Accident involving LNG Truck
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MONDAY 16/10/2017 – E313 MASSENHOVEN

This Return of Experience document was drafted at the request of the CTIF Commission for Extrication and New Technology under the impulse of Chairman Major Van Esbroeck Tom Chair CTIF Belgium/Commission for Extrication and New Technology at CTIF

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Cover photo: BFM
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CTIF Commission for Extrication & New Technology

CTIF Belgium

CTIF is the ‘International Association of Fire and Rescue Services’. Its main aim is to support and encourage collaboration between fire services and other emergency responders from around the world. The organisation was founded in 1900 and currently has 39 members, among which Belgium but also other countries such as Japan, South Korea and the United States of America.

CTIF ensures the exchange of experience and knowledge in the area of security and rescue in the event of a fire or other disasters. Important goals are encouraging, supporting and developing international collaboration, both in the technical and scientific field, when it comes to prevention, firefighting, people and animal rescue, and offering technical assistance. In addition, the CTIF wants to enhance relations between fire and other rescue services.

In order to achieve this, the CTIF provides for scientific research, the publication of articles and reports, the organisation of several commissions and working groups, and collaboration with other organisations, besides rescue services, that are also concerned with safety and prevention.

CTIF Belgium

Belgium’s representation in the CTIF is organized via the Federal Public Safety Knowledge Centre (KCCE) of the Ministry of the Interior. Several Belgian experts participate in CTIF commissions or working groups via the KCCE. The budget for their participation in meetings is provided by the KCCE. Also, the KCCE oversees the provision of information and best practices to the Belgian fire service and its federations and networks. The knowledge and information gathered in committees and working groups is also processed by the KCCE. Examples are the worldwide recognition and sharing of the ‘CTIF Best Practice’ with ‘the management of pipeline incidents’ action cards and the implementation of the ‘new transport technologies’ course as part of newly reformed training for fire services.

The ‘National Committee CTIF Belgium’ consists of:
- First delegate: Luc Faes (Zone Commander HVZ Taxandria)
- Second delegate: Willy Vanderstraeten (Acting Director KCCE)
- Chairman: Tom Van Esbroeck (Major HVZ Centre & KCCE Expert)
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List of terms and abbreviations used:

- AGS: Adviser Hazardous Substances.
- LVO: Leader of Operations.
- PRD: Pressure Release Device
- LBM: purified and cooled biogas, so-called bio LNG or LBM (Liquid Bio Methane).
- LNG: Liquefied Natural Gas
- CNG: Compressed Natural Gas
- ISO: International Organization for Standardization
- CH₄: formula of methane with 1 atom of carbon (C) and 4 hydrogen atoms (H).
- TIC: Thermal Imaging Camera
- DME: Dimethyl ether
1. INTRODUCTION

1. Reasons for the investigation

No matter how old or new vehicles are, no matter how new the technology is, accidents will happen. The key task of any emergency responder is to help the public as best they can when things go wrong. But the responder equally wants to return home safe and sound after such intervention.

Because technology is rapidly evolving, it isn't easy to keep up to date with all the evolutions and innovations. They can make interventions very different and complex, both for volunteers and professional firefighters.

Emergency services aren’t consistently consulted or informed when new technology is introduced. As a result, emergency services may not be able to respond appropriately. When they don't, incidents get a lot of negative attention through social media nowadays.

Therefor it is important for all the information that currently exists and may be overwhelming, to be structured and standardised into concrete tools each emergency responder can use. It goes without saying that close collaboration between all stakeholders such as manufacturers, consumers and government, is needed to achieve this.

International contact and exchange of knowledge can help to ensure incidents are investigated thoroughly and lead to ‘lessons learned’ or ‘return of experience’. Integrated training and constant practice regarding emergency response can ensure public safety in incidents involving new forms of technology.
2. The accident

The accident involving 2 trucks occurred on 16/10/2017 on the E313 in the direction of Antwerp near Massenhouven.

