PROPANE EMERGENCIES

VIDEO / DVD
INSTRUCTOR'S TIPS

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INTRODUCTION

The Propane Emergencies (PE) video is a professionally designed training aid that is part of the Propane Emergencies educational curriculum. The video is available in VHS or DVD and is designed for maximum instructor flexibility. It can be used (1) as an integral element within the formal PE curriculum; (2) as part of a short drill or training session on propane; or (3) as a "stand-alone" training aid. The running time for the entire video is approximately 48 minutes. A copy of the script is attached as Appendix A for reference.

The PE curriculum uses the Eight Step Process" as a tactical incident management framework (see Section 7, pages 138–152). The video uses the Eight Step Process" as its framework for delivering training information. To provide for instructor flexibility when using the VHS tape, there is a 5-second black screen between each of the eight tactical functions making it easier for the instructor to use only certain portions of the video. If you are using the DVD, you can simply click on the hot button for the respective section of the DVD you wish to show.

Propane marketers and distributors are viewed by the fire service as product and container specialists. When conducting short drills or training sessions, it is recommended that the "Identify the Problem" and "Hazard and Risk Evaluation" sections of the video be used to support the classroom lecture and use of container props and cut-aways.

USING THE VIDEO: INSTRUCTOR NOTES

INTRODUCTION

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Reviews the applications and uses of propane as a fuel, followed by a brief discussion on propane incidents.	Section 2, pages 10–14	
• GOAL: To prepare emergency responders and propane industry personnel to safely handle propane incidents. Program describes a system for managing hazmat incidents, and show how it is applied to propane incidents, with an emphasis upon hazard and risk assessment.	Section 1, page 2–3	
• Review basic characteristics of propane.	Section 2, pages 10–20	Hydrometer can be used to illustrate some of these characteristics
• Introduction of the Eight Step Process"	Section 7, page 139–152	For more detailed info on the Eight Step Process", see the textbook *HM: Managing the Incident*

SITE MANAGEMENT AND CONTROL

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Tasks include initial approach and positioning, assuming command, determining the extent of the hazard area, establishing an isolation perimeter, and establishing hazard control zones.	Section 7, pages 139–140	
• Review the concept of hazard control zones and their application at propane emergencies.		For more detailed info. on hazard control zones, see the textbook *HM: Managing the Incident*, Chapter 5.

IDENTIFY THE PROBLEM

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Focus is on determining the type of containers involved, the type of fire or release, and the HM involved. Methods of identification include container shapes; container placards, labels and markings; and shipping papers.	Sections 4, 5 and 6	
• Propane cylinders are built to either ASME or DOT specifications. Non-bulk vs. bulk containers.	Section 4, pages 51–53	Point out these differences when conducting facility walk-around
• Basic features of propane containers - tank shell, various service valves and a pressure relief valve.	Section 4, pages 52–58	
• Reviews the four basic categories of DOT cylinders: portable cylinders, exchange service cylinders, engine fuel cylinders, stationary cylinders.	Section 4, pages 55–66	Have examples of DOT cylinders when conducting facility walk-around
• Review of cargo tank truck (MC-331) design and construction features. Bobtails Transports	Section 5, pages 84–98	Good background for walk-around
• Review of railroad tank car design and construction features.	Section 5, pages 99–107	Good background for walk-around

• Review of intermodal portable tank containers.	Section 5, pages 108–112	Not likely to be found with LPG, except in limited access areas (e.g., islands)
• Review of unloading and loading stations at terminals. Truck loading /unloading stations. Rail car unloading racks. Cylinder refilling stations.	Section 6, pages 121–129	Good background for walk-around
• Other sources of identification include pre-incident planning site visits, interfacing with industry reps, and shipping papers.		

