CHAPTER III

RECOGNIZING AND AVOIDING THE HAZARDS OF PROPANE

INTRODUCTION

Fatalities to first responders have involved propane. The purpose of this program is to:

- help you to understand the properties of propane,
- give you a basic knowledge of how the propane system works,
- make you aware of the hazards of propane, and
- offer approaches for responding to propane emergencies.

This chapter will help you better understand and determine what precautions need to be taken when responding to propane incidents. *Propane can be dangerous and can injure and/or kill emergency workers.* For specific facility and special emergency response needs in your service area, meeting with your local propane provider or the propane association on a periodic basis is strongly recommended.

PROPERTIES AND CHARACTERISTICS OF PROPANE

This section provides a general summary of the properties of propane. Key safety and tactical points are indicated.

Propane is a liquefied petroleum gas found trapped in pockets with either crude oil or natural gas. About 30 percent produced today is refined from crude oil, with the other 70 percent processed from natural gas. Propane is odorless, tasteless, and colorless in its natural state; an odorant (ethyl mercaptan) is added, similar to natural gas, so that leaks may be detected.

Propane belongs to a family of chemical compounds known as hydrocarbons. This means they are made up of hydrogen and carbon atoms only. Natural gas (methane) has one carbon atom and four hydrogen atoms; propane has three carbon atoms with eight hydrogen atoms. This chemical composition makes propane similar to natural gas in many characteristics.

At a temperature colder than -44°F and open to the atmosphere, propane will reside in its liquid state. It would appear to be water. Propane due to its chemical characteristics is portable energy as we can store it as a liquid in a container under moderate pressure and then use it as a gas when withdrawn from the container. Each unit of liquid propane in a container produces 270 units of propane vapor.

The ignition temperature of propane in air is 920°F. The heating value of propane is about 2,500 Btu/cf, with its flammability range in air 2.15 to 9.60 percent. As for natural gas, propane is non-toxic. However, it presents a possible inhalation hazard if released in a confined space, as it displaces oxygen and acts as a simple asphyxiate. Liquid propane is an effective refrigerant. It rapidly absorbs heat from the skin and can cause severe burns to the body.

Firefighter Fact Propane in its liquid state is about half the weight of water, while in its vapor state it is heavier than air and natural gas. Thus, when present, propane tends to go down and lay in low areas, while natural gas, being lighter than air, tends to travel upward.

Natural Gas	SG = .6
Air	SG = 1.0
Propane	SG = 1.5

PROPANE DELIVERY SYSTEM

This section provides an overview of the propane delivery system. Key safety and tactical points are identified. For specific facility and special emergency response needs in your service area, meeting with your local propane provider or the propane association on a periodic basis is strongly recommended.

Propane is shipped from the refinery or natural gas processing plant to a local terminal and from there to the end user. Shipment to the local terminal can be via truck, railcar, or pipeline. All propane is shipped under pressure in its liquid state. From the local terminal ("bulk plant") to the residence or commercial property, delivery is effected by a bulk delivery truck, called a "bobtail." This truck would hold about 2,000 to 3,500 gallons of propane.

The "bobtail" truck transfers propane via truck hose to the consumer's storage container. This container could either be a United States Department of Transportation ("DOT") cylinder, or an ASME storage tank. The design pressure of the American Society of Mechanical Engineers ("ASME") storage tank is 250 psig, while that of the DOT house cylinder would normally be 240 psig. Either type of container would have a filler valve, pressure relief valve, service valve, and liquid level gauge located within the cylinder neck-ring or the tank dome. Some of the individual process features can be combined in one valve on the container. All process connections are protected either by an excess flow valve or a check valve in the event of a downstream piping breakage. The DOT cylinders would normally be placed adjacent to the residence or commercial building with a pressure regulator installed within the cylinder neck-ring (collar) along with the cylinder valve. The cylinder propane capacities would normally be 47 gallons (200 lbs) or 100 gallons (420 lbs). Two or more cylinders could be manifolded together. Entry to the building would be via aboveground copper tubing or steel piping from the cylinder with a shutoff valve in the gas service line. A gas meter or second stage regulator would be optional.

