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Studstrup wood pellet silo fire

September 2022

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The Studstrup wood pellet silo before the fire

- Volume: 100.000 m^3
- Wood pellet total capacity: 65.000 tons

- The silo was constructed in 2015 with detection systems according to best practice

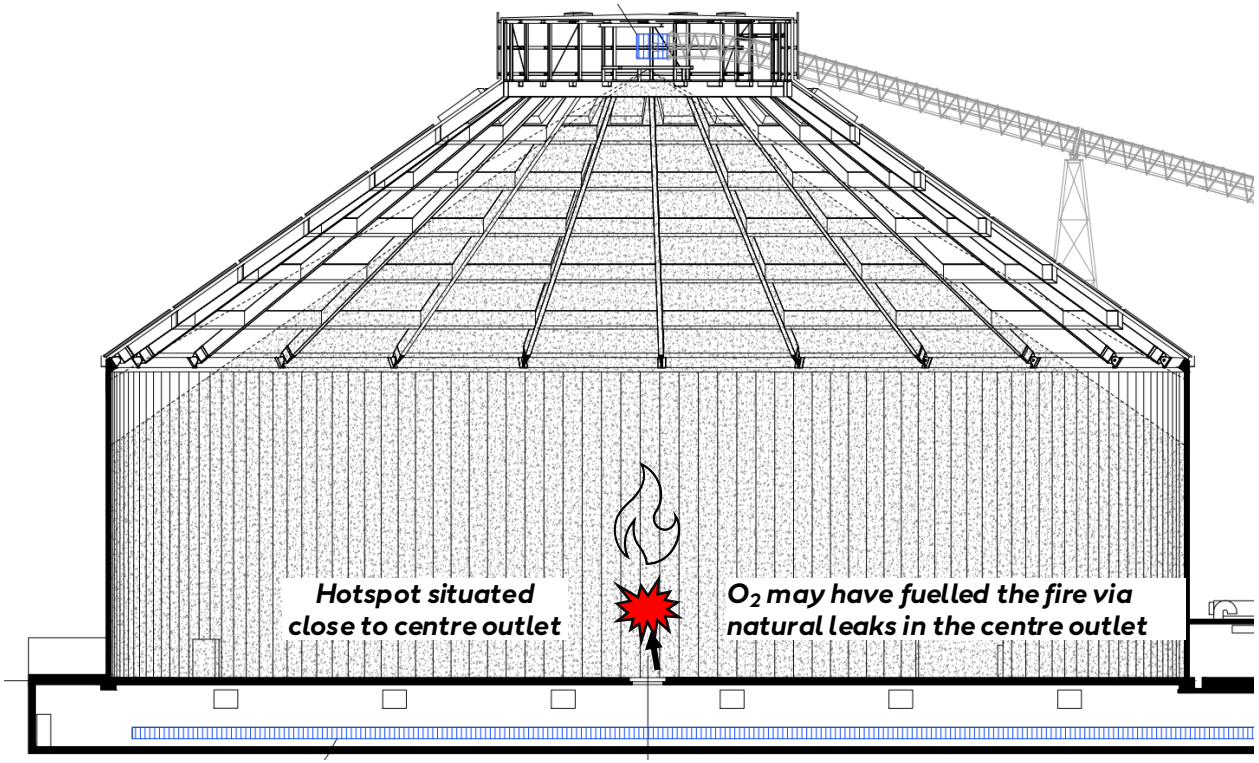
Primary Preventive barriers

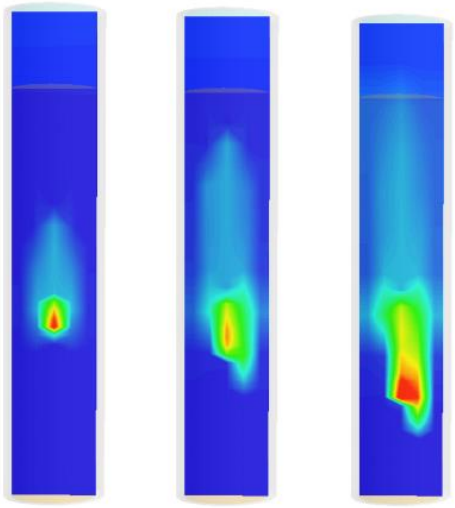
- 4 smouldering fire detectors in the headspace of the silo
- 4 IR-cameras for surface temperature monitoring
- 6 thermocouple cables for bulk temperature monitoring
- Spark detection system in transfer point beneath the silo

