Hydrogen release during unloading

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thrive™

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Meet Cargill

Cargill® Helping the world *thrive*

Our purpose is to nourish the world in a safe, responsible and sustainable way.

At a glance

155,000 employees

Working in **70** countries

More than **155** years of experience

A trusted partner for food, agriculture, financial and industrial customers in more than 125 countries.

Agriculture

Food

Animal nutrition and protein

Financial and industrial

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Guillermo López, CCPSC
Process Safety Lead
EMEA Region

Personal introduction

MSc. **Chemical Engineering**

10 years of experience on Process Safety:
- 5 years: Process Safety Engineer for TR, an international EPC contractor for Oil&Gas turnkey projects
- 3 years: Process Safety Site Engineer at Cargill (Martorell, Spain)
- Aug 2020 – Jul 2022: PS Sr. Specialist for EMEA Region
- Currently Process Safety Lead in EMEA

Main areas of competency:
- Design / Engineering
- Process Hazard Assessments
- Functional Safety
- ATEX
- Chemical systems

Our values

OUR VALUES

Put people first

Do the right thing

Reach higher

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Case Study

CASE STUDY

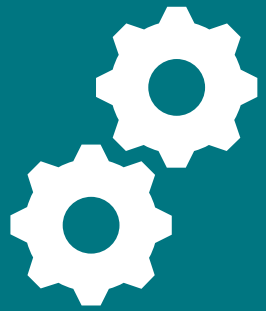
Some of our processes consume **hydrogen gas** (H_2).

Hydrogen is delivered to the site in large trucks or road tankers.

The truck is used as hydrogen reservoir.

Replacing an empty tanker is a high-risk operation

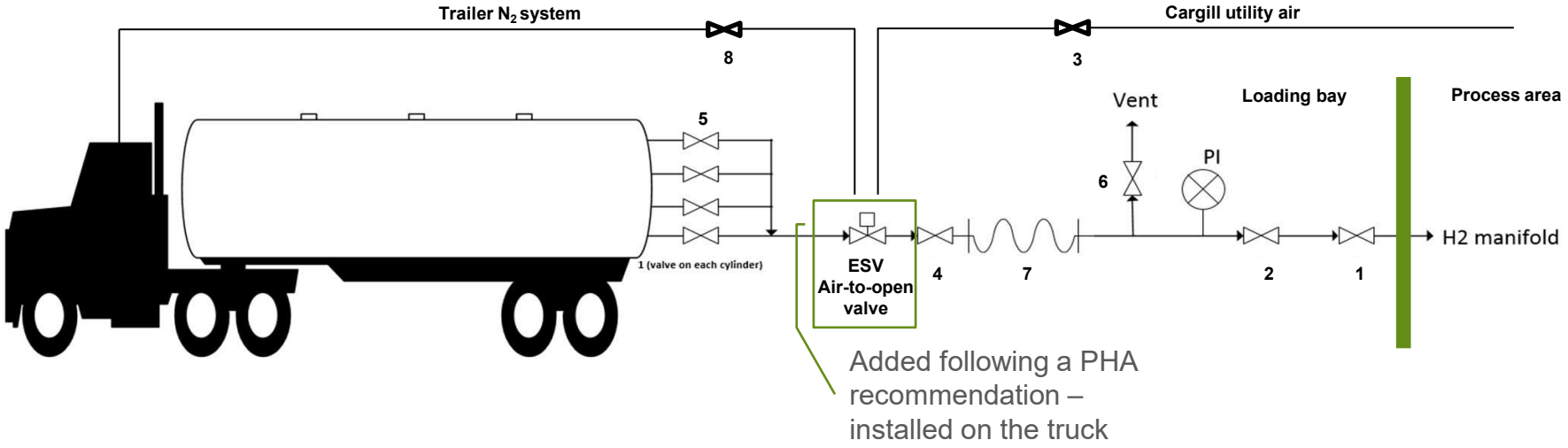
- The “empty” tanker still contains hydrogen gas at high pressure (≈ 80 bar)
- Always carried out at night – due to local regulations, H_2 trucks can’t be on the road during daytime
- The operation is carried out by the truck driver, supervised by his/her escort
- The operation involves multiple steps that shall be completed in the right order



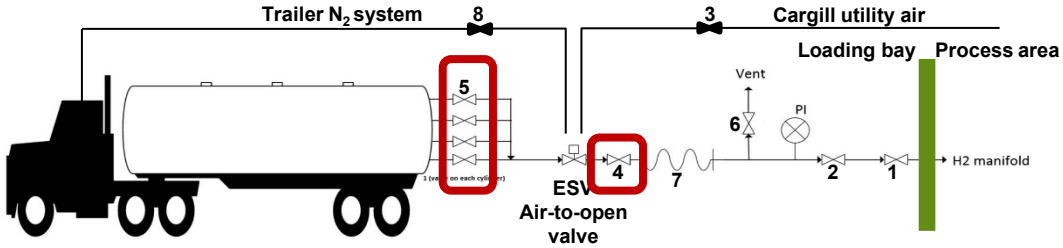
This process was subject to PHA

The PHA team identified the risk of hydrogen being released from the transfer hose in between the truck and the process if that connection would fail

System configuration



How it happened?



