JIVZ Forum #7: Process Safety
Local Case Studies + Learning Points

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Local Case Studies & Learning Points

1. Flash Fire due to Static Discharge
2. Toxic Exposure during Maintenance
3. Flash Fire during Hot Work
4. Flash Fire due to Equipment Design Failure
5. LOC due to Improper Tank Maintenance Works

1. Flash Fire due to Static Discharge

- **Electrostatic ignition** of flammable vapours occurred when flammable liquid was discharged into **plastic IBC** from a product tank.

- Investigation revealed that the main factor was due to **inappropriate use of plastic IBC** for handling flammable liquid.

- Operator failed to **ground the metal cage** of plastic IBC and failed to immediately **clean up flammable liquid spills** which has earlier overflowed from product tank.

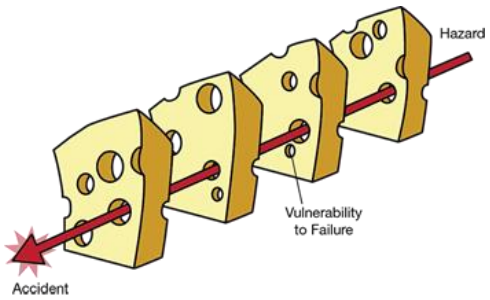
- **Poor operating practices** contributed to presence of flammable atmosphere around work area (e.g. operator allowed discharge of product onto the floor to drain off water first. The draining stopped only when flammable liquid was observed to be evaporating off the floor)

1. Corrective and Preventive Measures

- **Semi-conductive IBCs** or **metal IBCs** should be used to store flammable liquid. Plastic IBCs must never be used for storing flammable liquids.

- A thorough **risk assessment** must be carried out to consider the possibility of a flammable vapour or aerosol mist being produced from the liquid while taking into account the flashpoint and process parameters such as temperature and pressure. **Hazard of electrostatic discharges** must be considered as well.

- **Grounding clamps** and **conductive hoses** used must be checked for its electrical continuity at regular intervals by competent personnel.



- Splash filling should be avoided by **bottom filling** via an earthed conductive fill pipe or via grounded dip pipe. At the start of the discharging process, the linear velocity of the system should be no greater than 1 m/s until the inlet pipe is fully submerged.

- Operators should be equipped with **personal gas detectors** when working in potentially flammable atmosphere for early detection.

2. Toxic Exposure during Maintenance

- Three employees and one contractor were **exposed to highly toxic gas** during leak check of a reactor sight glass. The check was conducted following replacement of a sight glass that turned opaque with use.

- Investigation revealed that reactor was **not completely gas-free** due to a **passing valve**. **Toxic gas backflow** from downstream vessel into reactor. The passing valve issue was known but the **risk assessment** failed to include **safety impacts** on maintenance activity.

- Other findings include:
  - Lack of positive isolation between reactor and downstream vessel
  - Permit failed to cover the leak test job (only up to replacement job)
  - Lack of SWP developed for leak test job
  - No alarm raised by workers when personal toxic gas detector sounded
  - Alarms were raised by several fixed toxic gas detectors to the DCS but no actions were taken by those in control room

