Who Carries the Risk?

From Denial to Recognition – Turbine Oil Exposure and the Move Towards Less Hazardous Oils

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From concern to substitution



Photo: Halvor Erikstein

SLEIPNER

Where the story becomes practical

Equinor · Norwegian North Sea

3 gas turbin - generators



Photo: Equinor

LM2500

TURBONYCOIL 940 SE

Field test in an operational offshore aeroderivative gas turbine.

I will return to these turbine engines after explaining how we got here.

Image supplied by the user / Equinor Sleipner material.

LONG-TERM COLLABORATION

People who kept the issue alive

Susan Michaelis · Tristan Loraine · Judith Anderson

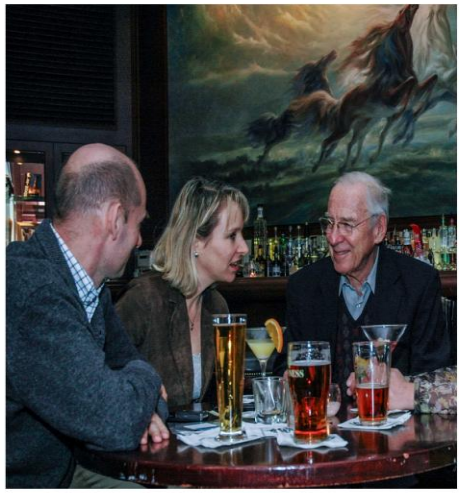




Photo: Halvor Erikstein

Chicago, 2006. Susan Michaelis and Tristan Loraine with Apollo 13 commander Jim Lovell.
“Houston, we have a problem” — a fitting message for two people who helped put contaminated cabin air on the international agenda.



GCAQE 2012 and Aircraft Cabin Air 2024 · Judith, Tristan and Susan

Early 2000s → long-term collaboration, research, information and international cooperation

2006

From concern to research

University of Washington, Seattle · Prof. Clement Furlong and colleagues

Exposure concerns

Aviation and offshore workers raised questions about turbine-oil exposure.

Scientific research

Different organophosphate structures were compared, including metabolic activation.

Safer chemistry?

Can anti-wear chemistry itself be made less toxic?

Next step

Take the science into product development.

SAFE was one of several supporters. Our contribution was modest, but important to us.

Furlong research programme; SAFE historical material. University name: University of Washington, Seattle.

Safety becomes part of engineering

The science moves into long-term product development

Traditional question

Will the oil protect the turbine?

+

New design question

Can the chemistry be less hazardous?

Performance + toxicology → TURBONYCOIL 940 SE

Not simply a new oil — a different development philosophy.

https://www.nyco-group.com/when-a-safety-engineered-oil-meets-high-performance/



Photo: Halvor Erikstein

2010

Statoil stated the principle

Statoil later changed its name to **Equinor**

> **We strive to replace products that may pose an HSE risk with other products that carry a lower HSE risk, provided they have technically acceptable properties.**

Statoil HSE management · March 2010



Sixteen years later → Equinor tests it in practice
Equinor is the first major oil company to test the oil in real life operations.

Source: Statoil HSE response reproduced in the user's Aircraft Cabin Air 2024 presentation.

Test of turbine oil TN940SE

- Equinor's turbine pool team was contacted by NYCO regarding the possibility of testing a new type of turbine oil.
- During 2025, Equinor and NYCO agreed to test TN940SE.
- The test is being carried out on an LM2500-PE gas turbine.
- A pipeline compressor package on Sleipner A was selected as the test unit, with a typical load of 15–20 MW.

