



GIIGNL - THE INTERNATIONAL GROUP
OF LIQUEFIED NATURAL GAS IMPORTERS

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GIIGNL - Technical Study Group

Safety Measures for Truck Loading, Unloading and Road Transport of Liquefied Natural Gas (LNG)



Content Disclaimer

The purpose of this document is to propose a set of safety recommendations related to loading / unloading and transport of LNG by road tankers, subject to the consideration of International Group of Liquefied Natural Gas Importers (GIIGNL) members. These recommendations shall not be considered a standard nor a specification and should only be viewed as a summary of the best practices used within the industry. No specific procedure, nor particular manufacturer of equipment, is recommended or implied suitable for any specific purpose in this document. Readers should ensure that they are in possession of the latest information, standards and specifications for any procedures and equipment they intend to employ. Although GIIGNL has attempted to use the most up to date and accurate information available, GIIGNL shall not be held responsible for the adequacy, accuracy, completeness, or correctness of such information. GIIGNL including its members, disclaim any direct or indirect liability as to the information contained in this document for any industrial, commercial, or other use whatsoever.



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Truck loading at Montoir-de-Bretagne LNG terminal - Credit: Elengy/Cyrille_Dupont



1. Introduction

1.1. Background

To meet the growing demand of the liquefied natural gas (LNG) and gas market, an increasing number of LNG importation terminals offer truck loading services to deliver LNG to remote areas via road tankers. Many countries have decided to implement these services as a cost-effective solution to supply customers who want to access natural gas supplies, but for whom connecting to the gas grid is not economically feasible, or who cannot wait until adequate pipeline infrastructure is developed. For industrial sites located far from the transportation or distribution networks and for the mobility market, LNG as a fuel has become a viable alternative to conventional fuels due to the reduced CO₂ emissions, particles and pollutant gases (NO_x and SO_x). LNG is also transported via road tankers to supply small power plants or for peak shaving needs. Hence, distribution of LNG via road tankers is set to continue to increase globally as a workable solution to deliver energy to remote areas as well as a means of encouraging the development of new markets.

The growing number of loading and unloading locations as well as the number of tankers on the roads increases the probability for an incident to occur. Most of the latest incidents that have occurred have fortunately had no, or very limited human and material consequences. However, a few of these near misses had the potential to cause catastrophic losses.

The key learnings from industry related incidents have been observed to be:

- Raising awareness of the hazards LNG poses to operational personnel, Emergency Response Services (e.g., firefighters) and the wider community as a whole.
- Preparing appropriate emergency response plans that are frequently exercised.
- Following appropriate operating procedures.
- Using personal protective equipment (PPE) that is appropriate for the hazards.
- Installing safety barriers that provide plant and personnel segregation on fixed and mobile facilities.

1.2. Purpose and scope of the document

The purpose of this document is to provide a panel of measures for consideration that operators undertaking LNG loading / unloading operations and transportation, can look to implement where possible.

These measures are based on operational experience and the lessons learnt from previous incidents that occurred within the industry.

2. Principal Recommendations

Principle recommendations related to the design, construction and operation of the LNG road tanker loading / unloading facilities should be applied. Some of the key recommendations are as follows.

- Application of the regulations, in particular:



- Traffic laws, such as the total weight allowed, speed limits, mandatory breaktime for personnel and other road safety guidelines.
 - The ADR agreement¹ or equivalent depending on the region.
 - The Standards and Codes / Permits requirements related to the design, construction and operation of the road tankers and LNG facilities.
- Application of policies and procedures related to LNG road tanker loading / unloading facilities.
 - Appropriate operations, maintenance and inspection of the facilities and equipment.

3. Specific Measures

What follows is a set of specific measures that have the aim of informing operational personnel as to good practices for LNG road tanker operations. The following measures are divided into five categories:

1. Technical measures for LNG road tanker design,
2. Technical measures for the design of loading / unloading facilities,
3. General organisational measures,
4. Measures specific to handling operations (loading or unloading),
5. Feedback from experience.

1. Technical measures for LNG road tanker design	
Measures	Main Objective / Risk Addressed
Use of a double-walled vacuum-insulated tankers (when not mandatory).	Enhanced structural integrity and hence a lower likelihood of a breach of containment following an external impact. Improved insulation, thus reducing heat flow into the stored LNG within the tanker.
Equipping the road tanker with an emergency shutdown (ESD) system that closes isolation valves and shuts down the LNG transfer pump(s) (when applicable).	The operator can initiate an ESD of the road tanker loading / unloading operation during an emergency event, thus minimizing the risk of escalation of the incident.
Coupling of the road tankers ESD system to the sites air supply.	Enabling the road tanker to connect to the sites instrumentation air system for enhanced ESD response.

¹ European Agreement concerning the International Carriage of Dangerous Goods by Road / Accord européen relatif au transport international des marchandises dangereuses par route.



