# LIQUEFIED NATURAL GAS (LNG)

## Liquefied Natural Gas


## Why Do We Need LNG?

- LNG storage is like a savings account for the gas industry
- During off peak NG usage, gas from transmission pipelines and liquefied and held in reserve
- During peak usage, the LNG is vaporized, then odorized and re-introduced back to the systems to augment the distribution supply

## Properties of LNG

## Composition

- 97% Methane
- 3% Ethane
- Trace quantities of Propane and Butane

## Source

- Liquefied Natural Gas is produced by a cooling process of Natural Gas

## Characteristics

- Color –
  LNG is colorless
- Odor –
  LNG is odorless

## Odor Continued

- An odorant is added to Natural Gas (Mercaptan)
- However no odorant is effective when added to LNG due to the very nature of the product

## Toxicity

- LNG is non-toxic
- However it is an asphyxiant
- An asphyxiant will displace the oxygen that we need to survive

## Specific Gravity

- 0.421
- Water is assigned a value of 1.0
- Any material with a specific gravity less than 1 will FLOAT on water
- Any material with a specific gravity greater than 1 will SINK in water

Specific gravity refers to a materials density in comparison with water. Water is always given a value of 1. Anything with a specific gravity less than 1 will FLOAT on water, while anything with a specific gravity greater than 1 will SINK in water. Examples: Hydrocarbons will float and corrosives will sink.

## Weight

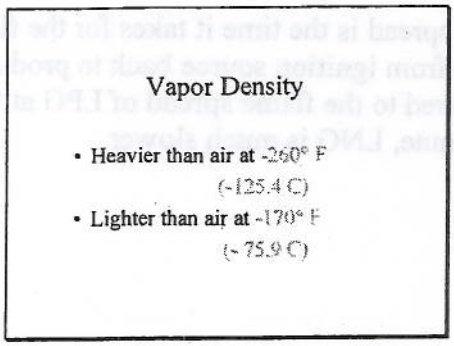
- LNG weighs 3.5 pounds per gallon
  (.41 Kilograms per liter)
- Water weighs 8.3 pounds per gallon
  (.98 Kilograms per liter)

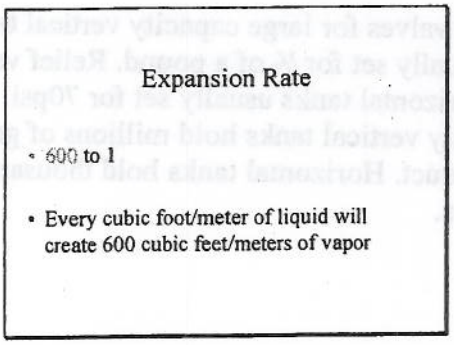
## Solubility

- LNG is NOT soluble in water

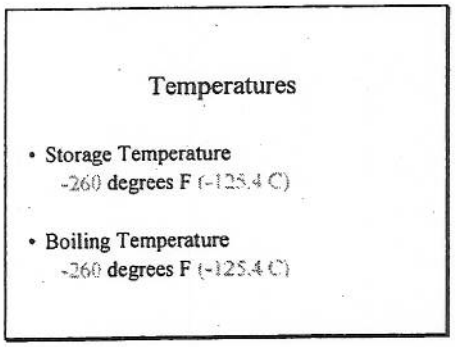
## Vapor Density

- .506 – it is lighter than air
- Air is assigned a value of 1
- Any gas less than 1 is lighter than air and will rise
- Any gas more than 1 is heavier than air and will collect in low spots such as ground level or basements, etc.

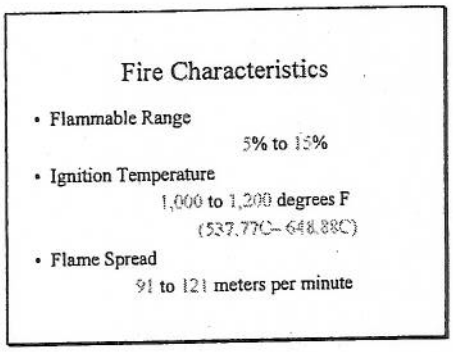


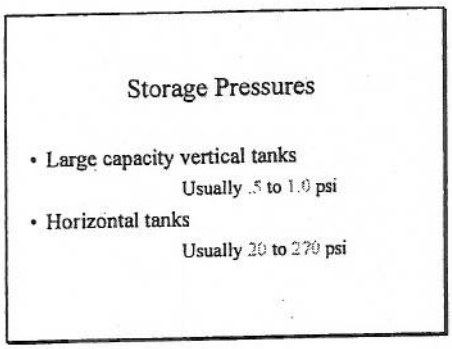

This is why Natural Gas is liquefied. For every truckload of liquid you would need 600 truckloads of vapor.