After the collision involving two trucks, of which one had caught fire, the motorway was closed for all traffic for over 8 hours.
Both the cargo and the cabin of the impacting truck caught fire.
The cargo of the second truck did not catch fire. One of the trucks involved was powered by LNG.
The teams arriving at the scene initially thought they were responding to a “normal” truck fire. However, during the intervention the LNG tank was noticed. This meant that non-standard procedures had to be used.

Photo: motorway closed for considerable time. Photo BFM

Specialists had to be brought in who had the required knowledge and tools to manage the incident.

Photo: cryogenic hose to release the pressure in the tank.
Special cold-resistant gloves in accordance with EN 388 3222 and EN 511 220 standards

Also, the correct information on how to proceed in such interventions was not readily available, meaning all those involved (fire brigade, security forces, recovery service,...) were learning as they went.

The duration of the intervention had great economic impact which could have been avoided if emergency services had been well-informed/trained and the necessary specialist materials/knowledge had been readily available.

The manufacturers of both the truck and the LNG installation were contacted about this.
2. TRUCK WITH LNG
1. What is LNG and where is it used

**LNG: Liquefied Natural Gas**

LNG shouldn't be confused with LPG, Liquefied Petroleum Gas. LNG contains between about 90 and 99 % methane. It is condensed into a liquid by cooling it to about -162 °C at atmospheric pressure. LPG contains mainly propane and butane and turns into a liquid when kept under high pressure. This is in contrast to LNG, which becomes liquid at atmospheric pressure, but at very low temperatures. Because of the different properties, the components and materials for both fuels differ too. However, we have to take into account that when an LNG leak occurs, the fumes will first spread low to the ground and depending on outside temperature/ground surface temperature and air humidity, they will vaporize and become lighter than air.

The properties of LPG are also entirely different to those of LNG. As vaporized LNG has the same properties as high calorific gas, it has the same advantages and disadvantages. Natural gas is lighter than air and therefore spreads and dissipates more quickly than LPG, which is heavier than air. LPG is more likely to explode than LNG.

**Properties of LNG:**

- Cooled liquefied natural gas;
- Formula CH₄
- Volume of LNG 600 times smaller than its gas form;
- Doesn’t contain the impurities of natural gas (especially nitrogen) so more energy;
- LNG’s energy density is about 60% of that of petrol and diesel;
- Storage and transport require very well insulated storage tanks;
- Pressure: up to 16 bar;
- Clear, odourless liquid;
- Explosion limits 5% - 15%;
- LNG is lighter than water;
- At temperatures above -110 °C LNG is lighter than air;
- LNG Density: +/- 450 kg/m³ @-160°C and 1 bar
  - As a comparison: CNG density: +/- 194 kg/m³ @ 30°C and 250 bar
- Vaporized LNG has an auto-ignition temperature of 620°C;
- Cryogenic (very cold) danger of frost bite: special PPE required;
- Be mindful of a low-hanging vapour cloud over a large area. LNG takes on the ambient temperature and mixes with air;
- The (visibility of) cloud depends on the temperature of the LNG and environmental factors such as outside air temperature and air humidity;
- Doesn’t contain **odorants** (only odourised when made into CNG).
  Below is an installation which infuses LNG with an odorant when LNG is made into CNG. One drop of THT (tetrahydrothiophene) per two cubic meters of gas is added. This odour can’t be added to LNG because it would freeze;
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• LNG colourless (visible as a white mist when the surrounding air condenses (vapour);
• A visible cloud does not necessarily contain LNG, it may only be condensation!
  • in case of leakage in a confined space the supply of humid air is limited and an invisible
    flammable mixture may form more easily;
• When a pressure relief valve releases pressure, this is clearly audible;

Photo: infusion with THT

Photo: THT
Use and storage of LNG
- Maritime LNG drive systems
  - Inland navigation
  - Maritime navigation
- LNG bunker systems
  - Fixed installations on land.
  - Installations on bunker ships.
- LNG refuelling stations for road traffic
- LNG systems for industry
- ...
LNG is traditionally used on a large scale: LNG ships unload up to 266,000 m³ at a time at import terminals where it is re-gasified in large quantities.

