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Fuel Gas Systems

Knowledge Objectives (1 of 2)
• Explain the impact of fuel gases on fire and explosion investigations.
• Discuss the characteristics of fuel gases.
• Identify common fuel gas system components.
• Discuss common piping for fuel gas systems in buildings.

Knowledge Objectives (2 of 2)
• Discuss common appliance and equipment requirements.
• Identify fuel gas utilization equipment.
• Describe how to investigate fuel gas systems.

Skills Objectives
• Conduct a fire and explosion investigation for fuel gas systems.

Introduction
• During every investigation, presence and condition of fuel gas systems must be:
  – Examined
  – Documented
• Fires and explosions often result from failures within these systems.

Fuel Gas Systems (1 of 6)
• Used to:
  – Control indoor climate
  – Heat water
  – Cook
  – Provide energy for manufacturing
Fuel Gas Systems (2 of 6)

- Most common: natural gas and commercial propane
- Can act as:
  - Initial fuel source (escaped or “fugitive” gas)
  - Initial ignition source
  - Both fuel and ignition source

Fuel Gas Systems (3 of 6)

- Natural gas explosion scene.

Fuel Gas Systems (4 of 6)

- Fuel sources
  - Fuel involvement usually results from compromised fuel delivery or containment systems.
  - Fuel that is escaped may be called “fugitive gas.”

Fuel Gas Systems (5 of 6)

- Ignition sources
  - Pilot lights and open flames from appliances served by fugitive gases
  - Static arcs from appliances
  - Electrical arcs
  - Arcs from switches or contacts in appliances
  - Other electrical equipment

Fuel Gas Systems (6 of 6)

- Both fuel and ignition source
  - Fuel gases can serve as both the first fuel and the fuel for the fire.
  - Fugitive fuel provides fuel for the fire to grow.
- Additional fire spread
  - Fire can spread because of fugitive fuel gas.
  - Natural gas and propane are common residential fuels.

Characteristics of Fuel Gases (1 of 4)

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Characteristics of Fuel Gases (2 of 4)

• Natural gas
  – Hydrocarbon gas composed primarily of methane
  – Often recovered from underground pockets during
    drilling for crude petroleum
  – Lighter than air
  – Flammable range 3.9–15%
  – Ignition temperature of 900°F to 1170°F (482°C to
    632°C)

Characteristics of Fuel Gases (3 of 4)

• Commercial propane
  – Recovered during the process of refining petroleum
  – 95% propane and propylene and 5% other gases
  – Heavier than air
  – Flammable range 2.15–9.6%
  – Ignition temperature of 920°F to 1120°F (493°C to
    604°C).

Characteristics of Fuel Gases (4 of 4)

• Other fuel gases
  – Commercial butane
  – Propane HD5
  – Coke oven gas
  – Hydrogen
  – Acetylene

Odorization

• By law, odor is added to LP-gas and commercial natural gas.
  – Butyl mercaptan most often used in natural gas
  – Ethyl mercaptan or thiophane in LP-gas
• Supply company adds it as a safety feature
• Can often be smelled during fire investigation

Gas Systems

• Transport fuel gas directly into consumers’ buildings and appliances
• Natural gas is supplied from central location
  – Via underground supply service lines
• LP-gas is contained in bulk supply, often at consumer’s location.

Natural Gas Systems

• Transmitted (in this order) through:
  – Transmission pipeline
  – Main pipelines (mains)
  – Service mains or service laterals
LP-Gas Systems (1 of 5)
- Storage supply is often located at consumer’s site in tanks or cylinders
- Alternatively, the gas may be in bulk storage locations offsite and piped underground, similar to natural gas systems.

LP-Gas Systems (2 of 5)
- Tanks are larger than cylinders.
  - Cargo tanks are mounted on a chassis and used to transport LP-gas.
  - Portable tanks transport LP-gas, but are not on a chassis.

LP-Gas Systems (3 of 5)
- Cylinders are upright and tend to be smaller than tanks.
  - Most frequently used in rural homes and businesses, mobile homes, recreational vehicles, and for outdoor barbeques and motor fuel

LP-Gas Systems (4 of 5)
- Container appurtenances:
  - Pressure relief devices
  - Connections for flow control
  - Liquid level gauging devices
  - Pressure gauges
  - Pressure regulators
  - Vaporizers

LP-Gas Systems (5 of 5)
- A vaporizer is used when there is a demand for large quantities or propane; it converts liquid propane to gas.

