

Norwegian Dam Failure - August 2023

Storm Hans was a significant system that impacted Norway and Sweden between 8th -12th August 2023. Estimated damage from the storm is estimated at just under 1 billion euros. A key event during the storm was the overtopping and failure of a dam at Braskereidfoss.

Braskereidfoss hydroelectric dam, owned by Hafslund Eco overtopped during daylight hours on 9th August 2023 with the flood gates partially closed, despite increasing water levels overnight. The dam was unmanned and the operations centre in Lillehammer was overwhelmed by the rain event. Attempts to rescue the situation were abandoned as overtopping also inundated the hydroelectric plant, removing back up power systems. During the day, the Norwegian Army was deployed with consideration given to a controlled failure through explosives. The dam overtopped and the embankment subsequently eroded.

A 2018 risk assessment considered the scenario that evolved as a risk and accepted that risk in 2021. There was no technical failure according to the final investigation report with a lack of redundancy, staffing and system testing identified as key elements of a systemic failure. The case study has a full investigative report with over 30 learnings available.



Braskereidfoss Dam post failure (Bård Langvandslien) and during overtopping August 2023 (Norwegian Police)



Resources available

- Rainfall data
- Media coverage
- Official investigation

Useful to

- Regulators
- Government
- Dam owners
- Critical infrastructure
- Disaster managers
- Boards

Governance Questions

Is risk assessment outcome based on consequence? Or has event likelihood been used as a proxy?

Are there additional risk management measures in place to mitigate asset non conformance?

Do exercises consider credible, but low likelihood scenarios?

Are the sufficient resources in place to avoid fatigue?

Event learning examples

Category	Event	Learning/prevention activity
<small>Source for the event learnings is the translated public report commissioned by Hafslund Eco. Prevention activities are broader industry learnings inferred from the event.</small>		
Risk appetite	A risk and vulnerability analysis in 2021 considered scenarios such as Storm Hans, with the risk assessed as low, classified as green, and accepted, "without further measures". The dam identified that there was insufficient freeboard in 2018.	In the example, it's unknown if the risk was accepted by those owning the organisational risk, or those assessing the risk. Risk appetite statements are a key input for critical infrastructure risk assessments linked to org. risk matrices that includes consequence.
Operational risk	Gate raising required human intervention based on alarms which were missed in a busy operations centre.	Redundant and resilient process needs consideration for actions that require human intervention. Have single points of failure been identified in process mapping?
Operational risk	Flood event happened at unusual time of year and the peak of 1800m ³ /s was reached within hours. The general time for the rising limb of the hydrograph in the catchment had been 3-4 days.	Scenario testing of high peak, low volume floods, to confirm asset performance against a range of conditions is valuable to identify the risk uncertainty envelope and aid planning.
OH&S	Fatigue: Ops centre staff were on a 16-hour shift from 3pm to 7am	Overnight shifts should be minimised. Planning of long shifts when operating critical infrastructure should be a trigger to review arrangements. Is event response in line with organisational OH&S, or best practice? Ideally, overnight shifts should be shorter than those occurring during daylight hours for staff no usually working shift patterns.
Operational risk	Gates were left unmanned at 20% of capacity with rainfall forecast. Assumption was that the Ops Centre would handle any response.	Decisions should be based on rainfall assessments and defensible criteria, and process, based in policy for organisational risk management. Are decisions repeatable and founded in system and process?
Emergency Planning	Onsite staff had no access to the keys required to enter the building and raise the gates. Some success was achieved with staff arriving 30 minutes later. Power failure ended this mitigation attempt.	Granular issues can lead to an organisational crisis. System mapping to identify critical dependencies in advance can unearth important assumptions. Can technological advance been investigated to mitigate risk? In the example at hand, \$40 smart locks may have prevented the dam failing as the gates might have been raised sooner.
Continuity Planning	Redundant power supply was located in an area more likely to be impacted by the hazard if the power supply failed. The hazard and power supply were interrelated. This was identified in a 1992 review but not mitigated.	Consideration of when redundancy equipment maybe needed and locate appropriately. Are power and communication redundancies independent of the hazard?