water heater and gas dryer installed in a beauty salon need special consideration?

Chlorine and fluorine compounds are present in many products that are used in a beauty salon. When burned, these compounds form acids that corrode the heat exchanger and vent system. The only way to avoid the subsequent problem of excessive corrosion of the heat exchanger surface and vent system is to isolate the heating or water-heating appliance so that it uses only outside air for combustion, ventilation, and draft hood dilution.

Direct-vent appliances are not required to meet these requirements because these appliances are designed to obtain their air for combustion from the outside atmosphere and discharge flue gases outside as well. Even with direct-vent systems, it is important that the combustion air source is not located in an area where these chemicals are used (e.g., swimming pools).

9.1.7 Process Air. In addition to air needed for combustion in commercial or industrial processes, process air shall be provided as required for cooling of appliances, equipment, or material; for controlling dew point, heating, drying, oxidation, dilution, safety exhaust, odor control, and air for compressors; and for comfort and proper working conditions for personnel.

9.1.8 Appliance Support.

9.1.8.1 Appliances and equipment shall be furnished either with load distributing bases or with a sufficient number of supports to prevent damage to either the building structure or the appliance and the equipment.

9.1.8.2 At the locations selected for installation of appliances and equipment, the dynamic and static load carrying capacities of the building structure shall be checked to determine whether they are adequate to carry the additional loads. The appliances and equipment shall be supported and shall be connected to the piping so as not to exert undue stress on the connections.

Local building codes should be reviewed for the installation requirements of certain appliances, especially in multifamily residential occupancies. Some codes specify appliance location, provide fire protection requirements for mechanical rooms, and may include specific requirements for rooftop installations.

When adding a large appliance to an existing building, such as a new rooftop heating and cooling unit, the installer should check building plans and obtain verification that the building can support both the weight and forces developed during operation or that structural support has been added.

9.1.9 Flammable Vapors. Appliances shall not be installed in areas where the open use, handling, or dispensing of flammable liquids occurs, unless the design, operation, or installation reduces the potential of ignition of the flammable vapors. Appliances installed in compliance with 9.1.10 through 9.1.12 shall be considered to comply with the intent of this provision.

Areas of buildings in which flammable liquids are openly used, handled, or dispensed include any area where non-water-based paints and varnish are used. Appliance options include the use of direct-vent appliances or an indirect steam or hot water coil in a make-up air unit with a remote boiler to ensure that the boiler is not in the proximity of the flammable vapors that are generated by the painting process. Installers must verify that the room in which an appliance is being installed is not an area where flammable vapors will be routinely present.

Although the future uses (or misuses) of a room cannot be predicted, it must be verified that gasoline, paint thinners, and flammable household solvents are not being stored and used in the room. A small spill of gasoline or other flammable liquid will create an invisible vapor cloud, which is generally heavier than air and will remain near the floor. This cloud can be drawn into an appliance through its combustion air intake, ignite, and flash back to the liquid pool.

Liquids that readily generate flammable vapors include gasoline, mineral spirits, acetone, denatured alcohol, oil-based paint and lacquer thinners, and camp stove fuel. For information on safe, recommended storage enclosures for these materials, see NFPA 30, *Flammable and Combustible Liquids Code*.

Residential gas water heaters designed as flammable vapor ignition resistant (FVIR) are available in all types and sizes in the United States. These water heaters, listed to ANSI Z21.10.1/CSA 4.1, *Gas Water Heaters — Volume I — Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less*, are required to meet a FVIR test as part of their listing. Although appliances are exempted when "the design, operation, or installation reduces the potential of ignition of the flammable vapors," FVIR water heaters should not be installed in the areas of concern. The FVIR requirements in ANSI Z21.10.1/CSA 4.1 are meant to provide protection from accidental spills in residential locations. The FVIR water heater design renders the water heater unusable after activation and may require replacement of the controller or replacement of the entire water heater. Commercial locations where routine handling of flammable liquids occurs due to business activities are in an entirely different hazard class that is not addressed by ANSI Z21.10.1/CSA 4.1.

