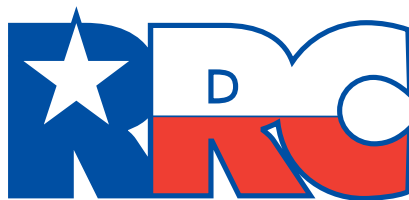


TEXAS LP-GAS EXAMINATION STUDY GUIDE

Service and Installation
Technician



RAILROAD COMMISSION OF TEXAS

October 2008

NOTICE

This publication is intended for use in its entirety as a guide for persons preparing to take Railroad Commission LP-gas qualifying examinations. Any other use or distribution of this publication or use or distribution of any portion of this publication for any purpose whatsoever is considered by the Railroad Commission of Texas to be misuse of this publication.

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Exam administration

Taking an examination in Austin

You may take any LP-gas qualifying examination in Austin without pre-registering (“walk-in”) on any business day, excluding holidays, from 8:00 a.m. to 12:00 noon at the AFRED Training Center. The Training Center is located at 6506 Bolm Road, at the intersection of U.S. Highway 183.

Tuesdays and Thursdays are the preferred days for walk-in examinations.

(See map to Training Center on page 25)

Taking an examination outside of Austin

You may also take any LP-gas qualifying examination at more than two dozen other locations statewide. Exam dates, times and locations are listed three months in advance on the Railroad Commission’s web site. To view a complete schedule, go to www.rrc.state.tx.us, click on “Propane/LP-Gas, Training & Certification” and select “Class/Exam Schedule.” The online schedule has links to maps showing each class and exam location.

You must register at least two business days in advance to take an examination outside of Austin. From the RRC home page at www.rrc.state.tx.us, click on “Propane/LP-Gas Training & Certification” and select “Register Now.” The web site allows you to register up to four people for an examination, a training class, or both.

When you register online, you will receive a return e-mail confirming the registration and the dates and locations of the exams. You will also receive advance notification of any changes in the examination date, time or location.

Payment for exams; LPG Form 16; ID required

You may pay your examination fee online by any major credit card. To charge to a credit card, go to www.propane.tx.gov and click on the “Pay Online” shopping cart. Be sure to print out the confirmation page in Step 6. Make a copy of the confirmation page for your records and bring a copy to the examination site. You may also pay by credit card for exams taken at the Railroad Commission’s Training Center in Austin.

For exams taken outside of Austin, you must pay the required examination fee by credit card, check or money order. Cash is not accepted at the Austin Training Center or for exams taken outside of Austin. The fee is \$40.00 for each employee-level exam. LPG Form 16, “Application For Examination,” may also be completed at the examination site. Fees are non-refundable by state law.

Examinees must also present an official state-issued driver’s license or photo ID at the exam site.

Open-book examinations

All Railroad Commission LP-gas employee-level qualifying examinations are open book.

Examinees may use a copy of NFPA 54, 2006 edition; NFPA 58, 2008 edition; the Railroad Commission’s *LP-Gas Safety Rules*, or a Railroad Commission Texas Propane Training course manual to take their service and installation examination. The course manual does not cover every topic included on the service and installation examination.

The questions on the employee-level service and installation examination are not organized by topic as they are in this study guide.

Examination Time Limit

The employee-level service and installation examination must be completed within three hours after the examination is given to you, including any breaks you elect to take. The examination proctor is the official timekeeper. You must submit both your examination and your answer sheet to the proctor within the three-hour limit.

Grades, reports and retakes

The minimum passing grade is 75 percent on all LP-gas examinations.

All examinations administered at the Training Center in Austin are graded on site, and examinees are immediately informed of the results. If you fail an examination that you took in Austin, you may retake that same examination only one additional time during a business day. Any subsequent examination must be taken on another business day, unless approved by the Commission.

Exams taken outside of Austin are graded as soon as possible, and the results of the examination are reported within 10 working days. If you pass an examination, the Railroad Commission will issue you a blue certification card within 10 working days. You will be notified by letter if you fail an examination.

Required First-Year Training Class

Certified service and installation technicians are subject to Railroad Commission training and continuing-education requirements. To maintain your certification, you must complete one of the following Railroad Commission eight-hour courses by the next May 31 after you pass your initial examination (Note: If you pass the examination between March 1 and May 31, you have until May 31 the next year to complete the required class.)

- 1.1 Introduction to Propane
- 3.1 Residential System Layout and Design
- 3.2 Residential System Installation
- 3.3 Appliance Conversions, Installation and Venting
- 3.5 Residential Appliance Controls
- 3.7 Electrical Troubleshooting and Repairing Residential Gas Appliances
- 3.11 Residential System Inspection

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LP-GAS EXAMINATION STUDY GUIDE: SERVICE AND INSTALLATION TECHNICIAN

Who should use this guide?

You should use this guide if you plan to take the Railroad Commission's employee-level qualifying examination to perform LP-gas service and installation activities. The service and installation certification qualifies you to perform all LP-gas activities related to stationary systems, including containers, appliances, and stationary engines.

The service and installation certification does not qualify you to fill containers or operate an LP-gas transport.

What books do I need?

This examination tests your knowledge of the laws and standards that apply to service and installation operations in Texas. These laws and standards are found in three books:

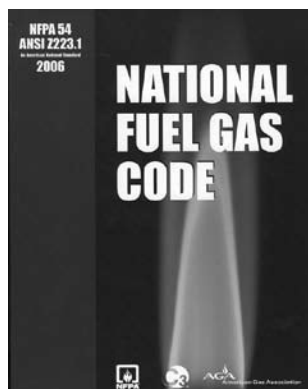
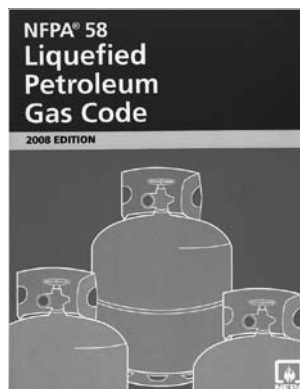
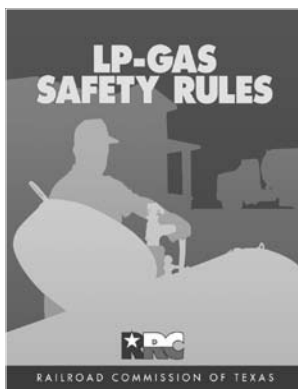
LP-Gas Safety Rules (Texas Railroad Commission, 2008)

NFPA 54: *National Fuel Gas Code* (National Fire Protection Association, 2006)

NFPA 58: *Liquefied Petroleum Gas Code* (National Fire Protection Association, 2008)

Where do I get these books?

