

# Liquefied Petroleum Gas (LPG)



## Propane (LPG)



1075 is the United Nations (U. N.) number used to identify Propane. 1978, not commonly seen, is also used to identify pure (odorless) Propane. Pure Propane is commonly used as an expellant gas for items such as shaving creams and deodorants.

## Properties of Liquefied Petroleum Gas

## Composition Of LPG

LPG is composed of both propane and butane

#### LPG Source

- LPG is a by-product of oil refineries
- Can also be found in gas and oil wells

LPG is a by-product of oil refineries during distillation process of crude oil, but can also be found in oil and gas wells.

#### LPG Properties

##### COLOR

- Propane is colorless

##### ODOR

- Propane is odorless
- Propane is odorized by adding Mercaptan

Pure Propane (1978) is odorless. 1) Propane placarded 1075 is odorized with Mercaptan, and therefore will be detected by the sense of smell. 2) Pure Propane U.N. 1978 is odorless. As mentioned earlier it is used as an expellant as well as other industrial processes, therefore it is not odorized. The ONLY way to identify where 1978 is is with a CGI.

#### LPG Toxicity

- Propane is non-toxic
- However, it is an asphyxiant

### What is Specific Gravity?

- The weight of a liquid as compared to water
- Why is that important?
  - LPG's specific gravity is .509
  - LPG will float on water

7

### Weight

- Liquid propane weighs approximately 4.4 pounds per gallon
- In comparison, water weighs approximately 8.3 pounds per gallon

8

### What is Vapor Density?

- The weight of an airborne concentration of a gas as compared to an equal volume of air.
- Why is that important?
  - LPG's vapor density is 1.6
  - This makes it heavier than air

9

### Expansion Rate

The expansion rate of propane is 370 times that of water. This means that for every gallon of liquid propane that is vaporized, it will expand to 370 gallons of gas.

### Temperature

Boiling Temperature: -42°F  
Liquid Temperature: -44°F to -42°F

### LPG Flammable Range

2.5% to 9.5%  
LPG is flammable in air at concentrations between 2.5% and 9.5% by volume. Below 2.5%, the mixture is too lean to burn, and above 9.5%, it is too rich.



### Expansion Rate

- The expansion rate of propane is 270:1
- Thus, storing and transporting propane as a liquid is more economically sound

10

Example: one 10,000 gallon road transport full of liquid equals 270 transports full of vapor

### Temperatures

#### Boiling Temperature

- - 44° F

#### Ignition Temperature

- 920° F to 1120° F

11

### LPG Flammable Range

- 2.2% to 9.5%
- Can be rounded off to 2% to 10%
- Which would be potentially more dangerous, a lean or rich atmosphere?

12

### LPG Flame Spread

- Approximately 900 feet per minute
- Similar to Gasoline

13

Compare this to LNG: Approximately 300 to 400 feet per minute. LPG flames spread twice as fast.

### Storage Temperature

- Propane is stored at ambient temperature
- Ambient temperature is the temperature of the day
- LPG is kept in liquid form due to pressurization

14

### Storage Pressure

- At higher temperatures the pressure will be greater
- At lower temperatures the pressure will be less
- 120 PSI at 70°F

15

### Transport Pressure

- Placing LPG in transport does not change the pressure
- Temperature is the factor affecting pressure

16

### Specific Dangers

- Flammable (2%-10%)
- Asphyxiant – will displace oxygen
- Frostbite (-44 degrees)
- Explosive – in confined spaces

17

### B.L.E.V.E.

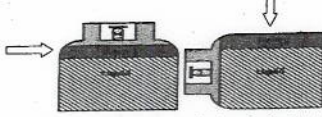
- Boiling
- Liquid
- Expanding
- Vapor
- Explosion



18

Does not have to be a flammable gas. Any container holding liquid above its boiling point can bleve when exposed to fire.

### The Vapor Space Is the Danger Area



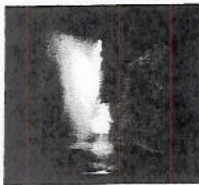
- Cool the vapor space of a heated cylinder
- Shut the gas off by the control valve if possible
- If the flow of burning gas cannot be shut off, allow the propane cylinder to burn itself out

19

The vapor space (regardless of the size of the tank), which is always at the top of a cylinder, is the area of most danger. The liquid inside will absorb heat when heat is applied to the cylinder at the liquid area, but the vapor space has no such capabilities. The cylinder should be cooled with water when it is exposed to a heat source.

