Centre for Research-based Innovation
The Research Council of Norway

Swipa | Subsurface Well Integrity Plugging and Abandonment

Offshore Norway P&A Seminar 2024

SWIPA – a scientifically-based approach for technology qualification

October 24, 2024

Harald Linga, SINTEF,
Centre Director SWIPA

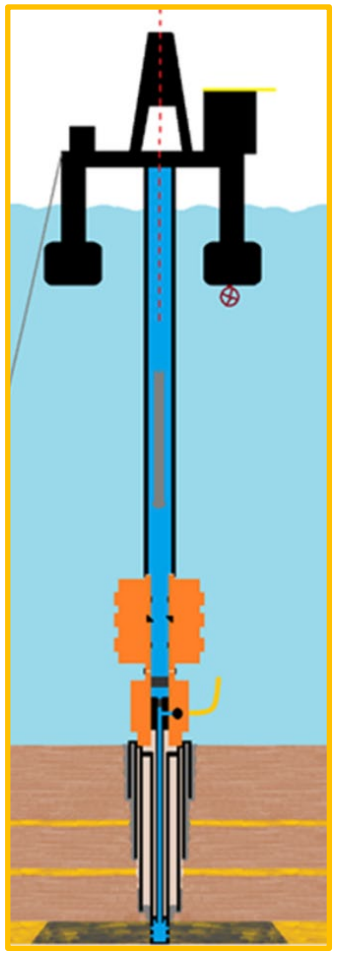
SINTEF NORCE NTNU Norwegian University of Science and Technology IFE Universitetet i Stavanger

