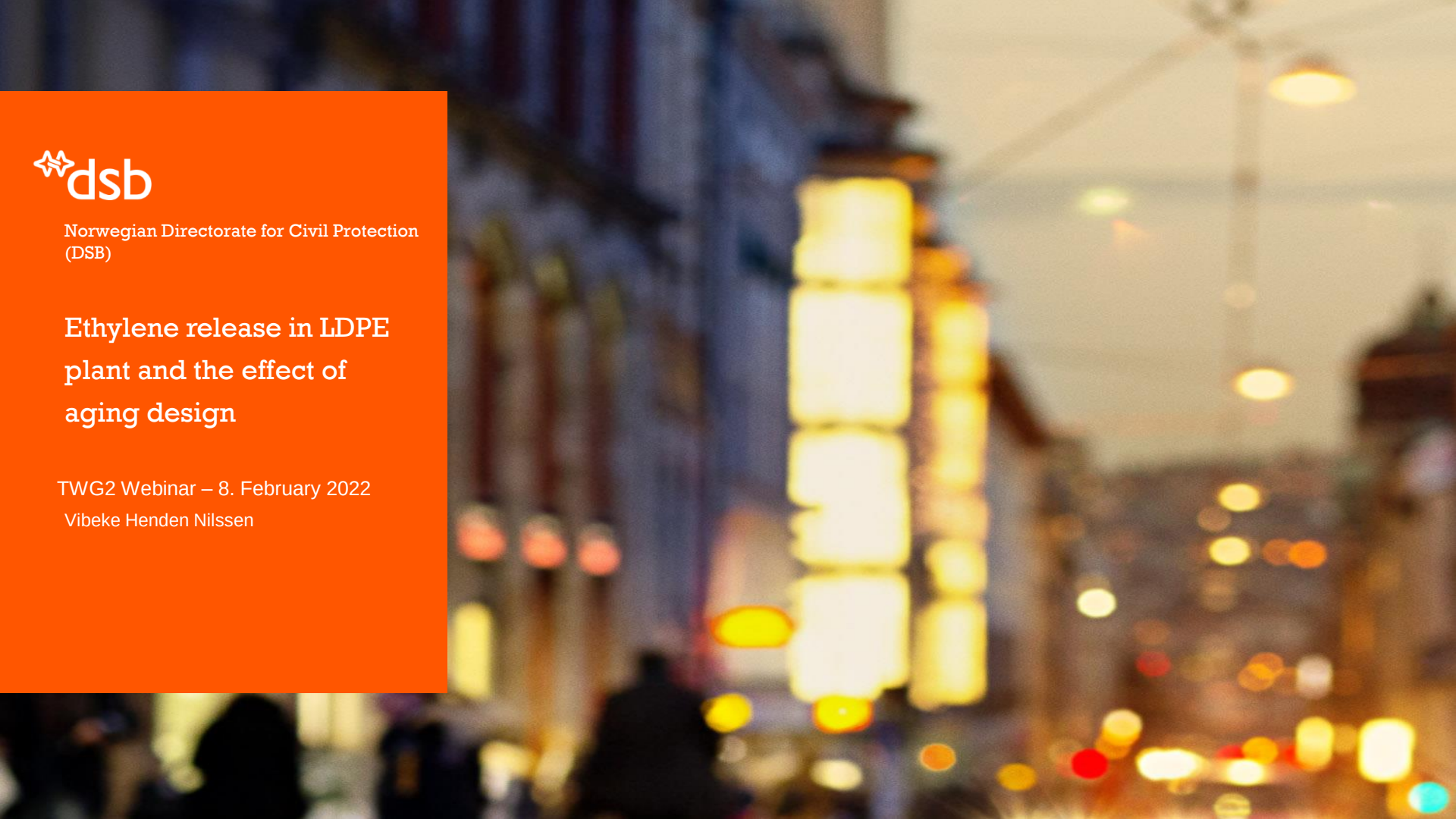

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Norwegian Directorate for Civil Protection (DSB)

Ethylene release in LDPE plant and the effect of aging design

TWG2 Webinar – 8. February 2022

Vibeke Henden Nilssen

Release of ethylene gas - September 2021

- LDPE plant (Low Density Polyethylene) – lower tier Seveso site - located in the south of Norway
- Construction period 1973-1977
- Norwegian oil and gas company as the original operator
- With shifting ownership through the years, the site today consists of one LDPE plant
- During normal operation, an ethylene gas leak occurred from a manual valve on the bottom outlet line on a high-pressure vessel