You may download the Railroad Commission's *LP-Gas Safety Rules* free online at www.propane.tx.gov/publications/lpg_safetyrules.pdf. You may also buy a printed copy of the book for \$7.00, tax included, by calling the Railroad Commission's publications office at (512) 463-6747. Printed copies of NFPA 54 and 58 are available for purchase from the Texas Propane Gas Association by calling (800) 392-0023. You may also order NFPA manuals online at www.nfpa.org; click on "Codes and Standards."



Sections and topics

Before you take this examination you should know the definitions on pp. 8-10 of this study guide and the contents of the sections of the codes and standards listed below. The actual examination questions may not cover all of the listed sections and topics.

NOTE: Section (§) 9.402(c) of the *LP-Gas Safety Rules* states, “Container capacity, piping system, and appliance exceptions. The Commission does not adopt language in any NFPA rule, chart, figure, or table pertaining to any LP-gas container having a water capacity of one gallon (4.2 pounds LP-gas capacity) or less, or to any LP-gas piping system or appliance attached or connected to such a container.”

LP-Gas Safety Rules (February 2008)

§9.35	Written Procedures for Gas Leaks
§9.126	Appurtenances and Equipment
§9.129	Manufacturer’s Nameplate and Marking on ASME Containers
§9.134	Connecting Container to Piping
§9.140	Uniform Protection Standards
§9.141	Uniform Safety Requirements
§9.306	Room Heaters in Public Buildings
§9.403(a), §6.6.2.1	Installation of Cylinders
§9.403(a), §6.6.3.1	Installation of Horizontal Aboveground ASME Containers

NFPA 54 (2006)

§3.3	General Definitions
§5.4	Sizing of Gas Piping Systems
§5.5	Piping System Operating Pressure Limitations
§5.6	Acceptable Piping Materials
§5.7	Gas Meters
§5.8	Gas Pressure Regulators
§6.1	Pipe Sizing Methods
§6.3	Tables for Sizing Gas Piping Systems Using Propane
§7.1	Piping Underground
§7.2	Installation of Piping
§7.3	Concealed Piping in Buildings
§7.7	Outlets
§7.9	Manual Gas Shutoff Valves
§7.13	Electrical Bonding and Grounding
§8.1	Pressure Testing and Inspection
§8.2	Piping System, Appliance, and Equipment Leakage Check

§8.3	Purging
§9.1	General
§9.3	Air for Combustion and Ventilation
§9.6	Appliance and Equipment Connections to Building Piping
§10.4	Clothes Dryers
§10.6	Decorative Appliances for Installation in Vented Fireplaces
§10.10	Duct Furnaces
§10.13	Food Service Appliances, Counter Appliances
§10.18	Infrared Heaters
§10.20	Outdoor Cooking Appliances
§10.23	Room Heaters
§10.27	Wall Furnaces
§10.28	Water Heaters
§10.30	Appliances for Installation in Manufactured Housing
§11.2	Primary Air Adjustment
§11.3	Safety Shutoff Devices
§11.4	Automatic Ignition
§11.5	Protective Devices
§11.6	Checking the Draft
§11.7	Operating Instructions
§12.1	Minimum Safe Performance
§12.3	Specification for Venting
§12.7	Gas Vents
§12.11	Vent Connectors for Category I Appliances

NFPA 58 (2008)

§3.3	General Definitions
§5.2	Containers
§5.7	Container Appurtenances and Regulators
§6.3	Container Separation Distances
§6.4	Other Container Location Requirements
§6.6	Installation of Containers
§6.8	Regulator Installation
§6.9	Piping Systems
§6.13	Hydrostatic Relief Valve Installation
§15.1	Tables for Sizing Pipe and Tubing

Terms and definitions

As a service and installation technician you need to know the terms and definitions relating to propane's physical characteristics and the operation of appliances.

NFPA 54 (2006)

NOTE: Informal terms that are sometimes used in the propane industry instead of formal technical terms are given in brackets.

Appliance. Any device that utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration, or air conditioning. §3.3.6

Appliance Regulator. A pressure regulator for controlling pressure to the appliance manifold. §3.3.86.1

Appliance Shutoff Valve. A valve located in the piping system, used to shut off individual equipment. §3.3.103.1

Btu. Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit (equivalent to 1055 joules). §3.3.15

Category I Vented Appliance. An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. §3.3.6.11.1

Category II Vented Appliance. An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent. §3.3.6.11.2

Category III Vented Appliance. An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. §3.3.6.11.3

Category IV Vented Appliance. An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent. §3.3.6.11.4

Controls. Devices designed to regulate the gas, air, water, or electrical supply to an appliance. These may be manual or automatic. §3.3.24

Direct Vent Appliances. Appliances that are constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors. §3.3.6.3

Flue Gases. Products of combustion plus excess air in appliance flues or heat exchangers. §3.3.50.1

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. §3.2.3

Leak Check. An operation performed on a complete gas piping system, the connections, appliances, and equipment to verify that the system does not leak. §3.3.62

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. §3.2.4

Orifice. The opening in a cap, spud, or other device whereby the flow of gas is limited and through which the gas is discharged to the burner. §3.3.72

Pipe. Rigid conduit of iron, steel, copper, brass, aluminum, or plastic. §3.3.76

Piping System. All piping, valves, and fittings from the outlet of the point of delivery from the supplier to the outlets of the equipment shutoff valves. §3.3.98.6

Pressure Test. An operation performed to verify the gastight integrity of gas piping following its installation or modification. §3.3.81

Quick-Disconnect Device. A hand-operated device that provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected. §3.3.28.3

Regulator Vent. The opening in the atmospheric side of the regulator housing permitting the in and outmovement of air to compensate for the movement of the regulator diaphragm. §3.3.105.3

Safety Shutoff Device. A device that will shut off the gas supply to the controlled burner(s) in the event the source of ignition fails. This device can interrupt the flow of gas to main burner(s) only or to pilot(s) and main burner(s) under its supervision. §3.3.28.4

Type 1 Clothes Dryer. Primarily used in family living environment. May or may not be coin-operated for public use. §3.3.18.1

Type 2 Clothes Dryer. Used in business with direct intercourse of the function with the public. May or may not be operated by public or hired attendant. May or may not be coin-operated. §3.3.18.2

Type B Gas Vent. A vent for venting listed gas appliances with draft hoods and other Category I appliances listed for use with Type B gas vents. §3.3.105.2.2

Type L Gas Vent. A vent for venting appliances listed for use with Type L vents and appliances listed for use with Type B gas vents.

