Dangerous chemical reaction at a waste recycling plant in Finland

Finnish Safety and Chemicals Agency (Tukes)

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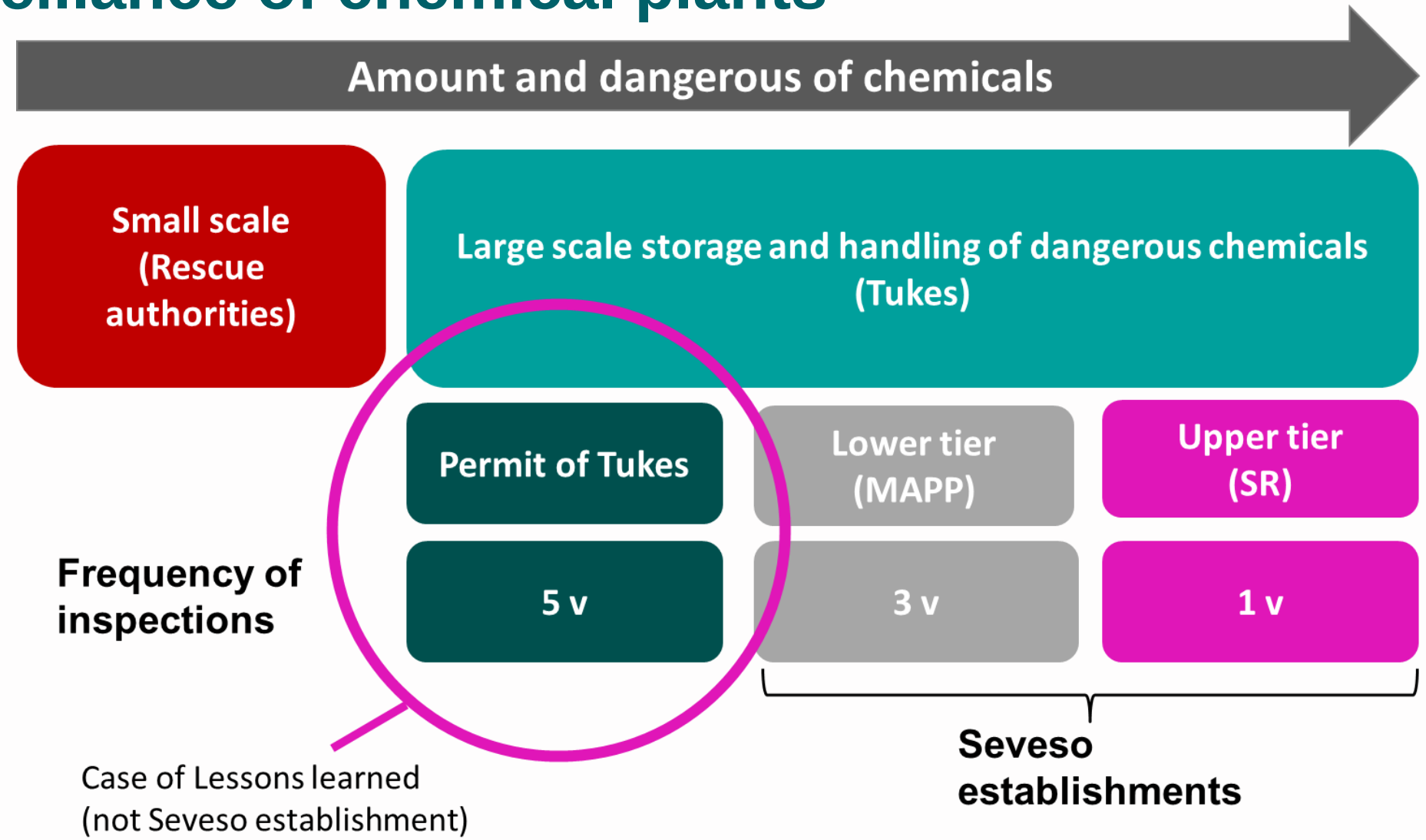
The aim of the presentation is

- to describe the accident and ”lessons learned”

Why this case is presented here in MJV

- The site was not a Seveso site – however it should have been lower tier site
  - Challenges:
    - the classification of waste
    - How to take into account dangerous substances which may be *generated during the loss of control of the process?*

Surveillance of chemical plants



Dangerous chemical reaction at a waste recycling plant in Järvenpää on 19 September 2022

