NORCE P&A Innovation Program

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Outline

1. About NORCE and P&A
2. The P&A Innovation Program
3. Phase I projects
4. Ongoing projects and activities

Brief history of P&A at NORCE

SFI 2011-19:

DrillWell
DRILLING AND WELL CENTRE FOR IMPROVED RECOVERY

AkerBP · ConocoPhillips Norway · wintershall · equinor · SINTEF · University of Stavanger · The Research Council of Norway · NORCE · NTNU Norwegian University of Science and Technology · sfi Centre for Research-based Innovation

RCN Infrastructure 2019-24:

NorPALabs
Norwegian P&A Laboratories

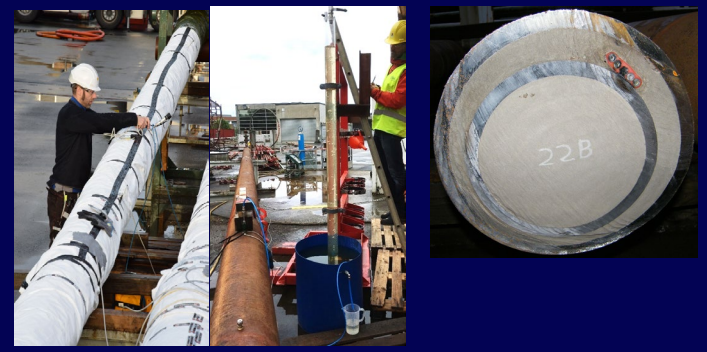
SFI 2020-28:

Swipa

JIP 2018-26:

P&A Innovation Program

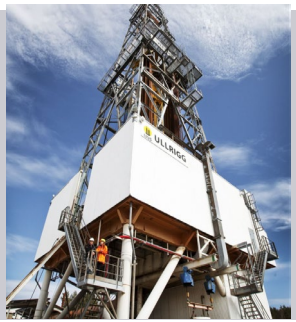
Highlight: Tubing left in hole experiment



NORCE – Current P&A Activities

P&A Innovation Program

- JIP – 7 partners
- Applied Research
- Full-scale testing and verification
- Program manager; Erlend Randeberg
- Ph. I: 2018-2023, Ph. II: 2023-2026



Norwegian P&A Laboratories

- P&A test well
- Full-scale lab for testing at downhole conditions
- NORCE Manager; Dave Gardner

