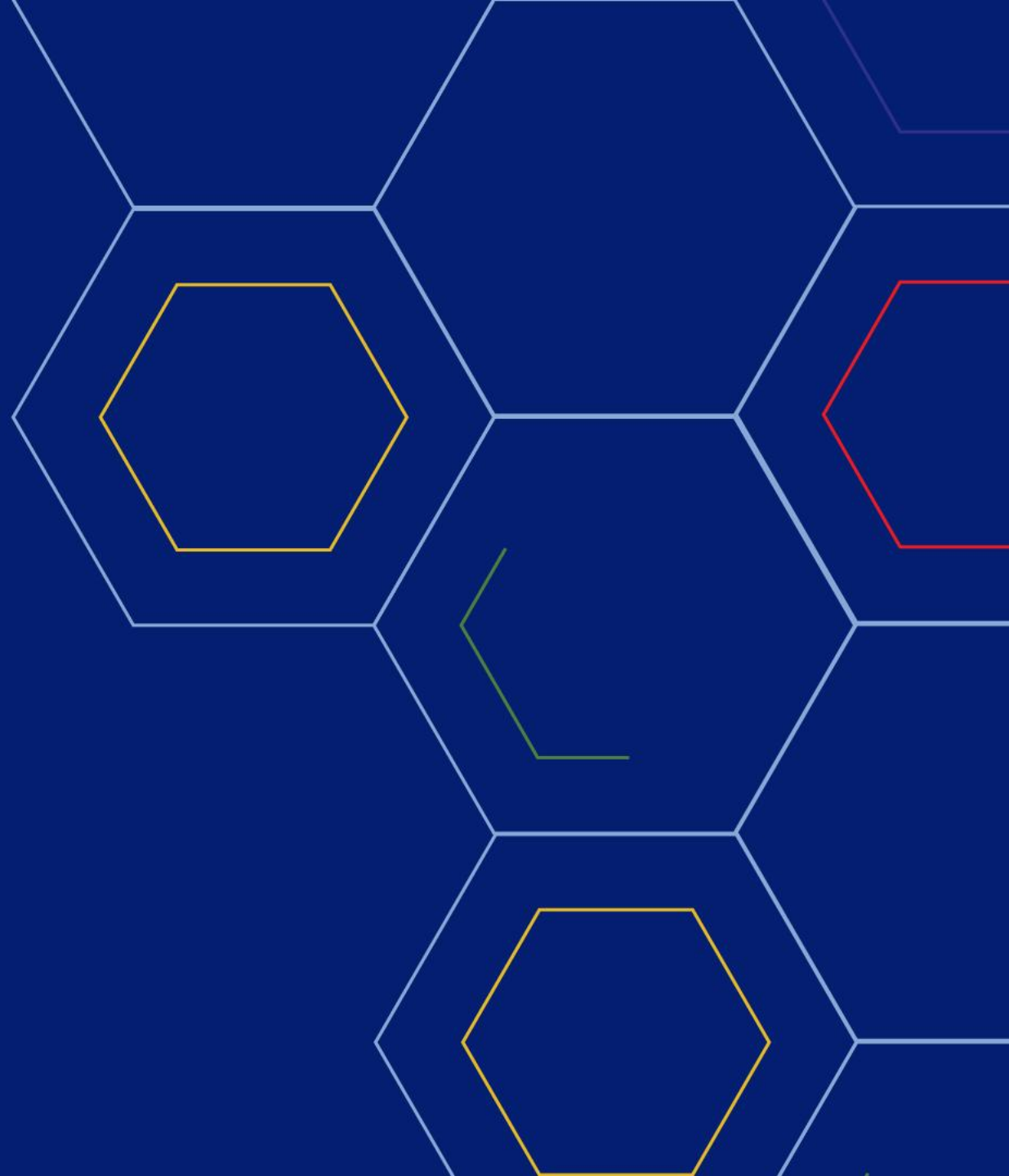




FUELS INDUSTRY
Association of South Africa

Learning from Incident: Internal Floating Roof Collapse





INCIDENT DESCRIPTION

Date:	24/10/2024
Location:	Crude Oil Tank Farm Durban
Equipment:	Crude oil storage tank with a Geodesic roof and internal aluminum floating roof
Description:	Following the crude filling, the internal floating roof (IFR) was found to be submerged.
Consequence:	The storage tank needed to be taken out of commission to repair the sustained damage.
Potential Consequence:	Due to the high volume of crude oil vapours there were a potential of fire and air pollution.