The ASME storage tanks could be installed aboveground or underground. The tanks would normally be a 500 gallon or 1,000 gallon (w.c) size. Propane is filled in a container to about 85 percent of its water capacity (i.e., a 1,000 gallon water capacity storage tank would be filled to a maximum propane volume of 850 gallons). The ASME container would be installed 10′ or further away from the building, with basically the same piping characteristics as the DOT cylinder installation, except that the piping run to the building from the ASME tank would normally be underground. It is important to note that all propane containers are never completely filled. The approximate 15 percent of the gross capacity (w.c.) of the container is used as a space for propane vapor. This allows for expansion of the propane liquid within the container. The propane pressure within the container is dependent on the outside ambient temperature. At 20°F the propane container pressure would be 40 psig; at 100°F, the pressure would be 172 psig.

Large multiple stationary ASME propane storage tanks ranging in size from 30,000 to 60,000 gallons (w.c.) are employed at various industrial plants and gas utility plants where propane is employed as a supplemental fuel to natural gas.

KEEPING THE SYSTEM SAFE

This section provides a reference of the regulations applicable to the propane distribution system in New Jersey.

Responsibility for system maintenance would be that of the user and the propane supplier. The governing regulation in New Jersey, established by the Liquefied Petroleum Gas Act (N.J.S.A. 21:1B-1 et seq.), for propane systems is N.J.A.C. 5:18 administered by the New Jersey Department of Community Affairs ("NJDCA"). The State has adopted NFPA pamphlet #58, the LP-Gas Code, as part of the state regulation. The propane supplier at the time of residential/commercial delivery is to inspect the container and outside system for acceptability and continued usage, Figure III-1.

GENERAL EMERGENCY RESPONSE PROCEDURES

This section provides approaches for responding to propane incidents.

Upon arrival at the scene, a security perimeter should be established. Special care should be used to position emergency vehicles so that equipment is parked well outside the area of greatest risk. Control ignition sources immediately. If possible, rescue should be performed from an upstream location.

Large releases of propane may travel great distances, find ignition sources, and flash back to the