Unvented Room Heater. An unvented, self-contained, freestanding, nonrecessed, fuel-gas-burning appliance for furnishing warm air by gravity or fan circulation to the space in which installed, directly from the heater without duct connection. §3.3.55.6

Vent Connector. The pipe or duct that connects a fuel-gas-burning appliance to a vent or chimney. §3.3.106

Venting. Removal of combustion products as well as process fumes to the outer air. §3.3.108

NFPA 58 (2008)

Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used to transport or store LP-gases. §3.3.13

Container Appurtenances. Devices installed in container openings for safety, control, or operating purposes. §3.3.14

DOT. U.S. Department of Transportation. §3.3.21

Excess-Flow Valve. A valve designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate. §3.3.74.2

Flexible Connector. A short [not exceeding 60 in. overall length] piping system component that is fabricated from a flexible material and equipped with connections at both ends. §3.3.25

Fixed Liquid Level Gauge. A liquid level indicator that uses a positive shutoff vent valve to indicate that the liquid level in a container being filled has reached the point at which the indicator communicates with the liquid level in the container. §3.3.29.1

Fixed Maximum Liquid Level Gauge [“outage gauge,” “spitter valve,” “spew gauge”]. A fixed liquid level gauge that indicates the liquid level at which the container is filled to its maximum permitted filling limit. §3.3.29.2

Liquefied Petroleum Gas [“LP-gas,” “LPG”]. Any material having a vapor pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes. §3.3.36

NFPA. National Fire Protection Association. §3.3.47

Pressure Relief Device [“popoff valve”]. A device designed to open to prevent a rise of internal pressure in excess of a specified value due to emergency or abnormal conditions. §3.3.58

Sources of Ignition. Devices or equipment that, because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable LP-gas vapor-air mixtures when introduced into such a mixture or when such a mixture comes into contact with them, and that will permit propagation of flame away from them. §3.3.67

Water Capacity. The amount of water at 60°F required to fill a container. §3.3.79

Key topics

NOTE: The list below is not exhaustive. You are responsible for knowing all the facts, rules, standards and procedures that apply to the LP-gas activities you will perform.

As you study the applicable codes and standards, pay special attention to the facts, rules and procedures related to the following key topics. Then, when you take the examination, read each question very carefully.

1. Containers and Cylinders

Unless it is specifically prohibited for use by another section of the *LP-Gas Safety Rules*, all appurtenances and equipment placed into LP-gas service must be listed by a nationally recognized testing laboratory such as Underwriters Laboratory (UL), Factory Mutual (FM), or American Gas Association (AGA). *LP-Gas Safety Rules*, §9.126(a)

In addition, to NFPA 58, §6.6.1.4, containers must be painted as follows: ASME containers, except vaporizers, must be painted white or aluminum, or any other heat-reflective color (such as light green, light blue, etc.). Darker, heat-absorbing colors (such as black, navy blue, etc.) are not permitted.

LP-Gas Safety Rules, §9.141(a)(1)

Cylinders must be installed only aboveground, and must be set upon a firm foundation of concrete, masonry, or metal and be firmly secured against displacement. The cylinder must not be in contact with the soil. *LP-Gas Safety Rules*, §9.403(a), §6.6.2.1

Containers that show excessive denting, bulging, gouging, or corrosion must be removed from service. NFPA 58, §5.2.1.4

The minimum horizontal separation between aboveground LP-gas containers and aboveground tanks containing liquids having flash points below 200°F must be 20 feet. NFPA 58, §6.4.5.5

An aboveground LP-gas container and any of its parts must not be located within 6 feet. of a vertical plane beneath overhead electric power lines that are over 600 volts, nominal. NFPA 58, §6.4.5.12

Flexibility must be provided in the connecting piping. Where flexible connectors are used, they must comply with 6.9.6. NFPA 58, §6.6.2.2

Horizontal ASME containers designed for permanent installation in stationary service above ground must be placed on masonry or other noncombustible structural supports located on concrete or masonry foundations with the container supports. *LP-Gas Safety Rules*, §9.403(a), §6.6.3.1

2. Underground Containers

Containers installed in areas with no vehicular traffic must be installed at least 6 in. below grade. NFPA 58, §6.6.6.1(A)

In areas where vehicular traffic is expected, a noninterchangeable underground container must be installed at least 18 in. below grade, or the container must be protected from damage from vehicles. NFPA 58, §6.6.6.1(B)

Approved interchangeable aboveground-underground container assemblies installed underground must not be placed with the container shell more than 12 in. below grade. NFPA 58, §6.6.6.1(D)

3. Nameplate

Nameplates on containers built prior to September 1, 1984, must include at least the following legible information:

- (1) the name of container manufacturer;
- (2) the manufacturer's serial number;
- (3) the container's working pressure; and
- (4) the container's water capacity.

Nameplates on containers built on or after September 1, 1984, must be stainless steel and permanently attached to the container by continuous fusion welding around the perimeter of the nameplate. *LP-Gas Safety Rules*, §9.129(d) and (e)

SAMPLE QUESTION

The discharge of the regulator vent on an underground tank installation must _____.

- A. Be above the normal water level
- B. Be above the highest probable water level
- C. Be above the grade level
- D. Terminate 3 inches above the height of the regulator

Answer: B

4. Piping and Tubing

LP-gas piping must be installed only by a licensee authorized to perform such installation, a registrant authorized by §9.13 of this title (relating to General Installers and Repairman Exemption), or an individual exempted from licensing as authorized by Texas Natural Resources Code, §113.081.

