

## Propane leak in an LPG depot

October 23, 1989

Le Blanc [Indre]

France

Leak  
LPG depot  
Propane  
Railcar  
Loading arm  
Equipment failure  
Rupture valve  
Disconnection

### THE INSTALLATIONS IN QUESTION

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#### The site :

The accident concerns an LPG storage facility employing 2 persons that includes a loading area for oil tankers. It was created in 1963 and, until 1987, a cylinder filling operation was operating at the same location. The depot is authorised to operate with several hundred tons of propane, corresponding to a sphere and 2 storage tanks.

Approximately 4,500 to 5,000 t of propane transit this depot each year. The site is delivered exclusively by railcar only and approximately 100 unloading operations are performed annually.

#### Safety measures in place : measures on loading arm :

The transfer station is equipped with loading or unloading arms, each of which are equipped with safety features in case of a rupture installed in 1988.

The device, of English design, is referred to as a double APC rupture valve. It is entirely mechanical and consists of 2 housings with sealing valves connected by 3 rupture blades designed to form the priority rupture point should the loading arm be subjected to abnormal stresses. The assembly is designed to break under an overall force of 3,000 daN. The rupture of the blades causes the 2 housings to loosen, thereby releasing the valves upstream and downstream from the device which, through spring action, isolates the 2 elements of the separated arm.

### THE ACCIDENT, ITS BEHAVIOUR, EFFECTS AND CONSEQUENCES

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#### The accident :

At approximately 1.30 pm on the day of the accident, a propane transfer operation from a railcar containing 45 t of product to the sphere is in progress. This is a standard operation (104 railcars were unloaded in 1989), which is outlined in a procedure.

The technical principle is as follows :

- A compressor is used to draw out the gaseous atmosphere of the tank being filled and discharge it to the gaseous atmosphere of the tank being emptied,
- The increase in pressure of the gaseous atmosphere causes the product in liquid phase to be discharged to the tank being filled (pressures between 9 and 14 bar),

The operation lasts approximately 90 minutes.

The arm was connected in the morning, around 11.30 am. At around 1.30 pm, five minutes into the operation, and while the 2 employees were still near the unloading station, a thick cloud appeared blocking all visibility, preventing human intervention within the cloud.

Technicians initiate the internal contingency plan : emergency services informed, securing of the site, operations are shut down, valves of pumping and storage facilities closed, firefighting equipment started, peripheral water curtains started and wetting of tanks, fire nozzles directed toward the gas cloud.

Once these operations were carried out and after several attempts to penetrate inside the cloud, the foreman approached the cloud's limit where the chain of the safety turnbuckle was supposed to be located. As the leak became weaker, the end of the chain came into view enabling the foreman to shut the valve at the bottom of the tanker, which stopped the leak.

Employees at the furniture plant are informed and are able to evacuate the site in 3 minutes and, according to their internal procedures, shut down the electrical installations at the transformer. Private citizens are also evacuated from their residence.

The 17 water sprayers actuated by the alarms formed a water curtain along the property line.

According to witnesses, the visible cloud represented approximately a 15 m radius sphere. On the day of the leak, the wind was blowing weakly from the west. Of the 5 detectors on the site, 3 detected the presence of gas and triggered the alarm and activated the warning lights on the control room mimic panel. These detectors are located up to 22m from the leak. The closest one which has not reached the triggering level (20% of the LEL) was located down wind and 48 m from this same location.

**The consequences :**

Five tons of propane were released. The accident did not have visible incidence on the environment. Considering the wind direction, the quantity released, the implementation of the protective measures and the presence of a full separating wall, the effects on the surrounding area has been limited.

**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 checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" 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"/>	<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>.

Level 3 attributed to the "dangerous materials released" illustrates the release of 5 tonnes of propane into the atmosphere (Q1 parameter).

**ORIGIN, CAUSES AND CIRCUMSTANCES OF THE ACCIDENT**

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After the accident, the administrative inquiry found no anomaly on the railcar involved. Similarly, the 4 railcars in line were all correctly braked and chocked.

No anomaly was observed on the equipment and installations in place. According to the testimony of the people present and rescue personnel, the alarm functioned correctly.

✓ **Malfunctioning of the APC device :**

The accident resulted from the rupture of only 2 of the 3 rupture blades equipping the device described earlier. The 3<sup>rd</sup> blade was folded but did not break, the 2 housings were spread only partially without disconnecting completely, thus preventing the springs from releasing completely and sealing the valves. The gas in liquid phase was released by the partially closed valves for about 8 minutes.

The device examined by the manufacturer and the operator showed no specific defect.

The rupture of 2 of the 3 blades may have been caused by a slight vertical displacement of the railcar which was probably due to a release of the internal stresses in the car's suspension during the unloading operation.