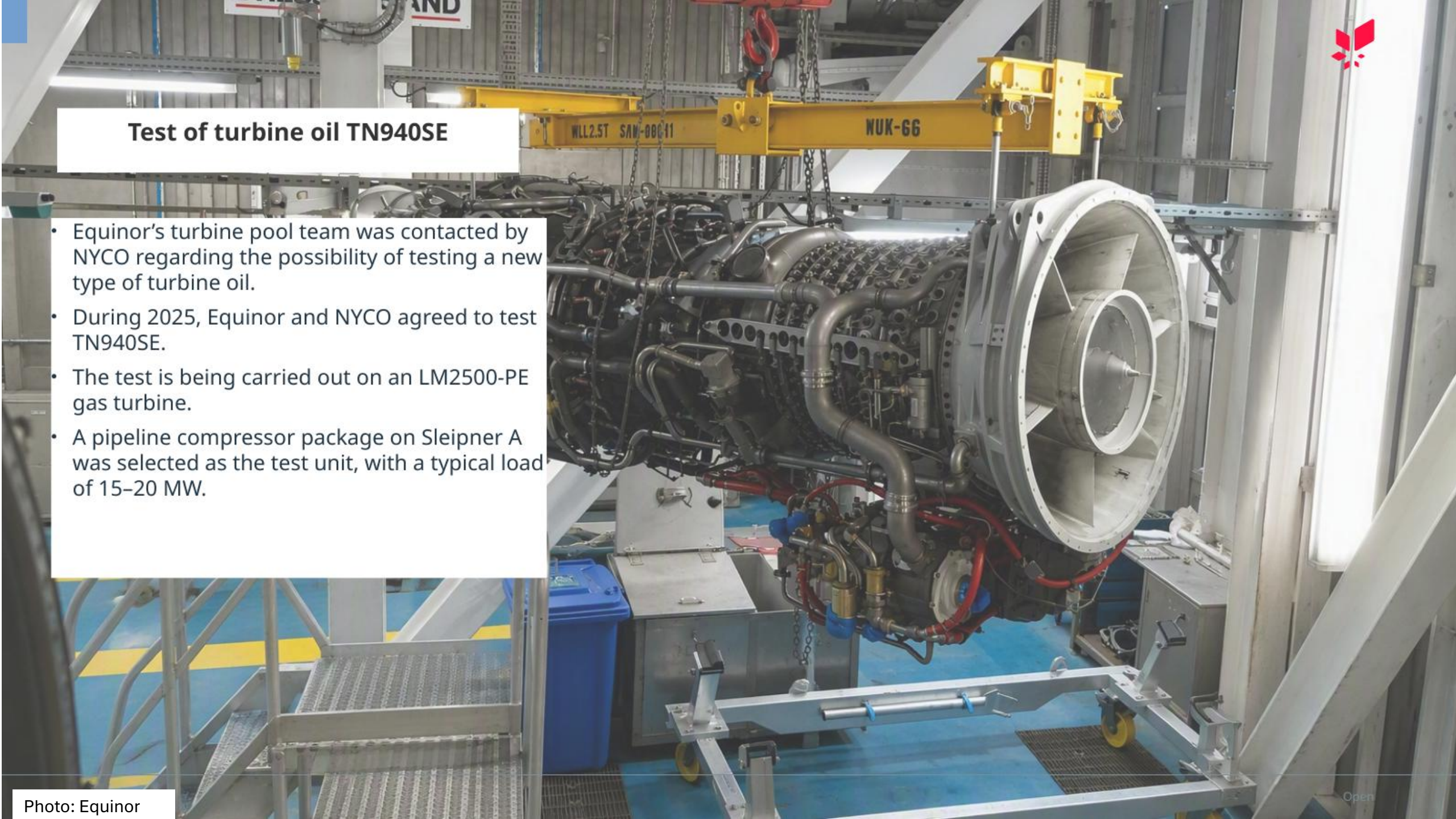
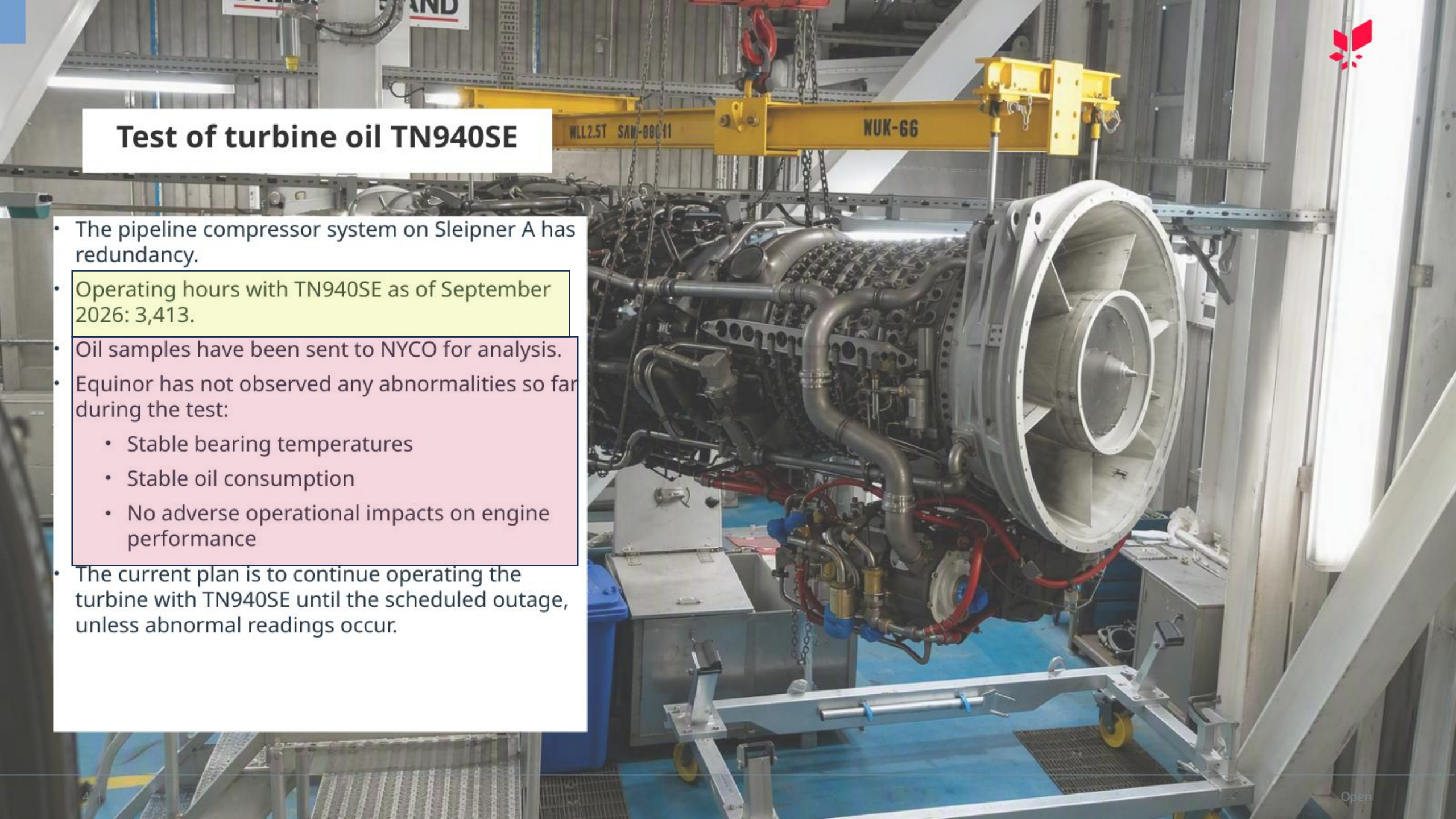