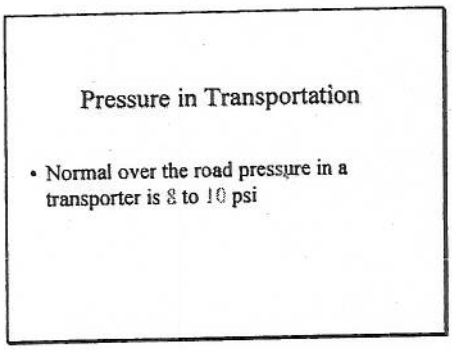

LNG is a cryogenic.




Flame spread is the time it takes for the flame to spread from ignition source back to product. Compared to the flame spread of LPG at 900ft per minute, LNG is much slower.



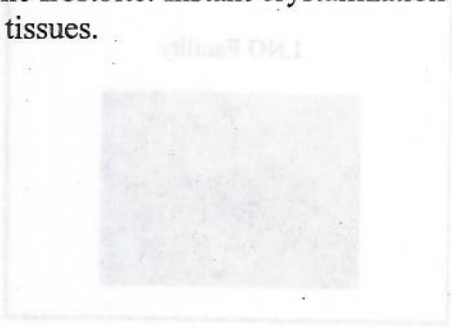

Relief valves for large capacity vertical tanks are usually set for ¾ of a pound. Relief valves for horizontal tanks usually set for 70psi. Large capacity vertical tanks hold millions of gallons of product. Horizontal tanks hold thousands of gallons.



Specific Dangers

- Flammable – range 5 to 15%
- Explosive – in confined spaces
- Asphyxiant – will replace oxygen
- Cryogenic – Frostbite, Tissue damage

Extreme frostbite. Instant crystallization of living tissues.



Extinguishment

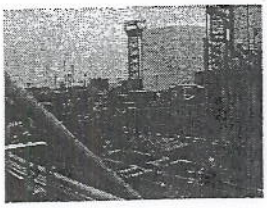
- Extinguishing Agent
  Dry Chemical
- Extinguishing Method
  Stop the flow of gas

After flow of gas is stopped, beware of puddles or areas of pooled LNG.

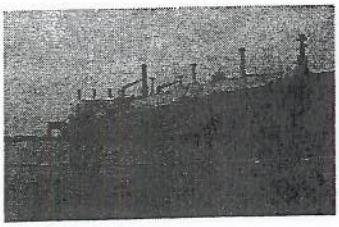
Video

LNG Characteristics

LNG Facility

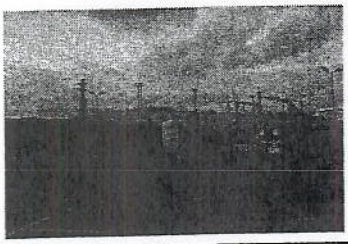


LNG Ship

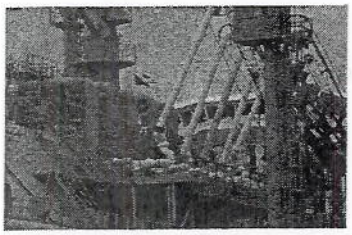


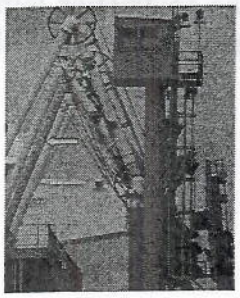
Most LNG ships carry 120,000 to 140,000 cubic meters of product. There are currently more that 300 LNG vessels in service around the world.

LNG Ship



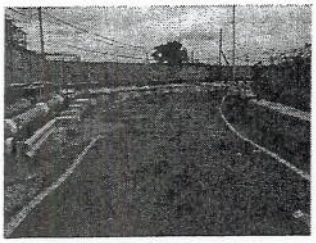
Four Liquid Lines (outside)



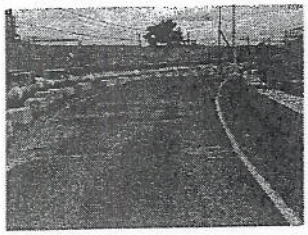


Vapor return line (center)

Liquid and Vapor Lines

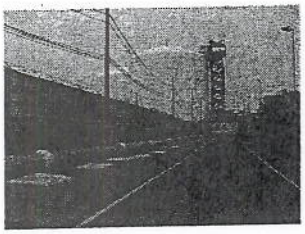


Containment Area in Road



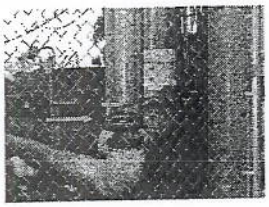
Low spots designed into the access road to act as containment areas in the event of a spill or leak.

Lines to Storage Tanks



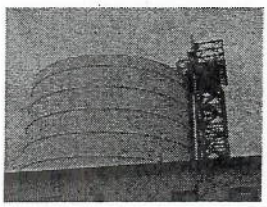
Notice the frost on the contraction joints, this gives an indication as to which line is liquid and which is vapor.