2. Corrective and Preventive Measures

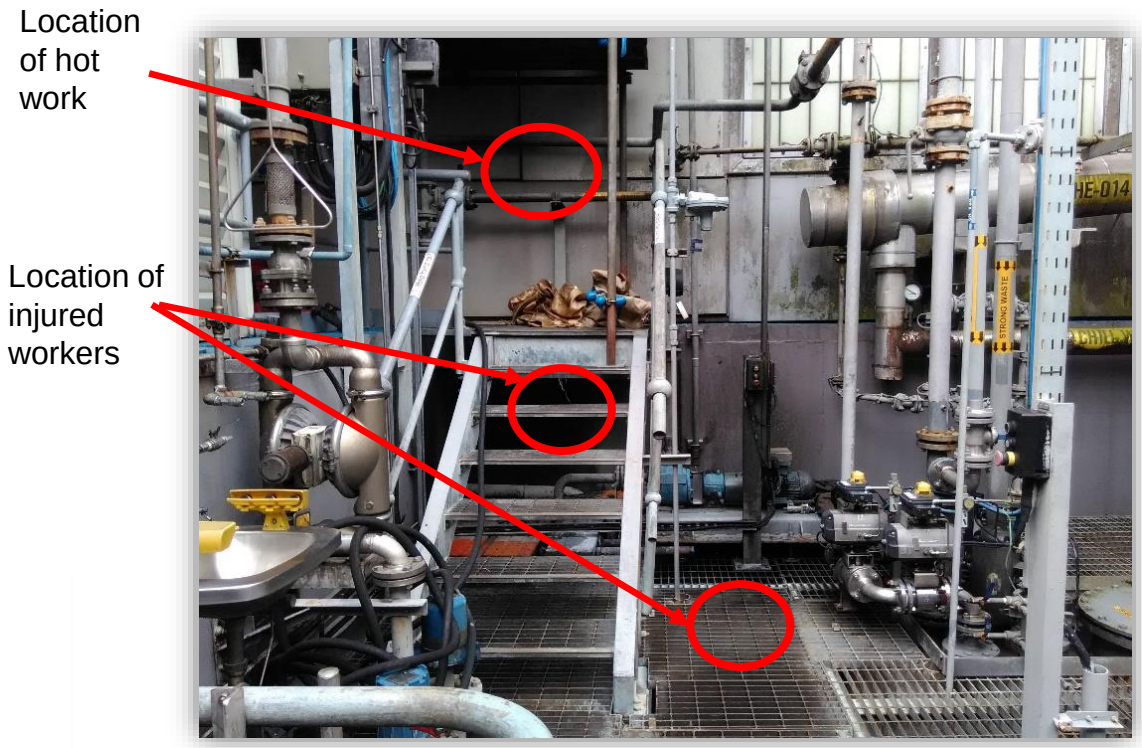
Passing Downstream Valve	Positive Isolation	Risk Assessment and Procedure	DCS Alarm	Emergency Response
• Repair or replace leaky isolation valve promptly.	• Explore mechanical solutions to achieve positive isolation of reactor from downstream system due to large piping (i.e. >30”).	• Train all involved on importance of conducting RA to cover all risks and communicating risks, prior to starting job. • Develop leak test procedure to minimise toxic gas presence in downstream system. • Verify gas-free status within work scope.	• Display fixed detector alarms more prominently in the control room.	• Re-train to inculcate right behaviour and response following detection by personal toxic gas detector.

3. Flash Fire during Hot Work

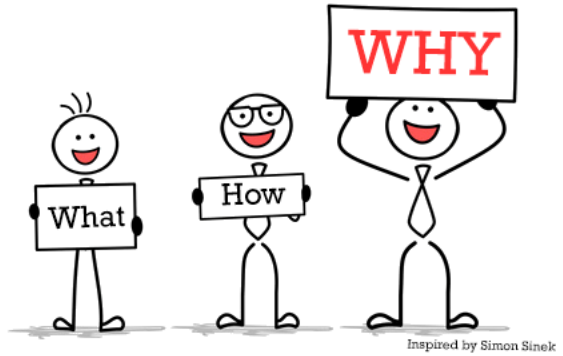
- A group of workers was carrying out hot work when a **flash fire** broke out. Two workers suffered burns and were conveyed to the hospital.

- Investigation revealed that there was a leak at the **strainer** beneath one of the waste tanks. This resulted in the **accumulation of flammable gas** in the area, which was ignited during hot work.

- Prior to incident, there was a **previous near-miss** where the strainer leaked as the solvent in the waste tank corroded the **O-ring** in the strainer cover. The O-ring was replaced, but the **valve handle seal**, which could also be corroded by the solvent, was not identified and replaced, resulting in the new leak that occurred.