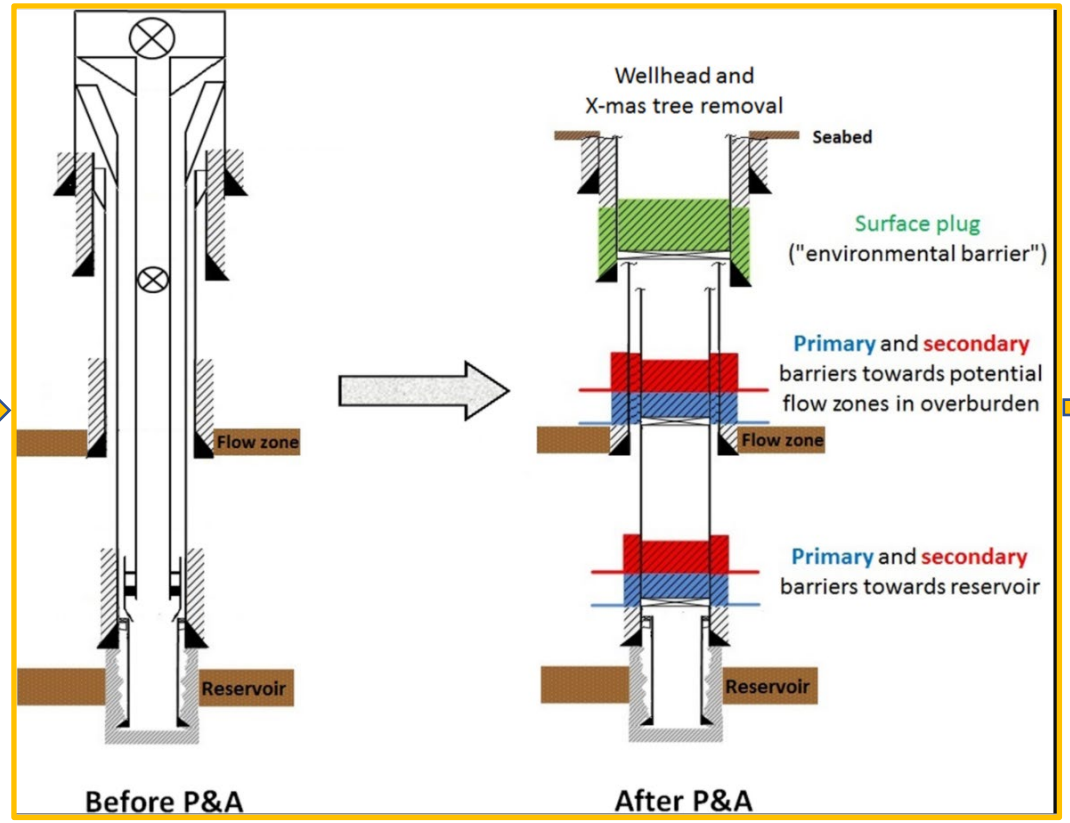
SFI SWIPA – in short

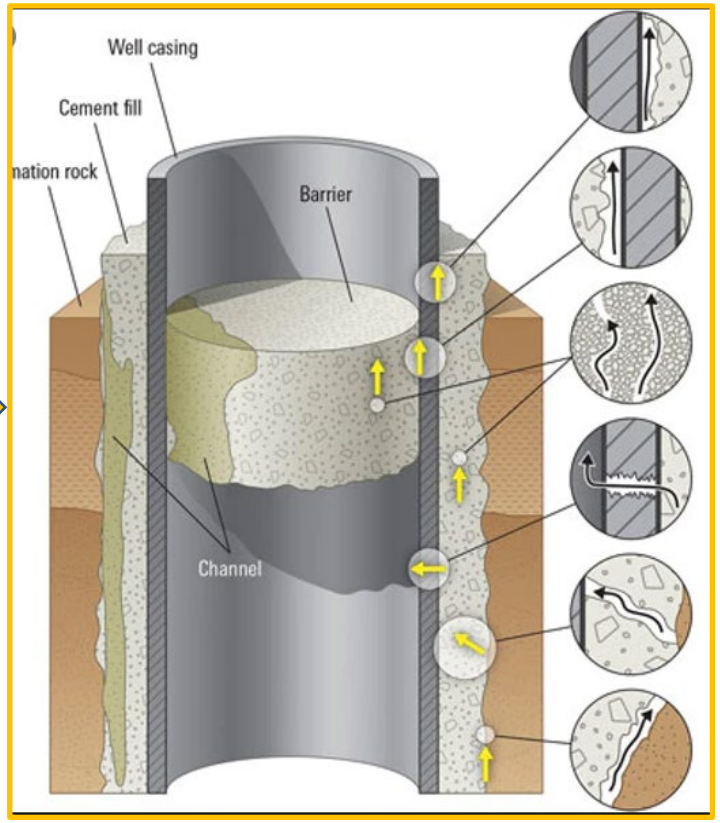
- **SFI - Centre for Research-based Innovation**
  - **Purpose**; further develop elite, creative research and innovation groups in close collaboration with industry
  - 8 years duration (2020 – 2028)
  - Max financing support from RCN 96MM NOK

- **SWIPA industry partners**
  - 5 R&D partners
  - 3 financing partners
  - 28 in-kind contributing partners
  - SWIPA academic partners: Brazil, US, Canada, Japan, the Netherlands

SWIPA – key tasks and industrial challenges







SWIPA – industry partners` feedback on well integrity topics

Well integrity topics		Primary impact towards industry			*Partners priority ranking* L- Lowest M- Medium H- Highest
no.	Description	Standards & regulations	Operation	Material selection	
1	Sealant properties of barrier materials	x		x	H
2	Placement of barrier material		x	x	M
3	Verification of barrier integrity	x	x	x	H
4	Re-use of petroleum wells, storage and disposal			x	L
5	P&A tools and operations		x	x	M
6	Evaluation of results, technology qualification, innovations	x	x	x	H