HAZARD AND RISK EVALUATION

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• This section focuses upon (1) the hazards of propane, its physical and chemical properties, and its behavior both inside and outside of a container; and (2) the risk factors to be considered during a propane release or fire.	Sections 2 and 8	Most firefighter injuries and deaths occur due to a lack of risk evaluation!
• NFPA 704 ratings for propane are reviewed to assess the hazards— Fire = 4 / Health = 1 / Reactivity = 0		
• Discussion on the explosive range, ignition temperature, vapor density,	Section 2, pages 10–24	
• Excellent graphics illustrating the behavior of propane liquid and vapor, including the operation of pressure relief valves (PRV's).	Section 8, pages 158–161	Be well-versed with the concept of a BLEVE, and expect a number of questions from fire service personnel.
• Discussion of the risk evaluation process, including risk factors to be considered.	Section 8, pages 154–165	The recommended flow for fire impingement on bulk containers is a minimum of 500 gpm at the point of impingement.

SELECT PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Structural firefighting clothing and SCBA is required for propane fire and leak control emergencies.	Sections 8, pages 164–165	

INFORMATION MANAGEMENT AND RESOURCE COORDINATION

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Emphasis is on the application of an Incident Command System (ICS) organization at a propane incident, including unified command.	Section 7, pages 132–135	The fire service should be very familiar with the ICS system. May want to inquire on what they see as the role of the propane marketer within the ICS organization, reporting arrangements, etc.

IMPLEMENTING RESPONSE OBJECTIVES

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Strategy and tactical decision-making	Section 7, pages 135–138	
• Approaching a gas leak—tactical considerations	Section 8, pages 157, 201–203	Scenario 11 can be used to illustrate these concepts
• Handling propane fire scenarios	Section 8, pages 157, 204–207	Scenario 12 can be used to illustrate these concepts
• The BLEVE concept	Section 8, pages 158–161	Be well-versed with the concept of a BLEVE, and expect a number of questions from fire service personnel.
• Discussion on damage assessment of pressurized containers, including types of damage (e.g., dents, scores, road burn, etc.).	Section 9, pages 247–252	Scenario 16 can be used to illustrate these concepts
• Off-loading and uprighting of cargo tanks and rail cars.	Section 9, pages 244–246, 252–272	Review local and regional capabilities for off-loading and uprighting LPG containers.
• Flaring operations	Section 9, pages 259–261	Expect questions re: flaring, including local capabilities, types of flaring devices, duration, etc.

DECONTAMINATION OPERATIONS

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Decontamination operations	Section 7, page 149	

TERMINATE THE INCIDENT

VIDEO OUTLINE	TEXTBOOK	COMMENTS
• Termination operations	Section 7, page 150	

PROPANE EMERGENCIES VIDEO SCRIPT

INTRODUCTION

Propane is a safe, energy-efficient, clean-burning fuel. For many decades, it has been used in the home and in the workplace. Common uses include heating; cooking; as a motor fuel; and on the farm or ranch running equipment, heating livestock barns, and drying grain. It's also used in industrial plants for manufacturing processes, running fork lifts, and fueling machinery.

Accidents involving propane, while infrequent, do occur. These incidents can result in propane leaks and releases. Because propane gas is flammable, there is also the potential for fires and explosions —threatening lives and property.

This program is designed to prepare emergency responders and propane industry personnel to safely handle propane incidents. It is called "Propane Emergencies." The video is one part of a comprehensive training program which includes a companion text and facilitator's guide.

This program will describe a system for managing hazardous materials, and show it is applied to incidents involving propane. Special emphasis will be placed on hazard and risk assessment as well as recommended mitigation strategies and tactics.

PROPANE 101

Propane is often referred to as LP Gas. It is a by-product of the crude oil and natural gas refining process. The two major refined gases are propane and butane.

Propane is a hydrocarbon with the chemical formula C3H8. At atmospheric pressure and normal temperature, propane exists as a gas. It condenses into a liquid at minus 44 degrees Fahrenheit. When stored in approved containers, propane exists as both a liquid and gas under moderate pressures. This greatly reduces its volume, making it easier and more economical to transport and store in large quantities.

Because propane odorless and colorless in its natural state, a commercial odorant is added so it may be detected if it leaks from its container. NFPA 58, Liquefied Petroleum Gas Code, states that all LP-Gases must be odorized prior to delivery to the bulk plant by the addition of a warning agent that can be detected down to a concentration in air of twenty percent of the lower flammability limit. The odorant is inert, non-corrosive, and burns completely in the gas flame.