Primary mitigating barriers

- Nitrogen purging system based on liquid nitrogen
- Fire foam system for surface fire fighting
- One primary gate and two secondary smaller gates for emergency extraction of the wood pellets

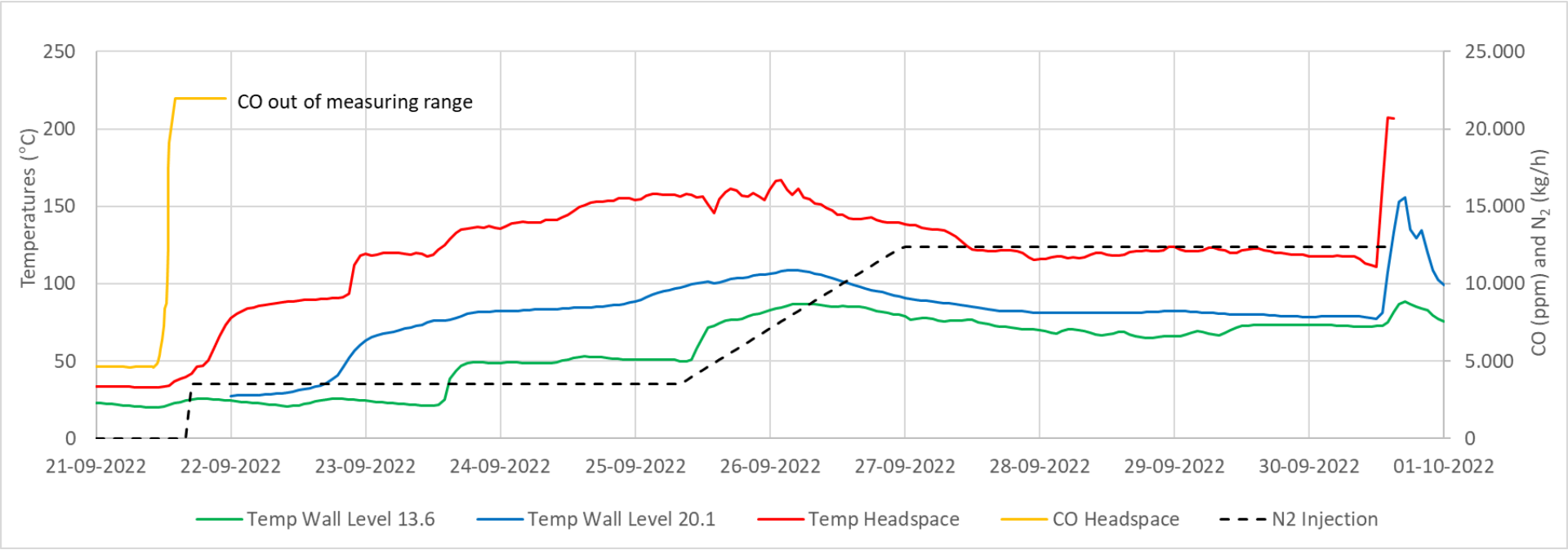
Root cause conclusion: Late detection of a deeply buried smouldering hotspot resulting from critical self-heating





Source: Henry Persson, Fire extinguishing and preventive and preparatory measures

The first indication of critical self-heating was a rapid rise in CO concentration in the silo headspace



