European Union Network for the Implementation and Enforcement of Environmental Law

Lessons Learnt from Industrial Accidents 2024 Seminar

Final Report

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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the European Union (EU) Member States, and of other European authorities, namely from acceding and candidate countries of the EU and European Economic Area (EEA). The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 8th Environment Action Programme that guide European environmental policy until 2030, the EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" on Flagship 5 and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

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Executive Summary

This edition of this seminar dedicated to lessons learned from industrial accidents was held on 3th of September in The Hague in The Netherlands. The goal of this meeting was to bring together Dutch and European inspectors and let them discuss on subjects offered by the organisation. It followed largely the approach of the French examples but with a Dutch twist. It was only one day and a combination of 6 cases and 2 more high level presentations on trends and data use by two national study organisations (BARPI and Dutch RIVM). This seminar is organised by IMPEL/SEVESO plus (Bureau for cooperation between national and regional SEVESO inspection partners – The Netherland)s, on behalf of the IMPEL network. 130 participants, representing 27 countries, took part in the event. 29 from outside NL. The event was organised hybrid (and recorded). 30 participants registered to join online. Many more can see it on a later date and time. The topics covered during the seminar were mainly focussed on incidents related to new energy carriers hydrogen and the ones related to the pressure on the power grid and related power outage and effects on industry.

Safety culture was often mentioned. The examples show that this is something that could be taken onboard in future seminars. The more widely recognized picture of declining numbers of major incidents does not help to keep focus. Other lesson is that even at less risky thought activities, things can go very wrong. It was discussed that inspectors should put more effort in evaluating safety studies from companies. Jerome Bai of the French accident investigation centre Barpi gave an insight into how their database of 60,000 French incidents could be used. If combined on a European scale this would greatly improve insight in trends and where to focus on during inspections. Chairman of the DCMR board and Regional Minister of Zuid Holland, Meindert Stolk, concluded the meeting. The evaluation showed that there is a clear need among the inspectors for this kind of substantive knowledge exchange.

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1. Lessons Learned From Accidents seminar The Hague The Netherlands 3rd of September 2024

On September 3rd 2024, there was a meeting Learning from accidents (LFFA) where lessons learned from incidents were exchanged between European Seveso supervisors. It was organised by the Expert Team Industry & Air of Impel together with the Dutch SEVESO plus partners from DCMR, Dutch Labour Inspectorate and LEQ (Fire department). The following points of attention/recommendations can be analysed.

1. Try to create big data with the data on incidents that is available in all kinds of European countries, but start in the Netherlands. This will allow you to do better trend analyses in the long run and learn lessons on how to prevent this in the future.

   The presentations by RIVM (story builder) and BARPI (ARIA database) show that there is a lot of data on incidents in Europe. In order to extract trends even better, it is important to arrive at big data. It is advisable to discuss the sharing and merging of data about incidents in the context of IMPEL and to see if and how this can be achieved in the short and medium term.

2. Use the ARIA database to generate possible points of interest/priorities for Seveso supervision or for supervision of Seveso companies.

   Explanation: in an example of what the system can generate, it was shown that climate change is increasing the number of incidents. It will be interesting to see if this picture also comes from analyses of other incident databases. E.g. from story builder, Beacon etc. It was striking, for example, that drought also causes incidents. Another topic mentioned that you can look at within the ARIA database is, for example, due to 'power (outage) related incidents'.

3. Periodically include the assessment of HAZOPs in the supervision of Seveso companies. In particular, the critical LODs and the way in which the HAZOP came about require attention.

   *Explanation: a*fter incidents, the HAZOP is sometimes reviewed. In retrospect, it is signalled that it was incomplete or had insufficient safeguards built in.
   One of the reasons is that due to the scarcity on the labour market of qualified technical personnel, more and more employees are performing activities for which they have insufficient knowledge. It is especially important to know who (which knowledge teams/specialists) and how the HAZOP has been set up. This already gives an idea of the quality. Most common incidents with valves (valves/valves) are common.

4. All Seveso inspectors follow Valves training.

   Explanation: many incidents involved valves that did not close properly. There were inspectors in the room who indicated that the most important lesson is that valves can always leak. It turns out that not everyone knows this lesson. So in the HAZOP and during checks, always look at how critical the valve is in the LOD. And whether the quality of the 'valve' is sufficient for this and/or whether the risk in the event of failure is acceptable.