Purified and cooled biogas, so-called bio LNG or LBM (Liquid Bio Methane)

Photo: a bio LNG-powered truck Source IVECO
Biogas can be produced via the fermentation of:

- Animal manure;
- Treated sludge;
- Organic waste, road side grass;
- Seaweed;
- ...

To convert ‘dirty’ biogas into nearly pure (99 percent) and liquid methane of -162 degrees Celsius, several techniques are available which all use high pressure and low temperatures to separate gasses and liquefy them.

2.2 Types of LNG systems used in trucks

Mono-fuel (CNG or LNG)
Ignition in a gas engine is like in an “Otto engine”, it's a spark ignition system. Below is shown what happens in mono-fuel Scania and Iveco models.

Figure: Otto engine Source Hochschule EMDEN LEER
Below is an example: the mono-fuel IVECO STRALIS LNG

Photo: Mono-fuel IVECO STRALIS LNG

Photo: Mono-fuel IVECO STRALIS LNG
The IVECO STRALIS LNG has 2 LNG tanks which each have:
- Unladen weight in kg: 325 kg;
- Capacity in kg: 256 kg.
These are interconnected.
Refuelling and pressure release is only possible from one side.

Dual-fuel
Dual-fuel exists in several combinations
- LNG/Diesel;
- LNG/CNG.

How does a dual-fuel engine on diesel and methane work?
In this example: diesel and methane (methane-diesel drive system)

In a dual-fuel engine the compression ratio of the air/fuel mixture keeps the ignition on through auto-ignition.
This happens in the dual-fuel Volvo models.

The methane CH$_4$ can be used in the form of natural gas or biogas.
How much gas or diesel the engine consumes varies and depends on the pressure on the engine. The parts of the diesel engine are the same for a methane-diesel system and the engine can run on diesel only.
The methane-diesel function automatically switches on when the engine reaches normal operating temperature.
It is not possible to manually switch between diesel and methane-diesel.
The tank always needs to have diesel fuel as the engine can't run on natural gas alone.
Refuelling

Refuelling is done by connecting the nozzle. Irregularities between connectors need to be removed. These may lead to icing. Depending on the refuelling station, the pressure in the tank may have to be reduced in order to refuel. Sometimes to below 10 bar, the pressure is indicated on the pressure gauge. Pressure is lowered by connecting the vent hose to the vent receptacle during an intervention this receptacle can be used to connect a cryogenic hose to reduce pressure (see below).

Photo: refuelling with

Photo: vent line
Volvo Euro 6: Dual Fuel
The dual-fuel principle is at the base of the technique. But the new truck will run mainly on LNG and for a maximum of 10 percent on diesel.
This new tank design has a few notable differences.
- The tank valves have been designed differently;
- No separate vent line, this is incorporated in the nozzle.
- Capacity LNG tanks 115 kg (275 l), 155 kg (375 l) or 205 kg (495 l) together with a small diesel tank
2.3 LNG system of the truck concerned

**Methane-diesel drive system**

As the marking suggests, the vehicle is powered by 2 fuels. On one side of the truck is a diesel tank and on the other is a methane gas tank in the form of deep-frozen natural gas (LNG).
A system ensures the engine can run on a blend of methane gas and diesel fuel.

**LNG tank**

The liquefied gas is stored in a low temperature tank at below -130 °C. The low temperature is maintained thanks to a vacuum and insulation (perlite) in the annular space of the tank.

The tank walls are made of inox.

It is a kind of vacuum flask called a cryogenic storage dewar, after the Scottish chemist and physicist James Dewar.

The capacity of the tank is 155 kg LNG, which amounts to 273 litre liquid LNG, corresponding to 171 normal cubic meters (at 1 bar and 15°C).

This is comparable to filling a living area of 10 by 7 meters and 2.50 meters high from top to bottom with gas at atmospheric pressure (1 bar).

![Photo: example cross-section of a double-walled LNG tank Source VOLVO](image1)

![Photo: perlite, used as insulation in the annular space of the tank Source SIBLI](image2)
Stainless steel tank
The LNG tank is made of stainless steel which has a low coefficient of expansion. This means the tank is well-protected against temperature fluctuations.

