

BARRIERS AGAINST UNCONTROLLED VAPOUR GENERATION IN ATMOSPHERIC TANKS

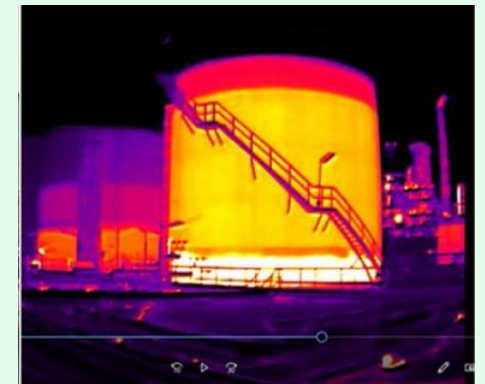
CROSS EQUINOR LEARNING FROM SLOP OIL TANK INCIDENTS IN 2019 AND 2021

SYNERGI 1600678 AND 1641991

EXTERNAL VERSION FOR SHARING OUTSIDE EQUINOR
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The Equinor SSU Learning Panel





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WHAT this is ABOUT

In Nov 2019 there was a serious incident with gas release from a slop oil tank. This was caused by overheating and sudden boiling resulting in froth over. A related incident happened some 13 months later. Internal requirements will be strengthened to secure barriers against incidents like this. Actions are specified in this package to document learning from the incidents across Equinor.

WHO this is FOR

- Assets/ projects involved with atmospheric tanks with heat input and/ or with the possibility for stratification (layering of fluids) - asset management, roles involved in operation and roles with responsibility for technical integrity or system design
- Process engineering discipline involved with specification of such systems

WHAT to DO

- Review the shared material and consider relevance for your Business Area or Cluster
- Review and implement the relevant actions specified in this document
- Document the implementation of actions in Synergi



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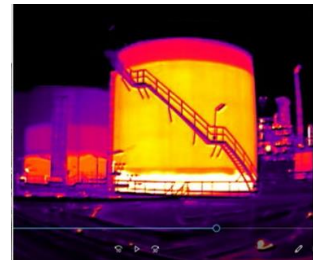
Information related to incidents in 2019 and 2021 can be found in Synergi and Slop – ref. table below.

Synergi reporting	Safety Investigation One pager Slop
LINK to Synergi case 1600678 LINK to Synergi case 1641991	LINK to Slop

This information package will be made available externally at [alwaysafe.no](https://www.alwaysafe.no)

CONTENT

- Film describing the incident and findings from internal investigation
- Information about new technical requirements in Equinor
- Actions

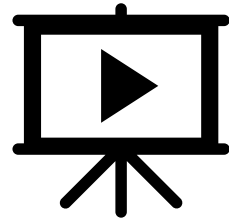


FILM Incident - uncontrolled vapour generation in tank

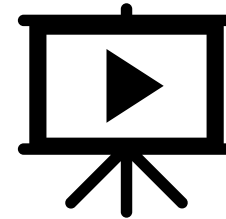
Please click the icon below to watch a ~12 minute film about the incidents.

The 2019 incident resulted in uncontrolled vapour generation, a large gas release and equipment damage. The incident had potential for tank rupture, fire and explosion - it was concluded that there was a major accident potential.

Watch film:



Watch film – with Norwegian subtitles:



Problem description:

Roll over / boil off / froth over are very severe scenarios for tanks with stratification of liquid layers with different properties. These scenarios have major accident potential. Slop tanks with water, hydrocarbon liquids and possible emulsions are especially challenging if the tanks are heated by heating coils. Stratification of layers in LPG and LNG tanks pose similar challenges.

Desired result from new requirements:

Effective safety barriers to avoid tank rupture and / or excessive vapour release due to uncontrolled vapour generation.

New requirement that will be included in TR3500 (ref. [slide 8](#) and [9](#) for full content):

Atmospheric storage tank emergency vapour venting requirements shall be designed to handle scenarios where sudden, violent vapour generation may occur, e.g.