5. Actions in the event of a power outage

   - Make sure that in the event of a power outage in an area/at a company, you have an overview of the entire chain that is affected by each company.
   - Have an idea of the state of the electricity network/utility network of providers. Is continuity of supply guaranteed and what agreements do companies have with their providers about this?

   *Explanation: m*ore and more incidents occur because the electricity network is outdated, poorly maintained or because demand cannot be met. It is unclear how these providers communicate about this to their customers. It is therefore important for a company to ask about this.

   Furthermore, it appears that it is not always clear what the effect of an outage will be on the other companies in the chain. This is mainly because there is no complete picture of the chain, at least in the government. The insights from Domino may be inadequate or impossible to generate at the touch of a button.

6. Also pay attention to low-risk installations in supervision.

   Explanation: low-risk installations within a plant often fall under a different safety culture. Changes in procedures do not always lead to an MOC. The case was about the danger of nitrogen. This danger is often underestimated. Often resulting in deaths.

7. Continue to pay attention to safety culture

   Explanation: in many cases, it emerges that a company's safety culture was insufficient. So it remains a concern.

2. Summary of presentation 2: Learning from Seveso Accidents with storybuilder by Henk Jan Manuel and Mark Spruijt from RIVM

- Storybuilder MHCA:
  - Incidents at Seveso establishments with hazardous substances.
  - Reported to and investigated by the Netherlands Labour Authority.
  - Since 2004: 372 incidents entered. (+ 15 more this year).
  - Administrative data: company type, type of incident, process stage, hazardous substance, equipment involved, type of injury, etc.
  - Measures: to prevent incidents and reduce effects. In 6 Lines of Defense. Per measure examined how and why it failed.
- What (summaries per subject)
  - The database contains 372 incidents with summaries. Searchable by keywords to perform your own analysis.
  - Example: supply chain safety is no criterion in the database, but a collection of summaries was made by searching on 43 incidents with (sub)contractors.
  - From that collection, it can be seen that 'Safe start-up of processes and activities' is 2x more important and causes 3x more casualties among contractors.
  -
- **Lessons learned**

  Procedures.
  - Is work really being done according to instructions, procedures, permits? And do you discuss it, if it doesn't happen? (Maybe it can be done better, faster, but if that really can't be done, explain why not).
  - If work is done according to the instructions, are these adequate for all circumstances? (Were they tested "in anger"?)

  Deviations.
  - In 50% of the incidents no (or no adequate) indication of a deviation.
  - Are there enough possibilities to detect deviations and handle these?

  Foreknowledge.
  - Even the simplest changes in a process can have severe consequences.
  - In retrospect most incidents where never foreseen.
  - Do we think of everything in HAZOP studies and the like?
    - => Use the summaries/database: can this happen here? What safety measures do we have?

With the Storybuilder database you can search for common causes. It is publically available from the site:

https://www.rivm.nl/documenten/download-storybuilder-applicatie

More information on the website:

https://www.lerenvoorveiligheid.nl/leren-van-ongevallen/analyse-van-incidenten-met-chemische-stoffen-bij-seveso-bedrijven

3. Summary of presentation 3: how to use the ARIA database by Jerome Bai from BARPI

What is BARPI

- Bureau for Analysis of Industrial Risks and Pollutions (part of the General Directorate for Risk Prevention of the French Ministry of Ecological Transition)
- Established in 1992 and based in Lyon (France)
- A team of 10 people and 4 contractors

Mission Barpi

- Collecting information relating to industrial incidents / accidents in a database called ARIA
- Analyzing these accidents, based on the information received, up to root causes
- Detecting trends and focus of attention
- Disseminating / sharing lessons learnt from accidents (experience feedback) through various formats (exchanges / publications / seminars…)
- Participating in the development of regulations
- Providing technical support to inspectors of classified facilities

in the analysis of accidents and the definition of root causes

ARIA database (since 1983)

- 60.000 incidents (90% in France)
- 1400 fields of information (900 for ICPE: Classified Facilities for Environmental Protection)
- 150 new events per month (around1800/year)

Structure of accidents / incidents in database

- site / facility / building description
- time / location / hazardous phenomena (fire, explosion or release)
- course of the accident and intervention of emergency services
- Consequences
- Visible and root causes
- Lessons learnt and corrective actions implemented

ARIA web site: https://www.aria.developpement-durable.gouv.fr/ (Gives access to Barpi publications and search tool on accidents)

4.1. Summary of presentation 4.1: Incidents at a hydrogen plant.

In March 2018, the first permission for the power to gas site was announced. It included the cooler, the compressor, the control room, the electrolysis with purification and drying unit, the storage, the trailer filling station and a research facility. The electrolyser is an alkaline electrolyser with 1 MW and produced at 20 bar and 80°C about 200 Nm³/h hydrogen. The hydrogen is den purified to a 5.0 purity by removing contaminations and humidity. After that, the hydrogen is compressed to 300 bar; the storage can contain about 1,2 tons hydrogen. There are three trailer filling point to fill hydrogen trailer at 200 bar.