"Contraction" Joint

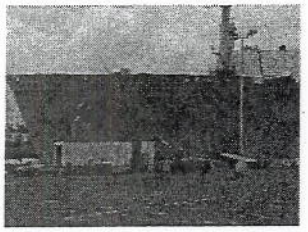


Joints that allow the line to contract due to extreme cold.

Storage Tanks

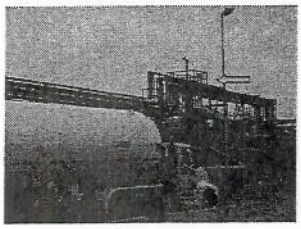


Fire Suppression Systems

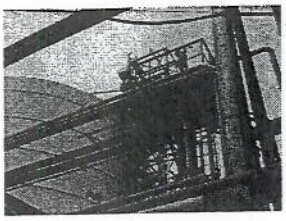


Water coming from around anchor is a visual indicator that the fire suppression system is being supplied.

Monitors for Fire/Vapor Control

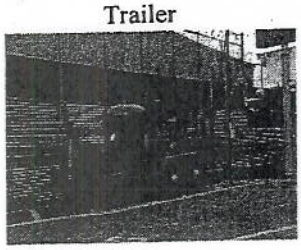


Monitor Tower



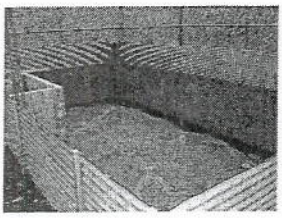
Water curtain appliances are located on both ends and each side of loading rack for vapor control.

Dry-Chemical Extinguisher Trailer



Large extinguisher trailer with dual hose reels.

Spill Containment Area

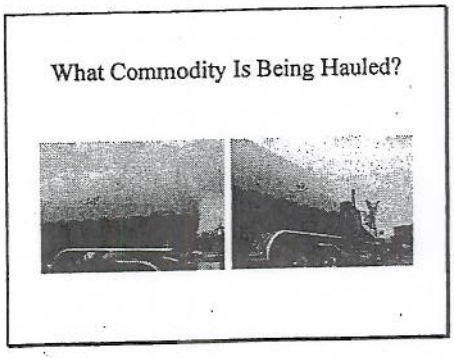


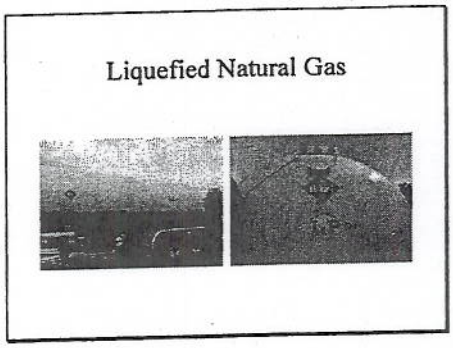
Areas that are designed to collect LNG in the event of a spill or leak. These areas are usually deigned to be deep instead of wide to reduce surface area, which minimizes vaporization.

Road Transportation

The reasons we are going to spend time on LNG in transportation are: At this time, 90% of all the LNG transported by road is done in the Northeast section of the country. The largest transporter of LNG in the country is Transgas located in Lowell, MA. With approximately 52 dedicated LNG tankers. A second regional transport company has added 18 trailers to the fleet of LNG transportation. There are approximately 25 different sites in Massachusetts alone that deal with LNG. The chances of responding to an LNG incident are not as remote as you would think.

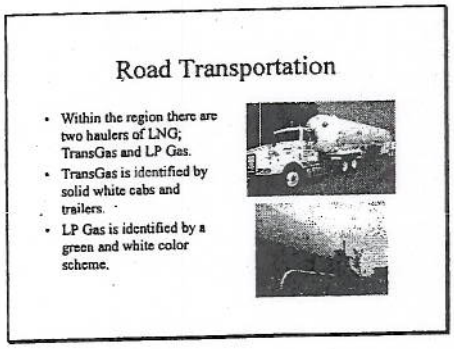
The basic design of an LNG transporter is of a double-shelled insulated container. For both transporting companies, Russell Engineering is the builder of the cryogenics tank. They are Approximately 12'6" high and 40 to 45 feet long. Capacities run from approximately 10,000 to 13,800 gallons, which makes the weight of the payload anywhere from 38,000 to 43,000 pounds. The payload is the amount of product, whether measured by weight (pounds), or volume (gallons)



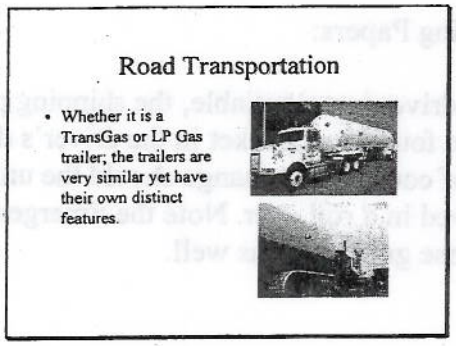




The only true way of identifying the commodity is by paying close attention to the trailer. In this case the UN 1972 placard indicates the commodity is LNG; in addition, being a dedicated transporter, LNG or its other trade names must be stenciled on the trailer. I.e.. "Methane Refrigerated Liquid", Liquefied Natural Gas" "Refrigerated Methane"

