Command and Control of Gas Emergencies

Objectives

- To discuss the use of combustible gas indicators (CGI)
- To identify the properties of Natural Gas, Liquefied Petroleum Gas (LPG,) and Liquefied Natural Gas (LNG.)

Objectives

- To identify components of the gas distribution system
- To review prior gas incidents
- To identify procedures for safely handling gas emergencies

Combustible Gas Indicators

Combustible Gas Indicators

- CGIs, 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.

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.

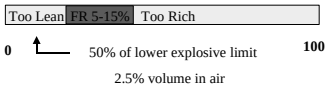
Instrument Operation

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

Combustible Gas Indicators

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



50% of lower explosive limit

2.5% volume 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.

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%.

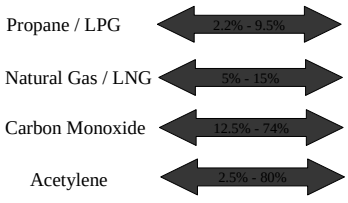
CGI

- 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



Video

Canada Gas Migration and Explosion Demonstration

Common Considerations for Gas Emergencies

- Properly position apparatus
  - upwind & uphill
  - water supply considerations
- Establish Incident Command System
- Ensure full protective gear with SCBA
- Notify Gas Company
- Evaluate need for evacuations, secure the area

Common Considerations for Gas Emergencies

- Use CGI's to monitor area
  - Consider possible migration routes
  - If burning, do not assume all the gas is being consumed (frozen ground)
  - Consider possibility of more than one leak (House service as well as street)

Common Considerations for Gas Emergencies

- Eliminate ignition sources
- Establish hose lines for:
  - exposure protection
  - vapor control
  - DO NOT fill excavation with water

Common Considerations for Gas Emergencies

- Consider ventilation needs:
  - If readings exceed UEL, consider passive ventilation
  - Be aware that other areas may be well within explosive range
- Notify other Utilities as needed
  - i.e. water, sewer, power

Explosive Limits

Natural Gas

1971

Natural Gas Properties

- Vapor Density .506 (lighter than air.)
- Non toxic, but is an asphyxiant
- Colorless
- Odorized with Mercaptan
- Explosive range 5% – 15%

System Pressures

- Transmission Lines
  600 to 1440 psi
- Distribution system
  100 psi or less
- Appliance use approximately
  1/2 to 1/4 psi (.5) - (.25)

Transmission Pipelines

- 12 to 36 inches in diameter
- Constructed of steel
- Some places only 3 feet below ground
- Shallow depth in harbor

Transmission Pipelines

- Valves could be up to seven miles apart
- Commonly located in the same path as power lines
- Run through populated areas

Video

Bronx, NY
December 29, 1989
Chicago, IL
October 30, 1998

Lessons Learned / Considerations

Bronx N.Y.

- Multiple agency response
- Communication problems due to noise
- Exposure issues
- Time required to shut down line
- Manpower / water supply

Lessons Learned/considerations

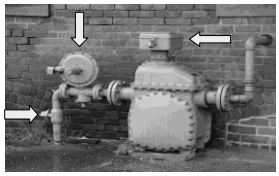
Chicago IL

- Multiple agency response
- Communications issues due to noise
- 24" High Pressure gas main
- The exposure was a 16 story occupied elderly housing apartment building
- Manpower / water supply

Distribution System

- Commonly 4 to 12 inch lines
- Intermediate pressure constructed of steel, plastic
- Low pressure approximately (.25 to .5 psi) constructed of steel, plastic or cast iron

Gas Regulator, Meter, Shut Off



Regulators

- Have been known to fail resulting in excessive pressure at appliance.
- If there is a failure in a regulator in a distribution system there will be multiple gas incidents over a large area.