The design used to enable the water heaters to pass the FVIR test is based on the principle first used in the mine safety lamp. In a mine safety lamp, a fine mesh screen encloses an oil lamp flame. If flammable gas enters the screened area, the gas ignites but the flame does not propagate outside of the lamp. See Exhibit 9.1 for an example of the construction of an FVIR water heater.



EXHIBIT 9.1

Cutaway of an FVIR water heater. (Courtesy of Rheem Manufacturing Company)

9.1.10 Installation in Residential Garages.

9.1.10.1 Appliances in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all burners and burner ignition devices are located not less than 18 in. (460 mm) above the floor unless listed as flammable vapor ignition resistant.

Household solvents, oil-based paint and thinners, and gasoline for use as fuel for automobiles, lawn mowers, and so forth are often stored in residential garages. Spills can occur when these

products are dispensed from their storage containers or during automobile maintenance. These flammable liquids vaporize readily, and their vapors remain near the floor. Available evidence indicates that elevating burners and ignition devices 18 in. (460 mm) or more above the floor locates them high enough so the vapors will not be ignited. Exhibit 9.2 illustrates the safe installation of a non-flammable vapor ignition resistant (non-FVIR) appliance in a residential garage.

FAQ

Is it permissible to install a water heater that is listed as an FVIR heater on a garage floor?

Much concern has been voiced regarding the ignition of flammable vapors by gas appliances — specifically, residential water heaters that are installed on a floor. Floor installation is allowed for FVIR water heaters based on their conformance with the requirements in ANSI Z21.10.1/CSA 4.1, which is cited in the commentary following 9.1.9. All new, listed storage-type water heaters of 75,000 Btu/hr (22 kW) or less produced for the U.S. market — with the exception of those for recreational vehicles — are resistant to the ignition of flammable vapors. The manufacture of instantaneous-type water heaters is covered under a different standard. Corresponding changes have not been made to require resistance to the ignition of flammable vapors in these instantaneous-type heaters because they have not been associated with such ignition.



EXHIBIT 9.2

Water heater installation in a residential garage. (Courtesy of American Gas Association)

9.1.10.2 Such appliances shall be located or protected so they are not subject to physical damage by a moving vehicle.

Appliances in the path of an automobile or other vehicle must be protected from accidental contact. An example of location protection would be an alcove installation where it is impossible for the vehicle to strike the appliance. Wheel stops (such as those shown in Exhibit 9.2), bollards, or walls must be used to prevent accidental contact with fuel-fired appliances.

9.1.10.3 Where appliances are installed in a separate, enclosed space having access only from outside of the garage, such appliances shall be permitted to be installed at floor level, providing the required combustion air is taken from the exterior of the garage.

The absence of a door between an appliance room or enclosure and the garage prevents any flammable vapors that may be present in the garage from interacting with the combustion air for the appliance. If the room has an opening into the garage, appliances cannot be installed on the floor unless they are flammable vapor ignition resistant (FVIR) as permitted under 9.1.10.1.

9.1.11 Installation in Commercial Garages.

△ 9.1.11.1 Parking Structures. Appliances installed in enclosed, basement, and underground parking structures shall be installed in accordance with NFPA 88A.

NFPA 88A, *Standard for Parking Structures*, requires that all gas-fueled heating appliances in enclosed parking garages be in accordance with NFPA 54/ANSI Z223.1. A gas-fired appliance must be located such that the flame associated with the appliance is at least 18 in. (460 mm) above the floor or at least 18 in. (460 mm) below the floor–ceiling assembly. (See Section 6.2 of NFPA 88A.)

NFPA 88A does not require the installation of heaters at least 8 ft (2.4 m) above the floor to provide clearance for passenger vehicles in parking garages. NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, requires the 8 ft (2.4 m) installation height for repair garages. The appliance manufacturer's instructions should be consulted for the specific requirements for the installation of overhead radiant heaters to avoid overheating vehicles that could be parked underneath them.