- Abnormal heat transfer
- Variation in incoming fluid properties or temperature
- Roll over / boil off / froth over

The capacity should reflect the robustness of temperature controls and margins between safe operating limits and excessive vapour generation.

ACTIONS

to be documented in Synergi

Action Handler	Action #	Action Description	Closing criteria
Business Area/ Assets and Projects	1	Consider relevance (ref problem description on slide 6) for your Business Area and decide if actions 2-4 are relevant	All assets considered and conclusion on where action 2-4 are relevant have been made.
Assets and projects Roles with responsibility for technical integrity of relevant tanks	2	<p>For relevant heated tanks – verify existing barriers and operational procedures (including knowledge of these) to manage risk of froth over/ boil off– ref. strengthened requirements in TR3500</p> <p>For relevant LNG/LPG tanks – verify existing barriers and operational procedures (including knowledge of these) to manage risk of roll over/ boil off - ref. strengthened requirements in TR3500</p>	Conclusion on whether existing barriers against froth over/boil off/ roll over meet requirements.
Assets and projects Roles with responsibility for technical integrity of relevant tanks	3	Based on conclusions from the review of relevant tanks – decide if required to: a) Implement new technical barriers b) Modify existing technical barriers	Necessary modifications to technical solutions identified and implemented
Assets and projects Roles with responsibility for technical and operational integrity of relevant tanks	4	Based on conclusions from the review of relevant tanks – decide if required to: a) Update relevant documentation (e.g. Systems- and Operations manuals) b) Strengthen knowledge and awareness on froth over / roll over / boil off scenarios amongst operation and technical integrity personnel	Necessary updates in documentation identified and implemented

TR3500 Process Systems Design - Proposed strengthened requirements

SR-xxx API STD 2000 sec 3.2.5.4 / 3.2.5.5 / 4.2.2.5 Add. Atmospheric storage tank emergency vapour venting requirements shall be designed to handle scenarios where sudden, violent vapour generation may occur, e.g.

- Abnormal heat transfer
- Variation in incoming fluid properties or temperature
- Roll over / boil off / froth over

The capacity should reflect the robustness of temperature controls and margins between safe operating limits and excessive vapour generation.

Justification:

Safety – avoid tank rupture and / or excessive vapour release due to unforeseen vapour generation. Several serious incidents in the history related to scenarios.

Interpretation guideline (IG):

Typical causes to abnormal heat transfer could be a mechanical failure of an internal heating or cooling device (tube rupture), failure in heat input controls (manual or automatic), (ref. incident at Mongstad; Synergi 1600678). More information on relevant scenarios see API STD 2000.

Roll over / boil off / froth over is a severe scenario for tanks that may have stratification of layers with varying properties. These scenarios have major accident potential. Slop tanks with water and HC liquid and possible emulsions are especially challenging if the tanks are heated by heating coils; likewise is stratification of layers on LPG and LNG tanks.

Scenario for heated slop tanks with water and HC liquid present may cause the water phase to boil-off and suddenly break through the colder HC liquid layer above (froth over) with potential damage to tank, large gas release and fire. Two independent instrumented high level shutdown instrument barriers shall be installed if it is not feasible to install large enough emergency vent capacity to handle such cases. The requirements for such protections are given in TR1956 and TR2041.

When evaluating these scenarios it is important to carefully evaluate the maximum True Vapour Pressure (TVP) of the liquid routed to the tank. Safe operating margins related to max TVP shall be established

TR3500 Process Systems Design - Proposed strengthened requirements

For more information on roll over / boil over / froth over, see:

- EN 1473 Installation and equipment for liquefied natural gas- Design of onshore installations
- API STD 2000 Venting Atmospheric and Low Pressure Storage Tanks
- EEMUA publication 217 "Safe and effective operation of storage tanks for oil movements" - [LINK](#).