INCIDENT DESCRIPTION



IFR roof legs



IFR man way



Stillwell and seal



INCIDENT DESCRIPTION

Facts Gained - Design

- The tank features a full-contact internal floating roof.
- Filling and Emptying Rates:
 - Design fill rate: 5000 m³/h
 - Design empty rate: 900 m³/h
- During commissioning, the tank is filled at a rate of 250 m³/h.
- Vent Capacity:
 - Product datasheet vent capacity: 455 m³/h (should be 5000 m³/h)
 - Initial design required only one 10" vent based on 455 m³/h.
 - Six vents were installed to meet the 5000 m³/h design requirement.
- Inert Gas Handling:
 - Inert gas slugs from crude ships (stripping and pumping) are expected.
 - The tank's diffuser must accommodate this phenomenon.
- Diffuser Design:
 - Designed was not done by the IFR manufacturer.
 - The chosen diffuser is not recommended for this roof type, as large forces can impact the roof legs at lower crude levels.



INCIDENT DESCRIPTION

Facts Gained – Inspection and Maintenance

- Visual inspections are limited due to low light conditions. The geodesic dome lacks transparent panels to allow light to pass through.
- Yearly Leak Detection Analysis Report (LDAR) inspections are conducted to detect any leaks. However, access limitations have been noted, affecting the effectiveness of this technique.
- No distinct crude smells were reported during inspections.
- Two IFR plates had failed welds, not located near any roof legs. These failures could have occurred either before or after submersion.
- A severe rainstorm occurred post-decommissioning. No water leakage was detected, confirming the geodesic dome's integrity.
- Stillwell Inspection:
 - A large scratch was noted on one stillwell, indicating possible interference, which could have occurred before or after the incident.
 - A bent sliding plate was observed on the other stillwell seal. The presence of a roof leg next to the stillwell seal, which should not be there, likely caused interference. This interference bent the sliding plate, restricting IFR movement and allowing crude onto the roof.



INCIDENT DESCRIPTION

Facts Gained – Inspection and Maintenance

- Failed Weld on IFR Plate:
One of the two IFR plates with a failed weld, which is not close to any roof leg.
- Roof Leg Interference with Stillwell Seal:
Note how the sliding plate, which is not supposed to be constrained, is bent.





INCIDENT DESCRIPTION

Facts Gained – Tank Restoration

- The appointed service provider had no prior experience installing the specific model IFR.
- Supervision from Subject Mater Expert (SME) was declined during installation.
- Supervision from an engineering company was also declined during installation.
- The IFR was not installed according to the manufacturing drawings.
- A water stand test was omitted due to water handling practicality.
- During commissioning in 2021, the restored tank was filled at 250 m³/h. Multiple defects were noted and attended to, refer to the defect report:
 - Stillwell seals were installed incorrectly.
 - IFR rim seal not sealing adequately.
 - Anti-rotational cable interference with foam dam.
 - IFR panel leak.
 - Geodesic dome leaking.
 - Sagging areas on the roof; more roof legs needed to be installed.



INCIDENT DESCRIPTION

Facts Gained – Tank Restoration

- IFR Panel Leak Defect: The IFR panel leak defect was not communicated correctly. The sealing strip is not installed throughout the length of the joint, meaning the leak path will not seal all the way.
- Illustration of the Joint: Below is a picture to illustrate the joint. Note the bottom section is bolted during normal installation.





INCIDENT ROOT CAUSE

Summary of direct and underlying causes

	HUMAN ELEMENTS	EQUIPMENT ELEMENTS
DIRECT CAUSES	N/A	DC1 – Submerged IFR in crude oil: The immediate issue observed.
UNDERLYING CAUSES	<p>UC1 – Incorrectly joined IFR panels, resulting in poor sealing. This could lead to crude leaking onto the panels and removing buoyancy.</p> <p>UC2 – Possible weld failure on IFR panels, resulting in a crude leak.</p> <p>UC3 – Diffuser design is not compatible with IFR. This leads to large forces acting on the roof legs at low crude levels, potentially causing failure in the aluminum construction.</p>	<p>UC4 – Limited visual inspections due to low light conditions.</p> <p>UC5 – Limited effectiveness of yearly leak detection inspections due to access constraints.</p> <p>UC6 – Roof leg interfered with stillwell seal, restricting roof movement and allowing crude to spill on the roof.</p>
ROOT CAUSES	<p>RC1 – Project management failed to ensure effective coordination between the IFR manufacturer and the diffuser designer.</p> <p>RC2 – Scoping procedure also failed to ensure effective coordination between the IFR manufacturer and the diffuser designer.</p> <p>RC3 – Inexperienced personnel used for installation.</p> <p>RC4 - Denial of supervision from experienced personnel.</p>	



INCIDENT LEARNINGS

Key Learnings

- Full Contact IFR Considerations:
 - Since the IFR is made of aluminum, the components are lightweight and less durable than carbon steel. Attention should be given to the diffuser to mitigate any unnecessarily large forces.
 - The sealing strips of the IFR plates are essential components. Special consideration should be given to these joints to ensure proper sealing.
- The interphase between the stillwell seals and the IFR is critical. Any possible restrictions should be removed, and adequate tolerance should be provided.
- If any deviations from the design are noted during the construction phase, the designer should be informed to assist with a solution.



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Thank You