Perlite thermal insulation
Perlite is the name for a silicic volcanic rock. Due to its thermal conductivity it can be used for thermal and cryogenic insulation. It can be used for cryogenic purposes down to a temperature of about -300 °C.

Vacuum
There are three types of heat transfer: conduction, convection and radiation. The first two are only possible if there is matter in between substances (air). In a complete vacuum, heat conduction and heat convection are therefore impossible.

Radiation heat
It is important to know that the vacuum doesn't shield heat radiation. Radiation: all materials give off electromagnetic radiation, mainly in the "infrared" wavelength range. Radiation is in fact a transfer of energy which is absorbed by a receiver (the material the heat radiation affects).

Heat transfer through radiation can be shielded with materials that reflect radiation (LNG tank with shiny stainless steel that reflects heat radiation). This reflection is also the reason why you can't determine the \textit{exterior} temperature of an LNG tank with a thermal imaging camera. By putting a temperature label on it, you change the emission value (radiation emission) of the tank, ensuring a more accurate measurement.

![Figure: cross-section of a double-walled LNG tank Source Kurt Vollmacher](image-url)
Parts of the installation

Figure: Parts of the installation Source Chart
Figure: parts of the installation (without protective grid)

Photo: valves (with protective grid)

Photo: Pressure gauge Kurt Vollmacher
Photo: vent line behind driver cabin.

Photo: vacuum lock

Photo: refuelling
• **Primary pressure relief valve:** when pressure in the tank rises above **16 bar** this primary safety valve will vent. This primary safety valve is located behind the cabin of the truck. It is a PRD type: Pressure Release Device = pressure operated.

• **Secondary pressure relief valve:** when the primary safety valve doesn’t work and pressure rises above **22 bar** the secondary safety valve will activate. This secondary safety valve is located right above the manual vent valve. It has a red plastic end cap to avoid icing. The set pressure for the valve to open is 1.5 times the maximum operating pressure inside the tank. It is a PRD type: Pressure Release Device = pressure operated.

3 **Manual valve “pressure release” or “vent”:** this manual valve is closed during operation. It can be turned open to depressurise the tank, either to make refuelling possible or during an intervention (see below).

4 **Manual valve “intake”:** this manual valve is opened during operation. It can be closed to stop LNG flow from the tank to the engine.

5 **Pressure gauge:** the pressure gauge shows the pressure inside the tank. 2 values: psi (black marking) and bar (red marking).

6 **Refuelling receptacle:** the LNG tank is filled via this receptacle using a nozzle.

7 **Level meter LNG tank:** the meter is connected to the LNG tank and green led lights in the cabin show levels.

8 **Vacuum lock:** this lock ensures the vacuum is maintained and is also a pressure relief device. In case a leak occurs in the inner tank.

9 **Mounting tank:** the tank is secured in 3 places. With straps and a plate at the back keeping the tank horizontal.
**Vent connector:** receptacle to depressurise in the tank, either to make refuelling possible or during an intervention (see below).

### Mounting of the LNG tank

The tank is mounted to the chassis in 4 places:
- 3 straps;
- 1 rear mounting plate (to keep the tank horizontal).

*Photo: LNG tank*

*Photo: rear mounting plate LNG tank*
Lines attached to the tank

There are two lines attached to the tank:

- 1 line runs to the vent nozzle of the primary pressure relief valve;
- 1 line runs to the engine.

These lines are sometimes insulated.
How does it work?
When the cold liquefied gas heats up in the tank, it releases vapour which accumulates above the liquid and increases the pressure in the tank. This pressure is used to allow fuel to flow to the engine via the vaporizer. The vapour or liquid gas is used as fuel. The vaporizer ensures the gas is heated up to operating temperature in the engine. The engine's coolant flows through the vaporizer in order to heat the gas. The pressure of the gas on its way to the engine is about 10 bar. When an accident occurs the LNG flow to the engine is automatically stopped.