Use of isolation valves for liquid and gas lines on the road tanker which are controlled by fail-safe actuators and an excess flow valve (EFV) on the liquid line.	Reducing the likelihood of failure for the critical safety valves due to loss of the actuator drive source. Upon loading line failure, the EFVs will automatically close, minimizing the loss of containment.
Use of an inhibit system which maintains the closure of the product transfer lines when the road tanker brakes are not applied. Additionally, a safety system could be used to keep the brakes applied when the truck cabin is open.	Reducing the likelihood of a rollaway event and hence preventing loss of containment due to failure of a transfer line during if the road tanker moves off stand.
Equipping the road tanker transfer control system with a "deadman button".	The operator must be present during the transfer process and press the deadman button at regular intervals. Without responding in time, the LNG transfer will cease. When not undertaking tasks, the operator should stay outside the hazardous area.
Installing temperature sensors on the cold vent line of the road tanker, which can activate an alarm to the operators.	This feature notifies and hence minimises the accidental discharge of LNG through the cold vent line.
Establishing an identification system for the road tankers and the drivers which have been authorised to enter the site (for example based on a radio frequency identification (RFID) tag).	Only registered road tankers and associated drivers can access the loading / unloading site. The characteristics of the road tankers, in particular the maximum transportable quantity, should be registered in a database.

2. Technical measures for the design of loading / unloading facilities

Measures	Main Objective / Risk Addressed
Installing entry / exit roadway barriers and vehicle impact protection around plant and equipment.	Controlling the vehicle movements and reducing the risk of damage to the plant from vehicle impacts.
Installing gas, flame and cold detectors on the truck loading / unloading bays which have an executive ESD action. Best practice would be to install an array of detectors which have ESD activation based on a voting system.	Automatic activation of the ESD system which ceases the LNG and vapour transfer operations and closes the isolation valves.



<p>Providing clearly marked and suitable quantities of dry chemical powder extinguishers available throughout the facilities.</p>	<p>Providing appropriate mobile firefighting equipment will enable a plausible emergency response in the first instance to a fire event.</p>
<p>Installing low temperature sensors on the vapour transfer lines.</p>	<p>This recommendation is for the benefit of detecting the flow of LNG to the vapour transfer lines (i.e., for example due to incorrect line out to the road tanker).</p>
<p>Installing a vehicle / site control system link which enables the activation of the tanker ESD from the site control system (i.e., bi-directional ESD system activated either from the road tanker through the ESD pushbuttons or the site, for example during gas detection).</p> <p>The instrumented loop should be fast acting from detection to final element actuation.</p>	<p>Automatic shutdown of the loading / unloading operation in case of fire, gas or leak detection at the station. The remote activation feature is beneficial as the operator may not be able to access the local (tanker) ESD activation buttons during an emergency event.</p>
<p>Installing a break-away coupling on the LNG transfer lines, which automatically and without delay closes internal isolation valves in case of tension on the transfer line (hose).</p> <p><u>Nota:</u> Mainly useful when the cabinet is not equipped with a safety system which keeps the brakes applied when it is open.</p>	<p>Reducing the likelihood of a breach of containment due to the road tanker moving away from the stand whilst the transfer process is occurring.</p>
<p>Equipping each loading bay with a weight bridge and / or a flow rate meter that is linked to the tanker filling controller which programmed with the fill quantity of the tankers.</p>	<p>The use of an automated filling system combined with a manual check (which is not necessarily reliable) adds an additional layer of protection against overfilling of the road tankers.</p>
<p>Defining and maintaining hazardous area classifications which are also marked within the plant area.</p>	<p>Ensuring electrical equipment and other operational activities are appropriately controlled as per the hazardous area classification.</p>
<p>The road tanker loading / unloading bay should incorporate the use of an impounding basin for channelling LNG spills away from the plant. The impounding basin should be designed to accommodate the full volume of a road tanker. The impounding basin should be covered with low thermal conductivity concrete and foam</p>	<p>The impounding basin is a means of channelling LNG leaks to a safe location that is away from the plant. The impounding basin will then allow for the controlled vaporisation of the LNG. Preventing the build-up of LNG spills underneath road tankers reduces the risk of boiling liquid expanding vapour explosions (BLEVE) and other hazardous pool fire events.</p>



<p>glass blocks can also be installed at the bottom of the basin.</p> <p>Gas detectors can also be installed at the impounding basin to provide either a notification to the operators or an automatic activation of the firefighting systems (dry chemical powder and foam systems).</p>	<p>The installation of gas detectors with an associated alarm provides a warning system that an LNG leak has occurred.</p>
<p>Additionally, having the drainage sump of the impounding basin equipped with a rainwater pump, which should shutdown upon the detection of LNG (via gas detection or low temperature detection or other type of device).</p>	<p>It is important that the drainage basins are maintained free from standing water to ensure the catchment volume is kept available.</p>