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Intensifying pyrolysis

Flames visible in the penthouse from the surface fire

Emergency emptying of the silo using remote-controlled machinery

Main learnings from the fire in the Studstrup silo

- The fire was detected too late to be managed in a controlled way
- Temperature measurement system in the bulk of the pellets was not sufficient – no runaway temperatures were registered
- Smouldering gas detection system did not give a clear and unambiguous alarm at a sufficiently early point in time
- Insufficient system installed to control the temperature of the headspace and roof construction
- Fire foam not effective in extinguishing a surface fire on an uneven surface
- Only one gate for wheel loader access
- Challenge to maintain a high nitrogen purging capacity partly due to delivery bottlenecks

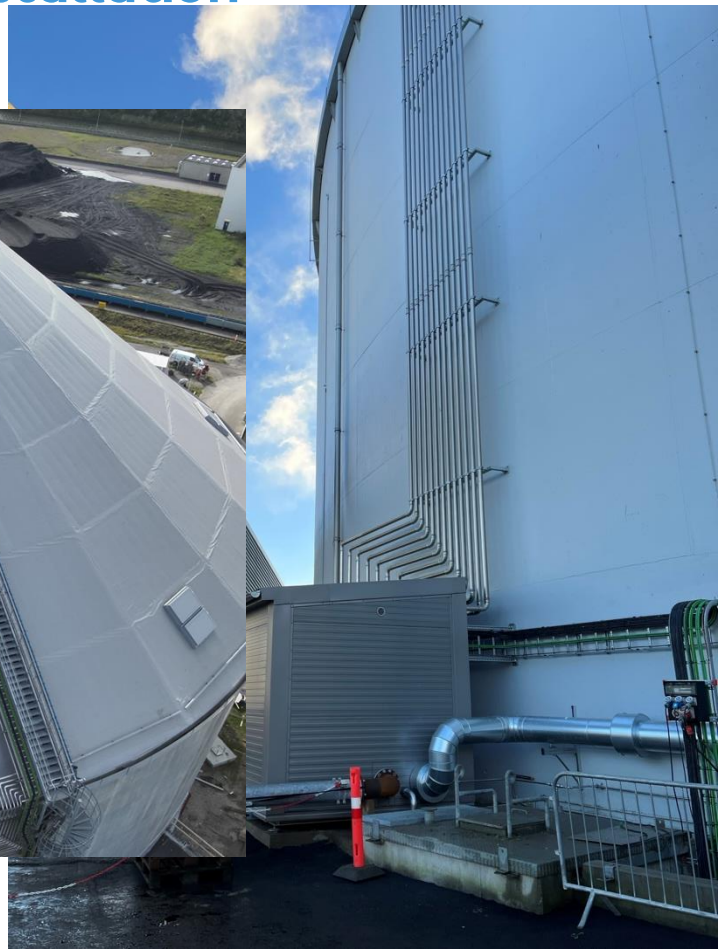
Updated fire strategy emphasizes improved monitoring systems and proactive early prevention