Propane leaks may result from leaking fittings or appurtenances, overfilled containers, problems during transfer operations, or accidents involving tank trucks or tank cars.

Most incidents involve the release of small quantities of propane gas. At ambient temperature, liquid leaks will vaporize and disperse, quickly spreading away from the source of the leak.

Propane vapor leaks are not readily visible. In large leaks, a hissing sound may be heard as the gas escapes. A liquid leak may be readily visible. Ice or frost may form at the point where the propane is leaking. A vapor cloud, or white fog, may form as the gas rapidly expands and cools, condensing moisture from the air.

Responders must remember that much of the vapor cloud, especially the outer edge, which may not be visible, is flammable. It will ignite if exposed to an open flame, an internal combustion engine, or other ignition source. A flashback may occur.

After assuming command of the incident, first arriving emergency responders must follow a list of priorities. These include determining the extent of the hazard area, establishing perimeter security, and designating control zones.

The Hot Zone is the area immediately surrounding the hazard where the risk is at the highest level. All non-essential personnel should be kept out of the Hot Zone. Any victims or other civilians should be removed from the Hot Zone if possible. Responders entering the Hot Zone, or any potential hazard area, must be equipped with positive pressure self-contained breathing apparatus (SCBA) and proper protective clothing. The Warm Zone is the area where hot zone support takes place. The Cold Zone is the area where the command post and staging areas are setup.

IDENTIFY THE PROBLEM

After the site has been secured, the next step in the process is to identify the problem. It is essential to know what kind of containers are involved, the type of fire or release, and the hazardous materials involved. There are a number of ways to identify the products.

What placards, labels, or markings are visible? The U.S. Department of Transportation classifies propane as a Class 2, Division 1 flammable gas. The four-digit identification number is 1075 for domestic use and 1978 for international shipments. On shipping papers, propane may be called liquefied petroleum gas, LP-gas, or propane.

By regulation, all rail cars transporting flammable gas must have the name of the commodity clearly marked on both sides of the tank car, and the appropriate placard on both sides and ends of the car.

It also important to know what kinds of containers are involved in the incident. Because of the diverse nature of the propane industry, emergency responders may encounter a wide variety of propane containers in use. Generally, the types of storage containers encountered are built to either American Society of Mechanical Engineers (ASME) or Department of Transportation (DOT) specifications.

Propane containers are fused, welded pressure vessels. They are usually found above ground, but also can be mounded or located underground. They are often painted a light color to reflect heat. They may be horizontal or vertical. They may range in size from approximately one pound to over 120,000 gallons. Containers are normally filled to 80 percent of their liquid capacities, leaving 20 percent for liquid expansion if ambient temperatures rise. ASME tanks are identified by an attached data plate which detail pertinent information about the container's design and construction features, including its water capacity in pounds or US gallons, year of manufacture and manufacturer's serial number, and other important items.

Under DOT regulations, containers with a water capacity under 1,001 pounds or 125 gallons of propane are considered non-bulk packaging.

Bulk storage containers are not intended to be moved. Containers with capacities up to and over 120,000 gallons are found at bulk plants and industrial facilities.

DOT cylinders are portable and range from small, up to a capacity of several hundred pounds. A cap, collar or protective housing is used to shield vulnerable parts such as pressure relief valves. There are four basic categories of DOT cylinders. Portable service cylinders are used for such things as barbecue grills, recreational vehicles, and hand torches. Because there are so many in use, these account for many of the propane emergencies that occur. Exchange Service cylinders are mostly 60 to 100 lb. in size, or up to 23 gallons of propane. Empty containers are exchanged at the customer's

site for full tanks. Engine Fuel Service Cylinders are typically used as fuel tanks on fork lifts, lift trucks, farm vehicles, and building maintenance equipment. Some are permanently mounted. Stationery Service tanks may be used at industrial and home sites. They are installed empty and then filled from a propane delivery vehicle. Normal installation of DOT cylinders is vertical or with valving at the top of the tank.

