Massachusetts Firefighting Academy



Liquefied Petroleum Gas (LPG)

Objectives

- Discuss propane and its properties
- Show examples of common D.O.T. Cylinders
- Discuss overfilling of 20lb cylinders
- Discuss overfill protection/safety changes

Objectives

- Common A.S.M.E. Containers
- Propane in transportation
- Discuss BLEVE's and how to anticipate them
- Discuss CGI's and metering considerations

Pre - Test

Identification

Propane (LPG)



Properties

Composition Of LPG

LPG is composed of both propane and butane

Source

LPG is a by-product of oil refineries

Properties

COLOR
- Propane is colorless

ODOR
- Propane is odorless
- Propane is odorized by adding Mercaptan

Toxicity

- Propane is non-toxic
- However, it is an asphyxiant
- It will displace the oxygen in the air

Specific Gravity

- .509
- Water is assigned the value of 1.0
- Any liquid with a specific gravity less than 1 will FLOAT on water
- Any liquid with a specific gravity greater than 1 will SINK in water
- Therefore propane in its liquid form would float on water

Weight

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

Water Soluble

- Is propane water soluble?
- No, it will not mix with water

Vapor Density

- 1.6 - it is heavier than air since:
  - Air is assigned the value of 1.0
  - Any gas less than 1.0 is lighter than air and will rise
  - Any gas more than 1.0 is heavier than air and will collect in low spots such as ground level or basements, etc.

Expansion Rate

- The expansion rate of propane is 270:1
- Thus, storing and transporting propane as a liquid is more economically sound
- 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
- Impurities in the propane may affect the ignition temperature

Flammable Range

- 2.2% to 9.5%
- Can be rounded off to 2% to 10%
- What if the atmosphere is less than 2%?
- Said to be too lean
- What if the atmosphere is more than 10%?
- Said to be too rich
- Which would be potentially more dangerous?

Flame Spread

- Approximately 900 feet per minute
- Similar to Gasoline

Storage Temperature

- Propane is stored at ambient temperature
- Ambient temperature is the temperature of the day

Storage Pressure

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

Transport Pressure

- 120 PSI at 70°F
- Placing LPG in transport does not change the pressure
- Temperature is the factor affecting pressure

LPG Vapor Pressures

Temperature	Propane	Butane
- 44° F	0	0
0° F	24	0
32° F	54	0
70° F	120	31
100° F	187	59
130° F	286	97

Specific Dangers

- Flammable
- Explosive – in confined spaces
- Asphyxiant – will displace oxygen
- Frostbite

Extinguishment

AGENT
- Dry chemical agent

METHOD
- Stop the flow of gas

Review Pretest

Video

Portable Extinguishers

Common D.O.T. Cylinders

- One pound
  - Hand torches, small camping appliances
- 20 pound
  - Recreational vehicles, grills, torches
- 33 - 43 pound
  - Industrial trucks (forklift / zamboni) may run on either liquid OR vapor

Common D.O.T. Cylinders

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

Common D.O.T. Containers

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

30,000 - 40,000 Gallon
- Rail transports

Safety Relief Valve Operating Pressure:

D.O.T. Cylinders - 375 PSI

Note: At 160° F the Vapor Pressure of Propane is 390 PSI

The 20 Lb Cylinder / Gas Grills





Cylinder Overfilling

Cylinder Overfilling

At 80% full and at 60° F, a 20 LB. cylinder must be heated to 160° F for anything to happen to it.

Cylinder Overfilling

At 95% full and at 60° F, a 20 LB. propane cylinder would need only a 22° temperature increase to become liquid full.

Cylinder Overfilling

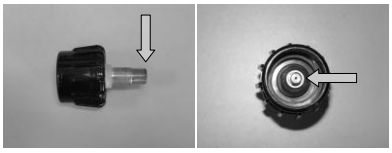
At 99% full and at 60° F, a 20 LB. cylinder would need only a 4.4° F temperature rise to cause a pressure great enough to operate the pressure relief valve.

Safety Changes

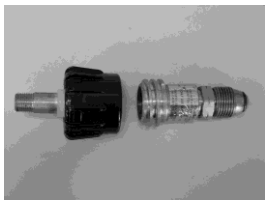
- Changes to gas grills
- Changes to D.O.T. cylinders