A licensee must not connect an LP-gas container or cylinder to a piping installation made by a person who is not licensed to make such installation, except that connection may be made to piping installed by an individual on that individual's single family residential home.

A licensee may connect to piping installed by an unlicensed person provided the licensee has performed a pressure test, verified that the piping has been installed according to the *LP-Gas Safety Rules* and filed a properly-completed LPG Form 22 with the Safety Division, identifying the unlicensed person who installed the LP-gas piping. *LP-Gas Safety Rules*, §9.134

Gas piping must be sized in accordance with one of the following:

- (1) Pipe sizing tables or sizing equations in Chapter 6
- (2) Other approved engineering methods acceptable to the authority having jurisdiction
- (3) Sizing tables included in a listed piping system manufacturer's installation instructions. NFPA 54, §5.4.3

The operating pressure for undiluted LP-gas systems must not exceed 20 psi. NFPA 54, §5.5.2

Cast-iron pipe must not be used. NFPA 54, §5.6.2.1

Steel and wrought-iron pipe must be at least of standard weight (Schedule 40). NFPA 54, §5.6.2.2

Copper tubing must comply with standard Type K or Type L of ASTM B 88, *Specification for Seamless Copper Water Tube*, or ASTM B 280, *Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*. NFPA 54, §5.6.3.2

Corrugated stainless steel tubing must be listed in accordance with ANSI LC 1/CSA 6.26, *Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*. NFPA 54, §5.6.3.4

Plastic pipe, tubing, and fittings used to supply fuel gas must be used outdoors underground only and must conform to ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*. Pipe to be used must be marked “gas” and “ASTM D 2513”. NFPA 54, §5.6.4.1

The pipe size of each section of gas piping must be determined using the longest length of piping from the point of delivery to the most remote outlet and the load of the section. NFPA 54, §6.1.1

Pipe must be sized as follows:

- (1) Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet must be determined using the longest run of piping and the load of the section.
- (2) The pipe size of each section of branch piping not previously sized must be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section. NFPA 54, §6.1.2

Table 6.3(a) through Table 6.3(m) must be used to size gas piping in conjunction with one of the methods described in 6.1.1 through 6.1.3. NFPA 54, §6.3

Means must be provided to prevent excessive stressing of the piping where there is heavy vehicular traffic or soil conditions are unstable and settling of piping or foundation walls could occur. Piping must be buried or covered in a manner so as to protect the piping from physical damage. Piping must be protected from physical damage where it passes through flower beds, shrub beds, and other such cultivated areas where such damage is reasonably expected. NFPA 54, §7.1.2

Underground piping systems must be installed with a minimum of 12 in. of cover.

- (A) The minimum cover must be increased to 18 in. if external damage to the pipe or tubing from external forces is likely to result.
- (B) Where a minimum of 12 in. of cover cannot be provided, the pipe must be installed in conduit or bridged (shielded). NFPA 54, §7.1.2.1

Gas piping in contact with earth or other material that could corrode the piping must be protected against corrosion in an approved manner. When dissimilar metals are joined underground, an insulating coupling or fitting must be used. Piping must not be laid in contact with cinders. Uncoated threaded or socket welded joints must not be used in piping in contact with soil or where internal or external crevice corrosion is known to occur. NFPA 54, §7.1.3

An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape must be buried with the plastic pipe to facilitate locating. One end must be brought aboveground at a building wall or riser. NFPA 54, §7.1.7.3

Piping installed aboveground must be securely supported and located where it will be protected from physical damage (also see 7.1.4). Where passing through an exterior wall, the piping must also be protected against corrosion by coating or wrapping with an inert material approved for such applications. Where piping is encased in a protective pipe sleeve, the annular space between the gas piping and the sleeve must be sealed at the wall to prevent the entry of water, insects, or rodents. NFPA 54, §7.2.1

CSST piping systems must be installed in accordance with NFPA 54 and the manufacturer's installation instructions. NFPA 54, §7.2.8

Where gas piping is to be concealed, unions, tubing fittings, right and left couplings, bushings, swing joints, and compression couplings made by combinations of fittings must not be used. Connections must be of the following type:

- (1) Pipe fittings such as elbows, tees, and couplings
- (2) Joining tubing by brazing (*see 5.6.8.2*). NFPA 54, §7.3.2

Outlets must not be located behind doors. NFPA 54, §7.7.1.2

Outlets must be located far enough from floors, walls, patios, slabs, and ceilings to permit the use of wrenches without straining, bending, or damaging the piping. NFPA 54, §7.7.1.3

The unthreaded portion of gas piping outlets must extend not less than 1 in. through finished ceilings or indoor or outdoor walls. NFPA 54, §7.7.1.4

Each outlet, including a valve, must be closed gastight with a threaded plug or cap immediately after installation and must be left closed until the appliance or equipment is connected thereto. When an appliance or equipment is disconnected from an outlet and the outlet is not to be used again immediately, it must be capped or plugged gastight. NFPA 54, §7.7.2.1

Each aboveground portion of a gas piping system that is likely to become energized must be electrically continuous and bonded to an effective ground-fault current path. Gas piping must be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. NFPA 54, §7.13.1

Prior to acceptance and initial operation, all piping installations must be inspected and pressure tested to determine that the materials, design, fabrication, and installation practices comply with the requirements of NFPA 54. NFPA 54, §8.1.1.1

A piping system must be tested as a complete unit or in sections. NFPA 54, §8.1.1.5

The test medium must be air, nitrogen, carbon dioxide, or an inert gas. OXYGEN MUST NEVER BE USED. NFPA 54, §8.1.2

Appliances and equipment that are not to be included in the test must be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test must not be required to be tested. NFPA 54, §8.1.3.3

Where the piping system is connected to appliances or equipment designed for operating pressures of less than the test pressure, such appliances or equipment must be isolated from the piping system by disconnecting them and capping the outlet(s). NFPA 54, §8.1.3.4