No matter what the size or shape, all propane containers have three common components—a metal tank shell, various service valves, and a pressure relief valve.

Propane and other LP gases are often transported in bulk containers—cargo tank trucks, railroad tank cars, pipelines and vessels. Cylinders are moved in semi-trailers and on rack body trucks. Responders should be aware that other commodities such as anhydrous ammonia are sometimes transported in MC 330 or MC 331 tank trucks or stored at propane facilities.

Special attention is given to the construction of vehicles designed to carry LP gases. Since 1967, cargo tanks operating in the United States are constructed to MC-331 cargo tank specifications, though some older MC-330 vehicles are still in service. MC-331 cargo tanks in propane service are single compartment. MC-331s are built to very high standards and can maintain their structural integrity in rollovers. A tank's structural integrity does not depend on its chassis or trailer for support. In a rollover or accident, the tank should remain intact even if the truck is damaged.

The transportation workhorse of the propane industry is known as the "Bobtail." Bobtail tank capacities normally range from 750 to 6,500 gallons with the most common sizes in the 2,800 to 3,500-gallon range.
Larger semi-trailer tank truck units, known as transports, have typical capacities of 11,000 to 12,000 gallons. These units deliver propane to bulk plants and marketing facilities. Some states now allow tandem or pup propane cargo tank trucks.

While tank truck sizes may vary, all have the same basic design, construction, and safety features. They have pressure relief valves; temperature, pressure and fixed liquid level gauges; remote emergency valve controls and shut-offs and excess flow valves. In propane service, most are painted white and are uninsulated.

Railroad tank cars, like tank trucks, are a means of delivering large quantities of liquid propane. Built to DOT specs, rail tank cars can have a water capacity as high as 34,500 gallons. Railroad tanks cars are designed for top loading and unloading only. Bottom outlets, even washouts, are strictly prohibited. In response to a number of serious accidents in the 1960s and 70s, new safety features have been added, including shelf couplers and heavy steel head shields to minimize the risk of puncture in a derailment.

To provide protection against flame impingement and fire, all DOT rail tank cars designed to carry propane are provided with thermal protection. They are designed to protect the tank's metal shell from radiant heat and flame impingement for a limited time. A dome cover is used to protect valves and fittings on top of the rail cars. The tank cars are equipped with a thermometer well to access temperature readings within the tank and sampling connections. Sampling ports can be the source of leaks.

Railroad tank cars have a number of safety features. These include spring loaded pressure relief valves and excess flow valves.

Intermodal Containers are used to move products from one mode of transportation to another such as from marine to rail or highway. Intermodal transportation is becoming more popular for International Commerce. Pressurized containers are commonly known as DOT 51 and IMO Type 5 Containers.

An integral part of propane transportation, is the loading and unloading process, which often is carried out at bulk plants. Deliveries are normally made by large transport vehicles at specially designed unloading stations called bulkheads, or truck risers. Most transports are unloaded by a liquid pump that can transfer as much as 300 gallons per minute of liquid propane. In the western United States and other locations, compressors may be used. Railroad unloading stations are located on sidings next to the bulk storage facility. Railroad tank cars do not have their own pumping equipment. A compressor is used for liquid transfer and to facilitate vapor recovery.

Each bulk plant is different. However, typical equipment includes bulk storage tanks, unloading stations, and filling stations. Bulk plants may have separate facilities for filling cylinders. Smaller pumps with a flow rate of 10 to 15 gallons per minute are common. Large numbers of cylinders, either filled or empty, may be warehoused at these bulk plants.

Increasingly, small cylinders are distributed through exchange cabinets at neighborhood retailers such as convenience stores or filling stations.

In addition to evaluating the containers and equipment, other ways to identify the problem are interviews with drivers or plant personnel, material safety data sheets, and emergency response plans. Phone calls to the emergency number listed on the shipping papers can provide assistance. Information gathered from pre-incident site visits and response guides like the North American Emergency Response Guidebook also may prove helpful.