Photo: Equinor

Test of turbine oil TN940SE

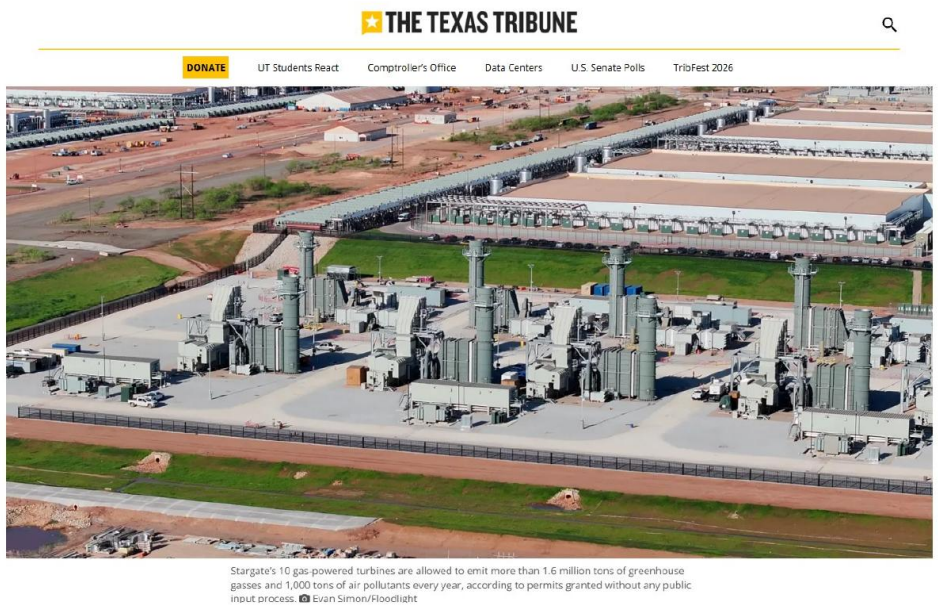
- The pipeline compressor system on Sleipner A has redundancy.
- Operating hours with TN940SE as of September 2026: 3,413.
- Oil samples have been sent to NYCO for analysis.
- Equinor has not observed any abnormalities so far during the test:
  - Stable bearing temperatures
  - Stable oil consumption
  - No adverse operational impacts on engine performance
- The current plan is to continue operating the turbine with TN940SE until the scheduled outage, unless abnormal readings occur.



