Explosion under a bridge deck following a fire which caused a gas leak

13/05/2018

Albertville (SAVOIE)

France

Piping / Distribution systems
Explosion
Victims
Property damage
Malicious intent

THE FACILITIES INVOLVED

The site:

The Albertin road bridge (Savoie county), crossing the Isère River, connects the towns of Grignon and Albertville. Two natural gas distribution pipelines, commissioned in 1998, were routed along the bridge, under the deck (see dotted green line in the image below): a steel pipe, measuring 114 mm in diameter, and the other polyethylene (PE) pipe, encased in a stainless steel sheath, measuring 125 mm in diameter. Other utility networks were present, including a telecommunications line (optical fibre) which was also routed through a stainless steel sheath next to the gas pipes and a 20 kV power line installed on the other side of the deck (view V2).

The Albertin Bridge as seen from above and indications of the various viewpoints (© DR)

The Albertin Bridge as seen from the right bank – view V1 (© DREAL ARA)

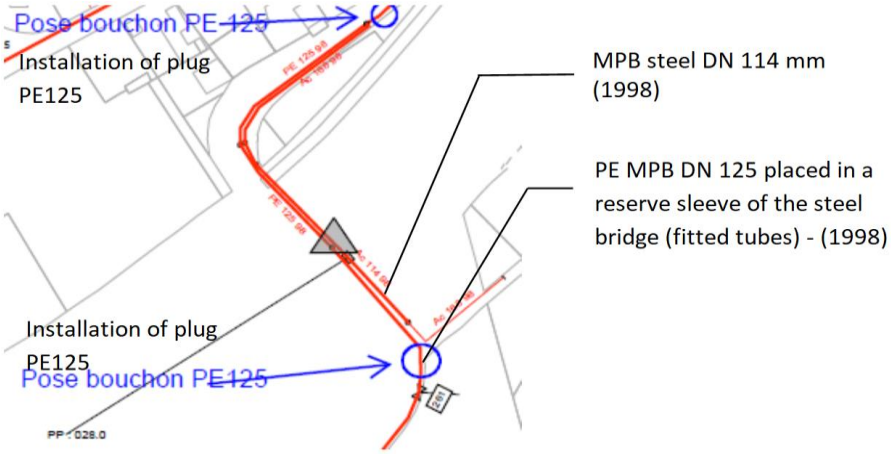


Diagram of the natural gas distribution network – layout of 2 gas pipelines (© gas utility)

For info

There are several pressure ranges on the distribution network:
- Medium pressure gas network:
MPC: pressure between 4 and 25 bar
MPB: pressure between 0.4 and 4 bar
MPA: pressure between 0.05 and 0.4 bar
- Low pressure gas network:
pressure less than 50 mbar

A maintenance room giving access to the technical duct networks is located inside a support pier on the right bank of the bridge (Albertville side). The maintenance room, occupied by squatters despite complaints from local residents, contains “inappropriate” equipment given the proximity of the networks: gas cylinders, gas cooker, etc.

Entrance to the technical room occupied by squatters (view from the parking area: V1)

Entrance door of the technical room added following the accident (© DREAL ARA)

Inside the occupied room

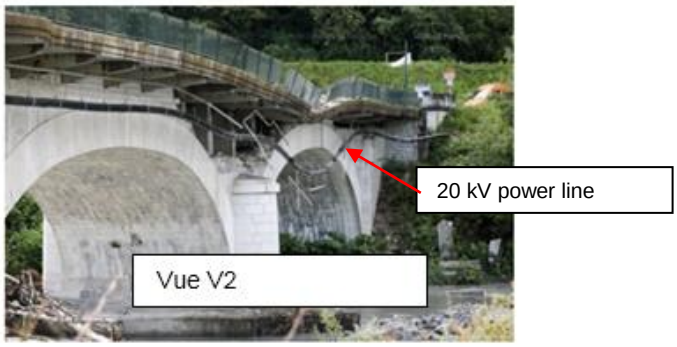
(© DREAL ARA)

THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

Chronology:

8:19 p.m.: a fire broke out in the premises occupied by squatters. Firefighters were alerted and set up a 100 m safety perimeter upon their arrival. Their intervention was hindered due to the presence of the 20 kV power line.

8:55 p.m.: an explosion occurred as the result of a gas leak, leaving the Albertin Bridge completely gutted. The gas utility services were able to close the shut-off valves on both sides of the bridge in an effort to stop the leak of natural gas.



Ignited gas leak (photo top left) and the collapsed bridge after the accident (© DREAL ARA)

Consequences:

In terms of the human consequences, four firefighters suffered from hearing problems as a result of the explosion.

The Albertin Bridge was severely damaged and the reconstruction cost was estimated at 4 million euros. Traffic was prohibited across the bridge pending its repair.