Common Shut Off Locations

- Street side / Curbside (For use by gas company only)
- Service (Typically involving multiple meters)
- Meter
- Appliance

Video

Natural Gas First Response

Excavation Accidents

Bridgeport, Alabama

January 22, 1999

Fire Department NEVER notified

Bridgeport, Alabama

- Backhoe crew damages gas and water lines at excavation site
- Unknown to crew, gas line also separates at meter
- Area had not been marked prior to digging

Bridgeport, Alabama

- Escaping gas was heard, smelled, and bubbles were seen in the water
- Without investigating building, workers hoped the leak was in the street, and not at the service
- ONLY the utility company was notified prior to explosion

Bridgeport, Alabama

- Water main was shut off, but not gas
- Backhoe was restarted, and began removing debris from hole when explosion occurred

Bridgeport, Alabama Results

- 3 Dead
- 5 Seriously injured
- 1 Minor injury

St. Cloud, Minnesota

December 11, 1998

Fire Department responds with fatalities resulting

St. Cloud, Minnesota

- 10:50 cable crew drills through gas line
- 10:51 crew finds telephone and calls their supervisor
- 10:52 supervisor calls safety coordinator
- Safety coordinator tells supervisor to call gas company

St. Cloud, Minnesota

- Courthouse receptionist receives many complaints of gas odor
- Courthouse facility director goes out to investigate
- 11:05 he finds the source and telephones sheriff to report it

St. Cloud, Minnesota

- 11:06 St. Cloud Fire dispatches Engine 21
- 11:07 St. Cloud Fire notifies gas company
- 11:08 Engine 21 on scene
- Engine 21 has one Lieutenant and three Firefighter

St. Cloud, Minnesota

- 11:09 two firefighters start to use CGI, Pump Operator moves engine
- Lieutenant recognizes that private vehicles will have to be moved
- He walks to police station
- CGI crew checks near leak and outside of building

St. Cloud, Minnesota

- 11:16 gas company arrives
- Upon arrival of gas company the CGI crew returns to apparatus
- Only the Lieutenant remains in the leak area
- Gas serviceman goes into bar and gets 7 percent on meter

St. Cloud, Minnesota

- Gas serviceman goes to basement
- 11:29 Explosion in basement
- 12:25 gas shut down

St. Cloud, Minnesota

- 4 people killed, 1 serious injury, 10 minor injuries
- 3 businesses destroyed
  - Deli, Pub, Law Offices
- Total Loss $400,000.00

St. Cloud, Minnesota

- People trapped in explosion reported that they never saw fire department or gas company personnel before explosion.

St. Cloud, Minnesota

- At time of incident, St. Cloud Fire Department:
  - Had no written procedures for response to gas leaks
  - October of 1995 was last training on natural gas

St. Cloud, Minnesota

- Major Issues of Investigation:
  - Safety and emergency procedures of cable crew
  - The adequacy of the St. Cloud Fire Department procedures and training for responding to natural gas leaks

St. Cloud, Minnesota

- The National Transportation Safety Board concluded that the firefighters of the St. Cloud Fire Department responded quickly to the scene of the leak. However, once on the scene the firefighters actions did not fully address the risk to persons and property posed by the leak or minimize the potential of a possible fire or explosion.

Outcome

- A Standard Operating Guide was developed and implemented for response to natural gas emergencies.

St. Cloud, Minnesota S.O.G. Suggests Crews:

- Not rely exclusively on a single gas meter to detect gas concentration
- Eliminate possible sources of ignition
- Evacuate people and maintain site security

St. Cloud, Minnesota S.O.G. Suggests Crews:

- Check buildings, manholes, confined spaces in affected areas
- Also, gas company to provide and regularly calibrate 3 gas meters

Maple Heights, Ohio

March 11, 2002

Fire Department handles difficult situation successfully

Show Video

Maple Heights, Ohio

- March 11, 2002
- 12:43 p.m. Major water break
- Engine 1 dispatched, arrived and returned

Maple Heights, Ohio

- Two hours later
- Water flowing undermines gas lines
- 20-inch Natural Gas transmission line sags and separates
- Full response
- Incident Command established
- Sectors set-up
- Evacuation of civilians

Maple Heights, Ohio

- Water supply for engines and aerial tower
- Second alarm struck
- Gas, water, rocks blown 50 feet into air
- Personnel being struck by flying debris
- All sectors report heavy concentration of gas throughout neighborhoods
- Third alarm struck
- Water problems

Maple Heights, Ohio

- Utility pole 50 feet from hole bursts into flame
- Gas blowing by transformer caused static charge that started fire
- Command gives order "back-off and take cover"

Maple Heights, Ohio

- Fourth alarm struck
- 54 minutes later gas shutdown
- Hose lines advance on fire
- Overhaul includes checking areas and sewers for gas levels

Lessons Learned

- Position of apparatus is critical
- Always wear SCBA and full PPE when investigating reports of gas leaks
- Be pro-active, prepare for the worst

Lessons Learned

- Large-scale evacuations use much manpower and time
- Get mutual-aid coming early
- Chief officer's need aides

Command Decisions

- These decision will be made easier if preplanning, and training have been carried out

Video

Scranton, PA

Summary

Any building can become an explosion waiting to happen, even if they do not have natural gas service.

