

# LPG release and flash in the LPG road-tanker Loading facility of a refinery

23<sup>rd</sup> of April, 2004

Germany

Refining  
Road-tanker loading  
facility  
LPG  
Flash  
Fatality  
Threade-coupling  
loading-arm/road-  
tanker  
Material failure  
Management:  
periodic inspections

## THE INSTALLATIONS IN QUESTION

The accident took place in a LPG road-tanker loading facility in a refinery. The picture gives a glance on this kind of installation.

On the site involved, for a loading operation, the LPG tanker is connected to the loading installation via a jointed loading-arm. Loading is carried out under “spray loading”, in which the liquid phase is pumped through the foot valve into the vapour phase of the road-tanker’s tank. No vapour phase exchange takes place.



## THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

### The event:

At 7h30, as 15 t of LPG had already been loaded, there was a spontaneous separation of the connection between the loading-arm and the vehicle at the threaded coupling. This led to a release of LPG, which ignited and engulfed the driver. The force of the separation was sufficient to propel the loading-arm backwards until it impacted with the housing of the loading station. This led to the activation of the “pull-away” quick release coupling and the flow of LPG from the refinery was stopped.

The fire melted the pneumatic hose for the foot valve of the road-tanker and the pneumatic valve closed, stopping the release of LPG from the tanker.



### The consequences :

The driver, who was engulfed by the fire, died a number of days later as a result of the injuries received. The size of the release was estimated to be about 20 litres (ca. 10 kg).

### European scale of industrial accidents

By applying the rating rules of the 18 parameters of the scale made official in February 1994 by the Committee of Competent Authorities of the Member States which oversees the application of the 'SEVESO' directive, the accident can be characterised by the following 4 indices, based on the information available.

The parameters which comprise these indices and the corresponding rating method are indicated in the appendix hereto and are available at the following address : <http://www.aria.ecologie.gouv.fr>

Quantities of hazardous substances		<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Human and social consequences		<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Environmental consequences		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Economic consequences		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

## ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

### Material failure :

The investigation carried out after the accident showed that the cause of the LPG release was the failure of the threaded coupling. A closer inspection showed that the 3¼" ACME threaded coupling was extremely badly worn. The trapezium cross-section of the thread of the threaded ring was worn so badly, that it was reduced to a triangular form. The fitting (road-tanker) was worn so that it was slightly conical. The connection was therefore extremely instable. This meant that even vibration or a slight movement of the loading-arm could have been sufficient for the connection to fail.



Examples of worn threaded coupling : road-tanker fitting and threaded ring

### Practice failure :

Clearly visible on the threaded ring was the deformation caused by hammering the lugs (ears) with a hammer to tighten the coupling. This practice was common place. However hammering has a number of effects including: the thread may be worn by over-tightening or the ring may become deformed (oval).

Near to the loading-station a wrench for tightening the coupling was found on the ground, so it can probably be discounted that this driver had tightened the coupling by hammering in this case.

## ACTIONS TAKEN

This accident had immediate consequences for the LPG-industry throughout the State of Baden-Württemberg. A state-wide inspection programme was immediately started. The aim was to identify all couplings and fittings which were "at risk"

of being in a damaged state. All LPG distributors were inspected, as were LPG Storage tanks with a storage volume of 15 tonnes or more. LPG tanks which were known to have a frequent filling interval, where more wear could be expected were also to be inspected. All LPG road-tankers which were found were to be inspected, however most of the specialist haulage firms are based outside of Baden-Württemberg.

Due to the risk of similar events information was exchanged with a wide range of authorities and organisations. These included the State pollution control authorities and the authorities responsible for machinery safety, the German LPG trade association (DVFG), the Federal environmental agency (UBA) and the central reporting body for major accidents in Germany (ZEMA), the Federal Association of Hauliers and Storage companies (BSL), the Association of technical inspection bodies (VdTÜV), the Mineral oil trade association (MWV), and the colleagues in the local authorities across our international borders (DRIRE-Alsace, KCB-Basel-Landschaft, Sicherheitsinspektorat Basel-Stadt).

The technical regulations covering the handling of pressurised gases, in particular the technical regulation gases (TRG 402) regarding filling installations – operation of filling installations are the relevant regulations for this time of installation. Number 8.2 concerns the testing of manoeuvrable piping (hoses and jointed pipe-work). One of the most important aspects of the testing is the visual inspection of the outer-surface and as far as possible the inner surface with regard to their condition.

The Factory Inspectors who were instructed to carry out the immediate inspection programme were provided with a list of visual indicators to assess whether a potential hazard existed or not.

The thread was to be investigated with regard to the thread profile, damage to the thread (flat points, pitting, broken threads. Also damage to the lugs ("ears") of the threaded ring which indicate that the coupling had been tightened by hammering was to be identified.

In the course of the investigation and communication with the UK LPG Association a further testing possibility was discovered. The use of Go / No Go Gauges allow a quick assessment of the degree of wear of the threads of both halves of the coupling. The function is extremely simple. The gauges allow maximum 1 turn of the thread for threads which are OK, worn threads allow more than one turn. The threaded ring which was involved in the accident was so badly worn, that the gauge could travel four turns.



Initially within the inspection programme there were no clear criteria for assessing the quality of the couplings, so it was necessary to rely on the expertise of the factory inspectors.

The results of the inspection programme were as follows:

- ✓ In no single case was serious wear on the ACME-threads of the LPG storage tank fittings identified.
- ✓ In a few individual cases minor wear was identified. In these cases the fittings were replaced as a precaution by the operator.
- ✓ In a few cases signs of hammering could be identified on the threaded ring of the coupling, although the thread itself showed no signs of damage. The operators were required to ensure, that in future the coupling was no longer tightened using a hammer – as was common practice in the past.

However it was also reported that several operators were already informed by their LPG supplier and had already replaced the relevant fittings in their installations as a precaution. It is not possible to say afterwards, whether a fitting that has been replaced had signs of excessive wear or not.

## LESSONS LEARNED

From this event, the lessons to be learnt are rather simple:

- ✓ to make sure that in the future, the coupling was no longer tightened using a hammer – as was common practice in the past.

- ✓ to carry out regular visual checks or testing device
- ✓ Importance of the following lessons to learn :
  - ✗ to investigation the causes of the accidents,
  - ✗ to draw up measures and consequences
  - ✗ to communicate the causes, measures and consequences widely, throughout the industries concerned, with the authorities and across national and international borders
  - ✗ act upon the information which is received .

Whilst carrying out the investigation it was brought to Baden-Wurtemberg authority's attention, that a similar event had occurred in the UK. This event (at a third-party's depot) led to the company issuing a safety alert, dated 8 December 2000. This alert was distributed throughout the group production facilities. If this alert had been distributed throughout the whole of the LPG industry and the LPG has acted upon it then possibly the accident in 2004 could have been avoided.

As a concluding remark, the UK LP Gas Association has released a Technical Memorandum (No. 81) regarding ACME threaded couplings, dated April 2005. The group has also re-released its safety alert at the end of 2004.