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Ethylen release LDPE Plant September 2021

- Gas detectors in the nearby area gave alarm to the control room and the operators identified it as a gas leak in the recycle area of the plant
- Plant alarm was initiated and the fire brigade alerted
- Emergency shut down was activated from the control room
  - The emergency shut down system includes a remotely operated flare valve, which was blocked upstream by a manual closed valve

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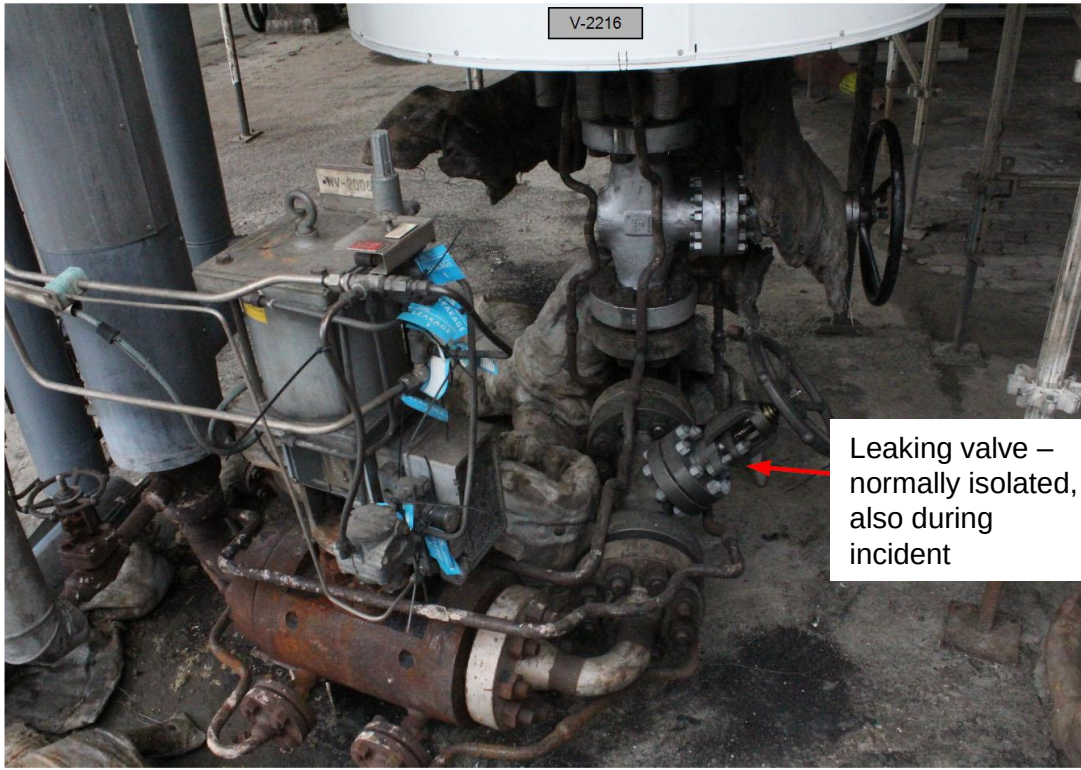
- The leak lasted about 70 minutes in total with approx. 800 kg of ethylene gas released
- The system had a gas pressure of 280 barg and a temperature of 80 degrees Celsius
- The leaking valve was installed new autumn 2019. No maintenance since



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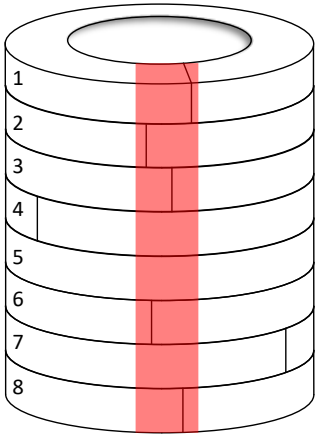
Direct cause of the accident

- The leak is likely due to wrong installation of the packing material installed in the valve stuffing box (by vendor)
- This has probably weakened the packing ability to withstand pressure



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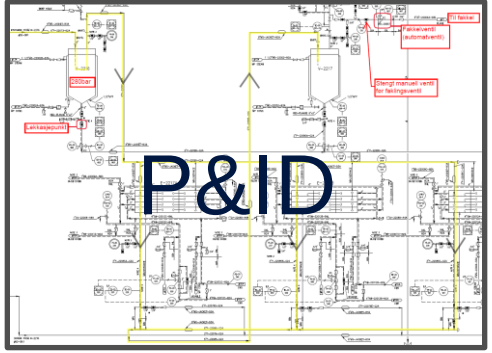

