LNG SAFETY Q&A REFERENCE

LNG – GENERAL SAFETY

WHAT IS LNG? WHAT ARE THE PHYSICAL PROPERTIES OF LNG?

LNG stands for Liquefied Natural Gas. Natural gas is the same gas used in homes for cooking and heating.

LNG is natural gas that has been changed into a liquid state by cooling it to -162°C (-260°F) through a refrigeration process at liquefaction plants.

Cryogenic liquids have boiling points below -150°C (- 238°F) (Source: Canadian Centre For Occupational Health & Safety, Chemicals & Materials, September 1, 2008 Copyright ©1997-2013 www.ccohs.ca)

LNG is a cryogenic liquid that is odorless by nature, and is clear, non-corrosive and non-toxic. LNG is composed primarily of methane, together with ethane, propane and other heavier hydrocarbons.

When LNG warms, it re-gasifies (transforms back into a gas).

HOW IS LNG FORMED FROM NATURAL GAS? WHAT IS THE LIQUEFACTION PROCESS?

LNG is natural gas that has been liquefied by cooling to -162°C (-260°F) through a refrigeration process at liquefaction plants.

Natural gas is treated and processed to remove unwanted components and contaminants such as water, organic and inorganic materials including hydrogen sulphide and heavy metals. This processing helps to improve the efficient and safe liquefaction of natural gas. Heavier hydrocarbon components such as propane and butane may also be removed.

The liquefaction process shrinks the volume of the gas by 600 times, which increases the energy density of the fuel and makes it easier to store and transport.

IS LNG SAFE?

LNG and natural gas are both hydrocarbons which will burn when exposed to air and ignited by a suitable source of ignition. In this regard, LNG is no different than other common petroleum fuels such as gasoline, kerosene and diesel.

LNG is a cryogen which means it must be distributed and stored in specialized equipment and tanks in order to keep the fuel in a liquid state. This equipment has been developed to high standards and must comply with standards designed by the National Fire Protection Association (NFPA). Requirements include being able to withstand a static force of 8 times the weight of the container plus contents without the loss of contents. Additionally, tanks are drop tested from a minimum height of 30 feet per SAE J2343. (Source: NFPA 52).

Handled properly, LNG can be safely stored, distributed and dispensed throughout transportation supply chains in an efficient manner. Decades of industry experience has demonstrated that, LNG poses no more or no less risk than other transportation fuels being used today. (LNG data source: CH-IV International Document TD-02109, Rev. 12, (published 2002, revised 2012) – “The Safety History of International LNG operations”, compared to DOT data for other transport fuels). LNG has properties that present less risk when compared to other fuel products used in everyday business such as LPG and gasoline.

WHAT HAPPENS IF LNG IS SPILLED?

Due to the fact that LNG is stored and transported in highly engineered systems (designed to maintain the fuels low temperature), an LNG spill is less likely than a spill of traditional petroleum fuels that are transported at ambient temperatures. In the unlikely event of an LNG spill, LNG will quickly vaporize and return to the gaseous state of natural gas – in other words LNG will evaporate and disperse to the atmosphere. It should be noted that LNG is not considered to be ecotoxic or environmentally harmful to the ground or water.

If spilled, LNG forms a visible white cloud as a result of condensation of water in the air. When LNG comes into contact with some solid surfaces, small amounts of ice may form. Initially, the cold vapors will stay at ground level near the release point. But as the vapors warm, they will disperse quickly. The risks associated with formation of a vapor cloud are described below. [See question: What are the risks associated with LNG vapor?]

In the unlikely scenario of a spill, the environmental impact is expected to be minimal because the LNG will completely evaporate with no residue on soil or water. However, freezing and embrittlement of the ground, organic tissue or other surfaces could occur in the event of contact with the cryogenic liquid. (Source: US Environmental Protection Agency – EPA, and The International Group of Liquefied Natural Gas Importers – GIIGNL)

WHAT ARE THE RISKS ASSOCIATED WITH LNG VAPOR?

