

Explosion in an LPG filling centre

16 September, 1974

**Hauconcourt – [Moselle]
France**

Release
Flash
Fire
LPG filling center
Propane
Carousel
Compressed air
Material failure
Organization /
conception
Victims
Material damages

THE INSTALLATIONS IN QUESTION

The site:

The site in question is an LPG storage facility and a filling centre. The facility can be broken down into several zones:

- a "Small Capacity" cylinder filling line (SC 13 kg) for butane and propane, equipped with various operating machinery, including a semi-automatic carousel and a paint booth.
- a manual "Large Capacity" cylinder filling line (LC 35 kg) for propane, with in-line filling by four rockers.
- a sorting and cylinder test preparation line (SC/LC).
- a cylinder (SC/LC) testing line.

The building is equipped with 2 ventilators (2,000 m³/h each), slaved to the arrival of the product on the carousel (SC) or on the filling station (LC). The enclosed diagram shows the layout of the facility.

The devices:

Filling is carried out by a clamp which is manually installed on the opening of the cylinder valve. An employee in charge of connecting the clamps actuates a lever which initiates the pneumatic cycle: the clamp is connected, the cylinder valve is opened, a gas valve is then opened to supply product to the clamp. Once filling is finished (through automatic detection by a cylinder weighing system), the next cycle is triggered: the gas valve and the cylinder valve are closed simultaneously, the clamp is disconnected, and the cylinder is ejected to the exit line. The cycle is designed so that an operation can not be performed unless the previous operation is completed.

THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

The accident:

On the day of the accident, at 4.55 pm, a 13 kg (propane) cylinder tipped over upon exiting the carousel, spraying liquid propane upward toward the hall's ceiling. The person in charge of connecting the clamps stopped the carousel's rotation. The foreman was attempting to place the cylinder upright when the "flash" occurred (the cylinder's valve had remained open): the foreman and 2 other employees were burned on the face and body. Another employee then actuated the site's emergency stop which activated the sirens, disconnection of the electricity (except for the lights), the closure of the valves on the spheres and the gas valves supplying the carousel and the 35 kg station, as well as the air compressors and ventilators.

When the air supply was disconnected, the filling clamps began to "open" slowly while the gas supply valves were closing slowly, thus creating new propane leaks in the workshop. The cloud thus continued to ignite, and the fire spread to the paint booth nearby.

Extinguishing operations were in progress when the same phenomenon began at the 35 kg station: there also, the clamps began to open due to a lack of air pressure. In this case, the gas caught fire also.

Finally, the fire was extinguished at 5.20 pm.







The consequences:

The accident resulted in 3 employees injured by burns (body, face).

Part of the hall's roof and siding had been blown out.

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.

Dangerous materials released			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Human and social consequences			<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"/>

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

While no precise information is available, the level 1 is given by default to the parameter « quantity of dangerous material released » regarding the release of propane from the clamps (parameter Q1).

The level 1 attributed to the parameter related to human consequences characterizes the 3 employees suffering from burns (parameter H5).

ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT

Post-accident analysis highlighted the following elements.

✓ Filling of 13 kg propane cylinders:

The gas cylinders are normally equipped with a flow limiter, installed on the cylinder valve, which prevents the massive release of product even when the cylinder is open. On the day of the accident, the work consisted in filling propane cylinders (with approx. a 13 kg load) that were not equipped with this type of device. Indeed, the use of greater propane flow rates (industrial use for roof waterproofing systems, for example) is not compatible with the presence of a flow limiter. An incident of this type would have been of little consequence (or none at all) with cylinders equipped with flow limiters.

✓ The cylinder valve that caused the accident:

All of the filling sequence operations were performed normally, including that corresponding to the closure of the cylinder's valve once it was filled. The following operation, which corresponds to the removal of the clamp, was initiated, although a jet of gas from the valve threw the clamp toward the valve wheel where it became hooked.

As the machine, that closes the valve, had operated normally, the reason for maintaining the valve open may be explained by the fact that it was blocked open when it was returned by the customer. The machine's gripping "bell" may have slipped on it without turning it and was inefficient.

✓ Falling cylinder:

When the cylinder was ejected to the exiting line, the ejection was correctly actuated but the cylinder fell down, as it remained attached to the clamp via the valve wheel. The liquid propane then spilled out.

✓ **Ventilators:**

As the emergency stop caused the ventilators to shut down, the released gas was able to accumulate in the workshop; release to the exterior was not possible because the ventilators were not working.