First incident

Operation started in December 2019. In June 2020, the first incident happened: a fire in the vent line. The vent line is a collecting vent line, which collects hydrogen streams from several points: - Safety valves of: o the electrolyser (30 bar) o the compressor (30 to 300 bar) o the storage (300 bar) - Regeneration of drying unit (30 bar) - Venting and safety valves from the trailer filling station (10 to 200 bar) In June 2020, an employee detected a flame at the outlet of the hydrogen venting line during trailer filling. He saw the air shimmering around the blowout. The operator made a plant shutdown and tried to find out the cause. They found a not fully closed hand valve. After closing this hand valve they discovered no further problems and the restarted the plant and continued to fill the trailer. In the evening the informed us – the regional authority about this incident in the morning. In addition, the way of communication was not how we told them to do. After we got the information, we directly ordered the immediate shutdown. In the evening two of my colleagues were at the plant, they had an inspection not far away. At the blowout of the collecting vent line, you can see very well the tempering colours. For us it was a real surprise to find a sharp-edged perforated plate at the blowout. The operator installed this plate because they feared small birds could nest there. This is not necessary because birds do not use nest places where frequent blowouts take place. So at least the hydrogen would have been ignited at this sharp-edged plate. In addition, the operator did not think about if the assembly of this plate could have any consequences for the plant. They were not able to answer to questions like reduction of cross section and change of backpressure of safety valves. They have an extern immission protection officer but they did not inform him about the change – and neither about the incident. As before mentioned, a not fully closed hand valve in the trailer filling station was the cause for the hydrogen release. After connecting the trailer with the connection line of the station, all the trailer lines and connections are flushed backwards from trailer to station with the remaining hydrogen pressure in the trailer. This flushing stream is also released by the vent line to the blowout. This flushing has to be done several times and therefore the upper hand valve must be opened and closed each time. For the operator it is not visible or touchable if the valve is fully closed or not. After closing of the valve – the operator assumed it fully closed – the trailer filling was started. However, this valve was not fully closed, so the hydrogen could go the way direct from the storage to the blowout. The ignition took place already in the vent line or at least at the perforated sharp-edged plate. The authorised expert supposed several measures; here are some of the most relevant: – A temperature measuring is installed to detect a hydrogen fire. This measurement is connected to the process control system. - 2 - – The hand valve will be changed from a valve rod with a ballpoint to a regulating tip. Due to the ballpoint, already a little opening leads to a relative high section where hydrogen can be released.

Second incident

The operation of the plant restarted in September 2020. In June 2021, alkaline was release from the electrolysis stacks. Nearly one year later, we got the information from the police that an explosion with release of alkaline took place at the same electrolyser plant. The operator told us, that an abrupt leak at the stack lead to a short circuit and the release of alkaline at 30 bar and 70°C. This release caused the smokescreen of the production room. The process control system directly made a plant shutdown. No employees were in the electrolyser room and outside no impacts were detected. After dismantling the following causes were identified: o During assembling of the cells to the stack, mechanical deformation at the micro lines took place. o Therefore and because of deposits coming from the activation of the electrodes, it came to blockades of alkaline lines. This resulted in local high temperatures, which destroyed the membrane. The mixture of hydrogen and oxygen with the presence of electricity leaded to the explosion. The frame of the stack was damaged and alkaline was released to the electrolyser room. The stack producer informed all other sites, which used this stack. A new construction method should prevent from mechanical deformation of the micro-lines. The deposits of the activation of the electrodes cannot totally be avoided but with flushing and controls the expected to have a better situation. To avoid splashing of alkaline the new stacks have a cabinet with lamellar structure so that the heat is not blocked in the cabinet. In addition, the entry to the electrolyser room is only possible through the process control system room, so that it is easy for the operator to get information about the status of the plant. This status is now also visible with lights outside. At the entry, a board with presence cards is installed. The restart with new and different stacks took place in March 2024. As a result, you can see that the operation is intermittent with no long-term practice.