3. Corrective and Preventive Measures



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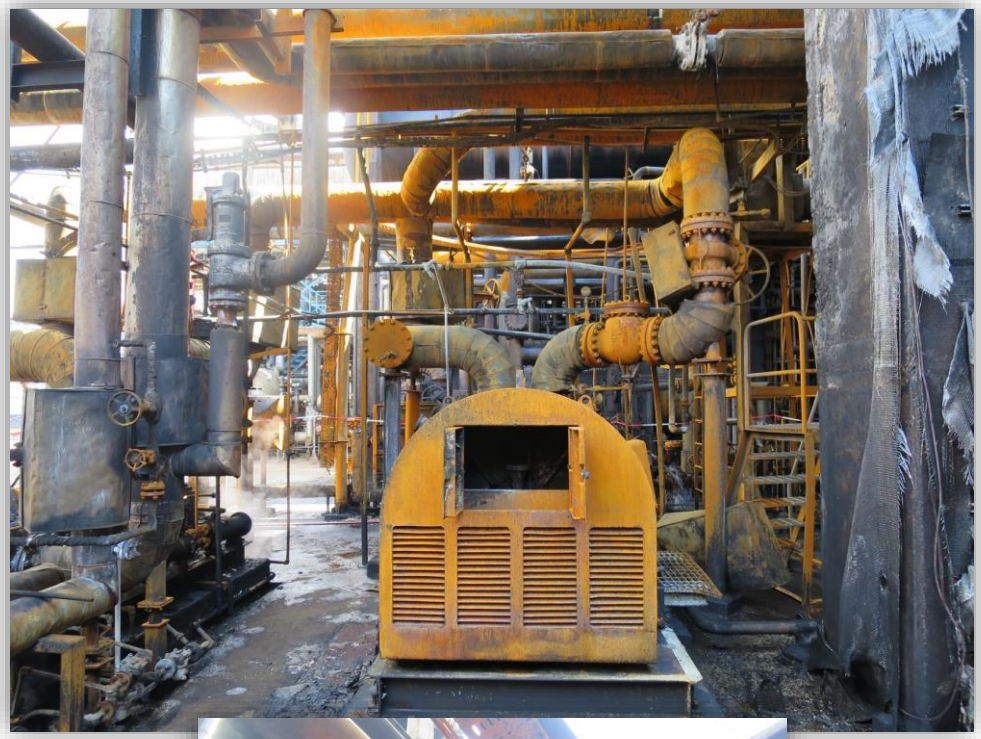
Near Miss (NM) Reporting	Management of Change (MOC)	Hot Work Permit	Gas Detectors	Training	Personal Protection
• Identify root cause and put in measures that address root cause of all NM incident reports. • Identify materials or components of tank strainer could be corroded by the solvent in the tank.	• Measures identified through NM reporting need to be managed. • MOC assessment includes assessing the scope for change. • This includes systemically identifying and replacing incompatible seals used plantwide.	• Conduct gas checks and implement other control measures • Prevent fires and explosions, before issuing any hot work permit.	• Install fixed gas detectors at strategic locations near hot work. • Equip at least one worker carrying out hot work with a portable gas detector.	• Ensure workers are familiar with the SWP before starting work. • Otherwise, provide the workers with refresher training.	• Provide suitable PPE, such as fire-retardant clothing to all workers performing works involving flammable substances.

4. Flash Fire due to Equipment Design Failure

- Leak from **centrifugal pump mechanical seal** resulting in **crude oil** flashing into a vapour cloud.
- Vapour cloud contacted hot surface from exposed steam headers, causing a hot surface auto-ignition.
- The fire, impinging on **dead leg piping** containing crude oil, caused a pipe rupture, further fuelled fire and prolonged firefighting efforts.

- **Temperature** of crude oil service was marginally **close** to the single mechanical seal **design temperature**.
- Exceeding the maximum design temperature of the seal may cause damage to elastomeric parts, such as O-Ring.



4. Corrective and Preventive Measures

For **centrifugal pumps** with similar services:

- Upgrade pump seal to **double mechanical seal**.
- Install **vibration monitoring** with trip function to enhance integrity.