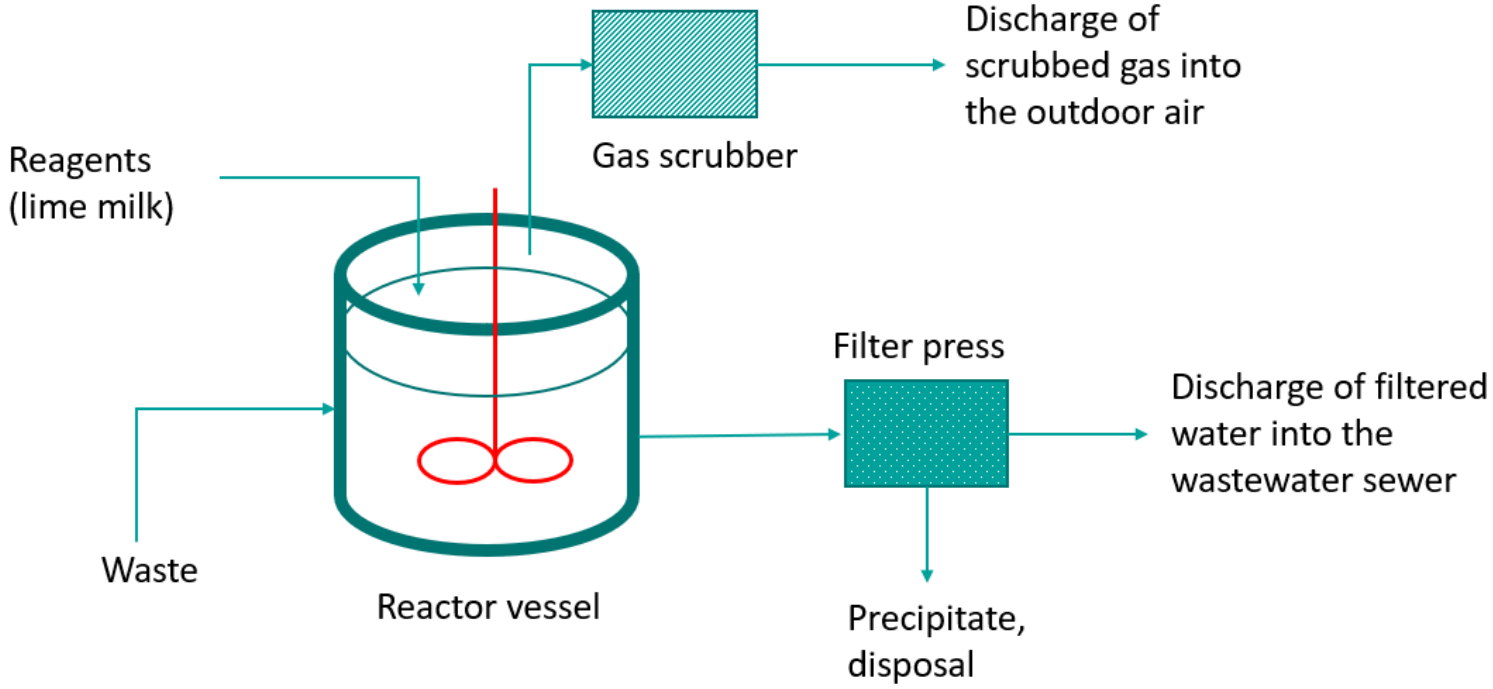
Accident investigation

Investigation team: Senior Officers Timo Talvitie and Aatu Isotalo

Description of the event

Description of the event → Analysis → Lessons learned

- **Liquid acid and metal salt solutions** are delivered to the processing plant for hazardous waste chemicals **for neutralisation and precipitation.**
- Chemicals are processed in reactor vessels as a batch process.



Description of the event

- A **solid metal salt precipitate was stuck in a reactor vessel**, and it had to be removed.
- Employees decided to **remove the precipitate using mixed acid waste** delivered for processing, which contained ***hydrogen fluoride, nitric acid and acetic acid***, as well as their reaction products.
  - The mixed acid waste was pumped into the reactor vessel over the metal salt precipitate and left there to act.
- The mixed acid waste **started to react** with the metal salt precipitate, generating a toxic gas, which **was released** from the reactor vessel **through an open sampling connection**.

- Top of the reactor vessel
- The **sampling connection** through which the gas was released into the facility is highlighted by the red arrow.
- The sampling connection is covered by a **cover plate held in place by a clamp**.

- Image: Tukes

Description of the event

- The two shift employees **detected the gas leak and tried to stop the reaction by feeding neutralising lime into the vessel** (lime milk).
  - To do this, they had to start a pump and turn manual valves **in the facility filled with toxic gas**.
- One of the employees **died after being exposed to the gas, regardless of the safety mask worn and first aid administered**.
  - **Rescue services were called after the unconscious employee had been carried out of the facility.**

Description of the event

- Rescue services delivered **the exposed employees to emergency care and isolated the dangerous area**.
- **People living in the area were warned** during the accident using an emergency population warning and vehicle speakers of the rescue department and the police.
- Filling the vessel with water was selected as the protective measure, but a **suitable coupling to connect the rescue vehicle to the plant's pipeline was only found after some searching**.
  - During the rescue operation, the generation of gas decreased, and its stoppage was ensured by filling the vessel with water.