Expansion

In June 2024 the company got the new permit for additional 5 MW electrolysis (PEM) with a compression to 500 bar, an additional storage about 3800 kg, four new trailer filling points with 200 and 500 bar. The new unit will be connected to the existing storage and to the existing trailer filling points. The maximum quantity of hydrogen on site will be 12,8 tons. So: welcome to Seveso!

Lessons learned

- Hydrogen is not new, but many operators are new to all that.
- Time pressure due to government R&D funding and new regulations, e.g. EU “green hydrogen”.
- Many proposals from companies with lots of advice and consultation by the authorities.
- No proposal is the same, different questions and concepts.
- Very few experienced third-party experts for hydrogen (outside of refineries)
- The location of the plant is significant for the permitting process.
- Until now, little experience from incidents at new hydrogen plants, especially with electrolysers: Hydrogen Incidents and Accidents Database HIAD is now - 3 - available as an EXCEL file.

Version HIAD 2.1 can be downloaded from:

https://minerva.jrc.ec.europa.eu/en/shorturl/capri/hiadpt o Lessons learned from HIAD 2.0: Inspection and maintenance to avoid hydrogen-induced material failures, Computers & Chemical

Engineering, Volume 173, May 2023, 108199 https://doi.org/10.1016/j.compchemeng.2023.108199
o Statistics, lessons learned and recommendations from analysis of HIAD 2.0 database, International Journal of Hydrogen Energy, Volume 47, Issue 38, 1 May 2022, Pages 17082-17096 https://doi.org/10.1016/j.ijhydene.2022.03.17

4.2. Tear of an H2 hose in the cylinder pack handling

March 2019, Italy

1. <u>The accident and its consequences</u>

The accident occurred in March 2019 at a site that produces technical gases using hydrogen cylinder packs. The site produces oxygen, nitrogen, and argon by fractional distillation of air.

The packs are constituted of hydrogen (90 kg) used for the purification of Argon: the impure Argon (O_2) is sent to 2 reactors with a catalyst where, thanks to the Hydrogen, it is purified from the Oxygen (with the formation of H_2O). In the site were present 5 packs of 20 hydrogen cylinders of 0.05 m^3/each (10 Nm3 each), charged to a pressure of 200 bar: 2 packs connected to the distribution system control unit, via a 5 barg and 6 Nm3/h line, while the remaining are in standby.

During the movement of a pack of H_2 cylinders, the operator, in order not to leave the hose hanging without support, hooked the hose disconnected from the empty pack to a pack in service. Once the latter was exhausted, when disconnecting it to move it, the next operator, not realizing the hose was attached, tore the hose.

There was a little release of H_2 (no trigger) with no injuries to the operator involved. The only damaged equipment was the hose connection. In the Risk Analysis, the Release of hydrogen due to rupture of the 1/2” pipe at 5 bar was hypothesized.

2. <u>The origin and its causes</u>

Due to distraction, the operator leaves the anti-tear cable of the empty station attached to the package to be handled.

Identified a lack of a procedure for handling the pack of cylinders, in order to safely manage the preliminary control phases and checks, the correct operational actions and activities to be implemented, the closing phases of operations.

There was no further information on the plant modification following the event and related risk analysis, as the manager treated it as an action following the analysis of the causes. Furthermore, no specification of the critical technical system (hose connection) involved.

In fact, the "ACCIDENT REPORTING AND ANALYSIS" procedure was not thorough with regards to the description of management factors, critical technical systems, and planned/scheduled actions, highlighting safety reviews and risk analyses, in the case of specific interventions to be implemented on the plants such as actions resulting from the analysis of the causes (Management of Change).

3. <u>Follow-up actions taken</u>

The site manager disseminated information about the event through specific staff training, with particular regard to: the description of the event, causes and consequences; corrective actions taken in the short and medium time; and Planned/scheduled actions with organizational and management implications.

The modification of the fuel system was implemented, consisting in the “Installation of a wall duct to house the hoses of each pack and thus exclude the possibility of hooking the hoses onto other packs so as not to leave them hanging (minimum possibility of human error)”. The registration of the Change has been prepared retrospectively in line with the provisions of the management system in force, reporting the following information: the actual dates of completion of the intervention, with the signature of the Manager in charge at the time of the event; no further assessments and actions to implement emerged.