When LNG comes in contact with air, it begins to vaporize, returning to its natural gaseous state – natural gas. In the unlikely event of any inadvertent leak, there are three main risks:

- Because LNG is a cryogen, there is a risk of cold burns if it is in contact with skin. In order to prevent the risk of cold burns, Personal Protective Equipment (PPE) should be worn by personnel conducting transfer activities (i.e., filling an LNG fueled truck). [See question: When working around LNG, should special clothing or other PPE need to be worn?]
- An LNG vapor cloud can be hazardous if allowed to collect in a confined space. Because LNG can replace oxygen in a confined space, there is a potential of asphyxiation. In the design of facilities that handle LNG, great care is taken to minimize congestion and confined spaces where LNG vapors could accumulate.
- While in liquid state, LNG is highly unlikely to ignite as there is limited presence of air which is an essential ingredient for combustion. However, LNG vapors are flammable and appropriate risk mitigation measures should be taken to avoid dangerous situations. [See question: Can LNG ignite?]

IS LNG POISONOUS OR TOXIC?

Because LNG is composed primarily of methane (known to be relatively inert), it is largely unreactive chemically. This means that LNG is non-toxic. (Sources: GIIGNL Information paper No. 1 – Basic Properties of LNG)

DOES LNG SMELL?

No, LNG is odorless, which is in contrast to natural gas commonly found in domestic applications such as heating and cooking. Odorants are added to natural gas used in domestic applications in order to help detect leaks and reduce the potential of asphyxiation. In LNG applications, methane detectors are used in place of odorants.

CAN LNG IGNITE? CAN LNG CATCH FIRE?

LNG is a fuel and like other fuels, will ignite when in the presence of the correct amount of air and exposed to an ignition source. While it is a liquid, LNG does not burn easily due to the low level of air. LNG vapors are flammable within a certain concentration range. This is called the "flammable range"; the limits are commonly called the "Lower Flammable Limit" (LFL) and the "Upper Flammable Limit" (UFL). For natural gas (methane) the range is 5-15%. This means that LNG will likely only ignite when the vapor concentration is between 5-15%; vapor concentrations outside this range contain either insufficient fuel or oxygen to ignite.

Several conditions must be present in order for an LNG release to result in a fire: 1) a spill/release must have occurred, resulting in the presence of LNG vapors (natural gas); 2) the concentration of natural gas in air must be between 5-15% volume; and 3) the air/vapor mixture must come into contact with an ignition source (for instance, a spark).

The fire hazards from LNG are broadly similar to other hydrocarbons such as gasoline, although gasoline is considered more flammable.

CAN LNG EXPLODE?

No, in its liquid state, LNG is not explosive. When LNG is heated and becomes a gas, the gas is not explosive if it is unconfined. Natural gas is only flammable within a narrow range of concentrations in the air (5%-to-15%). Less air does not contain enough oxygen to sustain a flame, while more air dilutes the gas too much for it to ignite. (Source: Federal Energy Regulatory Commission (FERC).

Furthermore, recent LNG hazard studies have discounted Boiling Liquid Expanding Vapor Explosion (BLEVE) hazards associated with LNG vessels. This is because LNG vessels have differently designed tanks than those used for gasoline and LPG, and it has been demonstrated that the combination of physical barriers makes direct thermal input to the LNG inner tank more limited. In the event that direct thermal input does reach the LNG inner tank of an LNG vessel, it is unlikely these tanks would rise to a pressure sufficient to cause a large flash of liquid and consequent BLEVE event. (Source 1: Sandia National Lab, LNG Safety Research Report to Congress, May 2012, Source 2: Robin Pitbalbo, DNV, "Potential for BLEVE associated with marine facilities", Journal of Hazardous Materials, Volume 140, Issue 3, 2007)

WHAT HAPPENS WHEN LNG FUEL COMES IN CONTACT WITH WATER?

LNG has a lower density than water. Therefore, if it comes in contact with water, LNG will float on top of it and vaporize quickly.

If enough LNG is spilled on water at a very fast rate, it is possible for a Rapid Phase Transition (RPT) to occur. A RPT is a phenomenon observed when two liquids of very different temperatures come into contact. LNG spilled onto water and undergoing a series of RPTs can create localized overpressures that look, sound, and behave like a small explosions. Where the explosive pressure is confined or where it is near structural elements, severe structural damage can occur.