Pre-incident planning visits are an important component of effective handling of propane emergencies. In addition to developing a positive relationship between industry and emergency response personnel, routine visits will alert emergency responders to the physical layout of the plant. During these visits, emergency responders can physically see the location of master shut-off valves to stop the gas flow in an emergency as well as master electrical switches and fire protection features. The names and phone numbers of propane specialists to contact in an emergency should be recorded.

Training is important and should be carried out on a regular basis with local propane industry personnel, emergency responders, and propane industry product and container specialists participating. In the event of an emergency, everyone will be better prepared to work as a team to handle the incident safely and effectively.

When available, combustible gas indicators and oxygen meters can help define the problem. It is also important to determine if other hazardous materials are involved. All data should be checked and verified. Each problem needs to be defined and prioritized.

HAZARD AND RISK EVALUATION

Once the site has been controlled and the problem identified, the incident commander must evaluate the hazards and risks in order to determine what strategy and tactics will be used to control the incident.

A good guide to understanding hazardous materials is provided by the NFPA 704 hazardous material identification system, which may be found in some workplaces. The red quadrant in the marking carries a products flammability hazard. Propane has the rating of four -the highest number—indicating a material that will readily vaporize, mix with air, and burn.

When propane gas combines with air in the proper ratio, it will burn. Its flammability range is between 2.15 percent and 9.6 percent. The percentage of propane in a mixture for ideal combustion is about four percent, or about 24 parts air to one part propane.

Propane's ignition temperature is about 920 degrees Fahrenheit. Common ignition sources include pilot flames, matches, lit cigarettes, and sparks from internal combustion engines, light switches, or electric motors. Once ignited, propane may burn at temperatures in excess of 3500 degrees Fahrenheit.

Propane is normally stored as a liquid under pressure. When pressure is released, the liquid boils, because of the drop in pressure. The gas is 270 times the volume of the liquid. This means a small amount of liquid can quickly turn into a large volume of vapor. The vapor can not always be detected visually. Rapid expansion and cooling may condense water particles, creating a visible white fog. The visible fog should not be used as an indicator of the flammable area, since, as the gas warms, the water vapor evaporates, making the plume invisible, although it may remain within the flammable range. The gases can travel to an ignition source and flash back.

Natural ventilation, wind speed, and humidity can affect how released propane behaves. While propane readily dissipates and mixes with air, its vapor density is 1.5, making it slightly heavier than air. However, in cool temperatures, high humidity, or still air, propane can accumulate in low areas and confined spaces before dissipating. Special caution should be taken in ditches, underground utility services, and low areas.

NFPA 704 assigns propane a health hazard classification of one, which indicates materials that will cause minor irritation or mild residual injury.

Propane is not toxic. Breathing small amounts of propane usually has no noticeable effect. However, exposure to higher concentrations may result in dizziness. Death can occur by asphyxiation if the concentration is high enough since propane displaces air. Contact with liquid propane can result in serious frostbite injuries. These characteristics make proper protective clothing and equipment especially important.

NFPA 704 assigns propane a zero reactivity hazard rating. This means it is normally stable and will not react with water.

In addition to risks presented by the product itself, there may be risks presented by the container, especially if it is under stress. Because propane is stored under pressure and has such a low boiling point, internal gas pressures will fluctuate in response to external temperature changes as the liquid warms and cools.

Spring-loaded pressure relief valves, or PRVs are an important safety feature designed to operate in the container to control internal pressure. If the pressure within the container exceeds a pre-set limit, the pressure relief valve, is activated, releasing vapor into the air. PRVs are usually set to open between 250 and 375 psig, depending on the container design pressure. This protects the container from failure under normal conditions. As temperature and pressure drop, the relief valve will normally close.

Weather conditions may present another hazard, especially precipitation and wind. Wind may accelerate dispersion of propane vapor and move it away from exposures or ignition sources. But, it may also push the release toward ignition sources or confined areas.

When responding to an incident at a propane facility, emergency teams may encounter other hazardous products. Some propane marketers are multi-product businesses. Accordingly, gasoline, diesel fuel, or agricultural chemicals may be present.