280 bar in vessel

V1: Point of gas leakage

V3: Remotely controlled flare valve (part of emergency shut down system)

To flare

V2: Closed manual valve (original design)

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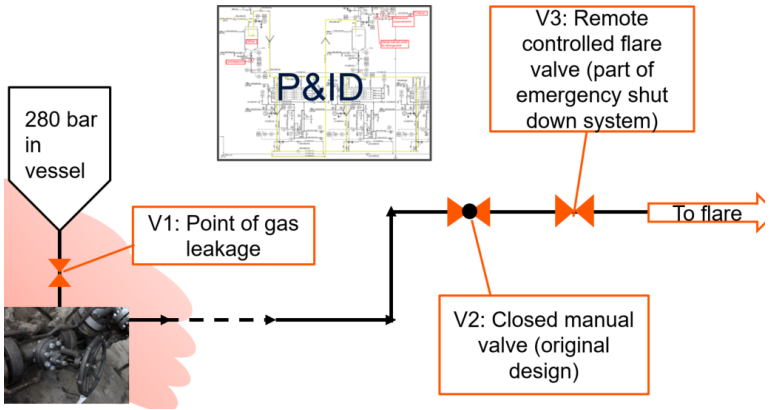
Escalating effect – blocked flare system

- The released amount would have been much lower if the manual valve (V2) upstream the remotely controlled flare valve (V3) had not been closed
- The valve (V2) was closed due to leaking of gas through the flare valve (V3) to the flare during normal operation
- If the flare valve (V3) had been available (not blocked), the system could been depressurized earlier



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Escalating effect – difficulties in accessing the valve to flare system

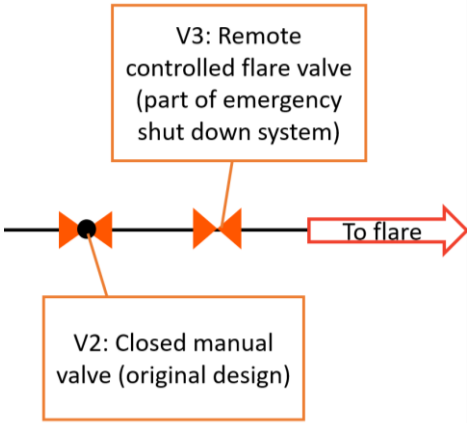
- The manually closed valve (V2) to the pressure release system (to flare) was located just above the point of leakage
- There it was not safe to enter the area in order to open the valve, until the pressure was decreased to a certain level (after about 60 min pressure was 60 bar)
- This resultet in a high release rate of gas for a long period of time

Why was the manual valve (V2) closed?

- The remotely controlled flare valve (V3) is used to depressure the gas to flare at plant shutdown (both planned and unplanned)
  - This is a part of the plant emergency shut down procedure
- From 2001 to 2019 this valve was maintained or modified several times due to malfunctions
  - Due to high pressure and extreme (low) temperatures during depressurization it did not hold tight after use.
- From 2019 the manual valve (V2) was kept in a permanent closed position to prevent continues leak of Ethylene in V3
  - This was seen as temporary change and poorly risk assessed
- Replacing V3 was planned but postponed several times – until the gas release in September 2021

Aging aspects to safe design

- Original design of the plant was with a manual valve to the flare system
- The system was modified by installation of a remotely controlled valve. The remotely operated valve became then a part of the emergency shut down system
- Due to process conditions this new valve had malfunctions through several years
- The emergency shut down function was then intendedly put out of function
- During the accident this showed to be an important missing safety function and escalated the amount of gas released
- Other design solutions should have been evaluated earlier



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Lessons learned from the establishments investigation

1. Ensuring packing material is installed correctly from vendor might require new procedures.
2. Closing manual valve upstream flare valve to protect it from wear is not recommendable. Suitable valve installation for the process conditions must be followed so that important functions are intact and operational.

New type flare valve was already planned for test during the planned stop of the plant in autumn 2021 and is now installed.

Findings from accident inspection

1. The system for safe operation has had a significant shortcoming in that a critical safety function has been disconnected and shut down for a long time.

2. The system for managing temporary changes is deficient.

Thank you for your attention!

Wish you all a safe and happy day!

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