Analysis

- The **exact hazardous properties of the mixed acid waste were unknown**.
  - The waste had been classified as corrosive, but **not as toxic**, even though it also had more severe hazardous properties.
  - The **assessment of hazardous properties was based on a transport classification and a misinterpreted laboratory analysis**.
- The hazard of a toxic gas generating during a neutralisation and precipitation reaction had been **identified in risk analyses, but the specified risk management measures were not followed** in the situation.
- **Smaller gas leaks and odour nuisances had taken place previously**.
  - The **root causes of the incidents had not been identified**.

Analysis

- **Precipitation** in reactor vessels caused problems during processing.
- The employees' attempt **to remove the precipitate using mixed acid waste was not a planned, agreed or instructed measure**.
  - However, placing new batches over the precipitate had been found to make it easier to remove the precipitate in some cases.
- The reactor vessels did not include **any automated functions to detect dangerous reactions**.
- The equipment had been **modified during its lifecycle**, but **the impact of the modifications on risks or working methods/instructions had not been assessed**. (MOC)
- The employees' **training, competence and protective equipment were insufficient** to act in a serious (major) gas leak.

Lessons learned

- While the CLP regulation does not apply to waste, **the hazardous properties of waste chemicals must be known**, and a hazard classification in accordance with the CLP regulation must be defined for them.
  - Identifying hazardous properties in detail is a prerequisite for successful risk management.
- Permit applicants **must identify the volume of toxic gases generated in dangerous reactions** during the chemical plant's permit phase **and take the volume into account in determining the scope of operations.**
- **Process risk assessments** must be clear and help identify the severity of risks and define safety-critical measures.
  - The defined **risk control measures and their impact on risks must be known by everyone** who is responsible for them.

Lessons learned

- **Any near misses related to chemical handling processes must be investigated** thoroughly to identify their root causes.
  - Instructions must be in place for the registration and investigation of non-conformities and further measures, defining tools/methods, responsible and other persons, and the targeted schedule, as well as other factors required to identify root causes.
- **The defined instructions must always be followed** to the letter when handling dangerous chemicals and carrying out safety-critical tasks.
  - Any irregular tasks must be subject to a separate permission (**work permit**) so that all hazards involved are assessed exhaustively.
- **Automated protective measures** significantly reduce the risk of identified dangerous incidents and are less affected by human error than purely manual measures.
- **Factors related to maintenance and upkeep must be addressed in the design and selection of process equipment.**

Lessons learned

- Changes in technical systems and operating procedures must be handled through a systematic **management of change** procedure, during which their effects are assessed.
  - Work instructions and any changes required in them must be addressed. It is also important to notify the responsible employees of the assessed effects of changes and provide them with relevant training.
  - Any significant changes must be reported to Tukes.
- When preparing hazard and accident guidelines for employees who do not have any special expertise in accidents or rescue operations, **the feasibility of the instructions must be assessed exhaustively.**
  - Operating models must be simple and advise employees against taking risks.
  - Sufficient protective equipment must be available in the case of an accident, and detailed instructions on how to use it must be defined.
  - It is also necessary to **assess at what stage an accident has become so dangerous that rescue measures taken by employees are no longer safe**. In such a situation, activities must be limited to ensuring a safe exit and providing guidance for rescue services.

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Recommendations

1. The company must take the findings presented in the conclusions into account in its operations. The conclusions also apply to other production plants at which hazardous chemicals are handled and stored to develop accident prevention measures.
2. Waste handling companies must identify the hazardous properties and reactivity of waste chemicals in as much detail as possible based on the CLP regulation's classification criteria. Classifications and labelling related to the transport of dangerous goods may not necessarily provide sufficient information about the hazardous properties of chemicals to the extent required by the chemical safety licence.
3. Producers and handlers of waste chemicals must ensure, through the exchange of information, that the hazardous properties and classifications are understood similarly in all parts of the waste chain.
4. Waste producers must ensure that handlers and recipients of waste are authorised to handle the waste chemicals in question, considering the environmental and safety permits issued (by the Regional State Administrative Agencies and Tukes). The hazardous properties and classifications of waste must be compared to the waste items permitted for handling and storage in the production plant's licences and to the classifications of hazardous chemicals.
5. Operators that handle and store hazardous chemicals must address the volumes of chemicals generated by identified dangerous reactions or other incidents when defining the scope of operations in permit applications (ratio calculation).
6. Tukes must ensure that the volumes of chemicals generated as a result of any loss of process control and the impact of any accident have been assessed and presented in the permit applications of production plants. Hazardous chemicals generated during incidents may be significant in battery warehouses and other locations where electric batteries are kept, where any fire may generate significant volumes of toxic gases.

More information:

Press release: Accident at a waste recycling plant in Järvenpää caused by a dangerous reaction | Finnish Safety and Chemicals Agency (Tukes)

Accident investigation report: Onnettomuustutkintaraportti_vaarallinen+_kemiallinen_reaktio.pdf (tukes.fi) (in Finnish)

eMARS Accident ID: 001344

Thank you for your attention!