Studies show that only a few events cause significant mixing. Those events that create the most mixing, and therefore the greatest likelihood of RPTs, occur relatively far away from an LNG vessel's outer hull. Therefore, the direct or additional damage of an RPT or a series of RPTs on the LNG vessel's outer hull is possible, but would likely cause minimal additional damage to the vessel. Source: Liquefied gas carrier.com; the California Energy Commission; US Department of Energy (DOE) LNG Safety Research, Report to Congress May 2012.

Spill rate, spill duration, and the spill surface conditions influence the RPT process. Higher spill rates and longer spill durations are more likely to produce rapid phase transitions. RPT is more likely with large volumes (e.g. Very Large Gas Carriers (VLGC)) in large bodies of water (e.g. harbors, great lakes, oceans/seas). Small volume releases from a road transport into a smaller body of water such as ponds, streams, rivers, creeks, etc will not incur a RPT. (Source 1: V. T. Nguyen, "Rapid Phase Transformations:

Analysis of the large scale field trials at Lorient", Shell Research Limited, External Report TNER.86.058, February 1987. Source 2: ABS Consulting report for FERC, "Consequence Assessment Methods for Incidents Involving Releases from Liquefied Natural Gas Carriers", FERC04C40196, May, 2004)

WHEN WORKING AROUND LNG, WILL ANY SPECIAL CLOTHING OR OTHER PPE NEED TO BE WORN? WILL LNG FUEL CONTACT WITH SKIN CAUSE DAMAGE?

As previously stated, LNG is a cryogenic liquid which can cause cold burns if in contact with skin.

Personal Protective Equipment (PPE) designed for protection against cryogenic liquids must be worn at all times when working with LNG. Some of the PPE required for various LNG operations/activities includes gloves, face shield, leather boots, and clothing that will provide protection against cryogenic temperatures.

IF THERE IS AN LNG VAPOR CLOUD FORMATION DURING AN INCIDENT, COULD THIS LEAD TO LARGE SCALE HARM TO THE ENVIRONMENT OR SURROUNDING COMMUNITY?

If there is a small leak during an incident, or the pressure relief devices/valves open and gas is released to the atmosphere, the released natural gas is unlikely to ignite. The LNG vapor will disperse and have no long-term impacts on the community. If the leak is large, there is a greater risk that the vapor cloud could ignite, resulting in a fire.

LNG vapor can be considered a greenhouse gas, but that is the only expected environmental impact. Natural gas is not toxic, non-corrosive and non-reactive, and it will disperse into the atmosphere as it warms.

LNG SUPPLY

WHERE AND HOW IS LNG STORED AFTER PRODUCTION?

LNG is often produced at large liquefaction plants with a capacity of 5 - 20 mtpa (million tonnes per annum). There are also smaller liquefaction plants which may be supplied by pipeline gas, or peak-shaving plants. Peak-shaving plants liquefy and store LNG when gas demand is low, and make it available when demand is high.

In large LNG production plants, LNG is stored at or near atmospheric pressure, usually in insulated, double-walled tanks ranging in size from 26 to 66 million gallons. The majority of LNG storage tanks built in the last 10 years worldwide have been designed as full containment tanks. In this type of tank, in case of leakage of the primary barrier, the secondary container is liquid and vapor tight. (Source: GIIGNL Information Paper No. 5 – Managing LNG Risks – Containment)

Once the LNG is distributed to smaller depots or fuel stations, LNG is kept pressurized in specially designed tanks. These tanks are double-walled and vacuum insulated, in either vertical or horizontal position.

WHAT ARE THE RISKS ASSOCIATED WITH THE TRANSFER OF LNG FROM LNG STORAGE FACILITIES (SUPPLY) TO LNG ROAD TRANSPORT TANK TRUCKS/TRAILERS?

If managed properly, LNG does not pose greater risks than other fuels that are loaded and transported every day. Spillage of LNG is the primary risk associated with the transfer (also called loading/unloading) of LNG into road transport tank trucks/trailers (this includes both tanker trucks and tank trailers), the first being LNG spills or leaks.