Propane (LPG)

LP Gas in the Community




LP Gas in the Community




Propane Gas Properties

- Heavier than air
  Vapor density - 1.6
- Expansion ratio 270:1
  1 gallon liquid = 270 gallons vapor
- Boiling point of -44 degrees F
  Butane is 32 degrees F

Propane Gas Properties

- Explosive limits are
  2.2% - 9.5% (2-10%)
- Pressure in container
  dependant on ambient temperature
  (-44F = 0 psi / 70F = 120 psi)

Common Propane Cylinders

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

Common Propane Cylinders

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

Gas Grill Emergencies

Scenario

Propane Storage

Common A.S.M.E. Containers

- 500 – 5,000 Gallon
  Normally found in commercial applications
- 10,000 Gallon and above
  Storage facilities

Common A.S.M.E. Containers

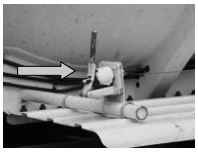
- 1,000 – 14,000 Gallon
  Bobtail delivery and Road transports
- 30,000 - 40,000 Gallon
  Rail transports

A.S.M.E. Storage Tank

Storage Facilities

LP Gas Transport

Transporter Emergency Shut Offs

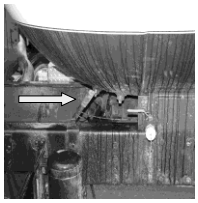


Front

Rear

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

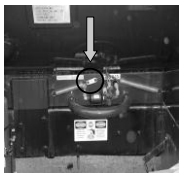
Bobtail Emergency Shutoffs

- Cable runs to rear of tank

Bobtail Emergency Shutoffs

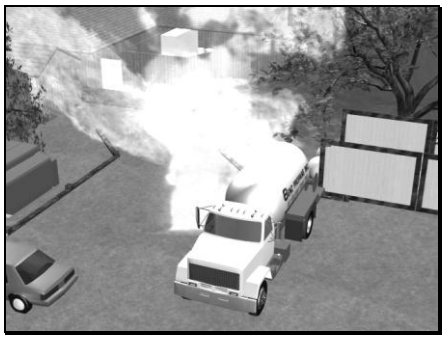
- Newer units are equipped with remote control shut off
- Device is activated by a garage door type control kept with the driver

Bobtail Emergency Shutoffs



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

Bobtail Scenario



Crescent City, Illinois
Propane Explosion
June 1972

Kingman Arizona
July 5, 1973

Kingman Arizona

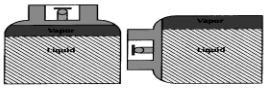
Kingman Arizona

Kingman Arizona

B.L.E.V.E.

- Boiling
- Liquid
- Expanding
- Vapor
- Explosion

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.

Video

Albert City Iowa and Kingman Arizona revisited

Buffalo, NY

December 27, 1983

Buffalo N.Y.

- An employee moving an illegal 500 gallon propane tank with a forklift, drops tank which breaks valve.
- Engines 1 and 32, along with Ladder 5 respond to a reported propane leak at a 3 story radiator warehouse.
- As companies arrive the leaking gas finds an ignition source and there is a massive explosion.

Buffalo N.Y.

- Ladder 5 (tillered) is thrown 354 feet into the front yard of a dwelling.
- Engine 1 is blown across st. Captain and driver are pinned in cab surrounded by burning debris.
- Engine 32 is blown up against warehouse across st and covered with rubble.

Buffalo N.Y. Results

- 5 members and 2 civilians killed instantly
- 9 members injured – 3 critically
- Another 19 members injured during rescue operations
- 60 – 70 civilians injured

Buffalo N.Y. Results

- The blast and fire ignited 14 residences and damaged as many as 130 buildings over a four block area.

