WESTERN RESERVE JOINT FIRE DISTRICT
SOP FOR RESPONDING TO
LIQUIFIED GAS EMERGENCIES

A. General

Liquified petroleum gas, LPG, is a mixture of several of the hydrocarbon gases, mostly propane but with quantities of butane and possibly ethane, mixed in as well. Pure propane is colorless and odorless. In order to make leaks detectable by humans, an odorant is added, similar to natural gas. Unlike natural gas, however, propane is heavier than air and will collect in low points, possibly traveling great distances, hugging the ground as it seeks a point of ignition. Propane has a wider explosive range than gasoline- 2.1% lower explosive limit (LEL) to 9.5% upper explosive limit (UEL), and since it turns into a gas at minus 44 degrees fahrenheit, it is always ready to ignite if it finds the conditions correct.

Liquified petroleum cylinders, as their name applies, contain propane in the liquid and the gaseous state. Propane gas can easily be compressed by putting it under pressure. If it is compressed enough, the gas turns into liquid. In doing so, it shrinks to 1/270th of its original volume as a gas. When the pressure is released, such as by opening the valve, liquid begins to boil off into a vapor. As it does, it expands back into a gas, at a rate of 270 parts for each part of the liquid that evaporates. It is this rapid expansion of liquid into gas that can wreak havoc in a confined space. Consider a leak of only one single quart of liquid propane (just slightly larger than the "bernz-o-matic" torch) in a closed area. One quart of liquid propane evaporates into 270 quarts of pure propane vapor. This vapor mixes with air in an amount up to 47 to 1 ratios (2.1% LEL) to produce 12,857 quarts of explosive gas air mixture that requires only the slightest spark to detonate. For this reason, firefighters must be extremely cautious whenever there is a leak of propane within any enclosed structure.

B. B.L.E.V.E.S.

With reference to the vapor-air explosion previously described, most firefighters think of a BLEVE. BLEVE's are particular threats to firefighters, since they often occur after arrival of the fire department, unlike most vapor-air explosions. However, propane gas usually ignites nearly immediately, which results in a fire and no explosion, or else the occupants take steps to stop the leak and prevent ignition. Once the gas leak is ignited, however, a chain of events begins to unfold that has been repeated many times. The outcome of the event depends on the timing (and training) of the responding firefighters. Almost always, the first thing that happens after ignition of the gas is that fire exposes either a gas cylinder involved or nearby cylinders. This starts the clock ticking.

As the gas cylinder is exposed to heat, the gas within the cylinder continues to rise, as the liquid propane boils faster. At 70 degrees fahrenheit, the pressure in a propane cylinder is usually 100 psi. If the temperature goes up to 100 degrees, such as on a very hot day,

or if the cylinder is heated by sunlight or fire, the pressure in the cylinder sky rockets to a 190 psi. If the temperature of the liquid were to continue to rise, so, too, would the pressure until the cylinder reached its failure point. At this point, a BLEVE would occur. A BLEVE occurs when a liquid above its boiling point is released suddenly from its container and the super heated liquid expands rapidly to its vapor. The resulting energy released is tremendous and may launch parts of the container in any direction. BLEVE's can occur with any liquid in a closed container, even water. If flammable or combustible liquids are involved, there is the additional damage caused by the fire ball. Even without this, however, the container shrapnel and scalding liquid can kill all in its path. These items can travel great distances.

BLEVE's are the result of too much heat being applied to the cylinder in the wrong location. While this heat raises the pressure inside the cylinder, it is usually not the pressure rise that directly cause the BLEVE. Most often, the cause of the loss of strength of the metal cylinder is when it is heated. In this case, the pressure pushes through the softened metal just as if it were a much thinner piece of material. Therefore, the insulation of the pressure relief valve on the cylinder will not always present a BLEVE from occurring, even though it operates and keeps the pressure inside the cylinder around 250 psi. If the metal is heated enough, it will fail at even lower pressures than that. The only way to prevent a BLEVE is to keep the metal shell from overheating.

C. Tactics at LP cylinder fires

The most likely encountered LP gas incident in the District will be the backyard barbecue.