NEW APPLICATION

Aeroderivative turbines are moving into AI data centres

A rapidly expanding land-based power market



https://www.texastribune.org/2026/07/09/texas-data-centers-ai-power-plants-pollution-state-permits/

https://www.reuters.com/business/energy/fast-tracked-power-plants-fuel-ai-boom-with-little-public-scrutiny-2026-06-16/

29 LM2500XPRESS

Nearly 1 GW for Crusoe AI data centres

- More turbines
- More technicians
- New locations
- Neighbour concerns: emissions & noise

Question for occupational hygiene: What lubricants are being used — and how were they toxicologically assessed?

Sources: GE Vernova (29 LM2500XPRESS, nearly 1 GW); Texas Tribune / Floodlight, 9 July 2026.

Same aeroderivative technology — different exposure pathways

The occupational-health question is not only which turbine oil is used, but where oil-bearing air, vents, drains and maintenance releases are routed

AIRCRAFT

Bleed-air system



- Bearing / seal system sits close to the compressor air path
- Seal leakage or maintenance faults can introduce oil products into bleed air

Primary focus: cabin / cockpit exposure

OFFSHORE LM2500

Continuous-duty package



- Package layout and vent termination are installation-specific
- Potential point sources include breathers, drains, sampling and opening after shutdown

Gap: measure hot vents and task peaks

U.S. NAVY LM2500

Source-controlled venting



- All bearing sumps vent to an air/oil separator
- Separated oil returns; residual air is routed to the exhaust duct
- Ventilated, insulated enclosure + controlled cooldown before entry

Design reduces release into normal work area

DATA CENTRES

LM2500 / LM6000



- Rapidly expanding land-based aeroderivative generation
- O&M work includes lube systems, water wash and hot-section maintenance
- Public task-based oil / OP exposure data remain sparse

Priority: verify vent routing + exposure

KEY QUESTION: Where does every lube-oil vent, breather, drain and maintenance release terminate?

Safer chemistry + source control + task-based exposure monitoring = prevention

Sources: FAA Cabin Air Quality (2025) / EASA cabin-air research for aircraft pathway; U.S. Navy NAVEDTRA 14114 & 14115 for LM2500 venting/enclosure. Offshore and data-centre vent arrangements are package/site specific and should be verified from P&IDs, OEM manuals and field inspection.