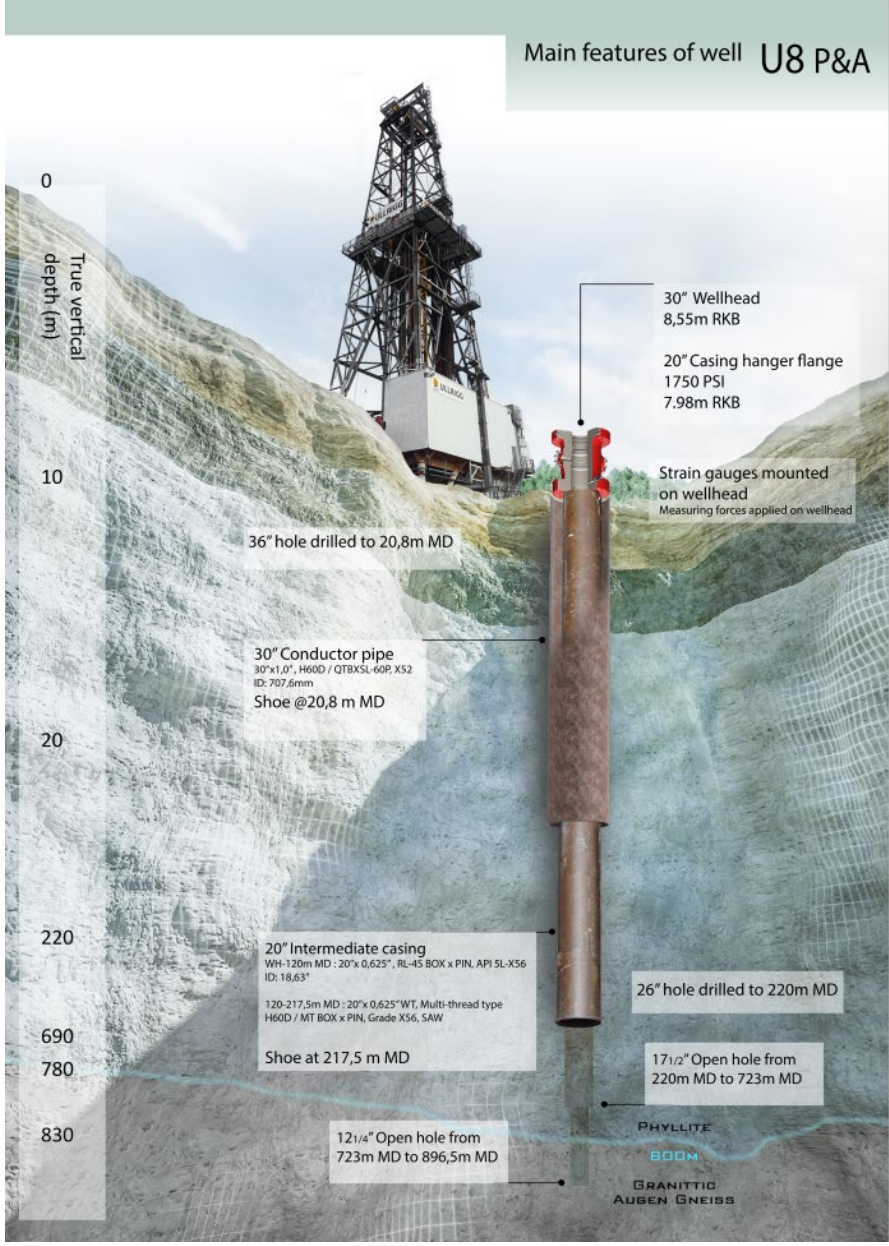
SWIPA

- Center for Research-Driven Innovation (SFI)
- Scientific understanding of permanent well barriers
- Improved well barrier design methodologies
- NORCE WP Manager; Erlend Randeberg

NorPALabs P&A Well

U8 P&A Well

- Dedicated P&A well
- 20” uncemented casing installed to 217 m
  17 ½” openhole to 723 mMD
  12 1/4” openhole to 896.5 mMD
- Available 13 5/8” casing to be run
- Additional equipment:
  - Well head
  - Casing & tubing hangers
  - Test-from-below sub
  - DTS



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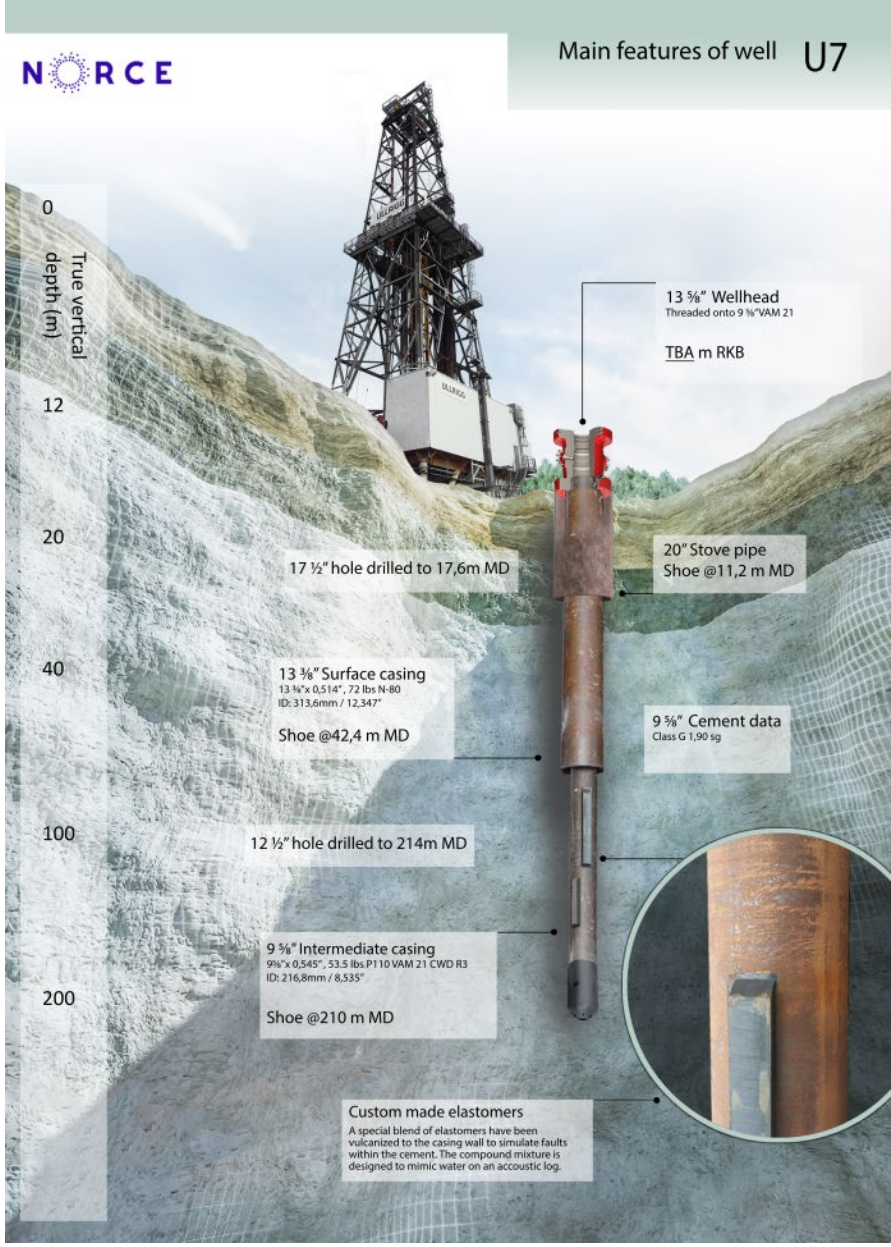
NorPALabs CBL Well