3. General organisational measures	
Measures	Main Objective / Risk Addressed
<p>Develop emergency plans for the loading / unloading site. The muster points should take into account the different incident scenarios that are likely to occur.</p>	<p>To provide clear emergency instructions that explain the steps to be taken during an emergency event, with focus on protecting personnel and minimising impact on plant and equipment.</p>
<p>Regular training of operators who engage in the loading / unloading activities. Focus should be applied to the hazards associated with LNG and gas and the control measures required to be implemented.</p>	<p>The on-going training raises and maintains awareness of operators and develops a safety culture within the organisation to continually strive to improve safety performance.</p>
<p>It is recommended that road tanker drivers are requested to demonstrate that they have undergone initial training and are taking refresher courses specific to the handling of LNG. The training should address the following topics:</p> <ul style="list-style-type: none"> • Properties of LNG and gas and the associated hazards • Loading / unloading procedures (with illustrations of the different steps) • Road transport of hazardous goods • Emergency procedures 	<p>These steps ensure that the road tanker drivers have acquired the competencies and experience to perform the tasks required from them.</p>



<p>Establishing an approval procedure to access the loading / unloading sites, which should comprise of:</p> <ul style="list-style-type: none"> • Checking of mandatory and required documents (license of the driver, ADR permit, vehicle registration and number of slot reservation) • Compatibility analysis of the road tanker with the loading facilities • Conducting a test loading / unloading to demonstrate the competencies of the driver (operator) and their familiarity with the equipment and the procedures 	<p>It is important that the road tanker complies with the regulations and is fully compatible in terms of access and connections.</p> <p>The driver (operator) should demonstrate their ability to perform the operation.</p>
<p>It is recommended that the driver keeps the following information readily available (preferably stored inside the truck's cab):</p> <ul style="list-style-type: none"> • the loading and unloading procedures for the tanker • the tanker's P&IDs² or engineering line diagrams, which should be displayed in the valve box • the emergency procedures • the safety data sheet for LNG 	<p>These steps enable the driver (or other interested party) to readily refer to the important documents as to the nature of the cargo and the safety procedures required.</p> <p>In particular the safety data sheet is useful for the fire brigade in case of a road traffic incident.</p>
<p>It is recommended that strict site access controls are implemented, and only approved road tankers and drivers be able to access the site.</p>	<p>Due to the nature of road tanker operations, it is expected that large numbers of tankers and hence drivers will attend the site each day. It is imperative that the access control measures be suitable to adequately verify the tankers and the drivers whilst maintaining a high level of security at all times.</p>

4. Measures specific to handling operations (loading or unloading)	
Measure	Main Objective / Risk Addressed
<p>It is recommended that operators wear the appropriate PPE for the task:</p> <ul style="list-style-type: none"> • Helmet equipped with a face screen and a chinstrap 	<p>PPE provides an important final safety barrier to protect personnel carrying out the handling operations.</p>

² Piping & Instrumentation Diagram



<ul style="list-style-type: none"> • Antistatic, flame resistance and high visibility clothing • Antistatic safety shoes with toe protection • Cryogenic protective gloves • Hearing protections <p>Operators should also use LNG specific and approved tools. The utilization of makeshift tools is strictly prohibited</p>	<p>Reducing the risk of ignition sources from static energy.</p>
<p>The following measures should also be applied:</p> <ul style="list-style-type: none"> • Once on the stand, the LNG road tanker engine should be switched off and the keys should be stored in a designated place. • The road tanker parking brake should be applied, and a wheel chock should be inserted to reduce the risk of rollaway. • A positive earthing system with an associated inhibit should be used to prevent the start of the transfer operation if the tanker is not correctly earthed. • Removing potential sources of ignition within the hazardous area of the loading / unloading bays • The road tanker transfer ESD system should be routinely tested. Where possible the ESD system could be tested prior to commencing an LNG transfer operation. 	<p>Reducing the risk of transfer hose / arm rupture due to tanker rollaway.</p> <p>All safety instrumented loops should be identified and routinely tested. Testing should include the sensing and actuating elements.</p>
<p>Each driver should be equipped with a calibrated portable gas detector and a portable flashlight rated for the electrical hazardous area classification.</p>	<p>Detection of small leaks as the gas is odourless and colourless.</p>

5. Feedback from operational experience	
Recommendation	Main Objective / Risk Addressed
<p>Analysis the incidents and near misses that occurred during loading / unloading operations and during the road transport of the cargo.</p>	<p>Identifying the root causes and learning from the incidents is paramount to adapting the safety practices and systems to be as safe as possible.</p>



<p>Collecting data from incidents, near misses and dangerous situations and reporting the findings to the relevant professional organizations.</p> <p>Publishing summaries (anonymously if required) and providing analyses of these events on a regular basis.</p>	
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