Where the piping system is connected to appliances or equipment designed for operating pressures equal to or greater than the test pressure, such appliances or equipment must be isolated from the piping system by closing the individual appliance or equipment shutoff valve(s). NFPA 54, §8.1.3.5

Test pressure must be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the pressure test period. The source of pressure must be isolated before the pressure tests are made. NFPA 54, §8.1.4.1

The test pressure to be used must be no less than 1½ times the proposed maximum working pressure, but not less than 3 psi, irrespective of design pressure: NFPA 54, §8.1.4.2

Test duration must be not less than 1/2 hour for each 500 feet³ of pipe volume or fraction thereof. When testing a system having a volume less than 10 feet³ or a system in a single-family dwelling, the test duration must be a minimum of 10 minutes. The duration of the test must not exceed 24 hours. NFPA 54, §8.1.4.3

The leakage must be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. **Matches, candles, open flames, or other methods that provide a source of ignition must not be used.** NFPA 54, §8.1.5.2

Where leakage or other defects are located, the affected portion of the piping system must be repaired or replaced and retested. NFPA 54, §8.1.5.3

Before gas is introduced into a system of new gas piping, the entire system must be inspected to determine that there are no open fittings or ends and that all valves at unused outlets are closed and plugged or capped. NFPA 54, §8.2.2

Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system must be checked for leakage. Where leakage is indicated, the gas supply must be shut off until the necessary repairs have been made. NFPA 54, §8.2.3

Appliances and equipment must not be placed in operation until after the piping system has been tested in accordance with 8.2.3 and purged in accordance with 8.3.2. NFPA 54, §8.2.4

When piping full of air is placed in operation, the air in the piping must be displaced with fuel gas, except where such piping is required by Table 8.3.2 to be purged with an inert gas prior to introduction of fuel gas. The air can be safely displaced with fuel gas, provided that a moderately rapid and continuous flow of fuel gas is introduced at one

end of the line and air is vented out at the other end. The fuel gas flow must be continued without interruption until the vented gas is free of air. The point of discharge must not be left unattended during purging. After purging, the vent must then be closed. Where required by Table 8.3.2, the air in the piping must first be displaced with an inert gas, and the inert gas must then be displaced with fuel gas. NFPA 54, §8.3.2

Polyethylene piping systems must be limited to the following:

- (a) Vapor service not exceeding 30 psig
- (b) Installation outdoors and underground. NFPA 58, § 6.9.1.1(3)

Corrugated stainless steel piping systems must be limited to vapor service not exceeding 5 psig. NFPA 58, §6.9.1.1(5)

LP-gas vapor piping systems downstream of the first stage pressure regulator must be sized so that all appliances operate within their manufacturer's specifications. NFPA 58, §6.9.2.1

LP-gas vapor piping systems must be sized and installed to provide a supply of gas to meet the maximum demand of all gas utilization equipment using Table 15.1(a) through Table 15.1(q). NFPA 58, §6.9.2.2

Metallic piping must comply with the following:

- (2) Vapor LP-gas piping with operating pressures in excess of 125 psig and liquid piping not covered by 6.9.3.3(1) must be designed for a working pressure of at least 250 psig
- (3) Vapor LP-gas piping subject to pressures of not more than 125 psig must be designed for a pressure rating of at least 125 psig. NFPA 58, §6.9.3.3

Piping in systems must be run as directly as is practical from one point to another, with as few fittings as practical. NFPA 58, §6.9.3.7

Piping systems including the interconnection of permanently installed containers must compensate for expansion, contraction, jarring, vibration, and settling.

- (A) Flexible metallic connectors may be used.
- (B) The use of nonmetallic pipe, tubing, or hose for permanently interconnecting containers must be prohibited. NFPA 58, §6.9.3.9

LP-gas piping must not be used as a grounding electrode. NFPA 58, §6.9.3.15

Flexible metallic connectors must not exceed 60 in. in overall length when used with liquid or vapor piping on stationary containers. *LP-Gas Safety Rules*, §9.403(a), §6.9.6.2

5. Meters and Regulators

Gas meters must be located at least 3 feet from sources of ignition. NFPA 54, §5.7.2.3

The gas pressure regulator must be accessible for servicing. NFPA 54, §5.8.3

Pressure regulators must be protected against physical damage. NFPA 54, §5.8.4

First-stage or high-pressure regulators must be directly attached or attached by flexible metallic connectors, to the vapor service valve used on stationary (permanent) container installations, and to interconnecting piping of manifolded stationary (permanent) container installations, or to a vaporizer outlet. NFPA 58, §6.8.1.1

All regulators for outdoor installations must be designed, installed, or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud, or debris). NFPA 58, §6.8.1.5

The point of discharge from the required pressure relief device on regulated equipment installed outside of buildings or occupiable structures in fixed piping systems must be located not less than 3 feet horizontally away from any building or occupiable structure opening below the level of discharge, and not beneath or inside any building or occupiable structure unless this space is not enclosed for more than 50 percent of its perimeter. NFPA 58, §6.8.1.6

A two-stage regulator system, an integral two-stage regulator, or a 2 psi regulator system is required on all fixed piping systems that serve ½ psig appliance systems [normally operated at 11 in. water column pressure]. NFPA 58, §6.8.2

Single-stage regulators is permitted on small portable appliances and outdoor cooking appliances with input ratings of 100,000 Btu/hr or less. NFPA 58, §6.8.2 (C)

SAMPLE QUESTION

Gas piping systems must be properly sized and installed to provide a supply of gas sufficient to meet _____ demand without undue pressure loss between the point of delivery and the appliance.