An Operating Instruction has been defined in the Plant Technical Manual, with indication of actions to be followed in succession by the operator, so that the possibility of committing human error is reduced. In the instruction, there are indications about checking, before any action, which ramp is actually in service using the arrow on the selector and not attaching the hose to other hydrogen packs.

Following the issuance of the operating instruction, information and training were provided to all site personnel, in particular the operators assigned to the activity in question.

Finally, signs have been placed on the field, so that it can be consulted in case of doubts.

4. The lessons learned

Apparently insignificant risks are underestimated due to the ease of execution and repetitiveness of the operations (routine). It is necessary to verify all the causes of accidents, as well as evaluate the impact of even the less significant and low probability ones

Operational errors, in the case of negligence and/or hurry, are the effect of a corporate safety culture not adequately developed: any "shortcut", to save time/money, combined with the lack of formalization of good practice, involves taking unnecessary risks.

The commitment to safety of managerial figures influences the behavior of workers, overestimating operational errors. Supervisors must monitor the correct execution of specific risk activities and Operators must demonstrate their knowledge through the use of correct work instructions and participation in training activities.

It is necessary the improvement of the operational experience analysis, through the exchange of information on accidents that have occurred with establishments carrying out similar activities, with the support of trade associations. Furthermore, the analysis of events must deepen the description of the related management factors as well as the critical technical systems, keeping track of them in the documentary analysis.

Finally, the site managers must communicate and disseminate information at all company levels through: specific training sessions on the analysis of operational experience, carrying out specific learning verification tests; updating/refreshing of field training on Operational Instructions, especially if connected to specific events; discussion of the findings at the review system meetings.

5.1. Leakage of a reactor due to failure of preventive maintenance

13/02/2020

Region of OD Groningen

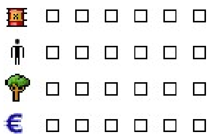
The Netherlands

Preventive maintenance

Reactor

Leakage

THE ACCIDENT AND ITS CONSEQUENCES



On February 13, 2020, a slurry of chlorine, hydrochloric acid and PVC spouts from a hole in the bottom of a 20-year-old titanium reactor. All 6 chlorine detectors in the room in which the reactor is placed are activated and measure 10 ppm (maximum measuring range detector is 10 ppm). The room extraction is activated, installation is secured and personnel is evacuated, emergency services are alerted. Water screens are placed outside the building to direct and dilute the chlorine vapours.

Air measurements are also carried out in the immediate vicinity. This shows that the concentration in the outside air quickly decreases (from 6 ppm in front of the water screen to 1 ppm chlorine behind the water screen). 17 tons leaked from the reactor, of which 30 kg chlorine.

Given the large amount of waste, inaccessibility of the seat of the fire, the risk of building collapse and the inaction of the operator, the public authorities decided to demolish the building, before setting to work on the piles of waste and spreading them to reach the burning areas and water them abundantly. About 6,000 metric tons of waste (about 7,500 m^3) had to be removed urgently to allow the intervention of the fire engines. The fire was finally extinguished 47 days after the outbreak. About 15,000 m^3 of waste was burned.

In the first days, an air quality monitoring station was set up near the site. Bulletins and health recommendations were released to the public. The PM10 particulate matter alert threshold was exceeded on 12 days, but acute toxicity thresholds were not.

THE ORIGIN AND THE CAUSES

In preparation for the start-up (end of January) after a shutdown of a number of days, the supply lines were flushed through the reactors. This requires the reactor to be filled with at least 150 litre of water during a stop period. In this case, after the tanks and reactors had been flushed, they were not filled up again, as the start-up would take place shortly afterwards. The chlorine supply line to the reactors was filled up to valve VSP2 shortly before start-up. In reactor 2, valve-2 let through and also the subsequent valve VSP1. As a result, chlorine come between valve-2 and valve-1, which subsequently dripped as liquid (dry) chlorine through the chlorine sparger at the bottom of the reactor. The titanium of the reactor wall reacted with the dry chlorine, causing damage to the reactor wall. In the following 2 weeks, this corrosion under the influence of hydrochloric acid continued. The hole in the reactor was formed on February the 13th.

The root cause is the passage of VSP2 due to the failure to perform preventive maintenance. Subsequently, the incident could have taken place due to a combination of a number of factors. Namely the passage of valve-2 and valve-1, which resulted in liquid chlorine standing between the two valves in combination with a completely empty reactor. Note that the safety of 150 L of water on the bottom was not there in the period between rinsing and start-up.