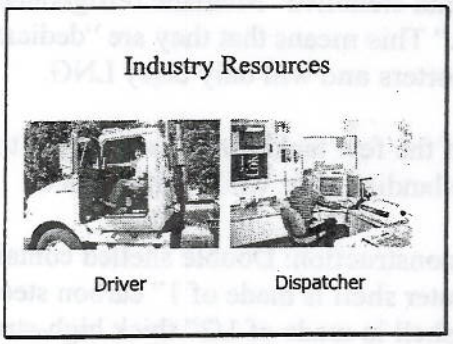
The point of the previous slide was to "trap" the students into thinking the commodity is LPG. Based on seeing the "LP" sign one would assume it is LP gas. The fact of the matter is that LP is the name of the truck company.




Transgas is based out of Lowell, MA while LP Gas is based out of Chester New York

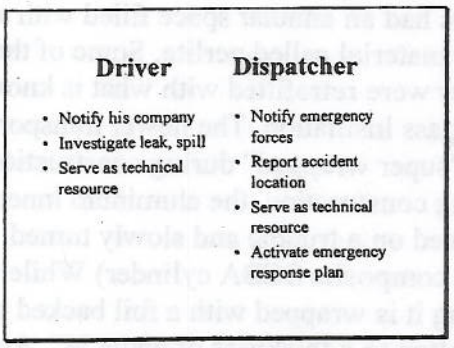



Much like a fire truck, every trailer has similarities and every trailer has its own unique idiosyncrasies.

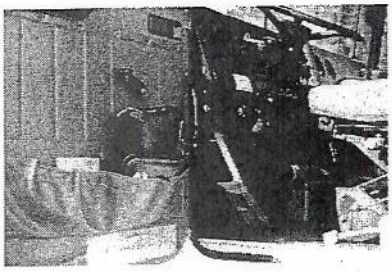



Resources:

Both the driver and the company dispatcher are excellent sources of information, and technical advice. Do not hesitate to get their input.



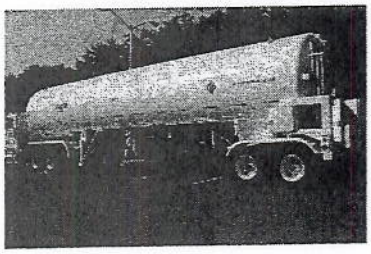
Shipping Papers



Shipping Papers:

If the driver is unavailable, the shipping papers will be found in a pocket in the driver's door. This of course may change should the unit be involved in a roll over. Note the Emergency response guidebook as well.

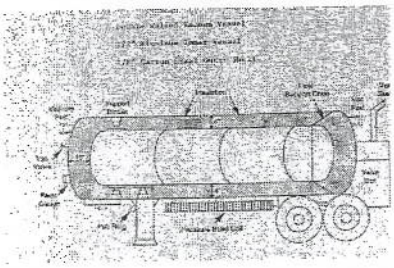
Road Transportation



There are 3 distinct features of the LNG transporter. The size of the tank, the "bucket box" at the rear, and the pressure building coils under the belly of the tank. They are placarded 1972 and stenciled "Methane refrigerated liquid." This means that they are "dedicated" transporters and will only carry LNG.

One of the few tanker trailers designed to rest on the landing gear while fully loaded.

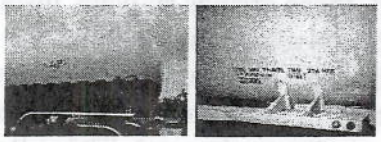
Road Transportation



Tank construction: Double shelled container. The outer shell is made of 1" carbon steel. The inner shell is made of 1/2" thick high-strength aluminum. There is an annular space between the two shells. This space contains an insulating medium, and is placed under a vacuum.

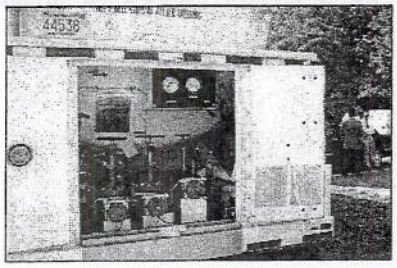
The insulating material is one of 3 types. Older trailers had an annular space filled with a white, fluffy material called perlite. Some of these trailers were retrofitted with what is known as fiberglass insulation. The newer transporters are now "super wrapped" during construction. During construction, the aluminum inner vessel is placed on a trundle and slowly turned. (Much like a composite SCBA cylinder) While it is turning it is wrapped with a foil backed paper insulation to a thickness of about ½". Again the annular space is placed under vacuum, which makes the transporter act like a thermos bottle. These 3 types of insulation can be found on trailers at the present time. As a rule of thumb, Trans Gas trailers numbered 90 and above are "super wrapped" trailers.