The social consequences of this accident were also notable:

- As public lighting was affected, a generator set was installed to compensate for the need for power;
- 125 customers were without natural gas;
- 15,000 telecommunication customers were cut off (Internet and mobile phone).

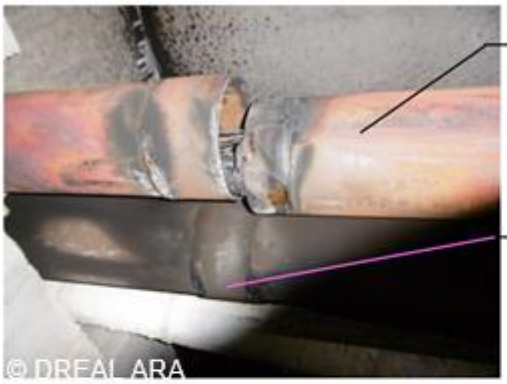
Status of the natural gas distribution network after the accident in the technical room:

Inside the pylon - Under the Albertin Bridge deck

Stainless steel sleeve containing optical fibres

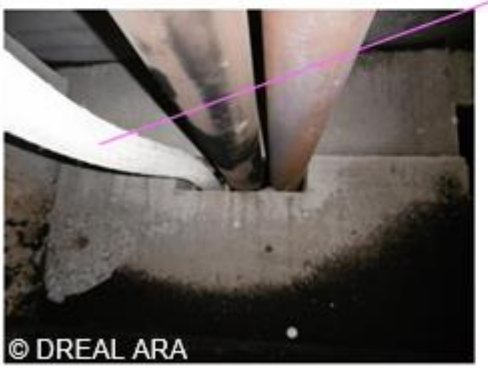
Stainless steel sleeve containing a PE MPB 125 gas pipe

Steel DN 114 gas pipe



Protective stainless steel sleeve for the optical fibre consisting of fitted tubes that separated due to the explosion

Traces of 'drippings' from the polyethylene gas pipe in the sleeve at the tube junction



Deflection of the steel gas pipe (deformation)

The heated section suffered deformation under its own weight

A temperature of 600 °C was reached in the bridge pier

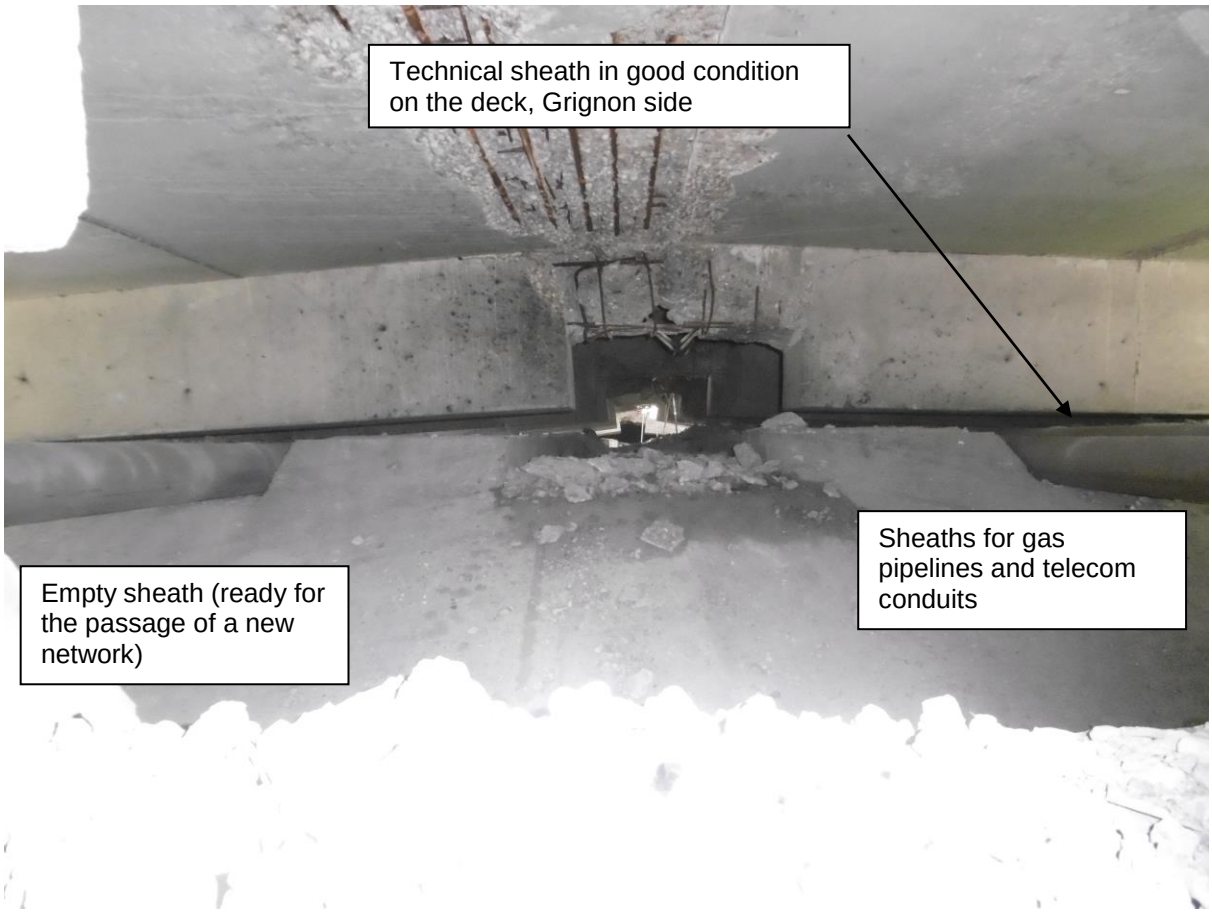
European industrial accident scale:

In accordance with the rating rules applicable to the 18 parameters of the scale officially adopted in February 1994 by the Member States' Competent Authority Committee for implementing the "SEVESO" Directive for hazardous substances and in light of available information, this accident can be characterised by the following four indices:

The parameters associated with these indices and their corresponding rating protocols are available at the following website: https://www.aria.developpement-durable.gouv.fr.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THE ACCIDENT

A fire broke out in a room occupied by squatters in a bridge support pier located on the right bank. The heat fluxes released caused deflection to occur on the steel pipe and caused the polyethylene pipe to become fused inside its sheath. Significant damage visible on the bridge's 2nd pier (view V2) was indicative of a strong explosion in this location that no doubt caused damage to the bridge deck on the Grignon side (view V3). The damage appeared to have been caused by the explosion. The pipes routed at this level did not seem to be damaged (leaks), as shown in the picture below.



Bridge deck and piping/conduit sleeves in good condition (view V3) © DREAL ARA

The most likely scenario explaining the explosion is that natural gas leaked inside the stainless steel sleeve after fusion of the polyethylene pipe. The gas migrated through the sheath into the confined structures located under the deck of the bridge, then escaped from the sheath through the tube junctions to form an explosive cloud around the 2nd pier.

The gas cloud's ignition source could not be determined accurately. However, several assumptions are possible:

- Diffusion of the gas from the molten polyethylene piping that spread in large quantities via the sheath under the bridge deck. Some of this gas then migrated to the fire zone, without exploding, and then the gas pocket in the middle of the deck was ignited;
- The self-ignition temperature (410 °C) of the natural gas was reached in the gas pocket, or there may have been contact with an incandescent solid.

ACTIONS TAKEN

Securing the technical room:

Following the accident, the public authority in charge of managing the bridge secured the room, closing it to prevent access (safety measures, ongoing administrative and judicial investigations).

Administrative follow-up:

Following the event, the DREAL requested that the gas utility provide further details, particularly regarding:

- The condition of the steel and polyethylene piping, based on a series of expert assessments;
- The types of danger points along the structure's route (overhangs, gutters, etc.);
- The latest monitoring and maintenance report on the ducts located near these danger points.

The DREAL also conducted a compliance analysis focusing on the design and construction of the structures and revealed nothing abnormal (regulatory framework applicable to pipelines, given their commissioning date in 1998: Decree No. 62-608 of 23/05/1962 establishing the technical and safety rules governing combustible gas installations).

For networks commissioned after 20 August 2000, the installation of buried or above-ground piping in covered passages or not open to the outside is prohibited (amended Ministerial Decree of 13/07/2000 concerning gas pipeline safety regulations (RSDG)).

Actions undertaken by the gas distributor:

The gas distributor conducted a leak test at 6 bar which showed that the steel pipe was free of leaks, unlike the polyethylene pipe which had completely melted.

The distributor also indicated that no incidents have occurred at danger points since 2015. Monitoring actions on danger points of the gas pipelines were conducted in 2015 and 2017, in the form of leak detection operations. No anomalies were discovered during these operations. In addition, systematic leakage detection operations were also carried out in 2015. For the monitoring of these pipelines in a confined environment, current gas utility procedures only provide for gas leak detection (by vehicle or on foot) across the entire bridge crossing, that is, outside the confined area. These procedures must be augmented to take this feedback into account.

LESSONS LEARNT

The Albertin Bridge event shows the importance of securing utility networks (telecommunication, gas, electricity, drinking water, etc.). The slightest accident on these utilities most often lead to major social problems (for 15,000 private mobile phone and Internet users, in this case).

Beyond this, several lessons relating more specifically to natural gas networks can be drawn regarding the following:

- identification among the danger points that have already been identified by the distributors or carriers (crossing of watercourses, railroad tracks, etc.) in configurations similar to that involved in the accident:
    - areas or premises where there is an abnormal build-up of heat;
    - confined spaces not open to the outside and which cannot be checked.
- development of an action plan to reinforce inspections in the areas previously identified or to study how such zones can be eliminated.