The likelihood of spillage or leaks at the connection to the truck is reduced by the many safety features of the system's design. For example, there are safety devices (e.g., sensors and alarms) to prevent over-filling and over-pressurization of the tanker truck, and to prevent the LNG road transport tank truck/trailers from driving away while still connected to the loading facility. There is an emergency shutdown system that would immediately stop the flow of LNG and minimize the size of the leak, should a leak occur. Some

operations use dry break couplings, such that if a hose were inadvertently disconnected, valves on either end of the connection automatically close, stopping the LNG from spilling. Furthermore, should a vapor cloud form, the likelihood of it catching fire is reduced by minimizing the presence of ignition sources in the vicinity (i.e., the prohibition of smoking and use of mobile phones, the application of special non-sparking equipment and the installation of "explosion-proof" electrical systems).

Another risk during transfer of LNG is cold burn. This can be minimized by the use of the proper PPE which was previously covered in this document.

HOW IS LNG TRANSFERRED FROM THE STORAGE TERMINAL INTO THE LNG ROAD TRANSPORT TANK TRUCKS/TRAILERS?

LNG road transport tanks trucks/trailers (this includes both tanker trucks and tank trailers) are generally filled at an LNG terminal. LNG can be transferred to the trailer or tanker truck from a storage vessel/terminal using two methods: by differential pressure (receiving trailer has lower pressure than storage vessel) or by means of a transfer pump. Generally, flexible stainless steel hoses are used; however, in some cases, hard piped arms with swivel connections or hoses made of multi-layer composite material are used. Additionally, many terminals provide controlled access or fleet/card lock to help ensure that the personnel performing the transfer operation are properly trained on safe practices.

TRANSPORT

HOW DOES LNG COMPARE IN TERMS OF ROAD TRANSPORT SAFETY HAZARDS WHEN CONSIDERED AGAINST OTHER FUELS?

All fuels should be considered as hazardous because they can burn; however, each type of fuel has characteristics that are different and need to be managed in order to allow for the fuel to be transported safely. For example, both gasoline and LNG vapors are flammable. However, if no ignition source is present, spilled gasoline will pool at ground level and require cleanup, whereas spilled LNG will warm, forming a vapor cloud (to a volume of up to 600 times the volume of LNG released), before rising and dissipating into the atmosphere. LNG will completely evaporate with no residue on soil or water, and no cleanup required.

As with other product transport vessels, such as those for gasoline or diesel, LNG road transport tank trailers can carry up to 13,000 gallons of fuel. LNG road transport tank truck/trailers are double-walled, with a combined vacuum and insulation system that helps to keep the cryogenic liquid cool. The inner tank can be made of either stainless steel or aluminum, and the outer jacket is generally made of carbon steel. These features make the storage vessel extremely resistant to physical damage and to the risk of external fire. These types of tank trucks/trailers are mandatory for the on-road transportation of LNG in the US, and are also common in Europe and Asia (Source: GIIGNL Information Paper No. 1 — Basic Properties of LNG).

WHAT ARE THE RISKS ASSOCIATED WITH THE FAILURE OF THE LNG STORAGE TANK ON THE LNG ROAD TRANSPORT TANK TRUCK/TRAILER? WHAT ARE THE SAFETY FEATURES OF LNG ROAD TRANSPORT TANK TRUCKS /TRAILER?

LNG road transport tank truck/trailers have an excellent safety record. [See: What types of vehicle accidents involving LNG road transport tank truck/trailers are on record?] In fact, the robust, double-walled, insulated construction of the LNG trucks'/trailers' storage tanks make an LNG leak extremely unlikely. The use of appropriate materials is key to ensure that the tanks can both withstand very low temperatures in order to avoid brittle fracture, and are strong enough to stay intact during a crash of the vehicle. In addition, the storage tank materials are designed such that corrosion should not occur.

LNG road transport tank truck/trailers are designed with similar technology that has been used to transport other cryogenic materials, such as liquid oxygen, nitrogen or hydrogen, so the design has already been

extensively used in industry. To remain a liquid, LNG must be kept in tanks that function like thermos bottles – they keep the cold in and the heat out (Source: GIIGNL Information Paper No. 1 — Basic Properties of LNG). The LNG storage tanks are double-walled and vacuum insulated. The inner tank can be made of either stainless steel or aluminum and the outer jacket is generally made of carbon steel. These features make the tank extremely resistant to physical damage and to the risk of external fire.