Once hazards are defined, the Incident Commander evaluates risks associated with them. Risk assessment also involves knowing when the fire or release started, how long it took for responders to arrive, the size and types of containers involved, and the availability of on-site fire protection.

Factors influencing risk levels include life and property exposures, the probability of harm to response teams, the proximity of ignition sources or other containers, the amount of product released, the levels of available resources, as well as exposure of containers to flame impingement and radiant heat.

Adequate water supplies, especially in rural areas, are extremely important for cooling containers exposed to flame. The recommend flow for stationary and bulk tanks is 500 gallons of water per minute at the point of flame impingement. Additional hose streams may be needed for exposure protection. If adequate water is not available, risk levels increase dramatically. Once life safety and evacuation needs are considered, a non-intervention strategy might be appropriate.

SELECTING PROTECTIVE CLOTHING AND EQUIPMENT

After evaluating the risks and hazards present, protective clothing and equipment must be selected. Emergency responders must use proper protective clothing when entering the hot zone. When dealing with propane releases or fires, normal structural firefighting clothing with positive pressure self-contained breathing apparatus is adequate. However, if other products are present, the protective clothing may have to be modified to suit the multiple threats.

MANAGE INFORMATION AND COORDINATE RESOURCES

During the incident, as more information becomes available, it is important for the incident commander to be able to manage and evaluate that information. As more resources arrive on the scene, they must be coordinated and folded into the incident management system.

Most propane incidents are small and can be handled safely and effectively by the local fire department and propane marketer.

Other more serious incidents may require the services of many different organizations such as the highway department, law enforcement, industry response teams, vehicle recovery services and salvage companies. This team effort needs to be coordinated to safely and efficiently resolve the incident.

Most emergency responders operate with a standard incident management system. Personnel may arrive at the scene who are not familiar with the system or how they should fit into it. The Incident Commander is in charge, and needs to get everyone working on the same plan, especially when safety issues or different agendas are involved. Industry personnel should report to the Incident Commander. However, at large incidents, they may find themselves working closely with a Planning Officer, an Operations Officer or a Safety Officer.

In some cases, multiple organizations from different jurisdictions may respond, including local, state, and federal agencies, propane industry personnel and contractors. In such cases an incident management technique called unified command may be established to mesh these diverse organizations. In the unified command format, the incident commander encourages discussion and develops a consensus on options before implementing a plan of action. Decisions are agreed upon by the leaders of each agency represented at the command post.

Equipment, water supplies and personnel must be coordinated to insure that resources are used effectively to mitigate the emergency. To make the most of limited water supplies or personnel, exposures may be prioritized according to their immediate threat. Of highest priority are those containers exposed to direct flame impingement. Second on the list are other containers, tanks and structures exposed to radiant heat. Of least priority are non-critical equipment or structures with no life safety issues.

IMPLEMENT RESPONSE OBJECTIVES

At this point, the incident commander must select the best available strategic goals and tactical objectives to produce a favorable outcome to the incident. Strategy is the overall game plan for controlling the incident. It is usually very broad in scope and selected at the command level.

There are three basic strategic modes. Offensive strategy is aggressive actions taken to quickly control the problem, such as shutting off the flow of gas, or effecting a rescue. These actions may resolve the incident more quickly, but also may carry a higher risk to personnel. Defensive strategies are less aggressive, and directed toward limiting the size and spread of the problem. For example, protecting containers or exposures. Finally, non-intervention is a decision made when the cost of action exceeds the benefits, such as when there is danger of container failure.

Strategy may change throughout the incident based on changes in risks. What seemed like a good plan at the start of an incident may change as weather conditions worsen, as resources are delayed in arriving or exhausted; or as the fire or leak spreads. Effective decision making requires good planning, thinking ahead and the ability to change strategy as the situation warrants.

The Incident Commander must decide the best way to handle the emergency. Offensive strategy may be justified to rescue trapped personnel. However, defensive strategy may be more desirable if it can limit the spread of the incident with less risk. Isolating the fuel source by shutting down pumps or remotely closing valves or cooling containers with unmanned streams involves less risk for fire fighters. Non-intervention is employed where there is high risk of container failure. Personnel are withdrawn and fires are allowed to burn until it is safe to re-enter the hot zone. Once a strategy has been chosen numerous tactical decisions must be made.