SWIPA - the Work Packages

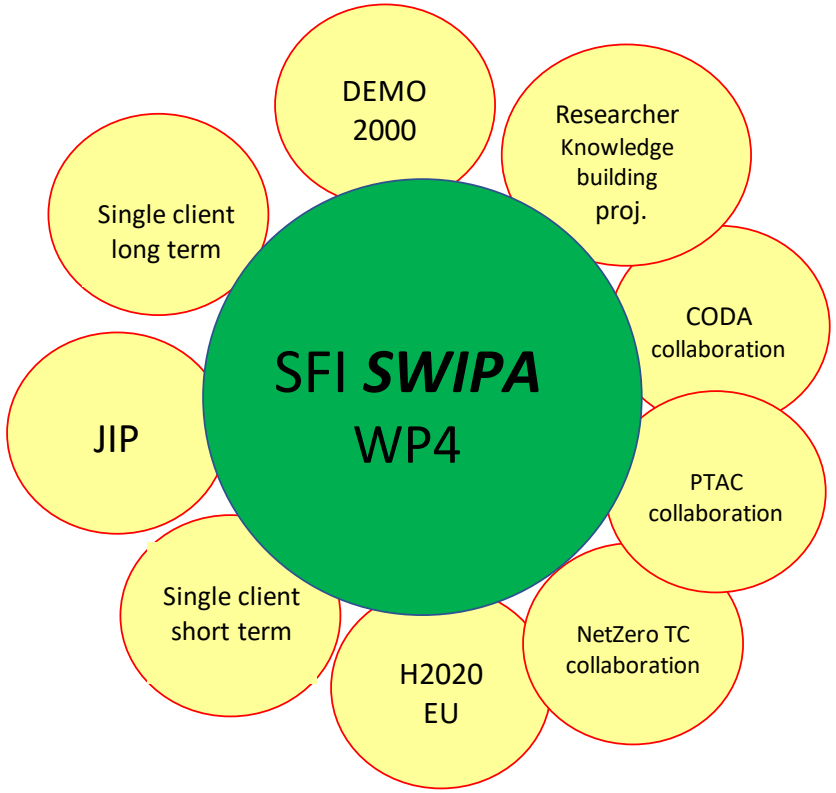
WP1
Well barrier materials and integrity

WP2
Barriers for storage and disposal

WP3
Upscaling and testing

WP4
Innovations and technology developments

TRL



WP1 & 2 - Well barrier materials and integrity

Objective:

- A fundamental understanding of different barrier materials, their sealing abilities, failure mechanisms and resulting leak rates

Potential innovations and implementations:

- Allowing for barrier acceptance criteria and "fit-for-purpose", risk-based approach to P&A
- New scientific understanding allowing for new ideas, products and services
- Improving present technology

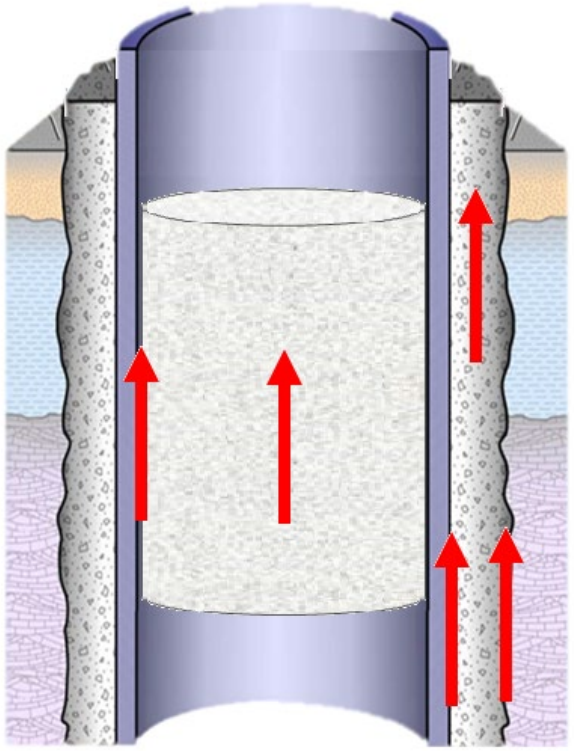
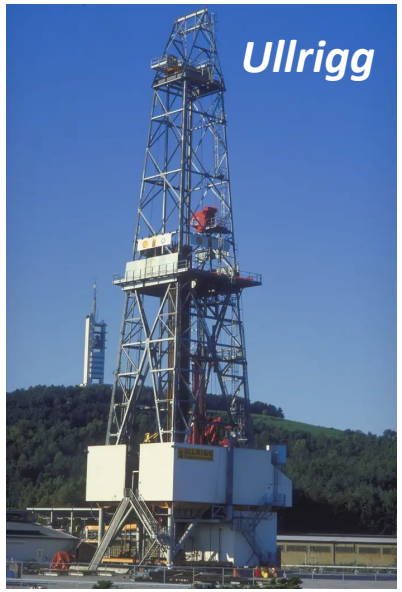