Cold boiling
When a liquefied gas converts into a gaseous state, this will draw heat from the liquefied natural gas, making the gas cool down again. This physical phenomenon is called cold boiling. This phenomenon ensures that the LNG being consumed cools the remaining LNG in the tank at the same time.
Boiling off:
One of the biggest challenges with deep-frozen liquefied natural gas (LNG) is to try and keep it liquid. This is not possible, and after a while the LNG will start to boil, the pressure in the tank increases and the pressure relief valve will open at a pressure of 16 bar. When the valve opens, it will be clearly audible. The natural gas will escape in gaseous form via the pressure relief line behind the cabin.

Forced pressure release:
LNG remains a cryogenic liquid. Releasing the pressure in gaseous form occurs quite quickly. The remaining liquid will boil for a considerable time. As soon as the internal energy is gone, between 1/3 and 2/3 of the liquid will remain. The energy needed for vaporisation, has to come from an outside source again. Moving the tank creates energy again enabling vaporisation (koudkoken) and increasing the pressure in the tank.
3. THE INTERVENTION

The fire service is informed about a rear-end collision. At the scene, firefighters encounter a fully developed fire inside a truck cabin. The LNG tank is initially not noticed because of the intensity of the flames.

Photo: image of fire at arrival emergency services Photo 2x ©RV (Luc Alain de Haes)
The fire is first tackled with high pressure, after which foam is used. An AGS is contacted and asked for advice.
They perform repeated checks for LEL concentrations.
A gas detection sensor proves more effective and works faster than a multi gas meter.
A leak is confirmed.
While awaiting further action and the arrival of an AGS, firefighters set up a water supply and the area is zoned off.

Situation after extinguishment
- Extremely deformed truck, the LNG tank has partly come loose from the chassis;
- It is only attached to the chassis with one strap and with a plate at the back;
- The mounting at the back is inaccessible;
- The manual valves of the LNG tank are inaccessible;
- The pressure relief valve is inaccessible;
- The connector of the primary pressure relief line is showing icing;
- An LNG leak is detected (already gaseous).
Photo: valves/connectors and pressure relief valve not accessible BFM Photo BFM

Photo: valves/connectors and pressure relief valve on a similar model
Photo: tank is only attached with 1 strap and back plate Photo BFM

Photo: diesel tank side of truck Photo BFM
There is no indication of the fuel level of the LNG tank (can only be seen on the truck's dashboard).
The truck + detached LNG tank can't be towed safely in this state.
The operational stage is announced to get more resources in.

Advice AGS/network AGS

As mentioned earlier the LVO contacts the Adviser Hazardous Substances (AGS) relatively quickly to gain additional information and advice.
In the AGS (Advisers Hazardous Substances) network, information is shared nationally and internationally via a WhatsApp group.
This was very much the case in this intervention.
They come to the conclusion that in this case the fire services/AGS don't have enough technical expertise regarding the installation.
External expertise (manufacturer) is needed to safely manage this accident.
This external expertise will have to come to the scene.
The LNG tank is shielded from sunlight with a screen.
This is to prevent the LNG tank heating up and venting gas from the primary pressure relief valve (16 bar).

Advice from LNG expert and mutual agreement with all parties (LVO/AGS) please note: this is not a standard response but a jointly agreed response based on the situation observed!

As the tuck and the LNG tank couldn't be towed safely, it is jointly agreed that the tank should be detached from the chassis.
The current pressure in the tank (16 bar) should be lowered before it can be disconnected and dismounted safely.
In addition, the manual red “intake” valve should be closed.
An area needs to be cleared to allow access to the valves, to connect a cryogenic hose and vent the gas at a safe distance. This cryogenic hose has to be brought to the scene (under police escort).
The cryogenic hose needs to be connected to the vent connector of the tank in order to release the pressure using the grey manual vent valve.
Cold-resistant gloves should be worn due to possible exposure to the extreme low temperatures of LNG when disconnecting.
Dismounting the tank is only justified after the above measures have been taken.
After dismounting the tank, pressure can be further released in a safe place.
Photo: overview of parts of a non-damaged LNG Tank

Photo: ‘vent’ connections cryogenic hose
Pressure release and dismounting the tank:

