Atmospheric pollution generated at a refinery

September 16, 1998

Petit Couronne (Seine-Maritime) France

Oil refining
Hydrotreating
Flaring
Toxic gases (H_2S)
Electric system (defects)
Utilities (steam)
Communication / Crisis management

THE FACILITIES INVOLVED

The site:

This refinery, located in the municipality of Petit-Crown (a suburb of Rouen), was responsible for producing oils, bitumen, fuels, domestic heating oil and liquefied petroleum gas (LPG). The facility was structured into 3 independent production centres. At the time of the accident, the site employed a workforce of 590 and its production capacity stood at 7 million tonnes of crude oil per year.

The unit involved:

The incident began within the electric supply network of the refinery's steam generation plant, disrupting operations at the diesel fuel hydrodesulphurisation (HDS) unit before affecting all other units present on the platform.

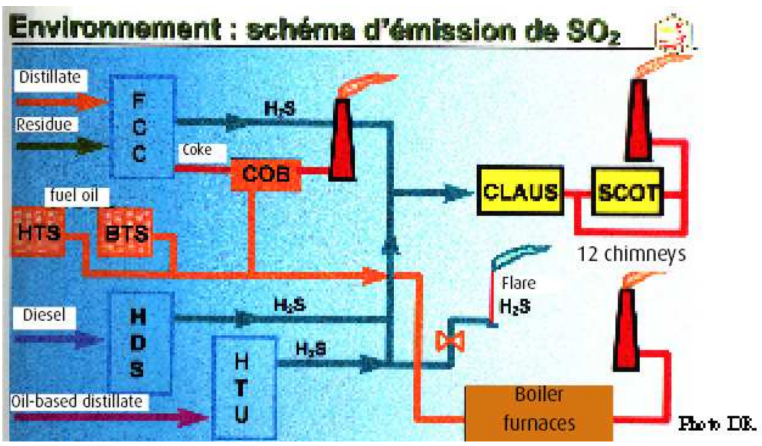
√ **Steam generation plant:**

This installation was producing steam at 46 bar and 450℃ for the rest of the refinery, especially for the HDS unit; it was composed of 4 boilers and the CO burner on the catalytic cracker. A portion of this steam was then depressurised to 22 bar or down to 3 bar, depending on user needs: the steam at 22 bar was used for the flare and served as an ejector at the HDS unit.

The refinery's electric power supply comprised two 90-kV lines; this voltage was transformed successively into 20 kV, then 3 kV and finally 380 V. The main plant was being fed by two 380-V lines. The site also contained backup diesel generators. The various stations were independent, uncoupled and never used simultaneously. The current supplied to the boiler electrical panel was 220 V.

√ **Hydrodesulphurisation unit (HDS):**

This installation served to remove sulphur content from diesel fuels until reaching a 0.05% equivalent. This reaction would occur in the presence of a catalyst within 2 reactors placed in series. The sulphur contained in the diesel was thus transformed into gaseous H_2S, which was then recovered and conveyed to the CLAUS SCOT unit. The H_2S traces remaining in the diesel were targeted for additional treatment: a steam stripper was used to separate these traces from the basic product, while a vacuum dryer coupled with a steam ejector was used to separate gases from diesel and help evacuate the device.



THE ACCIDENT, ITS CHRONOLOGY, EFFECTS AND CONSEQUENCES

The accident:

Sequence of events on September 16, 1998:

- √ 10:15 am: Shutdown of generators at the steam production plant subsequent to an electrical outage. At nearly the same time, the facility's safety mechanisms triggered a transfer of gases present to the flare.
- √ 11:15 am: The site operator notified the classified facilities' inspection authorities.
- √ 11:30 am: Operator launched the internal emergency plan and set up a crisis response unit. Sirens were sounded to initiate evacuation of all personnel subsequent to the detection of H_2S.

The air quality control network, upon request of the local DRIRE Agency, did not detect any abnormal readings from its sensors. On this day, the wind was blowing westerly - north-westerly.

- √ 11:45 am: Fire-fighters from the departmental fire and rescue services were alerted and arrived on the scene at 12 noon.
- √ 12:10 pm: The H_2S content measured at the HDS unit in the direction of the wind, inside the refinery, was in the range of 1 to 3 ppm.
- √ 12:40 pm: The sensors positioned outside the refinery were still showing zero readings. The flare flame was beginning to wane.
- √ 1:00 pm: The outside sensors were still detecting no presence of H_2S.
- √ 1:28 pm: The steam production plant was restarted.
- √ 2:15 pm: The level of "high pressure" steam once again made it possible to channel steam to the flare.
- √ 2:27 pm: End of the evacuation alert.
- √ 6:00 pm: The situation had been restored to normal as regards steam production.


Photo DRIRE HN

On the next day, September 17, all plant installations were once again operating normally.

Chronology relative to communication events among the various agencies involved:

- √ 11:15 am: The operator notified inspection authorities responsible for classified installations (DRIRE).
- √ 11:54 am: The DRIRE office was informed that the internal emergency plan had been launched, the crisis response unit activated and personnel evacuations underway.
- √ 12:10 pm: A regional television news crew arrived on the scene.
- √ 1:15 pm: A summary of the situation was faxed by the local Prefecture, which had separately been on alert for a nuclear drill, to the crisis response unit.
- √ 1:33 pm: The operator published an initial press release.
- √ 3:30 pm: A debriefing was held, in the combined presence of plant management, site personnel representatives, local political leaders, DRIRE staff and fire services officials.
- √ 4:00 pm: A second press release was published by the operator.
- √ 5:00 pm: Televised interviews with the operator and DRIRE officials were broadcast and the Prefecture published its own statement.