▲ 9.1.11.2 Repair Garages. Appliances installed in repair garages shall be installed in accordance with NFPA 30A.

NFPA 30A permits the installation of fuel gas appliances and provides code requirements that depend upon whether the repair garage is intended for major or minor repairs as well as the type of vehicle fuel systems (e.g., CNG, LNG, hydrogen) that may be present.

△ 9.1.12 Installation in Aircraft Hangars. Heaters in aircraft hangars shall be installed in accordance with NFPA 409.

9.1.13 Appliance Physical Protection. Where locating appliances close to a passageway traveled by vehicles or machinery is necessary, guardrails or bumper plates shall be installed to protect the equipment from damage.

Refer to Exhibit 9.2 for an illustration of a bumper plate installed in a garage.

9.1.14 Venting of Flue Gases. Appliances shall be vented in accordance with the provisions of Chapter 12.

9.1.15 Extra Device or Attachment. No device or attachment shall be installed on any appliance that could in any way impair the combustion of gas.

A combustion process must not be interfered with by the addition of unapproved accessories. The appliance manufacturer's instructions provide the information needed to determine whether there are any accessories approved for use on a particular appliance.

9.1.16 Adequate Capacity of Piping. When additional appliances are being connected to a gas piping system, the existing piping shall be checked to determine whether it has adequate capacity. Where the capacity is inadequate, the existing system shall be enlarged as necessary, or separate gas piping of adequate capacity shall be run from the point of delivery to the appliance.

9.1.17 Avoiding Strain on Gas Piping. Appliances shall be supported and connected to the piping so as not to exert undue strain on the connections.

The weight of an appliance should not be supported by the gas piping.

9.1.18 Gas Appliance Pressure Regulators. Where the gas supply pressure is higher than that at which the appliance is designed to operate or varies beyond the design pressure limits of the appliance, a gas appliance pressure regulator shall be installed.

Most gas appliances are designed for a nominal inlet pressure of 7 in. w.c. or 11 in. w.c. (1.7 kPa or 2.7 kPa), the normal building pressure for natural gas and propane, respectively. Appliance rating plates typically specify maximum supply pressure only slightly higher than these values. Where a building piping system operates at a pressure higher than the specified maximum, a pressure regulator called an *appliance pressure regulator* is needed. Many residential, commercial, and industrial gas piping systems deliver gas at a pressure of 2 psi (13.8 kPa) or higher to the proximity of the appliance, requiring the appliance installer to connect a "pounds to inches" or line pressure regulator ahead of the gas appliance.

9.1.19 Venting of Gas Appliance Pressure Regulators. Venting of gas appliance pressure regulators shall comply with the following requirements:

- (1) Appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the appliance, into the combustion chamber adjacent to a continuous pilot, unless constructed or equipped with a vent limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure.
- (2) Vent limiting means shall be employed on listed appliance pressure regulators only.
- (3) In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter.
- (4) Under no circumstances shall a regulator be vented to the appliance flue or exhaust system.
- (5) In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas is readily ignited by the pilot and the heat liberated thereby does not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined.
- (6) A vent line(s) from an appliance pressure regulator and a bleed line(s) from a diaphragm-type valve shall not be connected to a common manifold terminating in a combustion chamber. Vent lines shall not terminate in positive-pressure-type combustion chambers.

Item (1). Pressure regulators incorporate a diaphragm that moves up and down and compresses a spring as pressure increases. As the diaphragm moves, it adjusts the position of the valve that controls the flow of gas into the regulator. The space above the diaphragm must be sufficient to allow it to move up and down freely, and the space above the diaphragm is vented to the atmosphere to allow such free movement. Normally only air is vented from the space above the regulator, but if the diaphragm fails, natural gas or propane will be discharged.

Any gas that is relieved by a gas appliance pressure regulator must be vented safely to the outdoors to prevent the accumulation of a potentially dangerous concentration of gas