Releasing the pressure and dismounting the tank proves difficult because of poor access to the valves/vent connector and the back mounting plate. After disconnecting the LNG tank, pressure was further released in a more suitable place. After towing, the road was reopened.
Photo: towing and road reopened. Photo BMF
4. RECOMMENDATIONS
4.1 Recognition of drive system(s)

At arrival, the type of drive system was not immediately visible from a distance. This was partly due to the raging fire. The marking on the tank was added by the supplier of the tank itself. It had a reference to the UN Number 1972, meaning METHANE, REFRIGERATED LIQUID OR NATURAL GAS, REFRIGERATED LIQUID, with high methane content. However, the marking was too small to allow detection from a distance. However, the marking was still intact after the fire had fully developed. This is often used as an argument not to provide markings. This incident proves the contrary.

Photo: detail of completely intact marking on the tank. Photo BMF

Photo: completely intact marking on the tank. Photo BMF
Markings
All trucks should be marked in accordance with ISO 17840 part 4
Pictograms should be fire-resistant and reflective.

- Markings on the truck: \textit{the drive system(s)}:
  - Front of truck cabin;
  - Back of truck cabin;
  - Both sides of truck cabin
- Markings on the tank: \textit{content of respective tanks}
  - On the tanks themselves

Marking on a truck with 1 type of gas/storage provision (LNG)

Front and back of the truck

![Picture: Front and back of the truck Source: Kurt Vollmacher](@KVO)

Sides of the truck

![Figure: Sides of the truck Source: Kurt Vollmacher](@KVO)
Vehicle powered by **2 different gasses or gasses in different storage provisions (CNG/LNG)**
Front and back of the truck

![Side 1 truck](image1)
![Side 2 truck](image2)

Figure: Front and back of the truck Source Kurt Vollmacher

Figure: Side 1 truck

Figure: Side 1 truck Source Kurt Vollmacher

Side 2 truck

Figure: Side 2 truck Source Kurt Vollmacher
Markings on the truck and tank:

**DME Diesel**

**CNG Petrol**

**LPG Diesel and Hydraulic**

**LNG CNG and Diesel**

**Pressurised hydrogen and Electric CNG and Electric**

**Electric and Petrol**

**Electric and diesel**

Figures: Source ISO 17840-4

Note: ISO 17840-4 is info specifically intended for first and second responders. This mustn’t be confused with EN 16942.
EN 16942 is a harmonised marking using black and white symbols to indicate what type of fuel the pump dispenses. In new cars the fuel valve and the information provided by car dealerships display that same label, making it clear for consumers what fuel their car can run on.

Note: these markings are only provided for the vehicle, not for the cargo. For cargo please refer to the ADR. These specific markings were chosen to avoid confusion between vehicle and cargo.

Example of marking on a truck

Photo: marking on dual-fuel LNG/CNG truck
Tanks: displaying content in a uniform way

Current “commercially aimed” information:

![Figure: commercially aimed information Source Kurt Vollmacher](image1)

Proposal “safety- and intervention-oriented information”:

![Photo: safety- and intervention-oriented](image2)
4.2 Information/training/specialist material and technicians

Information on the vehicle concerned was not immediately available to the LVO or AGS officers. There were no clear uniform guidelines from the manufacturer either. Due to a lack of information about the type of drive system, knowledge and experience, external help is sought from technicians/specialists for the specific truck brand and so on. Via the AGS WhatsApp network information was also requested nationally and internationally. To manage the incident, staff and material had to be brought to the scene under police escort. Confusion could have been avoided if emergency responders had had access to clear, accurate and up-to-date information, guidelines and specialist material. Emergency responders should also receive adequate training provided by the manufacturers.

Proposal CTIF 2

ISO 17840

Provide detailed information in accordance with ISO 17840 and have this made available to emergency services on the respective website of the brand:

- Rescue Sheet (part 2)
- Emergency Response Guide: ERG (part 3)

Always using the below 10 chapters and symbols as defined by ISO 17840. Always in each language where the vehicle may be driving.