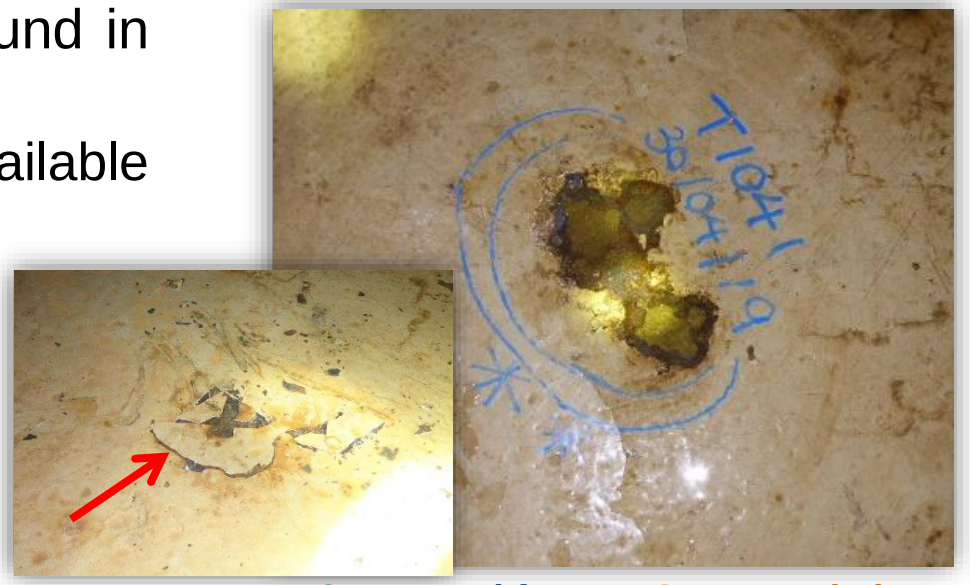
For other contributors:

- Enhance **dead leg management** programme to identify and drain off liquid-filled blocked-in lines.
- Ensure **tight shutoff** of isolation valves deemed as emergency block valves (EBV).
- Upgrade to EBV with **remote control function** outside the fire zone.

5. LOC due to Improper Tank Maintenance Works

A. 2 holes (of diameter 20mm and 25mm) were discovered at the **centre sump** of a 13-year-old tank.
- **Inadequate coating** done on the sump bottom.
- Lack of comprehensive procedure/supervision – **Obstructions** were not removed prior to coating application.
- Failure to understand importance of proper coating application.
- 6,000L of gasoline was released.

B. A cluster of 3 perforations within 1-sq foot area was found in the **bottom plate** of 28-year-old tank.
- Failure to detect tank **underside corrosion** using available scanning techniques
- Poor assessment of the tank's fitness for service.
- 190,000L of gasoline was released.



5. Corrective and Preventive Measures

- **Replace and recoat** damaged tank bottom sump and bottom plate.
- Relevel tank foundation, applicable to tanks of similar age and operations.
- Plug **weeping holes** around bund walls permanently.
- Reassess all API 653 inspection reports done for tanks of similar age and operations, prioritising tank bottom and sump.
- Ensure low suction and water draw-off pipes and other **pipework are dismantled** before inspection, surface preparation and application of coating.
- Improve maintenance strategy based on API 653 tank inspection regime, such as **internal acceptance criteria/guidelines** related to NDT results and inspection reports.
- Create a **scenario-specific emergency response plan** to include tank bottom leaks.

Key Lessons Learnt

1. Importance of proper understanding and management of electrostatic hazards.

2. Ensure system is positively isolated (with proper risk assessment conducted) prior to work commencement.

3. MOC process should consider the outcome of any incident or near-miss investigation, to identify and extend the necessary changes plantwide.

4. Review the need to upgrade asset/component specifications, with sufficient safety margin, to meet intended operating envelope.

5. Establish a set of internal acceptance criteria to determine if the asset is fit for continued service.

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Learning Reports

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Thank You!

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