One Way Travel Times



One-way travel time indicates the length of time before the trailer will build up enough pressure for the relief stacks to operate. However, for safety purposes the hours indicated are often well below the actual pressure/time ratio.

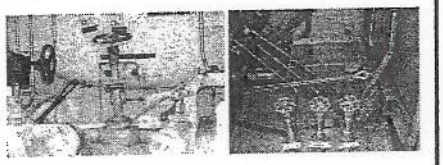
Bucket Box



Bucket box piping, valves and gauges: There are three main valves located in the bucket box. Common valve configurations the main liquid line is the furthest to the left, when looking at the box from the rear. The vapor return line is in the middle, and the trailer cool down valve is on the right. The two gauges at the top are the inches of water column gauge on the left, which measures the amount of product in the tank, and the pressure gauge on the right.

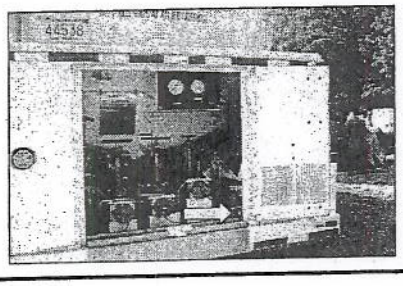
Remember.... over the road pressure is 8 to 10 psi. Unless loading or unloading anything above 10 psi indicates a possible problem with the trailer, such as a loss of vacuum, which might allow the pressure to rise. There are typically two pressure gauges on the trailer, one located in the bucket box, and one located on the driver's side front of the trailer. The inches of water column gauge measures volume. This gauge is only accurate if the trailer is in the normal upright position. Once on it's side, the gauge is no longer accurate. In the lower right hand corner of the bucket box is a small air valve that locks the trailer brakes when activated. Opening the right bucket box door activates this valve. It is designed to prevent "pull away" accidents during loading procedures.

All Controls and Valves Are Located In The Bucket Box



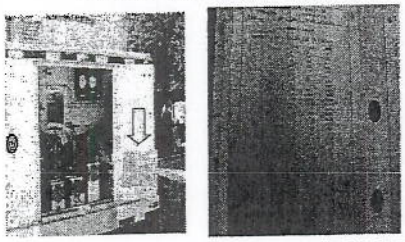
The bucket box: The red colored spring-loaded handles are part of the emergency shut down system. When the emergency shut down rings are pulled, these springs activate, instantly closing the valves. In the center of the slide you can see three tri-cock valves. These give a true indication as to the amount of liquid in the tank. The green indicates (empty), The yellow indicates (87%), and the red indicates (90%) The piping from these tricocks enters the tank at different levels. When opened and liquid flows out, that is a true measure of the liquid level in the tank.

"Vinnie Valve"



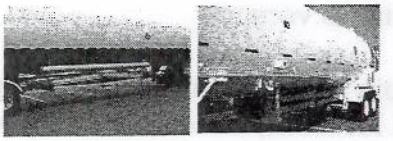
Safety device to help prevent accidental drive-aways. This activated causes the brakes to lock up.

Liquid Capacity Chart



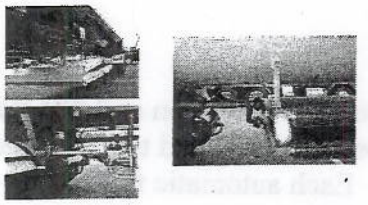
Located in the door of the bucket box will be a chart indicating the conversions for inches of water to gallons to pounds of the commodity.

Pressure Building Coils



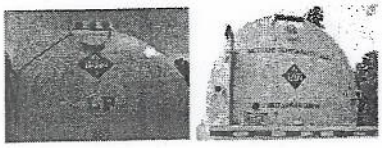
Close up of pressure building coils. These coils are used to facilitate unloading of the trailer. The cold LNG (-260F) is sent through the coils. As the liquid moves through it contacts the ambient temperature via the fins in the coils. This causes the liquid to vaporize. It then re-enters the top of the tank creating a head pressure, which is then used to force the liquid out of the trailer. Example: When a transporter arrives to deliver a load of LNG at the MFA, the pressure in the trailer is 8 to 10 psi. Our storage tank is anywhere from 20 to 60 psi. To be able to off load the trailer it is necessary to "blow down" the pressure in the storage tank by venting it to the outside air, while the pressure in the transporter is being increased via the pressure building coils. At our facility, as at most facilities, LNG is unloaded strictly by pressure differential. LNG is not normally "pumped" unlike LPG, which is normally pumped due to its pressure. Once the pressure in the transporter is greater than the pressure in the storage tank it can be off loaded.

Pressure Building Coils



While the coils on a Transgas trailer and a LP trailer looked different, the both operate off the same concept. Each liquid line consists of a 2" stainless pipe with a 3" stainless vapor return pipe.