Albert City, Iowa

April 9, 1998
2 Firefighter Fatalities

Carathage, Illinois

October 2, 1997
2 Firefighter Fatalities

Liquefied Natural Gas

Liquefied Natural Gas

- Cryogenic liquid
- Stored at -260 F
- Vapor is heavier than air at –260 F
- Becomes lighter than air at –170 F

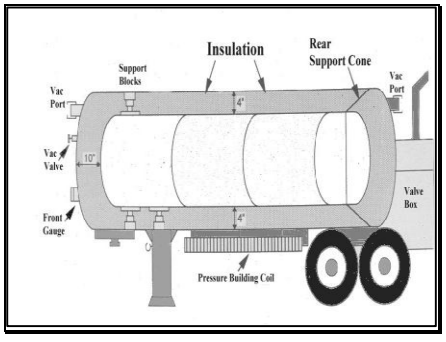
Liquefied Natural Gas

- Expansion ratio 600:1
- Not odorized during storage and transport
- Flammable range 5% - 15%

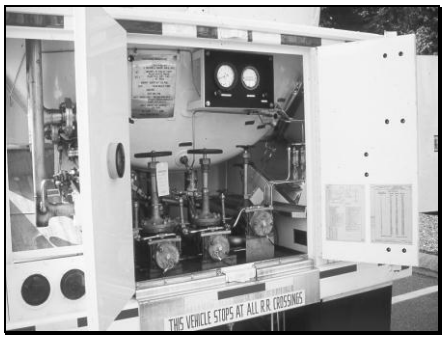
Video

LNG Properties

LNG Road Transportation




96
METHANE REFRIGERATED LIQUID
1972
2
THIS VEHICLE STOPS AT ALL R.R. CROSSINGS
44538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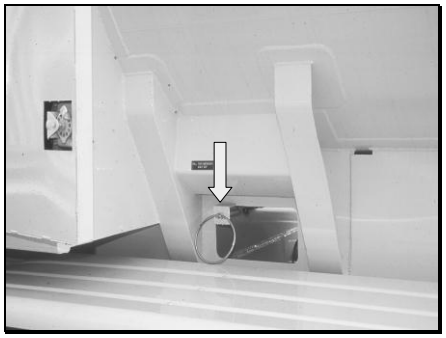
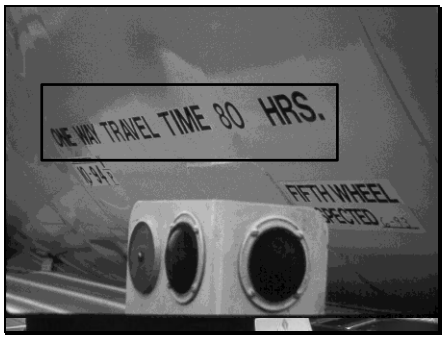
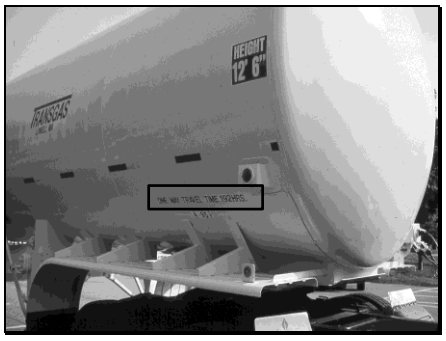
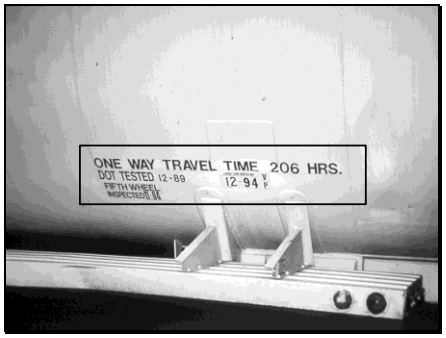



ONE WAY TRAVEL TIME 80 HRS.
FIFTH WHEEL


HEIGHT
12' 6"


ONE WAY TRAVEL TIME 206 HRS.
DOT TESTED 12-89
12-94

LNG Transportation

Scenarios

Summary

- Are YOU prepared?
  - SOG's
  - Pre-plans
  - Training
  - Confidence