

Leak of pressurised flammable gas within a petrochemical complex

17 October 2015

Gonfreville-l'Orcher (Seine-Maritime)
France

Leaks
Liquefied gas
Petrochemicals
Subcontracting
Guidelines

THE ACCIDENT AND ITS CONSEQUENCES

At a petrochemical facility, a liquefied flammable gas began leaking on Saturday 17 October 2015 at 5:33 pm. The incident lasted 21 minutes. The source of the leak was located in a zone containing three compressors (“ethylene” compressors 1 and 2, operating in an alternating mode, with just one compressor running at the time of the accident, namely “flare gas” compressor 3). The 7 gas detectors present in the zone were saturated at 100% of the lower flammable limit. The alarms on these detectors were automatically relayed to two control rooms as well as to the main fire response station. A loud noise could be heard both on the site and in the control rooms. A gas cloud, perceptible in the form of a fog bank approximately 4 m high by 100 m long, was also observed. The upper vibration threshold on compressor 1 was reached, causing two seconds later the shutdown of the compressor motor and closure of its discharge valve. Breaching the second gas detector threshold caused the motor on the third compressor to switch off and the closure of both its suction and discharge valves. Only the suction valve on compressor 1 remained open.

Within the first few minutes, teams suspected a problem had occurred on compressor 3. Technicians from the 2 control rooms involved left their workstations to perform field reconnaissance. Only after seven minutes, was it determined that the problem had in fact arisen from compressor 1.

The facility operator's response resources were deployed on-site. More specifically, a vehicle equipped with a fire hose was able to protect, by means of a water curtain, the furnaces at an adjacent unit. Other resources were placed to create water curtains that would contain the gas cloud. The personnel in neighbouring units were requested to seek shelter.

The seriousness of the event was reassessed 11 minutes after the outbreak. The on-call team was notified at this point.

Two technicians wearing additional individual protective gear, to muffle the extremely loud noises, engaged in corrective actions by handling two valves located a few metres upstream of the compressor zone. This operation took place 21 minutes after the onset of the leak, stopping it nearly instantaneously. The cloud dissipated right away. The suction valve on compressor 1 then became accessible and could be closed by the technician.

No fire nor explosion ensued, and no injuries were reported. Also, no installations sustained damage outside of compressor 1 (with damage limited to ejection of the hatch).

The internal emergency plan was not activated. Authorities were not notified on the same day by the operator, except for the port watchman. The inspection of classified facilities service was informed of the incident the following Monday.

THE ORIGIN AND CAUSES OF THIS ACCIDENT



© Site operator

This leak was caused by ejection of the hatch on one of the check valves fitted onto compressor 1. This valve was found lying 6 metres from the compressor.

Expertise pointed a poor clamping of the studs, exacerbated by the beating of the valve joint given that this joint had not been annealed at the time of assembly, in violation of procedure. This condition, combined with a damping error of the dowel already close to the plastic deformation, caused a beating of the check valve-lamp-lid stacking sequence, plus the failure of a stud and ejection of the stack. The compressor showed no signs of operating anomalies prior to this incident.

The duration of the leak (21 minutes) was particularly wide to the following causes:

- unfamiliarity with the automation in connection with the compressor motor stop in case of trigger by the high threshold of vibration. The operators did not know that the valve of the compressor did not automatically close in this particular case and that it was therefore necessary to order this closure remotely from the control room by actuating the emergency stop button;
- operators from the control room gave priority to field intervention. As a result, the information arriving in the control room could not be integrated, as no operator remained in the control room concerned.

ACTIONS TAKEN

The first site visit by the inspectors of classified facilities cited two instances of egregious regulatory non-compliance (namely the regulation requiring all equipment be secured subsequent to gas detection, and the ban on vehicle traffic at the facility once a gas alarm has been activated), along with 11 observations focusing on:

- verification of the compliance with company requirements for all services of subcontractors involved in compressor maintenance;
- organisational improvements allowing for the permanent presence of a control room technician capable of responding appropriately to relayed alarms;
- the need to conduct an analysis of all compressors;
- update of safety reports to incorporate the risk analysis of the site's compressors, and identification of both the existing and additional safety features to be implemented;
- the necessity of activating an internal emergency plan under such conditions, with the triggering of a general siren for the whole plant and interruption of traffic and all hot spot work;
- the need to deploy resources that block vehicle access to the zone where the incident has occurred;
- awareness of the risk giving rise to fire-fighter vehicle response within the zone of the incident outbreak (exacerbation by a hot spot);
- the need to remind technicians of the emergency stop function when securing a compressor;
- the need to regularly train personnel through role-play drills of incident situations;
- study of the domino effects had the leak ignited;
- submittal of a thorough incident report.

The compressor was completely refurbished by replacing all the studs (all check valves) and reassembling the fastenings on all main linings, plus the cylinder spacer, housing spacer and brackets. The unit was placed back into service on 23 December 2015. The revised maintenance task list was shared with the subcontractor assigned to maintain the compressor. A review and update of task lists on the other compressors at the facility were also undertaken. During the month following the incident, the connection of both the isolation actuation and the automatic compressor security actuation upon gas detection were performed. A reminder to teams was issued pertaining to the functionality of systems in place for securing the compressors.

Organisational modifications were introduced as well. Once the second threshold was breached on two gas detectors, the internal emergency operations plan would now be activated, which would impose triggering the site's general alarm, thus prompting the suspension of all traffic on the site. As another direct consequence, the authorities would be informed. On the whole, the criteria for activating the internal emergency plan would be simplified.

A second inspection was conducted in order to monitor the set of requested improvements. The prescriptions listed in the applicable Prefect order were then strengthened in various ways, namely:

- permanent presence of a control room technician;
- modifications to the overall expectations of gas detectors (especially with the introduction of objectives for testability, compensatory measurements in the event of malfunction, etc.);
- specifications of actions to be taken in the event gas detection thresholds were breached;
- clarification of the objective regarding regular personnel training;
- addendum whereby these personnel drills must entail simulated incidents involving zones being managed by distinct teams;
- for compressors capable of causing hazardous phenomena with consequences extending beyond the site boundary, the emergency stop buttons must allow for complete site safety.

An unexpected internal emergency drill was also organized in order to verify that these provisions were indeed being respected.

LESSONS LEARNT

Although this incident was not responsible for any consequences outside the site, nonetheless it is still important to communicate with authorities. The town mayor expressed regret for not having been informed of this event by the site operator. By activating the internal emergency plan, this level of communication would have been better managed.

The incident occurred on a Saturday afternoon, meaning that the site was experiencing relatively little activity and vehicle traffic. At another time of the week, the cloud might have encountered a hot spot due, for example, to automobile traffic in the zone, in which case it could have ignited causing damage to the site as well as effects beyond the site boundary (between 20 and 50 mbar in the event of a UVCE type explosion). It is thus essential for technicians to be able to react very quickly using efficient means to stop the leak and prevent contributions from hot spots within the given zone.