### When to Anticipate a BLEVE

- Activation of PRV
- Sounds from PRV increase
- Pitch from PRV becomes higher or louder
- Space between flame and PRV increases
- Water hitting the tank turns to steam



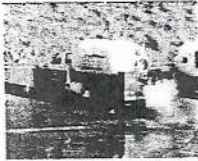
20

### Video Bleve Update

21



## Managing LPG Incidents



- The goal of any LPG incident is to control any vapors, prevent ignition and prevent a BLEVE from occurring.

22

## Extinguishing or Preventing Fire



The goal of vapor direction is to control the vapors into an area YOU want it to go.

The goal of vapor control/suppression is to dilute the gas concentration below its flammable range.

If a fire is present the intention is to keep the fire burning unless there is a confirmed life hazard and there is certainty the leak can be shut down.

23

Fire hose streams are used to direct, control, and disperse vapors, just as with natural gas or LNG.

## Extinguishment



- Extinguishing Agent:  
Dry Chemical
- Extinguishing Method:  
Stop the flow of gas

24

## Extinguishing the Fire

When using the dry chemical extinguisher the fire process is being interrupted simply by stopping the chemical chain reaction.

If the fuel amount is between the flammable range, oxygen is within range and there is an adequate heat source fire will erupt if the interruption of the chemical chain reaction is stopped.

25

## LPG In Storage

- LPG storage tanks are built to specifications based on their usage.
- LPG storage tanks will be built to specifications of either the Dept. of Transportation (DOT) or the American Society of Mechanical Engineers (ASME).



26

## LPG In Storage

- DOT storage tanks vary to their sizes.
- DOT tanks will be stored vertically.
- DOT tanks are referred to by "pounds." Example is a 20 lbs. tank on a grille.



27

With propane weighing 4.4 pounds per gallon, the reference of the size of the cylinder determines the gallonage. Example of the 20 lbs. LPG cylinder on the grille will provide approximately 4.5 gallons of liquid propane. A 100 lbs. cylinder will provide approximately 23 gallons of liquid propane.

### LPG In Storage

- ASME storage tanks vary to their sizes.
- ASME tanks will be stored horizontally.
- ASME tanks are referred to by gallons.



28

### Cylinder Capacities

- LPG cylinders are designed to be filled to approximately 80% capacity.
- The 20% vapor space allows for expansion of the product due to heat.
- Recent changes to the standards now provide for a safety device to prevent overfilling the container.

29

### Common D.O.T. Cylinders

- One pound
  - Hand torches, small camping appliances
- 20 pound
  - Recreational vehicles, grills, torches



30

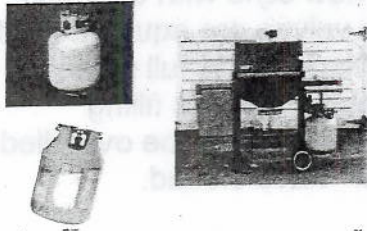
LPG cylinders can be everywhere. Think about the size of the cylinders and their locations. (For instance it is possible to find up to 200 full one-pound cylinders in a retail outlet.)

These are all D.O.T. cylinders, which are normally transportable.

Should be hydrostatically tested every 12 years

Vapor or liquid feed may be determined by cylinder orientation, i.e. vertical / horizontal.

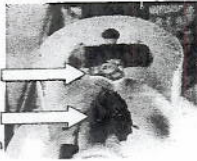
### The 20 Lb Cylinder / Gas Grills



The biggest problem in the Propane industry is the "disrespect" of the 20lb cylinder. Most people have propane in some form at their home. Almost everybody has one of these at home; in fact most people have more than one! In the off-season where are the cylinders kept?

### Safety Changes for Residential Use of LPG

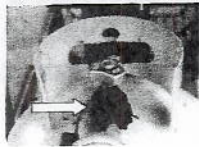
- Changes to residential use D.O.T. cylinders:
  - Overfill Protection Device
- Changes to gas grills:
  - thermocouple connection (QRC)



Improper use of LPG has brought about two major changes in regards to safety and LPG. The two changes are the OPD and the thermocouple connection.