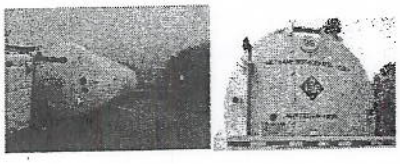
Vacuum Plate and Trailer Numbering



Vacuum plates are used to ensure the trailer remains under a vacuum. If the vacuum plate is out of alignment it indicates the trailer has lost or is losing its vacuum.

While both trailers each have vacuum plates in identical locations, trailer numbering will be on different locations. Transgas will provide the trailer number on the vacuum plate while LP will provide the number below their nameplate.

Vacuum Plate



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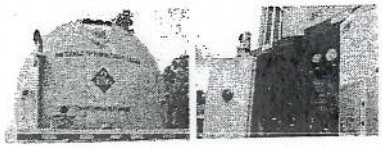
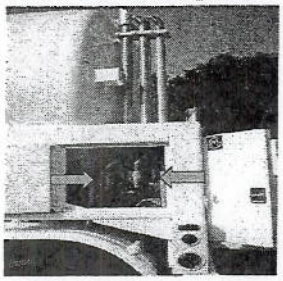
Pressure Reducing Stacks



There are three stacks on an LNG transporter. One "over the road" and two automatic relief devices. Each automatic release has its on release pressure.
"Over the road" valves are used by the driver if he/she determines it is necessary to manually reduce the pressure.

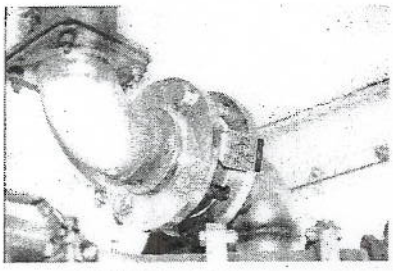
Pressure Reducing Stacks



Relief Stacks:
There are different configurations of relief stacks. Some can be like this, all on the left. Some may be all on the right. Still others might be split on both sides.

This is a newer trailer; both safety relief devices are spring-loaded. The first is set for 70 psi, and the other for 105 psi. Spring-loaded means that when the pressure drops below the set point, the valve SHOULD reseat. (close)

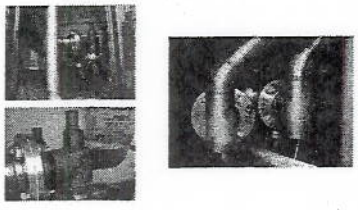
Burst Disc



Burst Disc:

Older trailers also have two safety relief devices. One is a spring-loaded relief valve set at 70 psi. The second is a burst disc (relief vent) set at 105 psi. Every trailer equipped with a burst disc is required to carry a spare. The theory is that if the burst disc ruptures, the extreme cold temperature will cause the load to "self refrigerate" after a short time. This would cause the pressure to drop below the operating pressure, and allow the driver to unbolt the device and replace the disc. The significant difference between a burst disc, and a relief valve is that a burst disc WILL NOT reset itself.

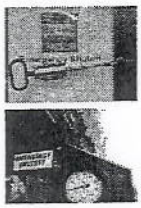
70 PSI and 105 PSI Self Closing Devices



Each stack operates similar to the concept of a pressure relief valve on a fire pump.

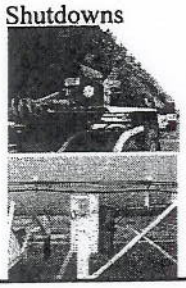
## Emergency Shutdowns

- LNG transporters have emergency shutdowns that can either be cable operated or pneumatically operated.



## Emergency Shutdowns

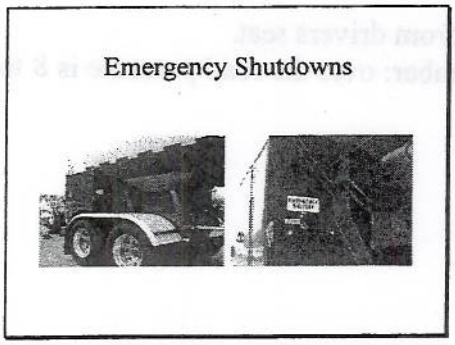
- One emergency shutdown will be on the drivers side of the trailer in the vicinity of the cab or landing gear.



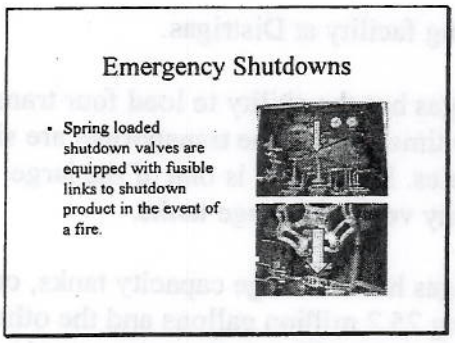
## Emergency Shutdowns

- The secondary shutdown will be located opposite the drivers side in the vicinity of the right rear axle.