Consequences of this accident:

Spectacular plumes of black smoke were emitted at the flare for several hours.

The estimations available relative to discharges throughout the event were as follows:

- √ SO_2 = 48 tonnes a day averaged over 3 days: 50 tonnes on Sept. 16th, 67 on the 17th, and 31 on the 18th.
- √ H_2S = Approx. 100 litres.
- √ Dust = The quantity could not be evaluated.

For comparison purposes, the site permit allowed for the following maximum values of SO_2 emissions:

- √ on average: 45 tonnes/day,
- √ as a maximum threshold for one-time occurrences: 70 tonnes/day.


Photo DRIRE HN

The European scale of industrial accidents:

By applying 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 on handling hazardous substances, and in light of information available, this accident can be characterised by the four following indices:

The parameters composing these indices and their corresponding rating protocol are available from the following Website: http://www.aria.developpement-durable.gouv.fr.

The level 1 assigned to the "Hazardous materials released" index reflects the atmospheric discharge of approx. 150 g of hydrogen sulphide (less than 0.1% of the upper-tier Seveso threshold set at 20 tonnes).

With no human or social consequences resulting from this accident, the corresponding index was assigned a "0" score.

Given the lack of data on either environmental or economic impacts, the two corresponding indices could not be rated.

THE ORIGIN, CAUSES AND CIRCUMSTANCES SURROUNDING THIS ACCIDENT

During a planned intervention on the steam production plant's main electrical panel (switching of a 380-V power supply onto another circuit), power went out for several seconds on the 220-V network, which in turn affected the central control station. This power outage activated safety features on the flame detection system of boilers supplied from this station, causing the boilers to turn off. Moreover, the lack of steam for the entire site led to shutting down all installations.

This switching step would not have triggered the electrical outage on the 220-V network, since the panels were being backed up by battery/inverter systems. On the day of the accident however, a circuit-breaker that provided continuity between this system and the panel was left in the open position.

It should be pointed out that these autonomously-powered safety devices were not affected by the outage, which made it possible to activate installation safety features according to the normal sequence.

In the HDS part of the facility, given the absence of pressurised water vapour at the level of the stripper and ejector (responsible for evacuating the unit under normal situations), the unit was exposed to a pressure surge and liquid seals were breached, causing H_2S contained in the gaseous phase to escape to the outside.

Lastly, let's note that the air quality monitoring network sensors were located in line with this site heading both westward (Roumare, Haye Valley) and southward (Grand Couronne). Since the plume was directed mainly south-easterly, these sensors did not detect any hydrogen sulphide.

ACTIONS TAKEN

Based on conclusions drawn from two analyses of the electrical incident that triggered the release of H_2S, the operator introduced several corrective measures aimed at technical and organisational aspects.

Design of the 220-V supply systems was modified in order to avoid electrical outages during all switching operations. The changeover procedure involving the 220-V supply has since incorporated verification of the circuit-breaker position.

Liquid seals on the evacuated HDS unit system were recalculated and their design modified: the vent diameter was increased from 2" to 4".

An additional safety study was conducted focusing on risks related to H_2S during transitional phases involving the units, networks and flares.

LESSONS LEARNT

From a technical perspective, this incident highlights the importance of the steam generation plant for all installations in a refinery, along with the need for this plant's operational reliability to ensure the safety of all other onsite units. Such reliability pertains, first and foremost, to the electric supply of installations and equipment. This event underscores the double necessity of: early identification of impacts due to electric supply failures on the various safety functions; and introduction of appropriate preventive measures.

Generally speaking, this analytical approach should help plan for the power supply of priority safety functions, according to the various scenarios of available electrical power, whether or not internal backup resources have been implemented. It also seems critical to regularly test and maintain facility backup systems as well as to lay out the procedures and training programs for technicians to be called upon should conditions deteriorate. Electrical power supply is not only a key function for production capacity, but also a strategic element in plant safety.

Concerning the aspects of crisis management and communication, the activation of regularly updated and tested emergency plans (whether internal or external - for the most critical situations) contributes to a coordinated implementation of appropriate mitigation measures for each situation.

Despite the difficulties involved in characterising certain situations and identifying potential effects, it is incumbent upon those possessing information, particularly facility operators and perhaps local authorities (as events dictate), to take the initiative of notifying the general public. The description of observed anomalies must, as early as possible, be compared to benchmark values and accompanied by initial mitigation measures (either adopted or intended) so that the public is able to assess the eventual health or environmental risks incurred and respond using all precautions deemed necessary.

Partial familiarity with a situation must not impede the dissemination of information, even incomplete or pessimistic to the point of drawing the public's attention: this initial official release is then gradually complemented as investigations proceed. The lack of official communication or the inadequacy of information broadcast on observed anomalies is bound to raise questions and concerns, leading to statements based on supposition or even rumours and placing actors in the awkward position of having to provide justification.

Without waiting for the serious accident to occur, these incidents offer the opportunity to establish a well-balanced communication protocol with society, capable of including both positive and negative elements, like anomalies and the corrective measures set into place. Such a spirit of information, in real time, on the part of facility operators could eventually narrow the gap in understanding between industrial actors and the general public over the efficiency of prevention measures and their limitations, while promoting emergence of the notion of collective monitoring.