### 20 # Valve Assembly

- Residential/Recreational connections of the 20 lbs. tank will be right hand thread

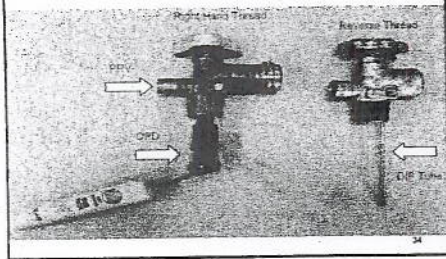


### Quick Connect Coupling/Quick Release Coupling.

Right hand thread, designed to be attached by hand (no wrenches required.) As the connection to the propane cylinder is made, the pin inserts into the valve assembly, which pushes back the check valve allowing propane to flow. The plastic connector is designed to melt during a fire (240 to 300 degrees F) allowing the check valve to close, which stops the flow of gas.



### DOT Tank Valve Assemblies



NOTE: This is a good example of the old style turn valve and the new style with the OPD. Also note that both valves are equipped with a dip tube, which indicates 80% full when "spitter" valve is open. Previous filling techniques allowed the tank to be overfilled by keeping the "spitter" valve closed.

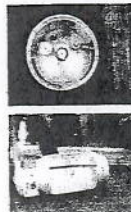
### Composite DOT Cylinders

- Composite LPG cylinders should be treated the same as steel LPG cylinders.
- Tank is lighter, liquid level can be seen
- Composite cylinders are not prone to explosions but fail by melting.



### Common D.O.T. Cylinders

- 33 - 43 pound
  - Industrial trucks (forklift / zamboni) may run on either liquid OR vapor
  - Connections of industrial use of LPG cylinders will be reverse thread



Vapor or liquid feed may be determined by cylinder orientation, i.e. vertical / horizontal. Notice the industrial tank has a volume gauge and connectors for the liquid or vapor space. Liquid will always be in the pick up tube.



### Common D.O.T. Cylinders

- 100 pound
  - Residential, usually in pairs, tar kettles
- 200 pound to 400 pound
  - Residential or commercial applications



37

### Common D.O.T. Containers

- 1,000 - 14,000  
Gallon
- Bobtail delivery and Road transports



38

Even though these are referred to as containers because of their size, and are measured in gallons not pounds, they fall under D.O.T. specifications, because they are moveable.

### Common D.O.T. Containers

- 30,000 - 40,000  
Gallon
- Rail transports



39

Even though these are referred to as containers because of their size, and are measured in gallons not pounds, they fall under D.O.T. specifications, because they are moveable.

**DOT Tank  
Safety Relief Valve Operating  
Pressure:**

- 375 PSI for fixed use tanks
- 375-450 for tanks used in transportation



40

20 lbs. tanks will have a 375-PSI setting.  
Forklift tanks may have a higher PRV setting.

**Common A.S.M.E. Containers**

500 - 5,000 Gallon  
- Normally found in commercial applications



10,000 Gallon and above  
- Storage facilities



41

A.S.M.E.- American Society of Mechanical Engineers.

Note the change from pounds to gallons when changing from D.O.T. cylinders to A.S.M.E. Containers.

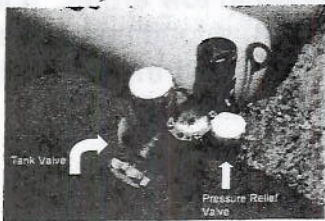
**Safety Relief Valve Operating  
Pressure:**

- A.S.M.E. Containers - 250 PSI



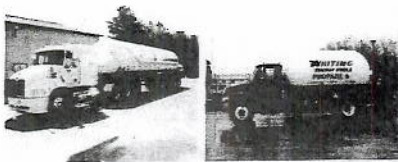
42

### ASME Tank Valve Assembly



43

### LPG in Road Transportation



44

Road transportation is performed by a LP transporter/trailer or a Bobtail.

### LP Gas Transports

- Over-the-road transporter. May be 10,000 to 14,000 gallons.
- Non insulated, single shell container.



45

Landing gear of trailer is not designed to hold the weight of the product and the trailer.

### LP Gas Transports

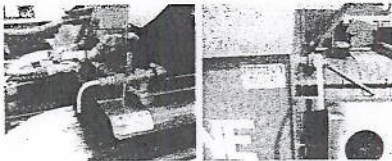
- Product is off loaded by a PTO pump capable of flowing 400 GPM.
- Loading and off-loading ports may be together at one location or may be separated between front and rear of the trailer.



45

Controls and valves may be located in one caged area or positioned in tow areas. If they are separated, typically, the loading valves will be at the rear of the trailer and the off loading valves will be up towards the cab.