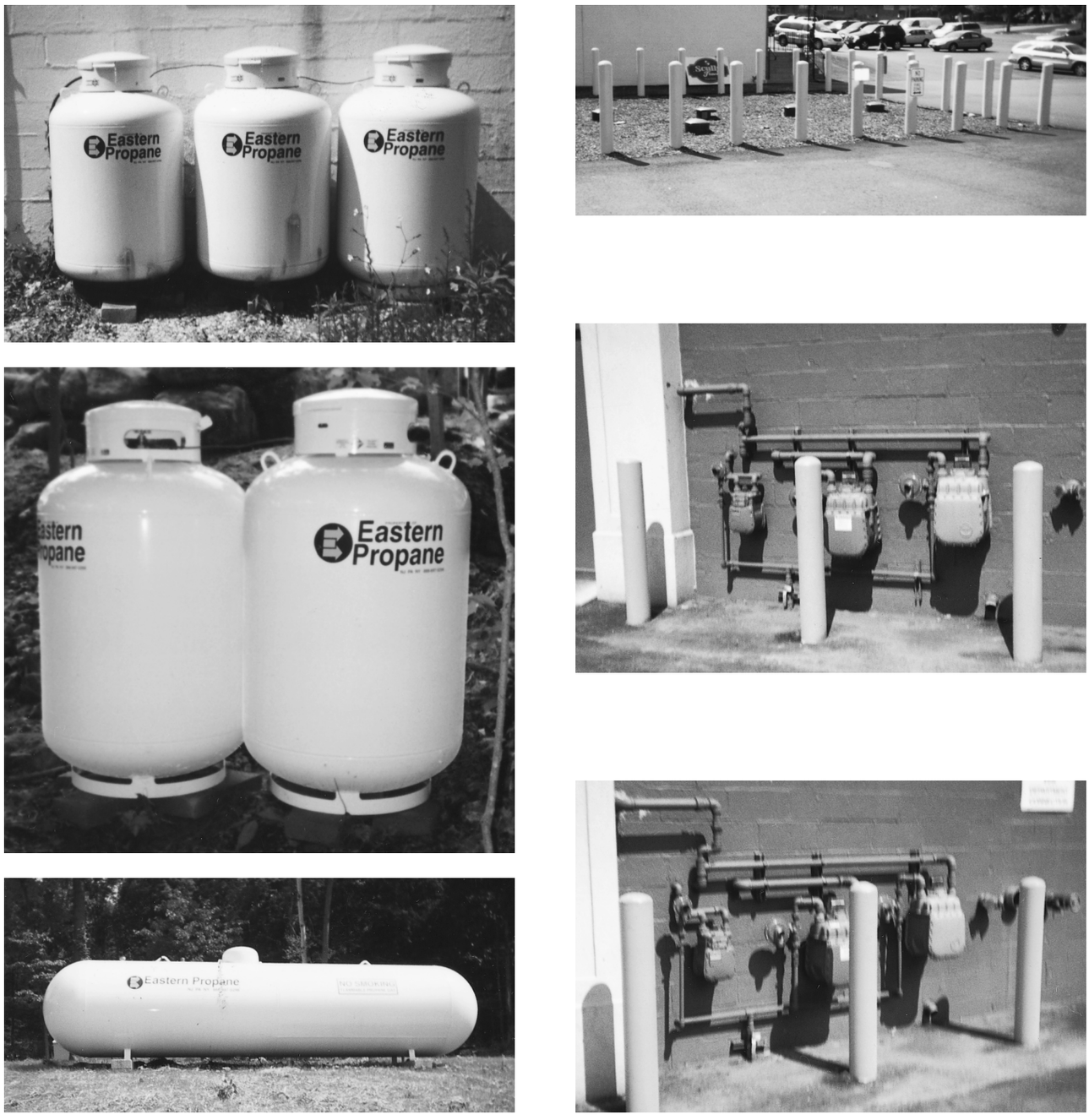

Figure III-1 Various propane facilities.

source of the leak. During approach to the incident scene, avoid committing or positioning personnel and vehicles in a hazardous position or situation. Remember—unignited propane is heavier than air.

For escaping gas, hose streams with fog nozzles are to be used to disperse the propane gas away from any possible sources of ignition. Approach the leak from upwind and keep out of any vapor cloud. A combustible gas detector should be used to determine if hoselines are effective in dispersing the propane gas. When the gas indicator is considered within a safe range (below 10 percent of the Lower Flammable Limit—LFL) rescue and repairs to shut off the flow of gas can be made by the fire service and the propane gas supplier.

For burning gas, approach the fire from upwind, making sure that one stays out of the range of any possible flashback. The top of the container (vapor space) supplying the fuel should first be cooled with hose streams (water should also be applied to the

Figure III-2 Propane placard.

Figure III-3 Propane tank.

balance of the container). Cooling the container will cause the pressure to be reduced, thus closing any relieving container relief valve that might be feeding the fire. *Do not extinguish the fire until the propane fuel supply can be shut off.* If a container service valve is controlling the fuel feeding the fire, the surrounding atmosphere should be cooled with converging fog streams while the fire service attempts to close the valve. Continue to cool the container well after the fire has been extinguished. The area around the container should be monitored for flammable gas using a combustible gas indicator.

If the source of the fuel cannot be shut off, let the fire burn. Continue to cool the propane containers and adjacent exposures, Figure III-2.

A propane tank contains liquid and vapor. Any external fire creating direct flame impingement on the vapor space will heat the tank's shell. If a vessel gets intense, concentrated heat on the shell area on top (vapor space) of the vessel, the metal will get hot and start losing its tensile strength. The vessel will start to swell in the hot area. This is an indication that the high pressure will soon blow out as the hot steel is being drawn thinner. When the blister rips, the whole tank contents will erupt upwards, causing a brief tower of fire. BLEVE is an acronym for Boiling Liquid Expanding Vapor Explosion. A BLEVE is defined as a container failure with a release of energy, often rapidly and violently, which is accompanied by a release of gas to the atmosphere and propulsion of the container or container pieces due to an overpressure rupture.