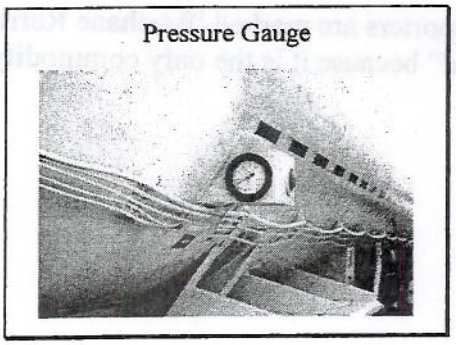
Cable system




Pneumatic system

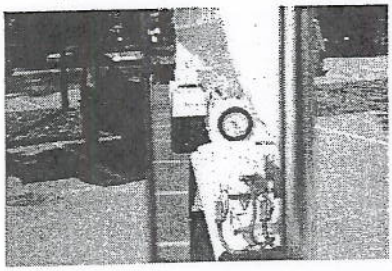



Another component of the emergency shut down system are fusible links holding the springs in position. Melting or breakage of either causes the springs to activate, closing the valves.



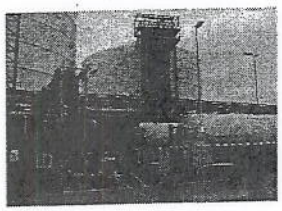

Remote pressure gauge mounted so that it can be seen in driver's rear view mirror.

Pressure Gauge



View from drivers seat.
Remember: over the road pressure is 8 to 10 psi.

Product Filling

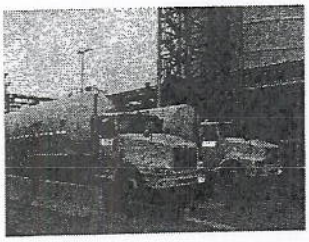


Loading facility at Distrigas.

Distrigas has the ability to load four transports at one time. Again, the transporters are sitting on scales. In the back is one of the large capacity vertical storage tanks.

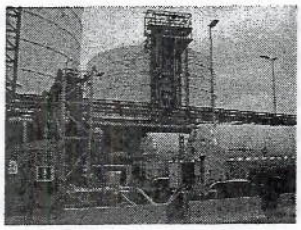
Distrigas has two large capacity tanks, one holding 25.2 million gallons and the other holding 16.8 million gallons for a total on site capacity of 42 million gallons (1 million barrels). These tanks are filled by ships, which come mainly from Trinidad and Tobago.

"Dedicated" Transporters

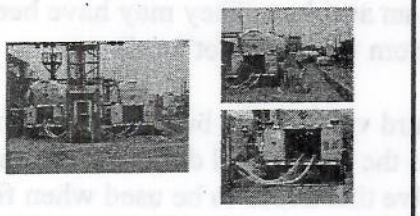


Transporters are marked "Methane Refrigerated Liquid" because it is the only commodity they carry.

Loading Rack

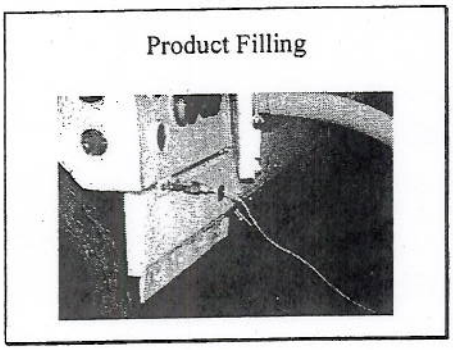


Product Filling



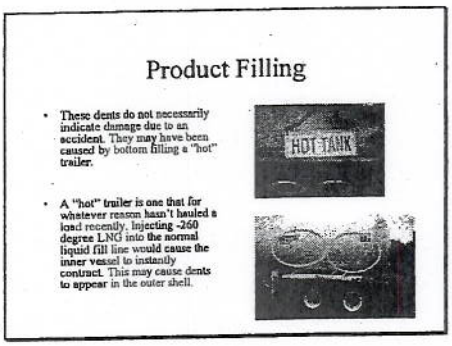
Loading Operations:
Loading and unloading is done by pump off. Here, two trailers are being loaded. The main liquid line and the vapor return line are hooked up. Both trailers are sitting on scales.

As we know, LNG is loaded mostly by weight. In MA, and RI they can be loaded to carry a payload of 43,000 pounds, which is approximately 90%. In fact, at Distrigas they open the 90% tricock when loading. When the valve starts spitting product, they stop filling even if the weight is less than 43,000 pounds. The ability to carry up to 43,000 pounds in MA, and RI is due to the fact that these states issue overweight permits. Other states do not issue overweight permits. Therefore they are only loaded to 80,000 pounds GVW, which equals approximately 38,000 pound of product.