- A. 50 percent of the appliance
- B. Maximum
- C. 75 percent of the appliance
- D. 90 percent of the appliance

Answer: B

6. Appliances

Listed appliances, equipment, and accessories must be installed in accordance with Chapter 8 and the manufacturer's installation instructions. NFPA 54, §9.1.1.2

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 must 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 must 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 must 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 must be upgraded to comply with Chapter 12. NFPA 54, §9.1.2

It must be determined whether the appliance has been designed for use with the gas to which it will be connected. No attempt must be made to convert the appliance from the gas specified on the rating plate for use with a different gas without consulting the installation instruction, the serving gas supplier, or the appliance manufacturer for complete instructions. NFPA 54, §9.1.3

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 must be installed so that all burners and burner ignition devices are located not less than 18 in. above the floor unless listed as flammable vapor ignition resistant. NFPA 54, §9.1.10.1

When additional appliances are being connected to a gas piping system, the existing piping must be checked to determine whether it has adequate capacity. (*See Section 5.4*) Where inadequate, the existing system must be enlarged as necessary, or separate gas piping of adequate capacity must be run from the point of delivery to the appliance. NFPA 54, §9.1.16

The required volume of indoor air must be determined in accordance with the method in 9.3.2.1 or 9.3.2.2 except that where the air infiltration rate is known to be less than 0.40 *ACH*, the method in 9.3.2.2 must be used. The total required volume must be the sum of the required volume calculated for all appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance with 9.3.2.3, are considered a part of the required volume. NFPA 54, §9.3.2

Outdoor combustion air must be provided through opening(s) to the outdoors in accordance with the methods in 9.3.3.1 or 9.3.3.2. The minimum dimension of air openings must not be less than 3 inches. NFPA 54, §9.3.3

Two permanent openings, one commencing within 12 in. of the top and one commencing within 12 in. of the bottom, of the enclosure must be provided. The openings must communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors, as follows:

(1) Where directly communicating with the outdoors or where communicating to the outdoors through vertical ducts, each opening must have a minimum free area of 1 in.²/4000 Btu/hr of total input rating of all appliances in the enclosure

(2) Where communicating with the outdoors through horizontal ducts, each opening must have a minimum free area of 1 in.²/2000 Btu/hr of total input rating of all appliances in the enclosure. NFPA 54, §9.3.3.1

One permanent opening, commencing within 12 in. of the top of the enclosure, must be provided. The appliance must have clearances of at least 1 in. from the sides and back and 6 in. from the front of the appliance. The opening must directly communicate with the outdoors or must communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors and must have a minimum free area of the following:

(1) 1 in.²/3000 Btu/hr of the total input rating of all appliances located in the enclosure, and

(2) Not less than the sum of the areas of all vent connectors in the space. NFPA 54, § 9.3.3.2

The required size of openings for combustion, ventilation, and dilution air must be based on the net free area of each opening. Where the free area through a design of louver or grille or screen is known, it must be used in calculating the size opening required to provide the free area specified. Where the louver and grille design and free area are not known, it must be assumed that wood louvers will have 25 percent free area, and metal louvers and grilles will have 75 percent free area. Non-motorized louvers and grilles must be fixed in the open position. NFPA 54, §9.3.7.1

Appliances and equipment must be connected to the building piping in compliance with 9.6.4 through 9.6.6 by one of the following:

(1) Rigid metallic pipe and fittings.

(2) Semi-rigid metallic tubing and metallic fittings. Aluminum alloy tubing must not be used in exterior locations.

(3) A listed connector in compliance with ANSI Z21.24, *Standard for Connectors for Gas Appliances*. The connector must be used in accordance with the manufacturer's installation instructions and must be in the same room as the appliance. Only one connector must be used per appliance.

(4) A listed connector in compliance with ANSI Z21.75, *Connectors for Outdoor Gas Appliances and Manufactured Homes*. Only one connector must be used per appliance.

(5) CSST where installed in accordance with the manufacturer's installation instructions.

(6) Listed nonmetallic gas hose connectors in accordance with 9.6.2.

(7) In 9.6.1(2), 9.6.1(3), 9.6.1(4), 9.6.1(5), and 9.6.1(6), the connector or tubing must be installed so as to be protected against physical and thermal damage. Aluminum alloy tubing and connectors must be coated to protect against external corrosion where they are in contact with masonry, plaster, or insulation or are subject to repeated wettings by such liquids as water (except rain water), detergents, or sewage.

(8) Materials addressed in 9.6.1(2), 9.6.1(3), 9.6.1(4), 9.6.1(5), and 9.6.1(6) must not be installed through an opening in an appliance housing, cabinet, or casing, unless the tubing or connector is protected against damage. NFPA 54, §9.6.1

Listed gas hose connectors must be used in accordance with the manufacturer's installation instructions and as follows:

(2) Outdoor gas hose connectors are permitted to connect portable outdoor appliances.

(a) An appliance shutoff valve, a listed quick-disconnect device, or a listed gas convenience outlet must be installed where the connector is attached to the supply piping and in such a manner so as to prevent the accumulation of water or foreign matter.

(b) This connection must be made only in the outdoor area where the appliance is to be used. NFPA 54, §9.6.2

Where flexible connections are used, they must be of the minimum practical length and must not extend from one room to another or pass through any walls, partitions, ceilings, or floors. Flexible connections must not be used in any concealed location. They must be protected against physical or thermal damage and must be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections. NFPA 54, §9.6.3.4

Each appliance connected to a piping system must have an accessible, approved manual shutoff valve with a non-displaceable valve member, or a listed gas convenience outlet. Appliance shutoff valves and convenience outlets must serve a single appliance only and must be installed in accordance with 9.6.4.1. NFPA 54, §9.6.4

The shutoff valve must be located within 6 feet of the appliance it serves except as permitted in 9.6.4.2 or 9.6.4.3.

(1) Where a connector is used, the valve must be installed upstream of the connector. A union or flanged connection must be provided downstream from the valve to permit removal of appliance controls.