Caution Any decision to approach a propane tank showing direct flame impingement on its vapor space must be made on a case-by-case basis after evaluating the hazards and risks and determining if an adequate supply of water is available to support firefighting operations. Bulk storage tanks can fail within 10 to 20 minutes of direct flame impingement if the containers are not adequately cooled, Figure III-3.

PROPANE CARGO TRUCK EMERGENCY RESPONSE

This section provides approaches for responding to propane cargo truck incidents.

A propane truck is involved in a traffic accident and a gas cloud is escaping from the vehicle. After securing the site, the objective for this operation is to control or stop the propane from escaping the truck. Firefighters in full protective clothing should deploy hoselines to disperse and dilute the flammable gas while an approach is made to ascertain exactly where the leak is. A combustible gas detector should be used to determine the effectiveness of the hoselines in dispersing the gas. If there is severe damage to the truck's piping, the truck may have to be unloaded. Considerable time may pass until a compatible vehicle is available on scene for product transfer. Some attempt to stop the leak via a fiberglass wrap or a freeze wrap may be attempted by the fire service employing a water fog envelope. As there is no fire situation, if the ambient temperature is about 90°F, hose water fog played on the top of the tank can be effective in keeping the tank's shell cool. If the ambient temperature is below 40°F, hose water application should not be applied as it would only raise the temperature of the propane inside the vessel and thereby increase the tank pressure and the leak. Water should be available in case of fire development and the need to cool the vessel shell.

PROPANE VEHICLE EMERGENCY RESPONSE

This section provides approaches for responding to propane vehicle incidents.

Propane motor fuel tanks may be installed in cars, vans, pick-up trucks, and buses. Propane motor fuel tanks are manufactured in a variety of sizes and shapes to accommodate different vehicle designs. Fuel tank capacities normally range from 20 to 65 gallons. For automobiles the tank is mounted in the trunk. The motor fuel tanks are DOT cylinders with a design pressure of 312 psig. The container relief valve is vented to the outside with the relief valve discharge directed up or down within 45 degrees of vertical. An automatic fuel shutoff valve located as close as possible to the carburetor is provided to close propane flow when the engine is not running, though the ignition switch may be in the on position. Each vehicle powered by propane is identified with a diamond-shaped label located on the lower right rear of the vehicle (the word *propane* is centered in the diamond in silver or white reflective material on a black background).

In the event of a vehicle accident and fire, the responders should cool the propane motor fuel tank on the vehicle. If there is a propane fire in the engine compartment, this can be controlled by shutting off the engine, which should automatically close the propane fuel supply valve. Rescue of people from the burning vehicle must be evaluated/rendered while the fire is attacked and extinguished. While the propane storage tank is continuously being cooled, the responders should locate the fuel supply valve on the storage tank and close it. Continue to cool the cylinder until well after the fire has been extinguished. The cylinder metal surface should be cool enough to touch. The area around the container should be monitored for flammable vapors using a combustible gas indicator.

BARBECUE GRILL FIRE/LEAK RESPONSE

This section provides approaches for responding to propane grill incidents.

Most barbecue gas grills are fitted with a 20-lb DOT propane cylinder. In the event of leaking propane gas, hose streams with fog nozzles are to be used to disperse the gas away from any possible sources of ignition. Approach the leak from upwind and keep out of any vapor cloud. A combustible gas detector should be used to determine the effectiveness in dispersing propane gas with the hose streams. When the gas indicator is considered within a safe range (below 10 percent of the LFL) the fire service should attempt to close the propane cylinder valve (note that this cylinder valve is right-to-tight), thus shutting off the flow of gas.

In the event of fire, the first objective is to cool the outside of the cylinder so that the cylinder pressure is reduced and the cylinder relief valve resets. Adjacent exposures should also be protected. The responders should then approach, from opposite the relief valve discharge, the cylinder under the protection of hand lines so as to manually close the cylinder valve (note that this cylinder valve is right-to-tight). Continue to cool the cylinder until well after the fire has been extinguished. The cylinder metal surface should be cool enough to touch. The area around the grill should be monitored for flammable vapors using a combustible gas indicator.

REVIEW QUESTIONS

1. What are the properties of propane and propane leaks that a first responder must consider when responding to a propane incident?
2. Describe your response to a propane fire?
3. What is a BLEVE?