✓ **Difficult operation :**

At the time of the accident, all valves especially the ones on the pipes connecting the storage devices were open to allow the transfer of the product. These were then promptly shut once the accident had occurred. However, due to the thick fog, the technicians could neither access the valves of the fuel tanker nor the end of the safety stretching screw chain.

## LESSONS LEARNED

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The analysis of this accident has made the technical and organisational provisions of LPG transfer stations more stringent :

### 1 - Rupture valve :

Considering the design of the device used, the aperture angle between the 2 half-bodies of the double rupture valve was not sufficient to allow the 2 valves to close completely.

This type of device must close under 2 types of stresses :

- an axial force, generally expressed as the maximum force allowing the 2 valves to close,
- a lateral force, which can be considered as the maximum angle to allow the 2 half-bodies, which form the double valve, to open : this angle must be as wide as possible.

For example, the 2 most frequent principles encountered in the filling centres and bulk stations are represented on the diagrams on the following page. The second device concerns the one modified after the accident.

**2 - Potential leak reduction systems** upstream and downstream from the arm were automated and slaved to setting site security :

- o pneumatic automation of the arm's base valve.
- o pneumatic automation of the turnbuckle system connected to the tank car's bottom valve.

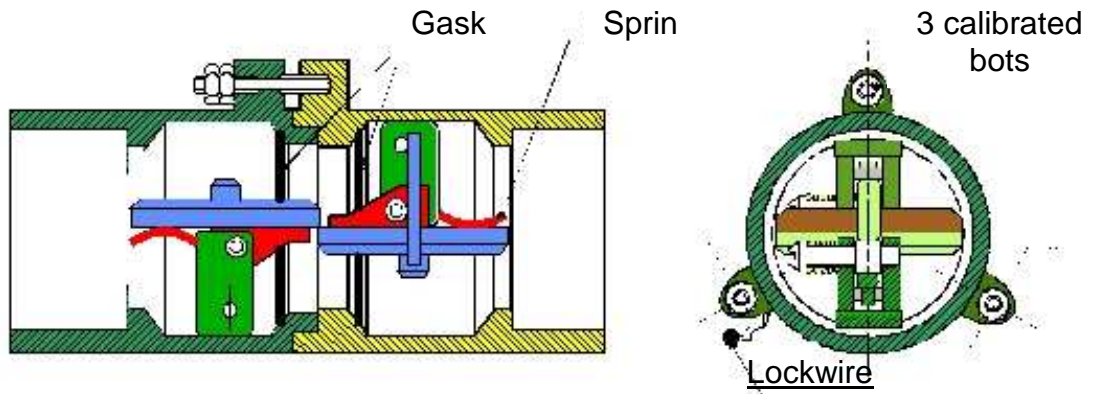
**3 - The personnel's intervention instructions** were reinforced to state that penetration of the gas cloud is strictly prohibited.

### *Other accidents at LPG depots of the type having led to the same problem :*

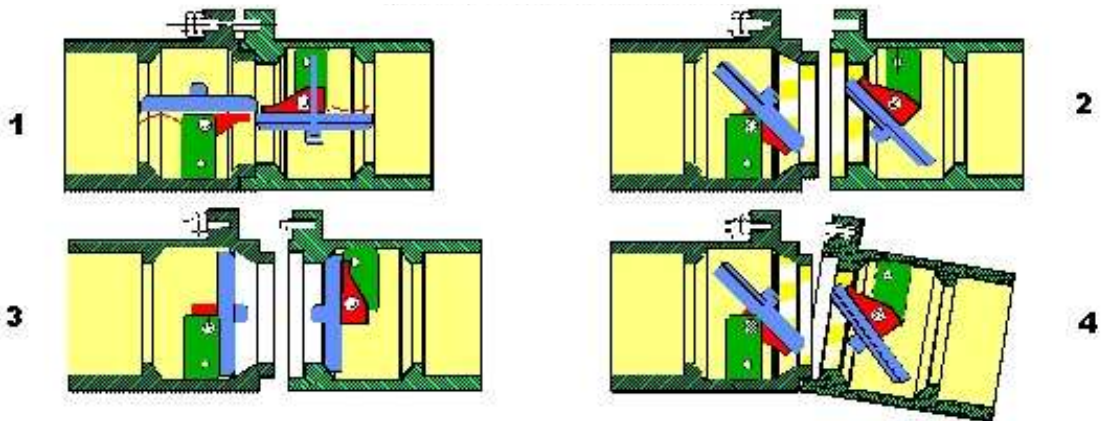
- *Le Port (974) on 12/26/1994 : see summary No. 7240 in the appendix hereto.*

The 2 principles the most frequently encountered in filling centres and bulk stations :