Another important aspect of the LNG road transport tank truck/trailers' design is pressure management. For safety purposes, the LNG transport tank truck/trailers are equipped with pressure relief devices/valves to prevent damage to the tank due to over pressurization. If the pressure in the vessel becomes high (for example: if the outer jacket is punctured due to a crash, which results in the failure of the vacuum insulation; or there is a fire underneath the truck; or from the naturally occurring heat transfer that is generated during the evaporation of the LNG), a primary Pressure Relief Device (PRD), or relief valve, will automatically open and safely release gas through an outlet pipe to the atmosphere, maintaining the pressure at a safe level. The trailers are also equipped with a redundant secondary PRD to release the pressure in the event that the primary relief valve fails.

The road transport truck/trailers have an Emergency Shutdown System (ESD) which, when activated, will close the main liquid supply valve and will stop the transfer pump (if present). The ESD systems of the truck and station are connected during LNG transfer/delivery and can be activated either by the driver of the truck, by a person at the filling station, or automatically, if a leak is detected by the system.

US (and Canadian) tank construction standards require vacuum-insulated double wall tanks with insulation which will stay in place in the event of a fire, as the combination of physical barriers makes direct thermal input to the LNG inner tank more limited. Vacuum-insulated double wall tankers are safer than single wall construction.

LNG transport tankers consist of two nested tanks that form an insulated vessel. This double layering of tanks and structural supports make the entire tank extremely robust to physical damage and the effects of external fires.

The tanks are tested to function safely at much higher pressures than the relatively low pressure level they normally operate at, and make use of multiple backup levels of pressure release devices.

WHAT CODES AND STANDARDS ARE FOLLOWED FOR LNG ROAD TRANSPORT TANK TRUCKS/TRAILERS?

LNG trailers built in the US comply with the Department of Transportation's design standards DOT CFR49 specifications– 49 CFR parts 173.318 and 178.338 (MC-338). This standard is used for trailers carrying cryogenic liquids, such as LNG, liquid nitrogen and liquid oxygen, from manufacturers who specialize in supplying such equipment. In 2010, the National Fire Protection Association (NFPA) updated NFPA 52 Vehicular Gaseous Fuel Systems Code to include detailed sections on LNG vehicles, fuelling stations and fire protection. US standards on LNG are considered a benchmark, and similar standards are also followed by other countries such as Australia and Canada. In Europe, LNG delivery tanker trucks are regulated by the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). ADR sets out the requirements for the classification, packaging, labeling and certification of dangerous goods. It also includes specific vehicle and tank requirements and other operational requirements. For example, all drivers of vehicles carrying dangerous goods (including those with a gross vehicle weight of 3.5 tonnes or less) must have an ADR training certificate.

WHAT HAPPENS IF THE TRUCK BREAKS DOWN OR ITS JOURNEY IS INTERRUPTED OR DELAYED? COULD BOIL-OFF CAUSE A PROBLEM? HOW WOULD IT BE CONTROLLED?

To remain a liquid, LNG must be kept in containers which function like thermos bottles – they keep the cold in and the heat out. Heat transfer occurs naturally over time, which results in the increase in temperature and pressure of the stored LNG, as some of the LNG vaporizes. As a safety measure, Pressure Release Devices (PRDs) are in place to ensure that the increase in pressure does not result in rupture of the tank, or a leak from any component. Should the pressure exceed a defined level, a PRD will open and release

gas through an outlet pipe to the atmosphere. Once the tank pressure has dropped back to normal operating pressure, the PRD will reset. However, due to the robust tank design (double walls and vacuum insulated) and the extremely low temperature of the LNG, it is possible for the tanks to remain at a safe pressure for many days, or even weeks, without a need for the PRD to open.

WHAT IS THE EMERGENCY RESPONSE PROCEDURE FOR A VEHICLE ACCIDENT INVOLVING A LNG ROAD TRANSPORT TANK TRUCK/TRAILER OR AN UNCONTROLLED LEAK OF LNG FROM THE VEHICLE TANK?

In the event of a vehicle accident, local emergency services and emergency response authorities should be notified. However, due to the nature of a cryogenic tank, it is unlikely that a vehicle accident would compromise an LNG storage tank. LNG storage tanks are double-walled, making it more robust against leakage due to a vehicle accident.