U7 CBL Reference Well

- Established in 2021 – funded by Equinor
  SPE-208699; *Construction of a reference well to support the qualification of cement evaluation logging tools and data processing*

- 9 5/8” casing is cemented with phantom "water channels" for logging purposes
- Allows for Ullrigg to run required tubing and carry out through-tubing-logging



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NorPALabs PLT

Pressure and Leakage Testing

- Measure barrier material sealing performance under realistic conditions
- Full diameter, relevant length, vertical to horizontal
- Maintain downhole conditions for extended test intervals

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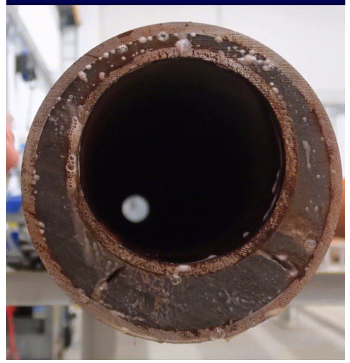
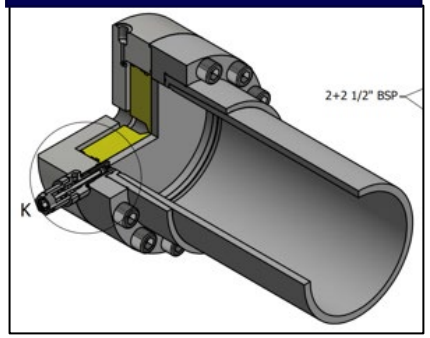
P&A Innovation Program
Phase I projects