Primary Barriers & Improvements

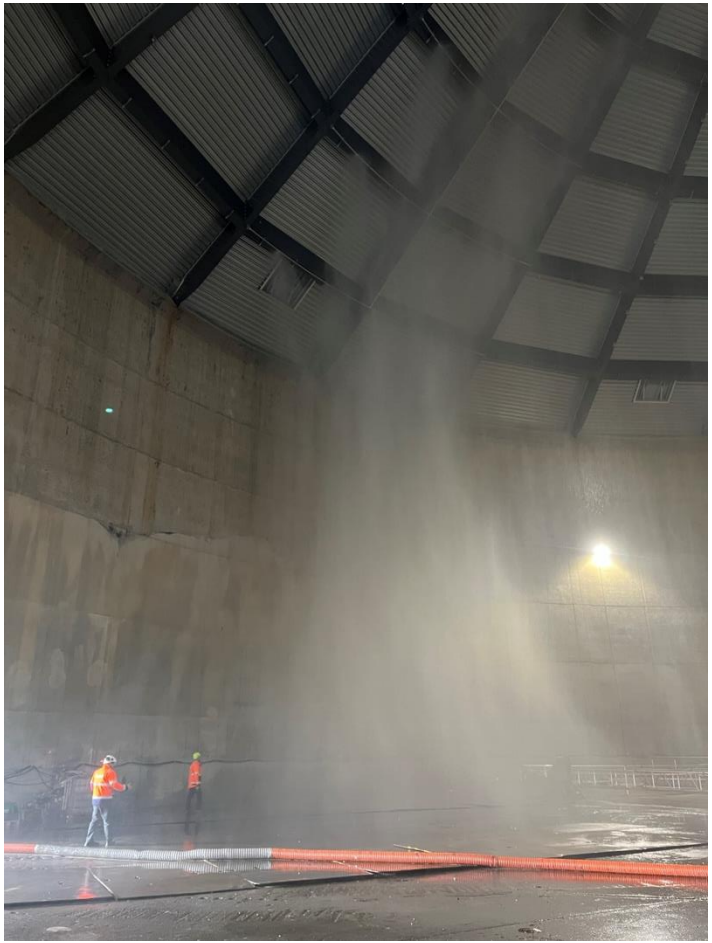
- **Temperature monitoring:** Increased from 6 (free hanging) to 65 (fixed) thermocouples cables (~2.000 measurements)
- **Gas monitoring:** CO, CO_2, and O_2 probes extract gases from the headspace (replacing smouldering detectors)
- **Nitrogen purging:** Continuous purging lowers oxygen; also increases gas diffusion to headspace
- **Water mist (headspace):** Sectionalized system to control headspace temperature (not for extinguishing)
- **Conveyor upgrades:** Central and side conveyors equipped with water mist and temperature sensors
- **Access:** Added two extra gates for efficient emergency emptying with wheel loaders
- **Wheel loaders:** Three remote-controlled, ATEX-approved wheel loaders shared across Ørsted sites
- **Roof monitoring:** High-temperature sensors installed on roof construction