1. Exposure Protection

Tactics at any LP gas incident should focus on the unpredictability of the situation. Cylinders exposed to direct flame contact, particularly when it occurs in the upper vapor spaces, and are subject to BLEVEing in as little as 10 minutes. In addition to the BLEVE hazard, there is a probability of sudden relief valve operation that can shoot a blast of fire at approaching firefighters. As in all firefighting operations, the strategy must be the same: protect life, protect exposures, then worry about extinguishment. The life hazard here may be less apparent than normal. Due to the spectacle that a well involved LP cylinder creates, civilians in close proximity usually back away on their own. The noise level can become uncomfortable in the immediate area. However, backing up 50 to 60 feet is not sufficient - clear the area for at least 150 feet in all directions. Structures directly exposed should be evacuated, and should include the homes on either side as well as any that abut adjoining backyards. Evacuation beyond this point is generally not necessary, since the cylinder fragments are unlikely to penetrate three framed walls. Seek some information from the homeowner regarding the cylinder's state: Home long has it been burning; how full it was and, if not plainly visible from the street, where is it in relation to the house, garage, etc.? Particularly, at leaking cylinder incidents, pay attention to open cellar windows that can let gas enter, looking for pilot lights, etc. The first engine should ensure a continuous water supply, preferably a hydrant capable of supplying three or four one and three quarter inch hand liens as a minimum. (Note: In the

event of a serious escalation of the incident, at least one line will be acquired within the exposed incident, one outside protecting the structure, and one controlling the cylinder fire.)

2. Approaching the cylinders

Firefighters should approach the cylinder using all available cover to shield their advance. Firefighters should "hide" behind a parked car, the corner of the house or garage, or any other substantial object until they have been applying cooling water effectively for at least two minutes. Chances are by that time the fire will have greatly decreased the intensity and, if it is working properly, the spring loaded relief valve will have shut itself off as the hose streams cooled the cylinder.

3. Hose Streams

A degree of care is warranted when selecting stream patterns. Use the reach of the stream to place some distance between you and the cylinder, at least initially. For this purpose, a straight stream or narrow fog may be useful. But as the distance between the nozzle and cylinder decreases, the angle of the fog pattern must be widened. In serious cases, where the nozzle can't hit the cylinder until the firefighter is only five or ten feet away (due to the position of the cylinder between houses, etc.), the initial attack may have to begin on a full wide fog. If too tight of pattern is used, there is a very substantial risk of knocking the cylinder over. This may cause the situation to worsen as liquid propane instead of propane vapors discharge. In addition, it is possible to chase a still burning cylinder all around the house with a hose stream, causing it to ignite other exposures.

4. Closing the valve

Assuming all goes well, and the initial water application succeeds in controlling the fire, resist the temptation rush this affair by trying to close the valve manually. Chances are this attempt will not be successful. One of the first things which usually occurs after ignition is the valve handle melting off. Even with a pair of vice grips or a wrench, success is not assured. There is a rubber "O-ring" inside the valve which almost ensures a leak once it is burned away, no matter how much the valve is tight. There is a possibility the valve itself may blow out the cylinder if handled improperly after being highly heated. The best course of action at this point is simply to slow things down.

5. Tactical Options

The Incident Commander must take a moment to evaluate options. What if the fire is put and the leak continues? Where will the gas accumulate? Are there any sources for re-ignition? How is the fire behaving? Is it burning steadily or subsiding slowly? Depending on the circumstances, the Incident Commander may elect to continue to allow a controlled burn, or he may elect to extinguish the fire. A fire should not be extinguished in built-up areas where gas can accumulate and find sources of ignition. On the other hand, where there is plenty of space and a good breeze blowing away from the exposures, it may be perfectly acceptable. All members should be aware of the consequences of an uncontrolled leak and know what to do about it, since quite often the fire is advertently extinguished the initial attack. In this event, continue application of

fog streams to divert the gases away from danger spots (cellar windows, etc.), and dilute the gas concentration with air that is carried in the fog stream. Remember the one ally on the firefighter's side, the container size. While 20 pound tanks can produce a sizeable fire, they are not the "eternal flame". They have a limited supply of fuel, and without a BLEVE may burn themselves out in less than 20 minutes.