(2) Shutoff valves serving decorative appliances must be permitted to be installed in fireplaces if listed for such use. NFPA 54, § 9.6.4.1

Quick-disconnect devices used to connect appliances to the building piping must be listed to ANSI Z21.41/CSA 6.9, *Quick-Disconnect Devices for Use with Gas Fuel Appliance*. NFPA 54, §9.6.5.1

Appliances must be permitted to be connected to the building piping by means of a listed gas convenience outlet, in conjunction with a listed appliance connector, used in accordance with the manufacturer's installation instructions. NFPA 54, §9.6.6

Where a sediment trap is not incorporated as a part of the appliance, a sediment trap must be installed as close to the inlet of the appliance as practicable at the time of appliance installation. The sediment trap must be either a tee fitting with a capped nipple in the bottom outlet or other device recognized as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, decorative appliances for installation in vented fireplaces, gas

fireplaces, and outdoor grills must not be required to be so equipped. NFPA 54, §9.6.7
Type 1 and Type 2 clothes dryers must be exhausted to the outdoors. NFPA 54, §10.4.2

Make-up air must be provided for Type 1 clothes dryers in accordance with the manufacturers' installation instructions. NFPA 54, §10.4.3.1

A decorative appliance for installation in a vented fireplace, where installed in a manufactured home, must be listed for installation in manufactured homes. NFPA 54, §10.6.2.2

Listed food service counter appliances such as hot plates and griddles, food and dish warmers, and coffee brewers and urns, where installed on combustible surfaces, must be set on their own bases or legs and must be installed with a minimum horizontal clearance of 6 in. from combustible material, except that at least a 2 in. clearance must be maintained between a draft hood and combustible material. Food service counter appliances listed for installation at lesser clearances must be installed in accordance with the manufacturer's installation instructions. NFPA 54, §10.13.2

Listed outdoors cooking appliances must be installed in accordance with the manufacturer's installation instructions. NFPA 54, §10.20.1

Unvented room heaters must not be installed in bathrooms or bedrooms.

Exception No. 1: Where approved by the authority having jurisdiction, one listed wall-mounted, unvented room heater equipped with an oxygen depletion safety shutoff system must be permitted to be installed in a bathroom, provided that the input rating does not exceed 6000 Btu/hr and combustion and ventilation air is provided as specified in 10.1.2.

Exception No. 2: Where approved by the authority having jurisdiction, one listed wall-mounted unvented room heater equipped with an oxygen depletion safety shutoff system must be permitted to be installed in a bedroom, provided that the input rating does not exceed 10,000 Btu/hr and combustion and ventilation air is provided as specified in 10.1.2. NFPA 54, §10.23.1

A room heater must be placed so as not to cause a hazard to walls, floors, curtains, furniture, doors when open, and so on, and to the free movements of persons within the room. Heaters designed and marked "For use in noncombustible fireplace only" must not be installed elsewhere. Listed room heaters must be installed in accordance with the manufacturer's installation instructions. In no case must the clearances be such as to interfere with combustion air and accessibility. Unlisted room heaters must be installed with clearances from combustible material not less than the following:

- (1) *Circulating Type.* Room heaters having an outer jacket surrounding the combustion chamber, arranged with openings at top and bottom so that air circulates between the inner and outer jacket, and without openings in the outer jacket to permit direct radiation, must have clearance at sides and rear of not less than 12 in.
- (2) *Radiating Type.* Room heaters other than those of the circulating type described in 10.23.3(1) must have clearance at sides and rear of not less than 18 in., except that heaters that make use of metal, asbestos, or ceramic material to direct radiation to the front of the heater must have a clearance of 36 in. in front and, if

constructed with a double back of metal or ceramic, must be permitted to be installed with a clearance of 18 in. at sides and 12 in. at rear. Combustible floors under unlisted room heaters must be protected in an approved manner. NFPA 54, §10.23.3

Wall-type room heaters must not be installed in or attached to walls of combustible material unless listed for such installation. NFPA 54, §10.23.4

Water heater installations in bedrooms and bathrooms must comply with one of the following:

(1) Water heater must be installed in a closet equipped with a weather-stripped door with a self-closing device, and all combustion air must be obtained from the outdoors in accordance with 9.3.3.

(2) Water heater must be of the direct-vent type. NFPA 54, §10.28.1

A water heater installation must be provided with overpressure protection by means of an approved, listed device installed in accordance with the manufacturer's installation instructions. The pressure setting of the device must exceed the water service pressure and must not exceed the maximum pressure rating of the water heater. NFPA 54, §10.28.3

A water heater installation or a hot water storage vessel installation must be provided with overtemperature protection by means of an approved, listed device installed in accordance with the manufacturer's installation instructions. NFPA 54, §10.28.4

Appliances installed in manufactured housing after the initial sale must be listed for installation in manufactured housing, or approved, and must be installed in accordance with the requirements of NFPA 54 and the manufacturers' installation instructions. Appliances installed in the living space of manufactured housing must be in accordance with the requirements of Section 9.3. NFPA 54, §10.30

The primary air for injection (Bunsen)-type burners must be adjusted for proper flame characteristics in accordance with the appliance manufacturers' instructions. After setting the primary air, the adjustment means must be secured in position. NFPA 54, §11.2

Where a safety shutoff device is provided, it must be checked for proper operation and adjustment in accordance with the appliance manufacturer's instructions. Where the device does not function properly to turn off the gas supply in the event of pilot outage or other improper operation, it must be properly serviced or replaced with a new device. NFPA 54, §11.3

Appliances supplied with means for automatic ignition must be checked for proper operation. If necessary, proper adjustments must be made. NFPA 54, §11.4

All protective devices furnished with the appliance, such as a limit control, fan control to blower, temperature and pressure relief valve, low-water cutoff device, or manual operating features, must be checked for proper operation. NFPA 54, §11.5

Vent-connected appliances must be operated for several minutes and checked to see that the combustion products are going up the chimney or gas vent properly, by passing a lighted match or taper around the edge of the relief

opening of the draft hood. Where the chimney or gas vent is drawing properly, the match flame will be drawn into the draft hood. Where not, the combustion products will tend to extinguish this flame. Where the combustion products are escaping from the relief opening of the draft hood, the appliance must not be operated until proper adjustments or repairs are made to provide adequate draft through the chimney or gas vent. NFPA 54, §11.6

Operating instructions must be furnished and must be left in a prominent position near the appliance for the use of the consumer. NFPA 54, §11.7

SAMPLE QUESTION

Gas piping inside any building must not be installed in or through a _____.

- A. Chimney
- B. Gas vent
- C. Air duct
- D. All of the above

Answer: D

7. Venting

A venting system must be designed and constructed so as to develop a positive flow adequate to convey flue or vent gases to the outdoors. NFPA 54, §12.1

Gas vents must be installed in accordance with the manufacturer's installation instructions. NFPA 54, §12.7.1(1)

The termination of gas vents must comply with the following requirements:

(1) A gas vent must terminate in accordance with one of the following:

(a) Gas vents that are 12 in. or less in size and located not less than 8 feet from a vertical wall or similar obstruction must terminate above the roof in accordance with Figure 12.7.2 and Table 12.7.2.