Develop turbine oils with performance and toxicology in mind from the beginning



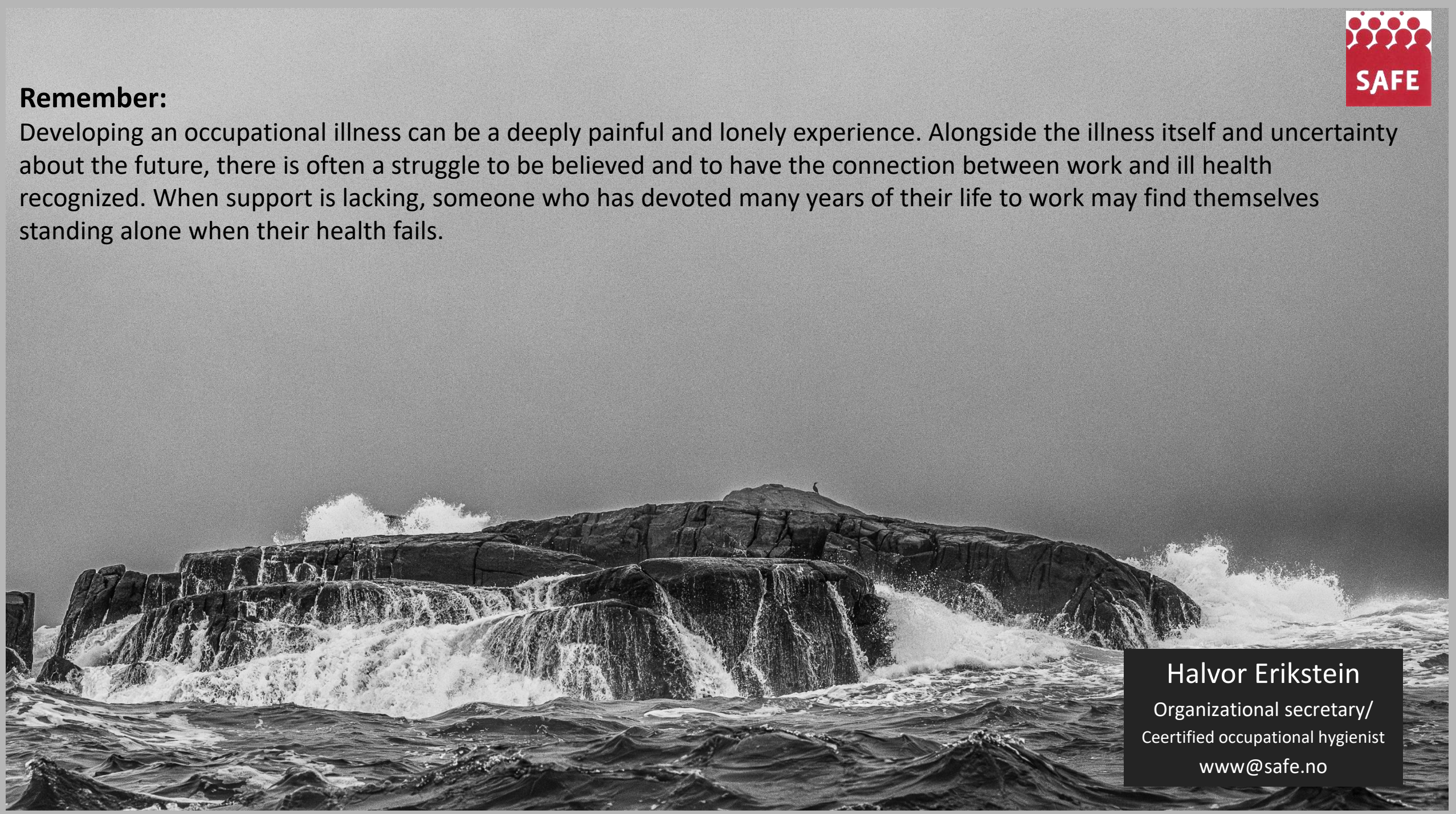
Performance qualification protects the turbine.

Toxicological qualification should protect the people.

The philosophy demonstrated in the development of TURBONYCOIL 940 SE should become a model for future turbine-oil development!

Remember:

Developing an occupational illness can be a deeply painful and lonely experience. Alongside the illness itself and uncertainty about the future, there is often a struggle to be believed and to have the connection between work and ill health recognized. When support is lacking, someone who has devoted many years of their life to work may find themselves standing alone when their health fails.



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Test of turbine oil TN940SE

- The Gas Generator (GG) was scheduled for replacement during maintenance on Sleipner A in autumn 2025.
- The replacement GG was put into operation with TN940SE in December 2025.
- The lube oil reservoir for the turbine package was drained of TN600.
- TN600 had previously been used in both the turbine package and the replaced GG.
- The installed GG had approximately 11,000 operating hours since overhaul.
- The oil reservoir was filled with TN940SE.
  - It was important that TN940SE could be mixed with residual amounts of TN600.
  - Avoiding a full flush of the oil system was important because flushing would involve:
    - increased complexity
    - increased risk of contamination
    - increased use of oil and chemicals
    - additional operational steps



Bearing and lube oil temperatures



Bearing and lube oil temperatures with TN600



Bearing and lube oil temperatures with TN940SE