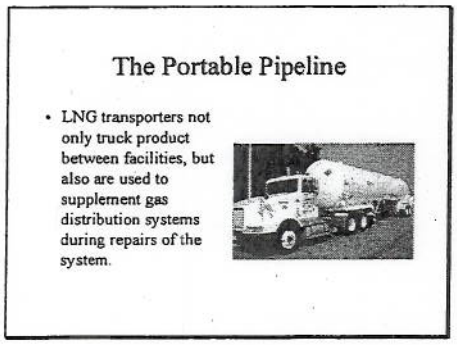

Grounding and Bonding:

All LNG trailers are grounded and/or bonded during loading and unloading. This is to prevent a static electrical charge from developing. Any time that liquid is flowing a static electrical charge can develop. There have been numerous incidents in the past where this static electrical charge has been the cause of fires, when the grounding/bonding step was not completed.

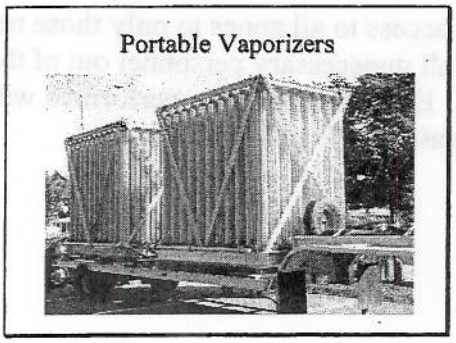



Dents in outer shell:
These dents do not necessarily indicate damage due to an accident. They may have been caused by bottom filling a "hot" trailer.

The third valve in the bucket box furthest to the right is the trailer cool down valve. This is the fill valve that needs to be used when filling a "hot" trailer. A "hot" trailer is one that for whatever reason hasn't hauled a load recently. Because of this the internal temperature has been able to approach ambient temperature. Injecting -260 degree LNG into the normal liquid fill line would cause the inner vessel to instantly contract. This contraction could possibly pull the outer wall in against the stiffening rings between the two shells. This could also cause hairline fractures to form in the outer shell, which could cause the trailer to lose its vacuum. This may also cause dents to appear in the outer shell. To avoid this, trailers that are considered "hot" are tagged, and filled through the cool down valve to start. The cool down valve leads to a pipe that runs across the top of the inner shell. This pipe has numerous holes in it (similar to a deluge sprinkler pipe.) As the liquid flows through these openings, it flows down the sides of the tank, gradually cooling the metal as it fills preventing any contraction of the inner shell.

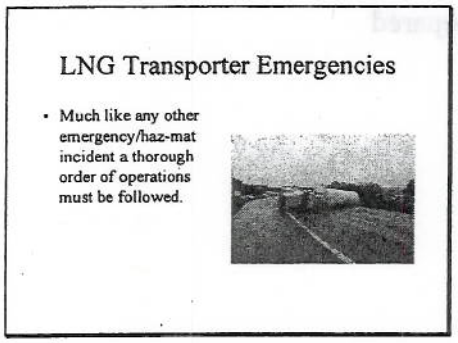



Another example of the growth of the LNG industry is the use of LNG transporters to supplement natural gas distribution systems while parts of the systems are being repaired.




Portable vaporizers:

Portable vaporizers have become an integral part of LNG transport in this area. These vaporizers would be used in connection with LNG transporters. They would be taken to a gate station where a connection to the main is located, and set up. The LNG would be off loaded from the transporter to the vaporizer where it is then converted back to Natural gas. The gas is then odorized prior to being injected into the gas main.




LNG transporter accident is no different from any other haz-mat incident. Follow the logical order of operations and base the tactical decisions on sound facts. The sound facts are based upon knowledge of the commodity and the transporter.

## LNG Transporter Emergencies

- Begin by identifying the commodity and its physical properties
- Detect if any leaks are present
- Ascertain the amount of product on site
- Determine the extent of the damage to the trailer and if it had lost its vacuum.

## LNG Transporter Emergencies

- Establish control zones
- Monitor the situation visually and with the use of a CGI and appropriate PPE.

Limit access to all zones to only those needed. Keep all unnecessary personnel out of the hot zone. Entry shall only be performed with appropriate PPE and for a reason.

## LNG Transporter Emergencies

- Establish water supply and deploy hand lines as needed for current or possible future vapor control issues.

Be prepared

## LNG Transporter Emergencies

In most tank incidents the fire service attempts to apply water to reduce pressure build up within the tank.

DO NOT APPLY WATER TO AN LNG TRANSPORTER UNLESS THERE IS FIRE IMPINGEMENT OR DIRECTED TO BY AN LNG SPECIALIST/TECHNICAL ADVISOR.

Applying water from a fire stream on an LNG tank will actually be heating it up and increasing internal pressure.

## LNG Transporter Emergencies

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.

## LNG Transporter Emergencies

- All agencies must work together under the unified command concept for the successful completion of the incident.

## 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.

## LNG Summary

- Much of the LNG transported by road is done in the Northeast section of the country
- The transportation of LNG in the region is trucked by TransGas located in Lowell, MA and LP Gas located in Chester New York

## LNG Summary

- There are approximately 25 different sites in Massachusetts alone that deal with LNG
- The chances of responding to an LNG incident are not as remote as you would think