### Emergency Shut Offs



Front

Rear

47

Front shut off located on drivers side near the cab of truck. Rear shut off located on passenger side opposite corner by the rear axle. Shut offs may be either pneumatic or cable operated.

### The Bobtail Delivery Truck

- Workhorse of the propane industry.
- Vary in sizes from 1,000 to 5,000 gallons.
- PTO pump capable of 60-90 GPM.



48

The "Bobtail" is the "work horse" of the propane industry. It can be found anywhere in any community.

### The Bobtail Delivery Truck



- Meter box and hose reel are areas for potential leaks.
- Typical hose reel is 1" in diameter and approximately 150' long.

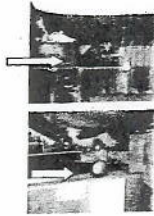
49

Common leak points are the meter box, flanges at hose reel, and connectors on piping.

Even after a small leak has been shut down, due to the size of hose and amount of hose there may be considerable delay in the releasing of the residual product.



### Bobtail Emergency Shutoffs

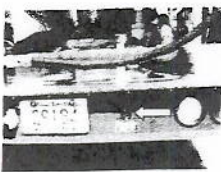


- Manual shutoff behind cab on drivers side of truck
- In the event of an emergency will close the main liquid discharge valve or PTO

50

The shutdown may be manual cable, pneumatic, or vernier throttle.

### Bobtail Emergency Shutoffs

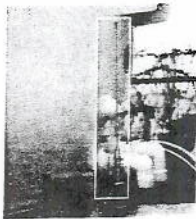


- Emergency shutdowns may also be located in the rear of the truck near the controls.

51

Whether it is cable or pneumatic the shutdown procedures are the same. The shutdown activates the "slug valve" which stops the liquid from leaving the tank.

### Bobtail Emergency Shutoffs



- Bobtails are now equipped with remote control shut offs.
- Device is activated by a garage door type control kept with the driver

52

This system allows the driver to stop the flow of product in the event of an emergency from a safe distance. Box indicates antenna located at meter box.

### Bobtail Emergency Shutoffs

- When the remote control is activated for emergency shutdown the PTO and the engine shutdown.
- Bobtails above 4,000 gallons requires a "Query" every five minutes to confirm delivery.

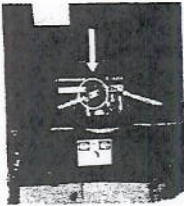


53

On bobtails greater than 3,999 gallons, every five minutes an alarm sounds requiring the driver to confirm delivery is being made. If there is no reply the emergency shutdown mode is activated.



### Bobtail Emergency Shutoffs



- Fusible link in cable can also shut down liquid valve in the event of a fire

54

### LNG Transporter Emergencies

- Each agency comes to the table with their own expertise.
- Safety is the #1 criteria in the mission to mitigate the incident.