Valhall sandwich sections

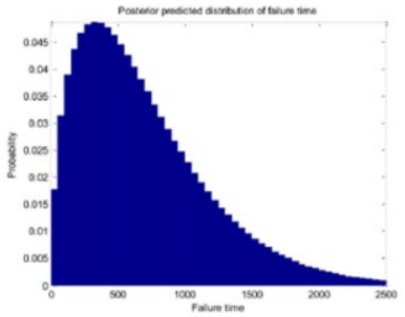


Fluid migration modelling and treatment

Full-scale P&A test



Industry-standard risk acceptance criteria



Rigless P&A Experiments

AkerBP ConocoPhillips BR PETROBRAS PETROLEUMSTILSYNET TOTAL

Barrier verification & Valhall Sections

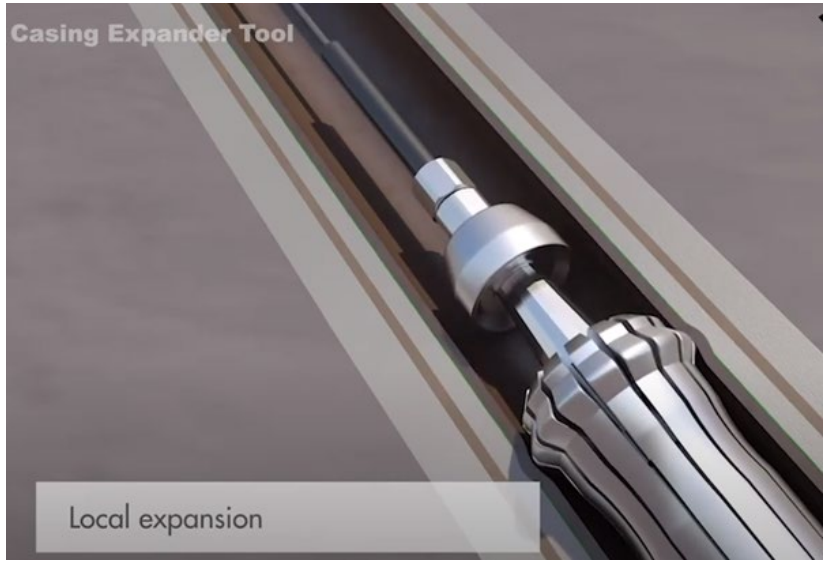
Objective: Improved log analysis by correlating log response to measured sealing quality of the annular cement

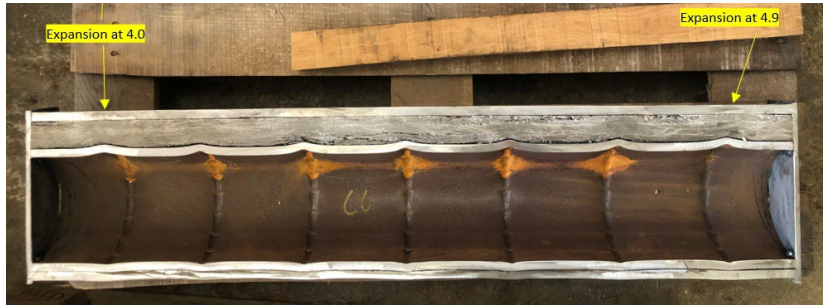
- 9 5/8” x 13 3/8” sandwich sections recovered from a Valhall production well constructed in 1985
- Measure the barrier quality of the annular cement sheath using acoustic logs, leakage tests, cement core plug analysis
- Compare logs to the physical measurements

Schlumberger	HALLIBURTON	Baker Hughes	Archer	TGT	WellGuard
Isolation Scanner	CAST - XRT CAST - M	ULTeX / INTeX / RAL	VIVID	Chorus	
2019	2019	2020	2019 & 2022	2019	2022

Fluid migration modelling & treatment

1. Understand fluid flow through realistic cracks and micro-annuli in order to determine leakage potential
2. Implement “state-of-the-art” SCP bleed-off and build-up model in leakage calculator software framework to improve the analysis of SCP test data
3. Develop and apply a standard methodology for the representative qualification of treatment technologies
   - Mechanical tools; e.g. Local Casing Expander
   - Chemical products; Resins, mineral solutions, …