FOLLOW-UP ACTION TAKEN

The risk evaluation shows that additional safeguards are desirable. One of these is

the replacement of manual addition of the water dose by automatic addition of the water. After each pump from the reactor, 150 L of water is automatically dosed. This is secured in the DCS system. A second safeguard is that before chlorine is applied to valve-2, the reactor must be filled with water. It was investigated whether an additional safeguard should be introduced. This concerned an extra valve between valve-2 and valve-1 with a barrier of either negative pressure (block & bleed) or nitrogen pressure in between with a monitoring and surveillance system. This system ensures a controlled environment at all times.

The measures taken and the measures still to be taken will prevent a recurrence of the accident. Taking the first 2 measures results in a too low risk reduction. Therefore, an extra measure will be taken to ensure that no chlorine is present between valve-2 and valve-1 if this is not desired.

The course of the accident shows that the occupancy rate was not sufficient and the staff was not sufficiently trained to operate certain systems during accidents.

LESSONS LEARNED

The identification of the hazards and the assessment of the risks was not yet fully completed. The accident scenario had not previously been included in the HAZOP study. This was adjusted after this experience. The danger of accelerated corrosion of the reactor due to chlorine is now recognised. However, the likelihood of this happening may be underestimated as a double valve in series and manual water addition to the reactor was considered sufficient.

No measures are described for the suspected cause: temporary encrustation of a small contaminant (iron chloride) on valve 2 and valve 1. The maintenance of these valves was based on corrective maintenance. As a result of the incident, the valves have been replaced and preventive maintenance is taking place.

5.2. Summary: Potential long term power outage at company X

22/09/2023

Netherlands, Brabant

<u>THE ACCIDENT AND ITS CONSEQUENCES</u>

First of, this was not an accident but a near miss.
On 22-09-2023 Company X informs the environmental services of an exceptional situation (ongewoon voorval). *'The main power supply cables, which power the entire site, show significant wear and are on the verge of failure'.* This situation raised alarms among various authorities due to the limited information provided. Consequently, the electricity provider and Company X were asked to supply more details and conduct a scenario investigation. The findings are as follows:

- Currently, safety is not at risk! In the worst-case scenario, if the power fails, the installations will shut down according to standard procedures, as was experienced during previous 'power dips';
- The cables will be replaced, and temporary measures will be implemented to ensure safety at the site and its immediate surroundings.

The local authority is highly concerned and is considering declaring GRIP 2 (Coordinated Regional Incident Management Level 2).

Situation Description
Company X's site hosts numerous installations, including a Phosgene and Chlorine plant. The power to these plants is supplied via four cables each. Additionally, there are two large generators on site capable of powering both plants. However, the Phosgene plant is currently vulnerable due to the following issues:

- Two of the four power cables are broken, and the remaining two are about to fail.
- The large generator for the Phosgene plant is undergoing major maintenance and is unavailable.

The Chlorine plant also faces challenges:

- All four power cables require replacement or repair, though they are not expected to fail imminently.
- The large generator for the Chlorine plant is 'end of life', meaning its functionality is not guaranteed.

Potential Consequences
Both Phosgene and Chlorine are extremely toxic. The release of these substances into the surroundings could cause a serious incident. The release of Phosgene is rated by the Regional Emergency Response Services as a disaster scenario and would heave a profound impact on human health in the vicinity.

<u>THE ORIGIN AND THE CAUSES</u>

This near miss was caused by aging of the power cables. The cables are underground beneath the road and lack protective sleeves. Heavy traffic in this area caused significant vibrations, leading to hairline cracks in the cables. Over time, moisture penetrated these cracks, eventually causing the cables to break down.

FOLLOW-UP ACTION TAKEN

The Seveso team decided to have a meeting with company X, where the company informed them of the plan to repair and replace the cables of the Phosgene plant. Later, it was found that repairing the cables was impossible, meaning all cables had to be replaced. As a temporary measure, many emergency generators are required to provide sufficient power during this operation.

However, this required several permits. These permits were initially not issued by the local authority due to the nitrogen deposition problem currently faced in the Netherlands. Eventually, the necessary permits were issued as a ‘toleration’ permit under the umbrella permit of Company X.