56

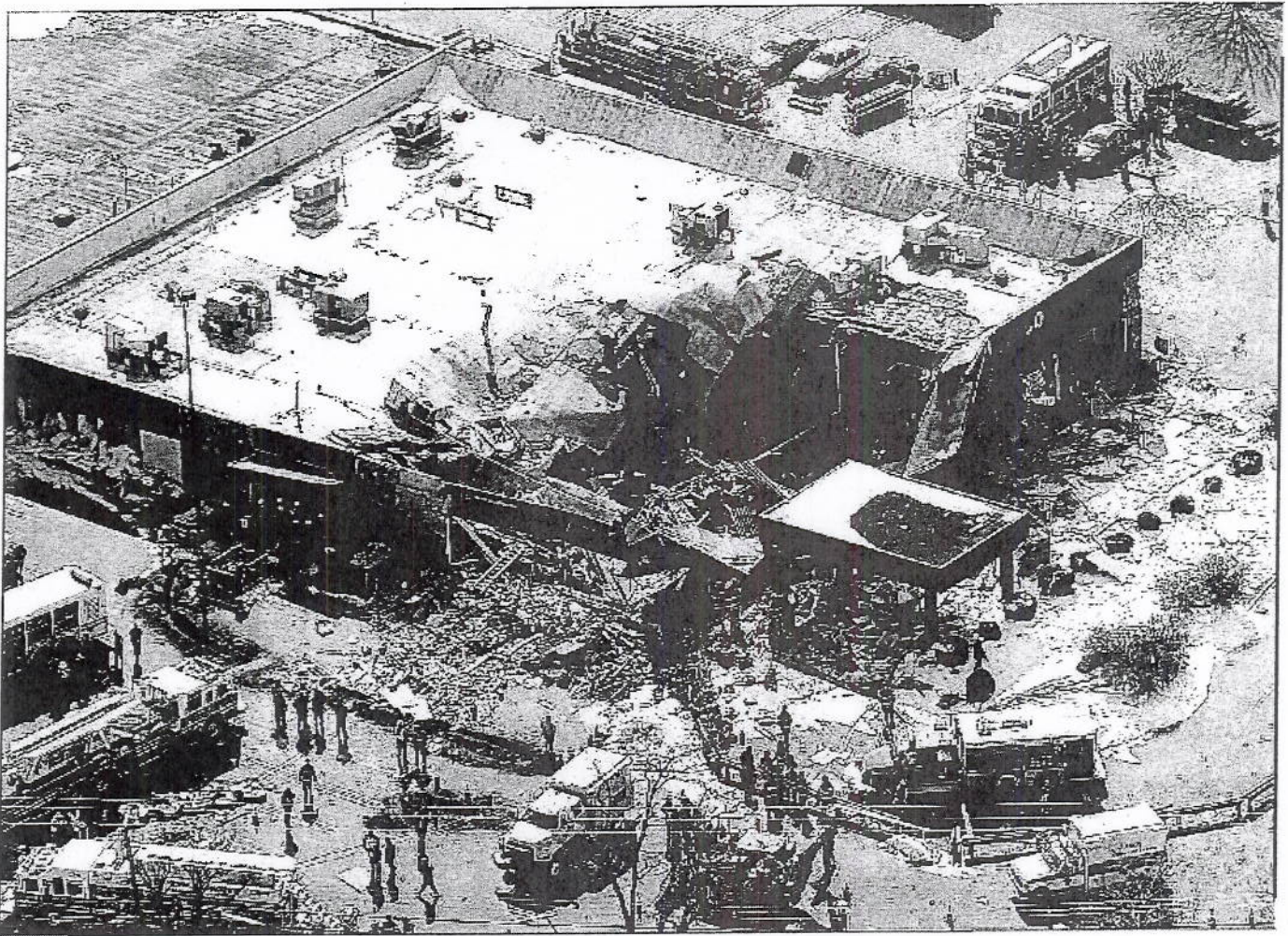
### Summary

- Vapors are **HEAVIER** than air and will collect in low spaces
- Liquid leaks are 270 times worse than Vapor leaks
- LPG is found **EVERYWHERE!**
- Refer to C.M.R. 527 Ch. 6 and NFPA 58 for further reference.

55

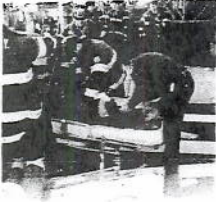
Ghent, West Virginia

Video

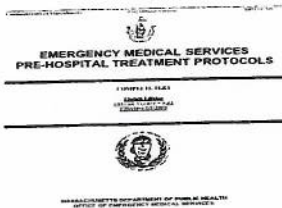


# EMS And The Gas Incident

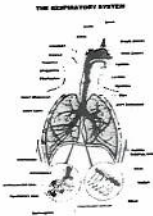
## EMS Patient Care



Always perform EMS care according  
to appropriate standards



## Respiratory Hazards



### • Asphyxiation

- Vapors mix readily with CO<sub>2</sub> in the lungs, signaling the body to stop breathing
- Extremely cold vapors may cause respiratory tract damage

## Respiratory Treatment

- Remove from source of exposure
- Place on high flow O<sub>2</sub>
- Check lung sounds for signs of pulmonary edema

## Respiratory Treatment cont.



- If possible, check WBC level
- Be prepared for potential respiratory decompensation
- Monitor for respiratory distress

## Respirators

- First step is to ensure proper fit
- Second step is to ensure proper use
- Third step is to ensure proper maintenance



### Respiratory Treatment

- Remove from hazard to minimize exposure
- Place on high flow O2
- Check lung sounds for signs of pulmonary edema

4

### Respiratory Treatment cont.

- If possible check SPO2 level
- Be prepared to support respirations if necessary
- Arrange for transportation to medical facility



5

### Frostbite

- LNG boils at minus 260 degrees F
- LPG boils at minus 44 degrees F
- Direct contact with skin will cause immediate loss of tissue