Common Fuel Gas System Components (1 of 5)
- Pressure regulation (reduction)
  - e.g., gas meter
- Service piping systems
  - Delivers gas from the main lines to the user
- Valves
- Gas burners/pilot lights
Common Fuel Gas System Components (2 of 5)

- A large natural gas meter.

Common Fuel Gas System Components (3 of 5)

- A 20-inch gas main pipeline.

Common Fuel Gas System Components (4 of 5)

- Furnace burners and gas control valve.

Common Fuel Gas System Components (5 of 5)

- Water heater pilot line and gas control valve.

Common Piping in Buildings (1 of 2)

- Maintain evidentiary value of piping and its components
  - Joints and fittings
  - Piping installation
  - Main shutoff valves
- Prohibited locations per NFPA 54 and other codes
  - Such as air ducts, chimneys, elevator shafts
- Electrical bonding and grounding

Common Piping in Buildings (2 of 2)

- The main shutoff valve controls the flow of gas throughout the entire building.
Common Appliance and Equipment Requirements (1 of 2)
• An appliance is compatible with only a certain type of gas; gases are not interchangeable.
• Appliance installation
  – May need additional regulator
  – Location where there is easy access and shutdown
  – Sufficient clearance between appliance and combustibles

Fuel Gas Utilization Equipment
• Investigator should be familiar with design and operation of:
  – Water heaters
  – Furnaces
  – Clothes dryers
  – Ranges

Common Appliance and Equipment Requirements (2 of 2)
• Venting and air supply
  – Exhaust venting prevents buildup of combustion products.
  – Fresh air from building exterior often necessary
• Appliance controls
  – For temperature, ignition, and shutoff
  – Gas appliance pressure regulators
  – Gas flow control accessories

Investigating Fuel Gas Systems
• Should be done in systematic, thorough manner
• Determine whether, and to what extent, system failed
• Interviews should touch on fuel gas system.

Compliance with Codes and Standards
• Investigator should determine that codes and standards were followed in:
  – Design
  – Manufacture
  – Construction
  – Installation
• Additional expertise or resources may be needed.

Leakage Causes (1 of 2)
• At pipe junctions
  – Inadequate threading, improper join, improper use of joint compound
• Unlit pilot lights or burners
  – Sensing system malfunctions or auto-shutoff valve does not operate and gas continues to flow
• Uncapped pipes and outlets
Leakage Causes (2 of 2)

- Malfunctioning appliances and controls
  - e.g., dirt or debris causes valves to leak
- Gas pressure regulators
  - Failure within internal diaphragm or of seals
  - Plugged vents
- Corrosion
- Physical damage to system

Pressure Testing

- Pressurize the system to isolate damaged sections of piping.
- Gas meters can also be tested.
  - If it is safe to reintroduce gas into system
  - The meter detects gas escaping from the system.

Locating Leaks (1 of 2)

- Tests can locate leaks in fuel gas piping
  - Soap bubble test
  - Use of gas detector survey (“sniffers”)

Locating Leaks (2 of 2)

- Soap bubble solution test.

Testing Flow Rates and Pressures

- Should be tested if gas system is suspected to be involved in fire ignition
- Can be done in field or at laboratory
- Conducted only by trained, knowledgeable personnel
- Potential ignition sources should be removed during testing.

Underground Migration of Fuel Gases

- Gases can travel great distances underground, through:
  - Sewer lines
  - Electrical and telephone conduits
  - Drain tiles
- Passing through soil can “scrub” the odorant out of the gas.
Summary (1 of 4)
- Fuel gas systems will likely be either natural gas or LP-gas.
- Natural gas systems are generally supplied via underground main lines, whereas LP-gas is supplied by a consumer tank on the premises.

Summary (2 of 4)
- Both types of fuel gases will supply fuel to various appliances that may heat water and the environment and be used for cooking or various other services.

Summary (3 of 4)
- Fuel gas systems are often damaged as a result of other activities occurring in the structure, allowing fuel gas to escape from the system.

Summary (4 of 4)
- When fuel gases escape underground, they can be deodorized as a result of the gas migrating through the ground.
- Fuel gas system tests should be conducted by trained laboratory technicians.