When cold, the LNG vapors are heavier than air and will initially stay at ground level near the release point. However, as the gas quickly warms up, it becomes lighter than air (around -150F) and will rise and dissipate into the atmosphere.

Only during extreme or severe failure of an LNG tank (where both walls of the tank are punctured) would the liquid contents leak out onto the road. As a safety precaution, the area should be cordoned off to reduce the risk of any ignition sources. The liquid natural gas pool will then vaporize, and dissipate into the atmosphere. If the accident results in a pool fire, the fire would be controlled by applying foam to reduce the gas/air interface, thus reducing the extent of the fire and allowing the LNG to vaporize slowly and burn off.

ARE EMERGENCY SERVICES TRAINED TO RESPOND TO INCIDENTS INVOLVING LNG ROAD TRANSPORT TANK TRUCK/TRAILER? ARE THERE ANY DETAILS THAT CAN BE SHARED ON THIS TRAINING?

Some municipal emergency services are trained in handling cryogenic liquids such as LNG. Emergency services are generally well-equipped to deal with hazardous material (HAZMAT) emergencies, LNG being only one type of HAZMAT situation. LNG training for first and emergency responders is available through a variety of sources including industry experts, utilities and some universities. This training is also recommended for drivers, dispatchers, and other front line employees.

RETAIL FUEL STATIONS

HOW SAFE IS AN LNG RETAIL SITE?

There are many safety features built into the design of an LNG retail site to prevent incidents. There are also measures in place to minimize impacts in the unlikely event of an incident.

As a precaution, sophisticated detectors and alarms are used to monitor LNG levels and vapor pressures inside the storage tanks, and to detect the presence of gas in the air. If a leak or an unusual situation is detected, alarms will sound and any fueling operation will automatically be stopped. Some operations use a dry-break system at LNG dispensing points, which provides valves on each end that close automatically if disconnected, preventing release. Fire eyes may be installed that pick up a flame signature which in turn shuts down the operation of the station.

In addition to these safety measures, if a spill were to still occur at a retail station, the chance of the vapor cloud being ignited is reduced by minimizing the presence of ignition sources in the vicinity (i.e., the prohibition of smoking and use of mobile phones, the application of special non-sparking equipment and the installation of “explosion-proof” electrical systems).

WILL LNG BE STORED IN UNDERGROUND OR ABOVE-GROUND STORAGE TANKS?

LNG will be stored in double-walled, insulated, above-ground or underground storage tanks.

HOW IS LNG TRANSFERRED FROM THE ROAD TRANSPORT TANK TRUCK/TRAILER TO THE RETAIL STORAGE TANK?

LNG can be transferred from the road transport tank truck/trailer to a storage vessel using two methods: by differential pressure (receiving vessel has lower pressure than trailer) or by means of a transfer pump. Generally, flexible stainless steel hoses are used; however, in some cases, hard piped arms with swivel connections or hoses made of multi-layer composite material are used.

ARE THE RISKS THE SAME AS WHEN LNG IS TRANSFERRED FROM THE SUPPLY STORAGE TANK TO THE DELIVERY TANKER TRUCK? ARE THERE ANY ADDITIONAL OR DIFFERENT SAFETY CHALLENGES?

In principle, the risks are the same, since the transfer mechanism and flow rates are similar. The safety provisions for transfer operations to an LNG storage tank in a fuel station are similar to those from a larger storage facility. The main difference is the proximity to the public. LNG fuelling stations are generally located close to public roads and buildings and allow public access to their site. To minimize the risk to the public, storage tanks have a clearance area around them (i.e., set back distance from other buildings/activities) and public access is restricted during certain LNG operations (i.e., transfer operations).

HOW ROBUST ARE THE STORAGE TANKS? WHAT ARE THEY MADE OF?

The storage tanks are very robust and are made of similar construction to those used in large storage facilities and truck trailers. [See question on: What are the risks associated with the failure of the LNG storage tank on the LNG delivery tanker truck? or Where and how is LNG stored after production?]

OTHER OPERATIONS

WHAT MEASURES SHOULD BE TAKEN TO REDUCE THE LIKELIHOOD OF A SPILL OR FIRE FROM LNG?