✓ **Aggravation associated with the management of utilities:**

✗ Air compressors:

At the site, considering the slaving and interlock systems in place, the emergency stop also causes the air compressors to shut down. As a result, the pressure drops in the compressed air network, including in the part which controls the equipment associated with the filling sequence.

✗ Clamps:

The clamps used (cross type RM65.300) operate on air pressure. To close the clamp, compressed air must be introduced into the cylinder which presses the piston. The piston's movement, while compressing the return spring, causes the valve to raise and thus allows the liquid in the cylinder to flow.

When the fill cycle is completed, rapid purging of the air contained in the cylinder closes the valve. The spring causes the valve to return rapidly to its seat and shuts off the supply of gas to the cylinder.

For the cylinders being filled, which thus had their valves open, the shut down of the air compressors caused the air pressure in the network to bleed off slowly, which explains the slow purge of the cylinders through the clamps (the device is the same on both the 13 kg and 35 kg cylinders) and thus the slow closure of the valves, causing gas to be released from the cylinders.

✗ Other valves:

The gas valves enabling the clamps to be supplied with gas also operate pneumatically. They were subjected to the same hazard and slowly closed, allowing the gas in the lines between the carousel and the manifold to leak out.

✓ **Ignition source:**

The ignition source may have been created by:

- A metallic impact:
 - the clamp (steel cylinder) may have touched the cylinder or the rocker when ejecting the cylinder from the turnstile;
 - the cylinder's base could have touched the line's metal structure.
- Static electricity:
 - poor electrical continuity may be suspected (metal braids in poor condition between the platform and the rocker system body); although the hypothesis is not very probable, an equipotential bond existed via the base of the cylinder between the rocker and the line;
 - the jet of propane exiting the cylinder may have produced this phenomenon.

LESSONS LEARNT

The lessons learnt from this accident can be outlined by the following 4 points:

- **1 – Leak reduction** (including the various contributions): presence of positive safety valves on the main supply line and on the return line to the tank.
- **2 – Device allowing the cylinder supply clamp to be left in place:** 2 principles currently exist:
 - the positive safety clamp (remains in position, even in a "no air" situation)
 - the supply line remains with compressed air. In this case, the electric power supply takes the air networks operation into account, after the emergency stop is actuated.
- **3 – Ignition sources:** inasmuch as they have not been precisely identified, feedback on this major point is difficult to established based on this event.
- **4 – Ventilator action** in a gas leak situation: considering the flow rate of the leaks and their position (turbulent jet), whether or not the ventilator is maintained had no influence on the accident.

Other accidents at LPG depots of the same type having led to a similar problem:

- Marignane (Bouches du Rhône), 08/19/1999: see summary No. 20350 in the appendix.
- Rognac (Bouches du Rhône), 09/12/2003: see summary No. 26468 in the appendix.

APPENDIX

No. 20350 - 08/16/1999 – Bouches du Rhône - MARIGNANE

74.8 – Services to companies

A propane leak (10 l) caught fire in a gas storage facility. The leak was caused by the impact between a filling clamp and an upright. An operator was slightly injured.

No. 26468 - 09/12/2003 - Bouches du Rhône - ROGNAC

40.2 – Production and distribution of gas fuels

Fire broke out in a gas cylinder filling centre on the automated carousel used to fill 13 kg propane cylinders. The cylinder was being filled when a leak occurred on the junction between the filling clamp and the cylinder's valve. The shut-down device allowing a "connection fault" to be detected at the station and stop the release was not activated: the gas jet was not oriented toward this device and could not activate it. The product leaked for 12 seconds. A flash occurred when the operator was able to activate the supply shutoff valve. The alarm was activated and the personnel, except for the intervention crew (3 to 4 people), made their way to the rendezvous locations. The accident was brought under control by fire extinguishers in less than 2 minutes. Property damage was limited: the station's compressed air line was damaged, plastic protection burned, roof damaged locally (a combustible transparent corrugated panel). However, the station was shut down for 3 weeks in order to conduct an expert evaluation of the event. The ignition of the cloud was most likely due to an electrostatic phenomenon: polycarbonate panels used for protection (to limit access to the stations) may have caused this phenomenon. According to tests, they easily build up an electrostatic charge. As a precaution and for feedback purposes, these plates were installed on all the operator's turnstiles. In addition, gas detectors were installed in immediate proximity of the cylinder junction which actuate the supply shut-off valve.