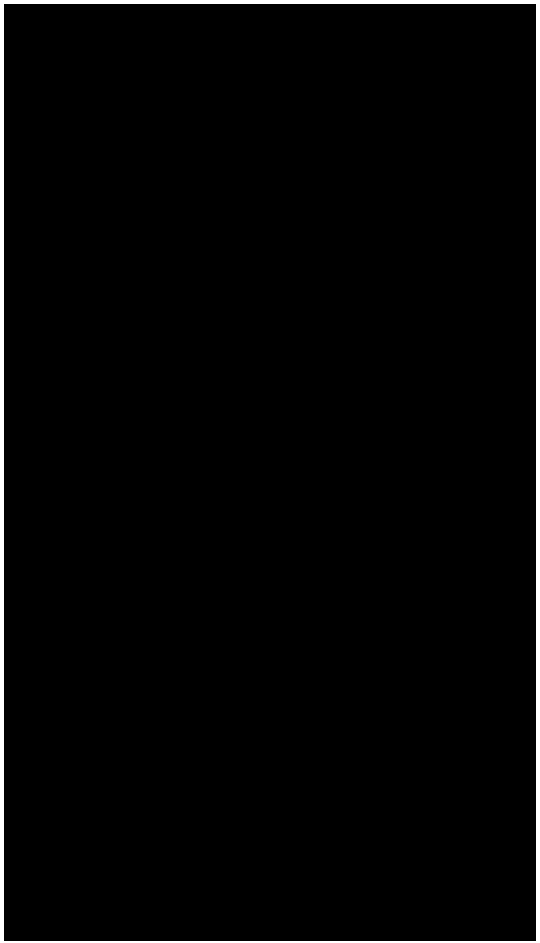
The reconstructed silo

Sectionalized water mist system installation



Test of water mist system in one section

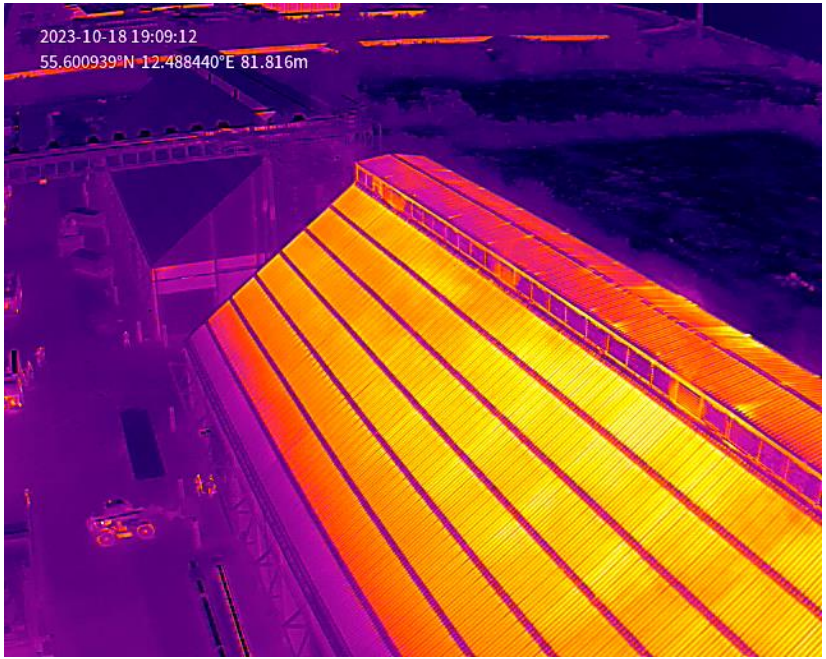




ATEX approved, remote-controlled wheel loader

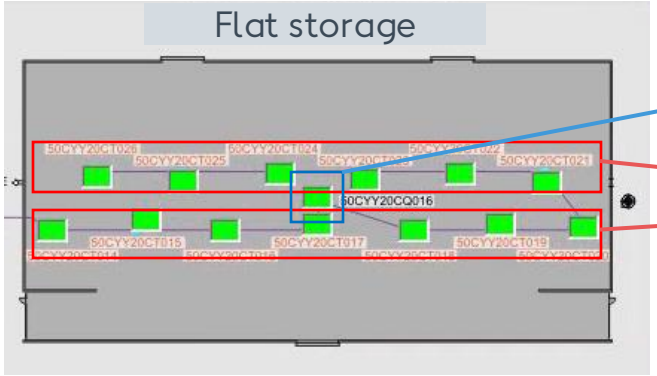
Avedore wood pellet fire in flat storage October 2023

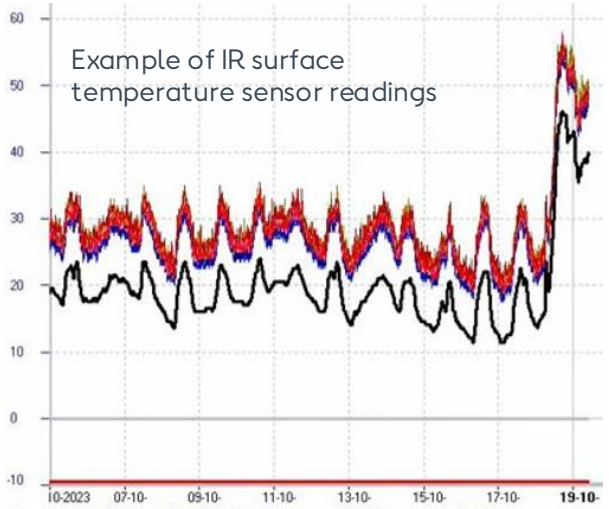
Smouldering fire in flat storage was first realized when white smoke was seen from the roof top



Root cause conclusion: The monitoring systems failed to detect the smouldering fire in time to allow a controlled response

Primary barriers	Remarks
smouldering gas detector	No clear alarms and insufficient data on absolute gas concentrations
IR surface temperature sensors	No temperatures above 45 °C was measured before Oct 19, 2023
Bi-weekly inspection with mobile IR camera	No temperatures above 45 °C was measured before Oct 19, 2023





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Images of the flat storage fire

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Thank you

Questions?

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