Disconnection procedure:

1. Close valves 1 and 2
2. Close valve 3 (ESV supplied with Cargill's air)
3. Disconnect compressed air hose from ESV
4. Close valve 4
5. Close valves 5
6. Open vent valve 6
7. Verify no pressure with pressure gauge
8. Disconnect hose (7)
9. Connect trailer N_2 to ESV
10. Open valve 8 – ESV opens

How the disconnection was carried out by the driver:

1. Closed valves 1 and 2
2. Closed valve 3 (ESV supplied with Cargill's air)
3. Disconnected compressed air hose from ESV
4. Partially closed valve 4
5. Driver left the 11 valves (5) open
6. Opened vent valve 6
7. Verified no pressure with pressure gauge
8. Disconnected hose (7)
9. Connected trailer N_2 to ESV
10. Opened valve 8 – ESV opened → **Jet fire of H_2 at 80 bar**

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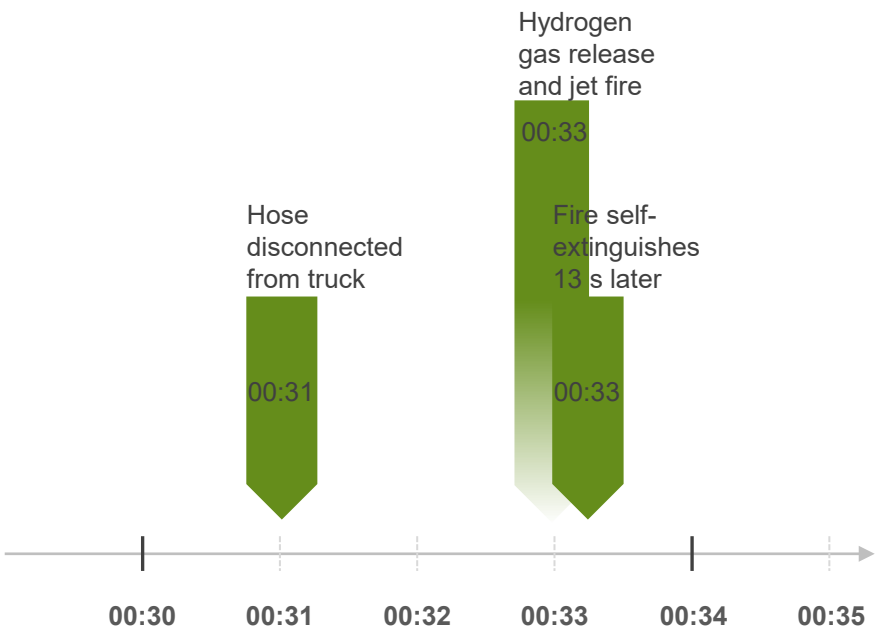
Incident timeline



Picture 1: Snapshot from CCTV

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Unloading facility

Picture 2: unloading bay after the jet fire

Picture 3: cylinder valves on the truck (left open the day of the event)

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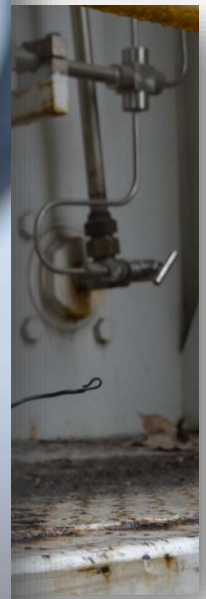
Conse

Picture 4: positio



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The consequences could have been much worse

- The driver jumped off the platform to escape from the jet fire
- A delayed ignition could have led to a gas explosion
- The truck containing hydrogen could have been affected
- The next loading bay was in use with a full tanker

Lessons learned

Cargill performed a systematic investigation

Hydrogen supplier as well as both internal and external experts contributed at different stages of the investigation

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Deviations from Operating Procedures led to the incident

- The valves on each of the 11 gas cylinders were found in open position, contrary to the procedure
- Valve 4 found partially open – the driver did close it but not fully
- The procedure (outdated) at this location differs from the standard practice followed by the supplier at other locations – addition of the ESV

LESSONS LEARNED

Trailer bay design contributed to the consequences

- Personnel in **line of fire**
- **Limited egress route** from the platform
- Roof and walls make the accessibility of the **emergency responders** more difficult

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LESSONS LEARNED

Management of Change system not followed after the PHA

The new ESV is recommended in the PHA but not subject to **MOC process**. A strong MOC process considers the operational and human factors impact of a new safeguard being installed. The verification step in the procedure was jeopardized.

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Deviations in the emergency response

- The driver tried to extinguish the fire using a fire extinguisher before the flow of hydrogen gas was shut
- The emergency response asks the driver to close the nitrogen flow to the ESV actuator
- The emergency responder took 44 minutes to get to the site

Time for questions