Safety Changes

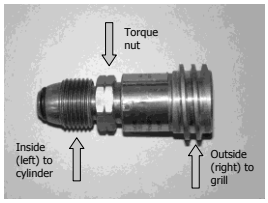
Gas Grills
Quick Release Coupling



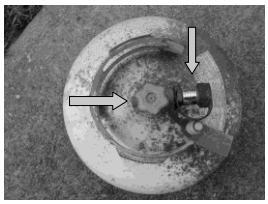
Adaptor With QRC



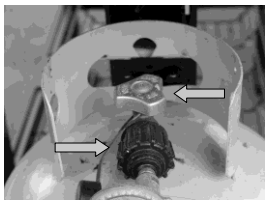
Adaptor



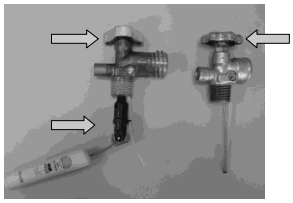
20 Lb Cylinder



New Valve Assembly



Overfill Protection Device (OPD)



Video

Overfill Protection Device

Common A.S.M.E. Containers

500 - 5,000 Gallon

- Normally found in commercial applications

10,000 Gallon and above

- Storage facilities

Storage Facilities



Safety Relief Valve Operating Pressure:

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

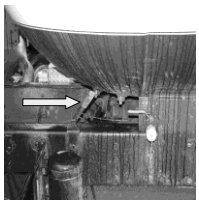
LPG in Road Transportation

The Bobtail Delivery Truck



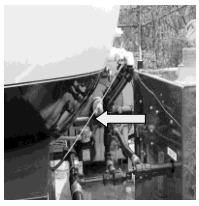


Bobtail Emergency Shutoffs



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

Bobtail Emergency Shutoffs



- Cable runs to rear of tank

Bobtail Emergency Shutoffs



- Newer units are equipped with remote control shut off
- Device is activated by a garage door type control kept with the driver

Bobtail Emergency Shutoffs

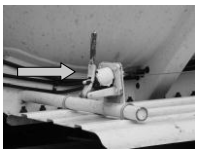


- Fusible link in cable can also shut down liquid valve in the event of a fire

LP Gas Transports



Emergency Shut Offs



Front



Rear

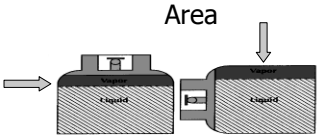
B.L.E.V.E.

- Boiling
- Liquid
- Expanding
- Vapor
- Explosion

Video

Bleve Update

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

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

Combustible Gas Indicators

Combustible Gas Indicators

CGI's, also referred to as "explosive meters" or "explosimeters," are used to test atmospheres that may contain a sufficient concentration of combustible vapors to cause an explosion or support combustion

Combustible Gas Indicators

There are three different scales used on various CGI models:

- Percentage of lower explosive limit (LEL)
- Percentage of gas in air
- Parts Per Million (PPM)

The most common is the percentage of LEL meter

CGI Response

- A properly set low level alarm on a CGI meter is 10% of the LEL for the calibration gas
- The reason this percentage is fairly low is that it serves as a safety factor

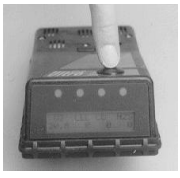
CGI's and Oxygen

- Oxygen concentrations will effect meter readings

Oxygen Meters

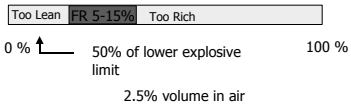
- Oxygen meters are used to detect the percentage of oxygen in atmosphere
- Most oxygen-sensing devices are calibrated to indicate concentrations between 0% and 25%

Instrument Operation



Combustible Gas Indicators

- If a meter reading is 50% LEL, this would be equivalent to 2.5% vapor in air



Carbon Monoxide (CO) and Hydrogen Sulfide (H_2S) Meters

- These instruments utilize a detector that operates by chemical reaction with the gas
- Like the oxygen meter, these meters are subject to interference from other gases or vapors

CGI

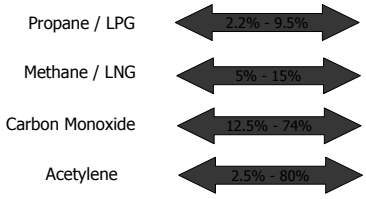
All CGI readings are relative to a calibration gas. When measuring another gas or vapor, the instrument still responds to the increased temperature of the filament



Conversion Factors

Combustible Gas/ Vapor	Correction factor when Instrument is calibrated on Propane	Correction factor when Instrument is Calibrated on Methane
Hydrogen	0.61	1.11
Methane	0.55	1.0
Propane	1.0	1.82
N-Butane	1.0	1.82
N-Pentane	1.22	2.22
Methanol	0.65	1.18
Ethanol	0.85	1.54
Ammonia	0.46	0.83
Toluene	1.57	2.86
Gasoline	0.85	1.54

Explosive Limits



Summary

- Vapors are HEAVIER than air and will collect in low spaces
- Liquid leaks are 270 times worse than Vapor leaks
- CGI's are the only way to tell where the vapors truly are
- LPG is found EVERYWHERE!