Tactics are the specific objectives to achieve strategic goals. Before any action is taken, entry teams must be thoroughly briefed on the objectives of the plan. Back up teams or rapid intervention teams should be equipped and in place should they be needed. Equipment and radios must be checked and tested. Escape routes are outlined.

A number of different tactics may be employed when responding to propane emergencies. In responding to a propane gas leak, there are several fundamental rules when approaching a gas leak. Sources of ignition should be eliminated. Use full protective clothing including helmet, gloves and SCBA. The leak should be approached from upwind under protection of hose lines. Firefighters should avoid entering the gas cloud and keep low behind the fog stream. Overturned vehicle should be approached from the wheel side. Tanks should be approached from the sides although this tactic in and of itself does not guarantee responder safety. Should the vessel fail, it will most likely travel in the direction it is pointed, though debris can travel in all directions. And there are risks from thermal radiation and pressure waves. If unable to shut off the fuel supply, the gas release should be dispersed with water fog. As fire fighters approach the vessel, water should be applied evenly at the proper application rate to the upper vapor space at the top of the container, cooling the top of the container, reducing temperature and pressure inside the container.

There may be incidents involving small liquid leaks from cargo tank trucks where valves cannot be shut off. A wet absorbing cloth can be wrapped around the leaking valve and allowed to freeze, which may stop the leak or slow it down. The truck can then be moved under escort with extreme caution to a safe area where the problem can be handled more effectively.

When responding to a propane fire, emergency responders should be aware that the approach is significantly different from structural fires or flammable liquid fires. Most importantly, if the fuel source can be shut off, the fire will go out. Thus, the source of the burning gas should be turned off. Should the fire be extinguished without stopping the leak, propane gas can continue to leak

and reignite and flash back to its source. If the fire does go out before the leak is shut down, hose lines should be used to disperse and control the vapor.

If there is flame impingement on the container, water can be used in an attempt to cool the container shell and reduce the temperature of the liquid, and therefore, the pressure within the vessel. A frost line may appear on the outside of the vessel indicating the liquid level within the vessel. Continued increase of pressure inside the container may cause the pressure relief valve to open, releasing propane into the atmosphere. For trucks, rail cars and containers which are not upright, approach should be made from the side opposite the relief valve.

Even though a pressure relief valve may be discharging properly, the container can still fail when exposed to fire. If a portion of the metal container fails a BLEVE can result—a boiling liquid expanding vapor explosion. A BLEVE can occur any time direct flame impinges on an LPG container at its vapor space. To prevent a container from failing, emergency responders must apply sufficient water at each point of flame impingement.

Developing this flow may not be possible in some areas. The incident commander must consider water supply and the proximity of mutual aid.

If the necessary water flow cannot be developed, it may be necessary to accept a controlled burn and evacuate everyone from a radius of 3000 feet from the fire. While not the only indication of impending container failure, an increase in the loudness of the relief valve, often characterized as a shrieking, may be one sign of a continuing increase in tank pressure and a deterioration of the tank's condition.

Emergency responders must work with propane industry and container specialists, to assess damage to pressurized containers involved in accidents. Damaged areas are potential sources for container failure. However, improper off-loading or uprighting attempts can cause container failure putting on scene personnel at risk.

Some common examples of pressurized container damage are scores—an indentation in the shell made by a blunt object; gouges—an indentation in the shell made by a sharp object; wheel burns—a wearing away of the metal through prolonged contact with a turning rail car wheel; dents—a deformation of the metal caused by impact from a blunt object; rail burns—a long dent with a gouge in the bottom caused by a tank car passing over a blunt object such as a rail. Longitudinal rail burns, passing over weld seems, are more serious; and street burns—long dents in cargo tanks which happen when containers overturn and slide along cement or asphalt roads.