The authorities insisted on an in-depth investigation to determine whether Company X was prepared for a prolonged power outage. After some discussion, it was decided that the Regional Emergency Response Services would perform this investigation. The installation scenarios from the phosgene plant, being the scenario with the most profound impact on the surroundings, were to be used as input. The following Lines of Defence (LOD’s) were to be investigated:

- Phosgene plant emergency system
- Power supply to on site fire department and equipment
- Power supply to fire-water pump system
- Availability of on site fire department members
- Other: Lessons learned from sitewide power dip 2022

The conclusion of the investigation was that Company X appears to be prepared for emergency power shutdown even for an extended period.

LESSONS LEARNED

- **Interest & Urgency**
  - Differences in interests and sense of urgency with the stake holders negatively influenced the process.
    - What is the real and realistic risk?
  - Different considerations at operational, management, and administrative levels.

- **Information & Communication**
  - Assemble the right commission with the appropriate stakeholders.
  - Does the commission have the right competences and knowledge?
  - Does the commission share the same perception?

5.3. A differentiated approach to incident investigations by Rob Paumen from the Dutch labour Inspectorate

Some facts

- 5.000 accidents reports per year
- 2.500 investigations per year
- 50% enforcement actions (until 2023)
- Underreporting 50%
- 50 – 70 fatal accidents per year
- 8 regional teams & 1 criminal justice team
- In total approximately 200 inspectors

Old method of accident investigation

1. Reporting accident
2. Inspector to the location of the accident
3. Starting the investigation
4. If necessary: Direct inforcement
5. Investigation causal connection
6. If Causal connection: Fine report
    a. Motivate violation
    b. Facts and circumstances
    c. Ground for moderation
7. Consequence: possibly a fine

Why an new working method?

- Fines often do not lead to improvements in working conditions
- Stimulating companies' learning capacity
- Investing in safety throughout the company (underlying causes)
- Political call to learn from accidents
- >70% inzet repressive work

In short: **Learning** in stead of punishing

new working method

After reporting of accident->

- Inspector to the location of the accident
- Starting the investigation
- Record facts and circumstances

- Request relevant documents
- Request employer reporting and improvement plan
- Investigation by employer
- Disapproval: possibility tot improve reporring
- Second disapproval: resume investigation by inspector
- If approved: Follow-up inspection of the improvement plan

Exceptions

- Fatal accidents
- Exceptionally serious injuries
- Minors
- Social impact
- History
- Exceptional situations

First lessons learned

- Hardly second disapprovals, but regularly a first disapporval
- Enforcement with follow-up inspection approximately 10%
- Time saving (van 37 naar 21,5 uur per investigation)
- Satisfaction inspectors sometimes negative

5.4. Nitrogen asphyxiation due to lack of risk awareness

Nitrogen asphyxiation

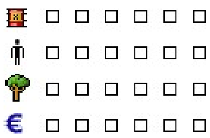
In silo building (confined space)

29/09/2016

Dutch labor inspectorate

South-West region

THE ACCIDENT AND ITS CONSEQUENCES



On September 29, 2016, the Dutch labor inspectorate received a report from the police that a fatality had occurred in the polyurethane factory of Dow Benelux in Terneuzen. The victim had probably become unwell due to lack of oxygen or possibly due to inhalation of nitrogen. Attempts were made to resuscitate the victim, but without success

THE ORIGIN AND THE CAUSES

The accident took place in a silo building. An operator entered the silo building without taking the precautions prescribed in the entry procedure. He wasn't wearing a personal oxygen monitor, there was no second person on guard, he didn't close the nitrogen valves outside the silo building and he did not follow the lock & key procedure.

The silo building was intended for the storage of sugar, the raw material for the production of polyols.There are two silos in the silo building, a storage silo (S1) and a weighing silo (S2) to transport a measured amount of sugar to the reactors. Nitrogen pressure is used in the silo building to transport sugar from the silo (S2) to the reactors and for flushing the filter installation of silo S1 on top of the silo building.

When the accident occurred, the concentration of oxygen in the silo building was greatly reduced, causing the victim to suffocate. The investigation has shown that various technical failures have led to nitrogen leakage in the silo building. It appears that the level measurement of silo S1 was defective and the membrane valves of the filter installation were stuck in open position due to caked sugar which created a continuous flow of nitrogen into silo S1. This could happen because no preventive maintenance was carried out.

The installation was not considered a high-risk installation. The installation has been modified several times over the years, but these changes have not been recorded. For example, no one appeared to be aware of the fact that the filter installation on the silo building was connected to the factory's nitrogen network in order to flush the filter. According to the P&ID in the entry procedure the filter was flushed with compressed air. Due to the absence of risk awareness, there was no preventive maintenance carried out. Because personal was not aware of the risks involved, it had become normal to walk in and out of the silo building without taking precautions.