6

## Frostbite Treatment

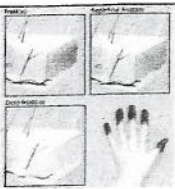
- Remove to safe area
- If possible elevate affected area to help minimize swelling
- Remove any clothing or jewelry in affected area



7

## Frostbite Treatment cont.

- Cover area with dry gauze and use cotton to separate toes or fingers if affected
- DO NOT rub area in an attempt to rewarm
- Arrange for immediate transport to closest appropriate medical facility



8

## Burns

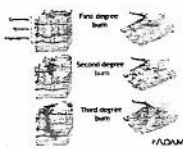
- There are several ways thermal burn injuries can occur when dealing with LNG, NG and LPG fires

Direct flame contact  
Radiant heat  
Steam burns

Steam burns often caused by perspiration trapped under firefighting PPE



## Burn Classifications



### • First Degree

Is superficial and causes local inflammation of the skin. Sunburns often are categorized as first degree burns. Characterized by pain, redness, and a mild amount of swelling. The skin may be very tender to touch

10

## Burn Classifications

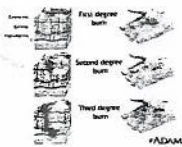


### • Second Degree

Deeper into the tissue and includes blistering of the skin in addition to the pain, redness and inflammation

11

## Burn Classifications



### • Third Degree

The deepest burn involving all layers of the skin, in effect killing that area of skin. Because the nerves and blood vessels are damaged, third degree burns appear white and leathery and tend to be relatively painless

12

## Determining Extent of Injury

Rule of Nines



## Burn Treatment

First or second degree burns involving a small area of the body

- Always ensure airway has not been compromised
- Gently clean the wound with lukewarm water
- Rings, bracelets, and other potentially constricting articles should be removed (edema, or swelling from inflammation may occur and the item may cut into the skin)

14

## Burn Treatment cont.

First or second degree burns involving a small area of the body

- The burn may be dressed with a topical antibiotic ointment
- Area may be covered with dry gauze.
- If there is concern that the burn is deeper and may be second or third degree in nature appropriate medical care should be sought, emergency transport if necessary

15

## Burn Treatment cont.

### Serious burns (second and third degree)

- Remove the victim from the burning area, remembering not to put the rescuer in danger.
- Remove any burning material from the patient.
- Always ensure airway has not been compromised.

16

## Burn Treatment cont.

### Serious burns (second and third degree)

- Call 911 or activate the emergency response system in your area if needed.
- Once the victim is in a safe place, keep them warm and still. Try to wrap the injured areas in a clean sheet if available. DO NOT use cold water on the victim; this may drop the body temperature and cause hypothermia.

17

## Burn Treatment cont.

Burns of the face, hands, and feet should always be considered a significant injury (although this may exclude sunburn)

18

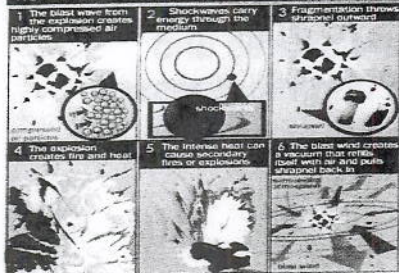
## Blast Injuries



A BLEVE involving an LPG storage container may result in both blunt force trauma and penetrating injuries

19

### How Bomb Blasts Work



20

## Blast Injuries

### • Primary

Injury from over-pressurization impacting the body surface

(blast wave)

21

Injuries could include Tympanic Membrane rupture, pulmonary damage and air embolization as well as hollow viscus injury

## Blast Injuries

### • Secondary

Injuries caused by projectiles (shrapnel) which could include container segments and other flying debris

22

Injuries may include penetrating trauma, fragmentation injuries and blunt trauma.

### Blast Injuries

- Tertiary

Injuries caused when the victim is displaced by the blast wind

23

Injuries can include blunt/penetrating trauma, fractures and traumatic amputations.

### Blast Injuries

- Quaternary

All other injuries

24

May include crush injuries, burns, asphyxia, toxic exposures and exacerbations of chronic illnesses.

### Summary

- There are many ways flammable gases can cause injury
- Scene safety is the primary concern for emergency responders
- Proper body substance isolation (BSI) practices MUST be followed
- It is very likely that it will turn into a mass casualty incident (MCI)

### Summary cont.

- Not all injuries will be readily apparent
- Rapid triage, treatment and transportation is critical
- EMS responders may be working side by side with other rescuers
- Post incident issues may need to be addressed