Full-scale P&A plug testing

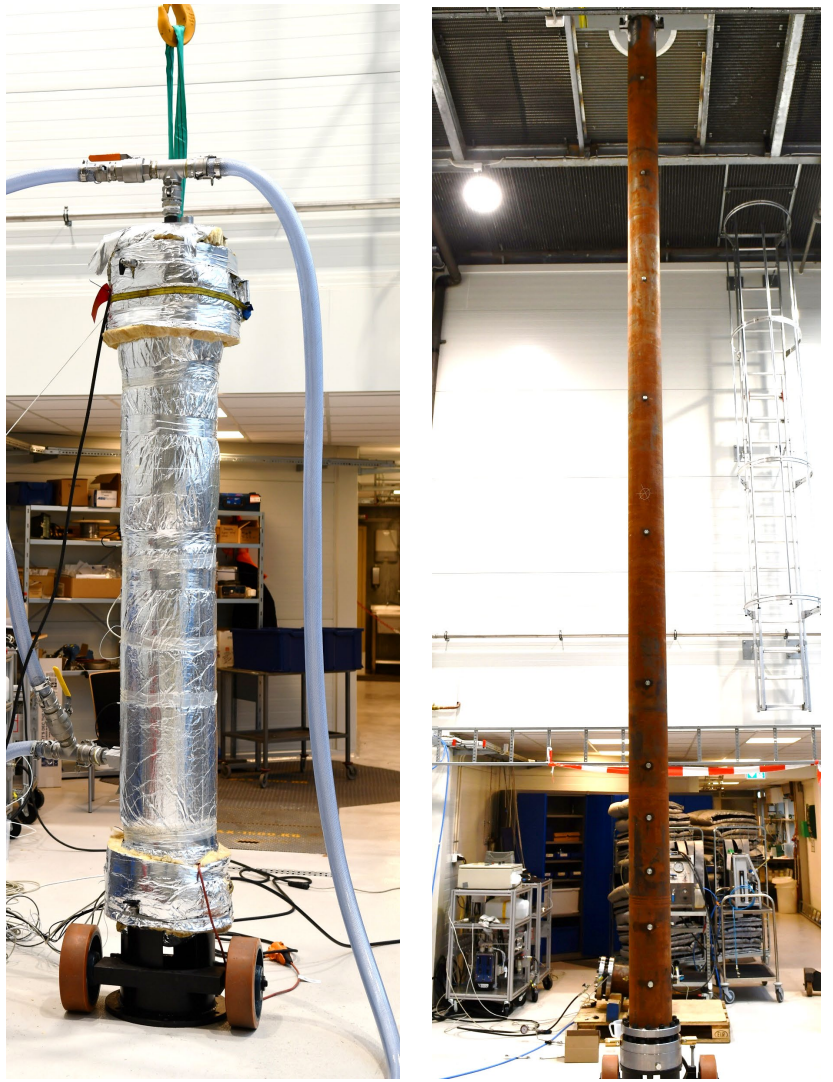
Investigate scaling effects when measuring the sealing performance of cement plugs

Using 2 & 8 meter long 9 ⅝ test cells:

1. 1.92 sg Class G cement
2. + 3% expansion additive

Cells held at downhole conditions throughout experiment, from cement curing to seepage testing