In all normal circumstances, LNG warms and begins to boil (and vaporize) as soon as it is released outside its storage container. Therefore, LNG facilities and equipment are designed to assure containment of the LNG and its vapors.

With safe design and operation, the risks associated with LNG can be managed. For example, some operations use a dry-break system at LNG dispensing points, which provides valves on each end that close automatically if disconnected, preventing a means for release. Furthermore, during loading or unloading operations, in the unlikely case that LNG is spilled, the volume spilled can be reduced by the automatic system that stops the flow of LNG when a gas detector senses gas is present in the air, or one of the pressure sensors on the truck detects a lower pressure as would occur during a leak.

In addition to these preventative safety measures, if a spill does occur at a facility, such as a retail station, the likelihood of the gas cloud being ignited is reduced by minimizing the presence of ignition sources in the vicinity (i.e., the prohibition of smoking and use of mobile phones, the application of special non-sparking equipment and the installation of “explosion-proof” electrical systems).

WHAT ARE THE SAFETY PRECAUTIONS THAT SHOULD BE MANAGED BY COMPANIES HANDLING LNG?

Safety should always be the top priority. Process safety means making sure facilities, tanker trucks and marine vessels, are well designed, safely operated, and properly inspected and maintained. The goal is to “keep it in the pipes” – that is, as long as LNG is contained within a closed system (piping, vessels, pumps, etc.), LNG is a safe commodity that can be used in everyday life. It is when LNG is released from that closed system that it may be exposed to means of ignition. As such, equipment and system designs should be rigorously inspected for points where LNG could be released and designs should include at least two or more barriers to address such scenarios.

The following safety standards are recommended as minimal standards for companies handling LNG.

DOT CFR 49 173.318 and 178.338;
NFPA 52 - 2013 Vehicular Gaseous Fuel Systems Code;
NFPA 59A - 2013 – Standard for the Production, Storage, and Handling of LNG;
NFPA 30 - 2012 Flammable and Combustible Liquids Code.

LNG FUELED VEHICLE OPERATION

WHAT SAFETY PRECAUTIONS NEED TO BE FOLLOWED WHEN PERFORMING MAINTENANCE ON LNG FUELED VEHICLES?

When a natural gas vehicle is serviced, it is important to follow manufacturers’ recommendations for repair to ensure fuel is removed when performing specific repairs. Generally, an expert in LNG truck mechanics will be required to carry out most work on vehicles. Due to the possibility of natural gas being released through the pressure relief devices/valves, LNG vehicles should always remain outdoors or may be serviced inside a workshop only if it has been outfitted for natural gas servicing as per NFPA 30A. Appropriate Personal Protective Equipment (PPE) is always required when working on trucks with LNG fuel systems.

HOW ARE THE FUEL TANKS FOR LNG FUELED VEHICLES CONSTRUCTED?

LNG fuel tanks for vehicles are very robust compared to tanks used for traditional petroleum fuels. They utilize a vacuum-insulated, double wall construction with insulation between the two walls. The tanks can be designed and certified to a number of standards including DOT-4L, ASME Section 8 Div 1, NFPA 52 and SAE J2343. The robust design provides additional protection in the event of a traffic accident to withstand ruptures or punctures. Additionally, the automatic release valves built into the tank will open and release gas in the event of excessive heat or pressure build up.

AT EACH STAGE OF THIS VALUE CHAIN, WHO IS RESPONSIBLE FOR MANAGING THE RESPONSE TO AN INCIDENT?

Industry standard is to follow the US National Fire Protection Association Standard NFPA 52 for the installation of gaseous fuel systems on a motor vehicle. NFPA 52 is designed to mitigate or eliminate the hazards that could exist for natural gas vehicles. NFPA is an authoritative source utilized by fire safety professionals, who are responsible for responder training in various aspects of motor vehicle and gaseous fuel incidents.

Individuals involved in transporting LNG or driving LNG fueled vehicles, should be trained and familiar with the various gaseous fuel components on the vehicle, as well as how to respond in the event of an incident. The operator is responsible for the safe operation and maintenance of the vehicle. In the event of an incident, the operator has a quick reference guideline in the operator manual with recommended actions to assist in managing the incident. The local emergency or fire authority should be contacted by the operator or a bystander if necessary, and operators should respond in accordance to their training to manage the LNG risks.