FOLLOW-UP ACTION TAKEN

The accident resulted in a criminal investigation and in a conviction of Dow. Dow had to pay a fine of 500.000 euro. In the verdict the judge took into account that Dow fully cooperated with the investigation of the Dutch labor inspectorate and that the Dow global organization also carried out an investigation.

After the accident Dow made several improvements:

- The silo building was demolished and a new one was build
- Life critical standards were renewed
- More attention for (risk) awareness by organizing toolbox meetings.
- Dow made technical changes to the installation
- Inspections and maintenance are improved
- Procedures are improved
- More attention for compliance with working instructions
- Internal audits with the subject entering confined spaces are organized

After the accident I unfortunately never had the chance to view the improvements Dow made.

LESSONS LEARNED

At Seveso establishments the focus is on the installations with the highest risks. This applies to the companies, but also to the inspectors.

Employees working with low risk installations have less risk awareness, despite that they are working in a Seveso establishment.

No preventive maintenance is carried out when an installation is considered as “a low risk installation”.

There is no such thing as a shared memory, so it is very important to properly record changes to installations.

The dangers of nitrogen are underestimated, why is nitrogen not considered as a dangerous substance? In industrial plants the use of nitrogen is as common as the use of water or air. It is my opinion that this should not be possible.

Annexes

Agenda

Learning from incidents– The Hague, The Netherlands
Impel Expert Team Industry and Air
&
Dutch Seveso plus partners

Tuesday 3rd of September 2024

Venue

PZH provincial government house Zuid-Hollandplein 1 The Hague

Monday 2th of September
Informal drinks at own costs for Impel members that arrived early at 20.00 in bar Cloos on plein 12 in central part of the Hague

Tuesday 3th h of September - 09.30 – 16.00

On-site registration *Day 1, 09:30 – 10:00*
On site registration and badge collection and sign in of on site participants (Impel guests must sign the attendance list)

Session 1: Welcome & Opening

Day 1, 10:00 – 10:20
Erwin de bruin (Seveso+ coordinator) and Marinus Jordaan (Impel Expert team leader Industry and Air)

1.1 Welcome by host
1.2 Welcome and short intro to program by Marinus Jordaan & Erwin de Bruin
1.3 Household explanations (wifi, emergency exits, logistics etc) **by Marinus Jordaan**

Session 2: RIVM, National centre for health and environment, learning from Seveso accidents in the Netherlands

Day 1, 10:20-10:45 speaker Henk Jan Manuel and Mark Spruijt

Session 3: Barpi, Bureau for Analysis of Industrial Risks and Pollution
How to use the ARIA database with thousands of French accidents by Jerome Bai

Day 1, 10:45-11:15 : Speaker Jerome Bai

11:15 – 11:30 short coffee/tea break

Session 4: Diving deep in 3 cases

Day 1, 11:30 – 13:00
Chair: Erwin de Bruin

4.1 accident at a hydrogen plant *in Germany by Mareike Strub from regierungspräsidium Freiburg*
4.2 accident with a hydrogen cylinder pack in Italy by Romualdo Marrazzo from ISPRA
4.3 accident with large acetic acid spillage at Indorama from Lucas Sluijs from the Dutch Safety board and Michael Chau from DCMR

13:00 – 13:45 ''walking Lunch''

Session 5 – Another 3 cases

Day 1, 13:45 – 15:45
Chair: Kees de Kraker

5.1 accident chlorine leakage from container at Dutch chemical plant by Harold Pijnenburg (ODG) and Stuart Gunput (ODNZKG)
5.2 accident power cut at Seveso company from Rob Kerste en Gert Castelijn working at the Dutch firefighting department Midden West Brabant
5.3 A differentiated approach to incident investigations by Rob Paumen from the Dutch labour Inspectorate
5.4 Accident at Dow Benelux, a differentiated approach from the Dutch labour inspector Ruud Jansen

Session 6 – Closure of conference
Day 1, 15:45 – 16:15
Chair: Marinus Jordaan

6.1 Last words by host provincial executive Meindert Stolk
6.2 Observations and summary of the day, evaluation by mentimeter cloud

16.15-17:30 drinks and some typical Dutch snacks
Time do do some networking/exchange contact info

19:00 Evening diner for international guests and speakers & walk through town
After a nice dinner offered to you by Impel we will also get to know The Hague a little bit better on a after dinner city safari