1. Identification/recognition
2. Immobilisation/stabilisation/lifting
3. Disable direct hazards / safety regulations
4. Access to the occupants
5. Stored energy / liquids / gases / solids
6. In case of fire
7. In case of submersion
8. Towing/transport/storage
9. Important additional information
10. Explanation of pictograms used

Aside from all other requested information in accordance with ISO 17840, the specifications in the ERG should among others contain the below information:
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How to manage different intervention scenarios and what safety measures should be taken during and after the incident.

What advice can the manufacturers of trucks and fuel tanks involved provide to intervention units?

A few scenarios:

- Truck on fire, with tanks involved (LNG, CNG, combinations of several fuels...).
  - Should water be used to cool the tanks?
  - Is there a danger the pressure relief valves might freeze over when using water?
    - PRD 16 bar on the outside?
    - PRD 24 bar on the inside?
    *Note: Set pressures can differ between LNG installations, but in most tanks it is 16 and 24 bar*

- Truck on fire, with LNG tanks involved, how can we check there is still vacuum pressure between the tanks?

- Truck involved in an accident, shut-off valves are iced, what do we do?

- Truck involved in an accident, gas leakage and manual valves can't be closed as a consequence of the collision.

- Truck involved in a serious accident, with damaged LNG interior tank (LNG leaking in liquid state).

- Truck is on its side, LNG is leaking via PRD in liquid state.

- Truck has to be moved with LNG still in the tanks after a fire or accident: how to go about salvaging the damaged vehicle and/or tank? How do you do this safely?

Development:

Allow emergency responders to advise in the developmental phase;
Emergency responders see situations from a different viewpoint;
Good and safe solutions can be found together.

Training provided by the respective manufacturers:

- Provide the necessary, accurate training for emergency services;
- Provide sufficient, accurate teaching resources to this end;
- Provide visits to/accurate training at the factory/factories themselves

Specific material and technicians:

- Have sufficient specific materials and trained technicians who can get to the scene with the materials ASAP (on-call service).
Provide the same for all new configurations such as the below LNG tank.
4.3 Ease of access to parts
The manual pressure relief valve or “vent” valve and manual “intake” valve were inaccessible after the accidents.

Photo: manual valves were inaccessible. Photo BMF

Photo: manual valves were inaccessible.
When mounting the tank, sufficient room should be left between the end of the tank and the rear wheel of the truck. For instance by removing the case circled in yellow.

Or by providing a sealed hatch A on the side of the LNG tank so the valves can be accessed in an emergency situation.

Photo: sealed hatch A on the side to allow access to the valves. Source Kurt Vollmacher
4.4 Reducing heat radiation to the LNG tank

As a result of the accident, the diesel tank came loose from the lorry. It was damaged, several cracks can be seen, the largest crack runs down to the ground. Also, a large discoloration can be seen on the container. Because the leaking fuel has caught fire, the LNG on the bottom may have been irradiated.

Photo: irradiation due to fuel leak. Photo

Photo: opening in the tank and clear dividing line fire contact/no fire contact
The tank shows blue discolouration on the inox pointing to excessive heat. The aluminium parts of the truck have melted which points to temperatures of over 660 degrees.

Photo: blue discolouration of the inox
Proposal CTIF 4

Could a thick 8 mm inox plate be mounted in an L shape to better protect the LNG tank against heat radiation coming from the bottom (leaking fuel) and the side of the truck? And could a layer be added between the brackets on the inside to stop heat conduction?

Figure: inox plate (shown in red) to protect against heat radiation. Source Kurt Vollmacher

4.5 Detection and informing people concerned

Proposal CTIF 5

Because no odorants can be added to LNG, it may leak to the cabin without the truck driver noticing. LNG can form an explosive mixture with air. The truck cabin should be equipped with gas detection so the driver can be alerted. This gas detection device should be connected to the automatic (electro-magnetic) valve for gas supply to the engine (as in hydrogen vehicles)

Make sure drivers/mechanics/...:
- know the dangers and can handle LNG correctly;
- are trained to know what to do in case of an emergency;

To this end, simple useful sheets should be drafted listing all the necessary information.