**1<sup>st</sup> device :**



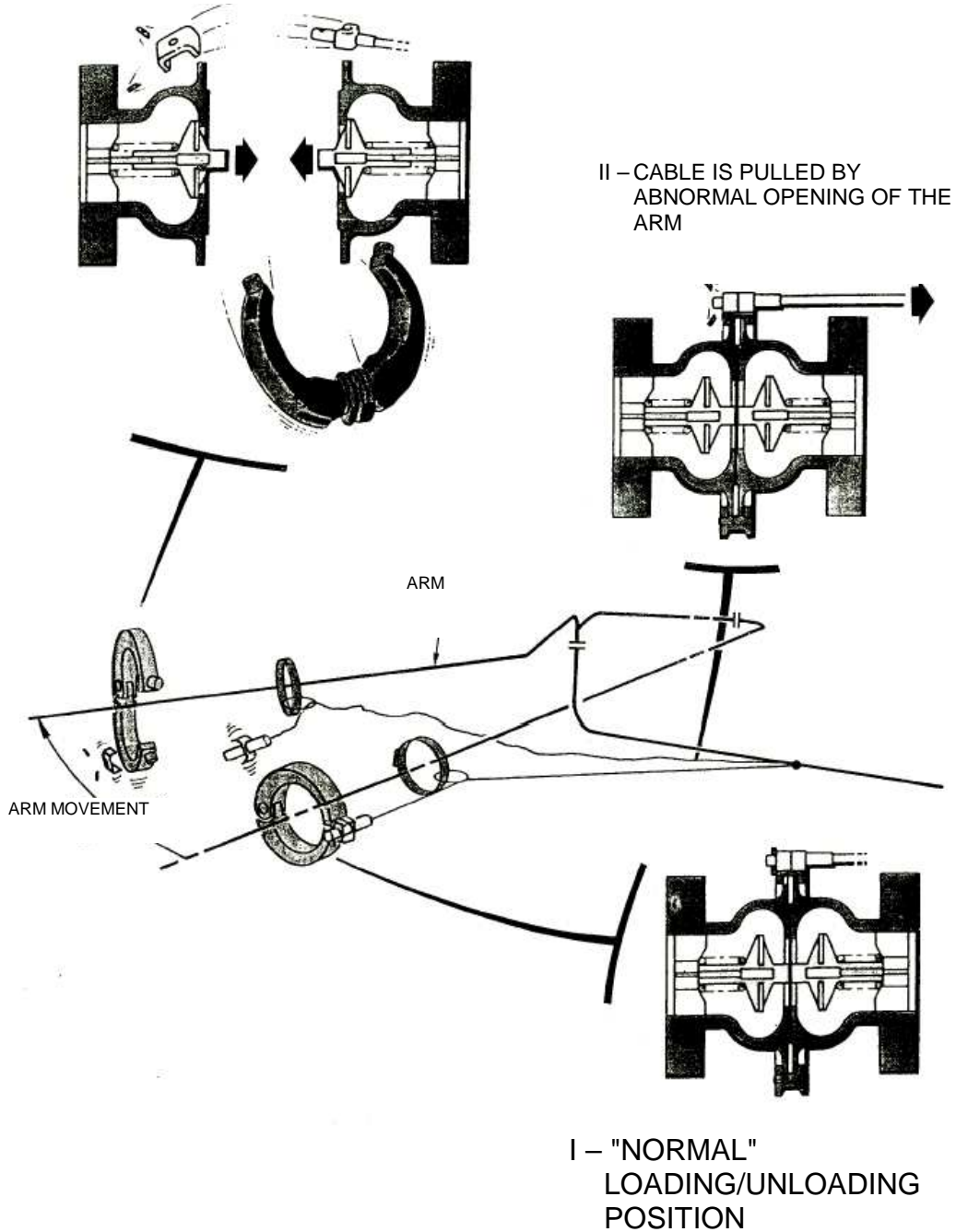
OPERATION OF THE DUAL RUPTURE VALVE  
(manufacturer's documentation)















**2<sup>nd</sup> device :**

*Device modified after the incident.*

**III - PIN RUPTURE,  
SEPARATION AND IMMEDIATE  
ACTUATION OF THE TWO VALVES**



**APPENDIX:**

     	<p><b>No. 7240 - 12/26/1994 - 974 – LE PORT</b>  <i>51.1 - Wholesale intermediaries</i></p>
     	<p>In the port, a gas leak occurred while a ship was being unloaded. An APC rupture valve, installed as a safety measure in case of high swells, became disconnected (rupture of 2 of the 3 pins). The movement of the 2 housings allows the two valves to function. As such, only a few kilograms of liquid phase butane were released. The watch personnel were able to close the hydraulic valve and a manual valve. The increase in pressure on the pump's discharge side caused them to shut down and close the safety valves. The pins ruptured due to the high degree of stress on the hose/valve connection, generated by the hose's stiffness. This device most likely aggravated the risk.</p>