Extensive & precise instrumentation



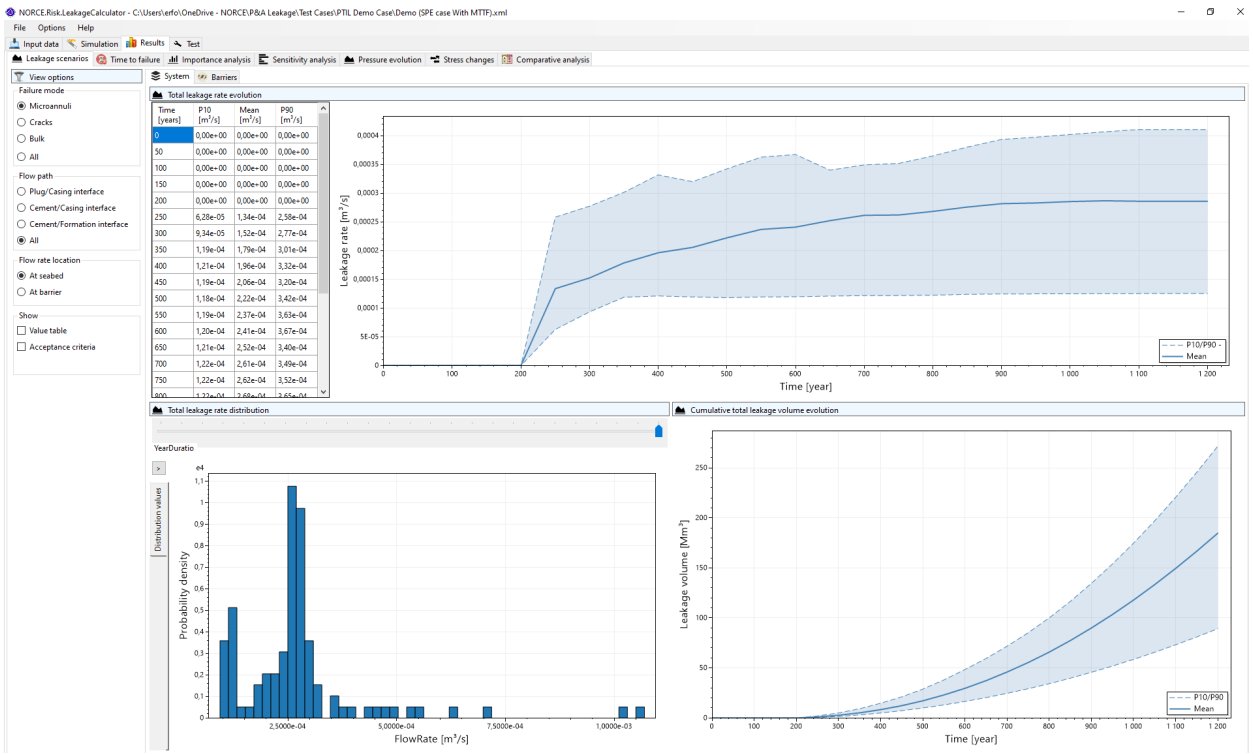
2m commissioning & 8m rig-up check

Risk-based approach to P&A

P&A Leakage Calculator

Objective: Enable operators to put a quality measure on any given P&A well design

- A leakage calculator is developed, leakage risk is determined by evaluating failure type probabilities and associated leakage potentials, based on available experimental data
- Project results can be used to evaluate cost/benefit of different P&A solutions
- Case studies are ongoing in parallel with further development of the functionality



Rigless P&A test examples

1. Mimic well features in U8 P&A Test Well
2. Through Tubing detection of control line flatpack (4 tools)
3. Cut the flatpack using Dynaslot perforating charges (2 gun types)
4. Coiled tubing PWC, plug drill out and log with Isolation Scanner
5. Retrieve well completion and cut into sections

Running 6 5/8” tubing + flatpack into P&A well U8

Phase I deliverables

28 publications:

1 associated PhD, 21 journal/conference papers, 6 technical reports

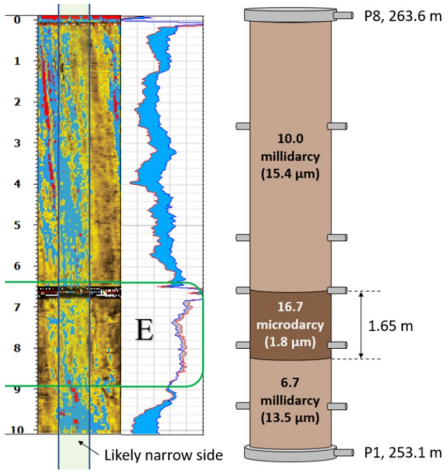
Finalized RCN competence project (KSP)

International collaboration; Brazil, Canada, US

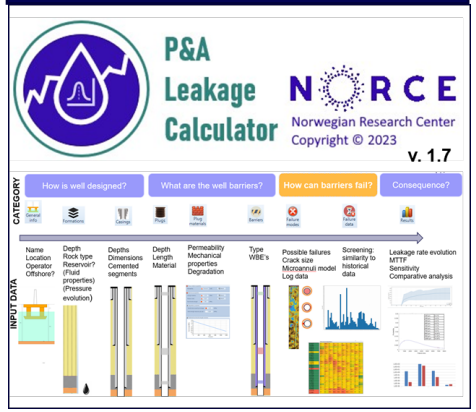
Strong interaction with service providers and operators

P&A Innovation Program – Phase II

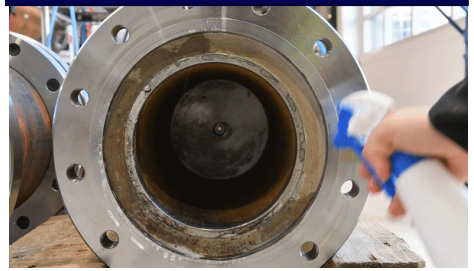
Stacked vs Continuous Barriers



P&A Leakage Calculator Phase II



Well Barrier Material & Seepage Treatment Testing



Rig-less Operations and Through-Tubing Abandonment

ConocoPhillips

Havtil Norwegian Ocean Industry Authority

AkerBP

equinor

PETROBRAS

TotalEnergies

Phase II – Ambitions

Continued strong user-involvement

Relevance to industry

Scientific achievements and publications

Seeking synergies with other projects

Thank you. Takk. Merci. Gracias. Obrigado.

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