When the incident involves a damaged and overturned tank truck or rail tank car, assessment is made to determine if the damaged container can be uprighted without removing the remaining product. The majority of MC 331s can be uprighted when loaded. If the container assessment indicates it is unsafe to do so, as much of the contents as possible must be removed from the damaged containers before they are uprighted or moved. In either case, rail, cargo tank or propane specialists should be consulted and should be included in the decision making process by the incident commander. This work requires skilled riggers, and container specialists.

Before any transfer or uprighting, there must be agreement on the plan of action. The Incident Commander must understand the hazards and risks involved. Moving ahead without a plan clearly explaining everything involved can create misunderstandings. Cooperation and honest communication between emergency response officials and industry specialists will facilitate a timely and safe outcome.

Many rollover accidents will not require product removal before uprighting. When the Incident Commander is satisfied it is safe to do so, qualified specialists can evaluate the task. Operating

hoisting equipment in emergency conditions is a complex and potentially hazardous job. Operators must be qualified in lifting and rigging operations.

In certain instances, the containers must be off-loaded before being safely uprighted or removed. These conditions include container stress or damage where off-loading will reduce that stress; leaking valves that cannot be repaired; or tanks in precarious positions like this rail car hanging off a bridge. In many cases, as much as half of the contents will remain inaccessible to conventional product transfer methods.

If there is need for product transfer or removal, a plan of operation must be established and communicated to everyone involved in the product removal or transfer operation. Back-up crews with fully charged hand lines connected to an uninterrupted water supply and at least two dry chemical fire extinguishers should be in place. An escape route and escape signal should be established. Combustible gas indicators should be used to make sure the atmosphere in and around the work area is safe. Instruments must be calibrated for propane or a conversion chart must be consulted. Personnel must continue to wear protective clothing and safety equipment equal to the hazards present. This is especially critical in confined areas. When the operation continues over several hours, frequent relief and rotation will keep workers alert.

NFPA 472 recommends that transfer operations involving flammable gases be grounded and bonded before off-loading the contents from a damaged container. This electrical connection Reduces the possibility of a static discharge—a source of ignition—during the transfer process. A qualified technician should be used for this. The off-loading process should be accomplished with pumps or compressors. All the while, emergency responders should remain in position should their services be needed.

When offloading is not feasible, or when pressure must be reduced in a damaged container, flaring may be carried out. Flaring is an emergency method to burn off the product in the containers in a safe and controlled manner. It should be carried out only by trained specialists. Flaring of large containers is a very time consuming process requiring several hours or several days.

DECONTAMINATION

Propane is a relatively high vapor pressure gas and is non-toxic. Exposure generally requires no decontamination. In the unusual event that responders are exposed to liquid propane, clothing should be removed to prevent frostbite injuries, then flushed with water to remove product and odorants, Turnouts can be laundered if odorants remain. If other products are involved, decontaminate accordingly. Responding to a propane emergency can be physically exhausting, especially working at long term incidents. Any personnel showing adverse signs should be seen by medical personnel for further evaluation.

TERMINATE THE INCIDENT

After fires and leaks have been secured, the emergency phase of the operation is over. However, there are still many safety concerns. Crews are usually tired and there is a general let-down from the excitement of the original incident. Accidents can and do happen during this phase of the incident.

Before emergency responders leave the scene, all personnel, equipment and supplies should be accounted for. Information should be gathered, including names and phone numbers of all responders in the event further medical issues arise. A debriefing is held with both private sector and public safety responders in attendance.

Finally, a short time after any significant incident, it is important to get all the players together to critique the incident. The idea is to focus on lessons learned and make improvements in the emergency response system, so that future incidents can be handled more efficiently and more safely.

Responding to an emergency involving propane can be a complex and highly technical procedure that sometimes involves many agencies, resources and tactical approaches. When emergency response teams are well prepared, and they are working as a team with industry safety personnel and propane marketers, costly mistakes can be prevented and the response effort will be successful. The result will be a timely solution, minimal property damage, and safety for all involved. To achieve this goal, emergency responders and propane marketers and transporters should work together toward a common goal- public safety.