(b) Gas vents that are over 12 in. in size or are located less than 8 feet from a vertical wall or similar obstruction must terminate not less than 2 feet above the highest point where they pass through the roof and not less than 2 feet above any portion of a building within 10 feet horizontally.

(2) A Type B or a Type L gas vent must terminate at least 5 feet in vertical height above the highest connected appliance draft hood or flue collar.

(3) A Type B-W gas vent must terminate at least 12 feet in vertical height above the bottom of the wall furnace.

(4) A gas vent extending through an exterior wall must not terminate adjacent to the wall or below eaves or parapets, except as provided in 12.3.5 and 12.4.3.

(5) Decorative shrouds must not be installed at the termination of gas vents except where such shrouds are listed for use with the specific gas venting system and are installed in accordance with manufacturers' installation instructions.

(6) All gas vents must extend through the roof flashing, roof jack, or roof thimble and terminate with a listed cap or listed roof assembly.

(7) A gas vent must terminate at least 3 feet above a forced air inlet located within 10 feet NFPA 54, §12.7.2

Where the vent connector used for an appliance having a draft hood or a Category I appliance is located in or passes through attics and crawl spaces, that portion of the vent connector must be listed Type B, Type L, or listed vent material having equivalent insulation qualities. NFPA 54, §12.11.2.3

Vent connectors for residential-type appliances must comply with the following:

(1) Vent connectors for listed appliances having draft hoods, appliances having draft hoods and equipped with listed conversion burners, and Category I appliances that are not installed in attics, crawl spaces, or other unconditioned areas must be one of the following:

(a) Type B or Type L vent material

(b) Galvanized sheet steel not less than 0.018 in. thick.

(c) Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027 in. thick

(d) Stainless steel sheet not less than 0.012 in. thick

(e) Smooth interior wall metal pipe having resistance to heat and corrosion equal to or greater than that of (b), (c), or (d) above

(f) A listed vent connector. NFPA 54, §12.11.2.4

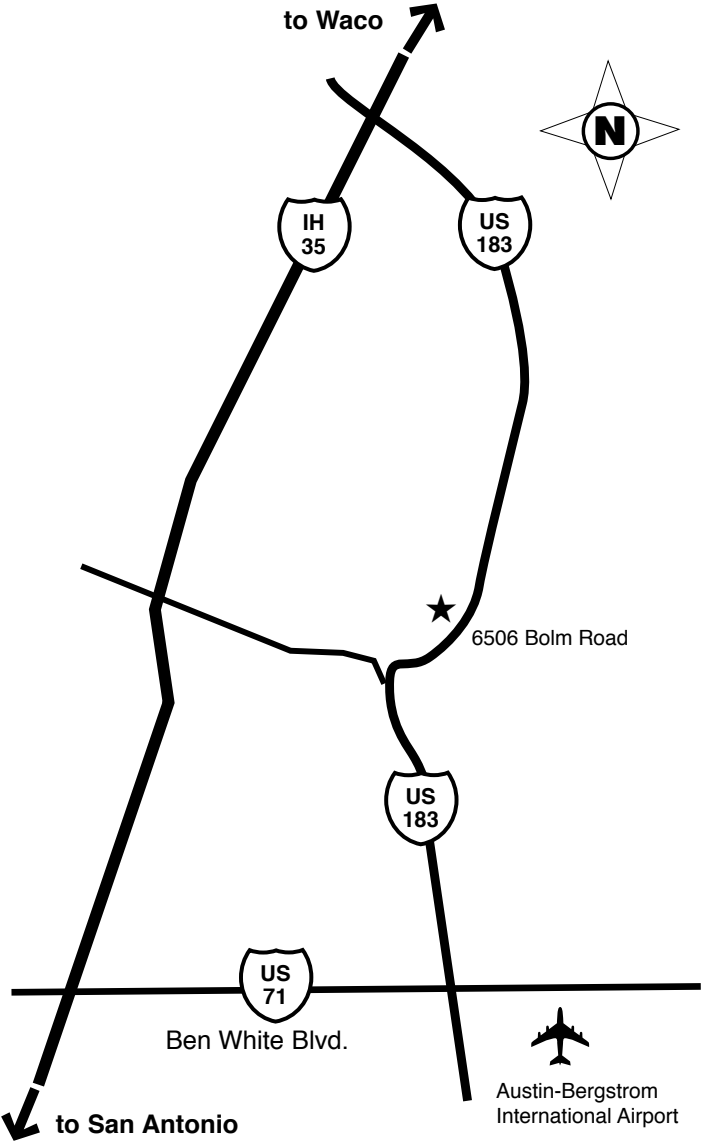
SAMPLE QUESTION

Under normal operating conditions the following equipment requires venting:

- A. Listed ranges
- B. Built-in domestic cooking units listed and marked for optional venting
- C. Listed hot plates and listed laundry stoves
- D. Both A and B
- E. None of the above

Answer: E

RRC/AFRED TRAINING CENTER 6506 BOLM RD., AUSTIN



DIRECTIONS TO RRC ALTERNATIVE FUELS TRAINING CENTER, AUSTIN

Entering Austin on I-35 going south:

Take exit 239/240 for Hwy 183 South/ Austin-Bergstrom International Airport. Stay on 183 past Cameron Road, U.S. 290, Manor Road, Loyola Lane, and Techni-Center Drive. Proceed down the hill on 183 and take the Bolm Road exit. At the light, turn right onto Bolm Road. The Training Center is on the northwest corner of 183 and Bolm Road. Enter through the double glass doors on the south side of the building.

Entering Austin on I-35 going north:

Take exit 230 for Texas Hwy. 71/Ben White Blvd. Turn right toward Bastrop. Stay on 71 for approximately 4.3 miles. Exit onto U.S. 183 North. Stay on 183 past the Colorado River bridge. Stay in the right lane and take the Bolm Road exit. Turn left at the light onto Bolm Road and go under the overpass. The Training Center is on the northwest corner of 183 and Bolm Road. Enter through the double glass doors on the south side of the building.