Figure from Vrålstad et al. (2019)
Journal of Petroleum Science and Engineering

WP 3 - Upscaling and testing

Objectives

- Investigate physical and operational scaling effects
- Enable development and implementation of new technology through testing under relevant conditions and realistic scale



NorPALabs
Norwegian P&A Laboratories

Test facilities
WP1: Plug Integrity Set-up (OIS)
WP2 Logging& verif. Lab (LVL)
WP3 Ann. flow&pipe pull lab (AFP)
WP4 Pressure & leakage test facility (PLT)
WP5 P&A research well (PAW)

SWIPA – partners feedback on well integrity topics

Well integrity topics		Primary impact towards industry			*Partners priority ranking* L- Lowest M- Medium H- Highest
no.	Description	Standards & regulations	Operation	Material selection	
1	Sealant properties of barrier materials	x		x	H
2	Placement of barrier material		x	x	M
3	Verification of barrier integrity	x	x	x	H
4	Re-use of petroleum wells, storage and disposal			x	L
5	P&A tools and operations		x	x	M
6	Evaluation of results, technology qualification, innovations	x	x	x	H

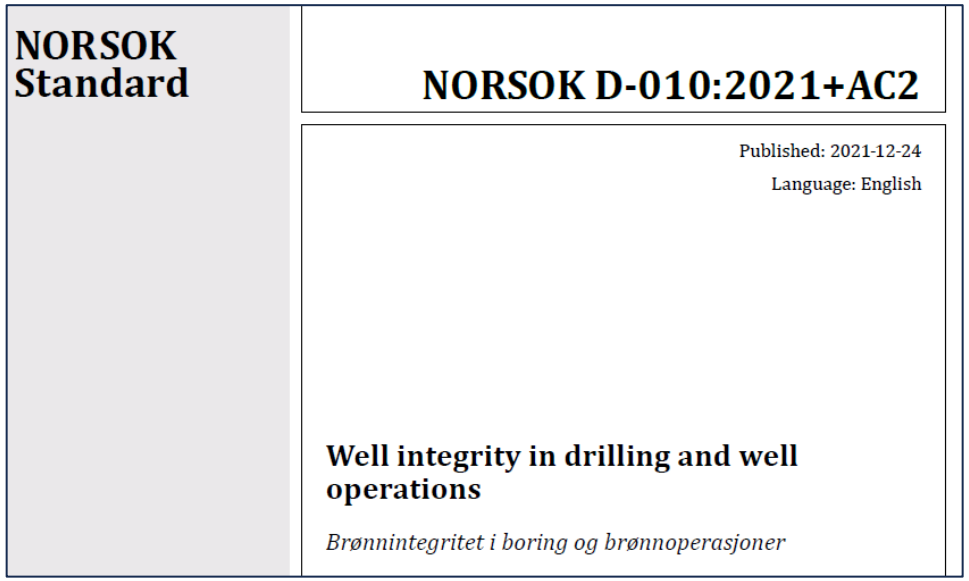
Well integrity and P&A – Standards and regulations

Norway has function-based regulations, where standards are an important factor in the interpretation of the various regulatory requirements.

The regulations refer to standards that provide more detailed descriptions of how things should be done.

The **NORSOK standards** are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authorities regulations.

NORSOK D-010 – prescriptive-based regulation - I



NORSOK Standard

NORSOK D-010:2021+AC2

Published: 2021-12-24

Language: English

Well integrity in drilling and well operations

Brønnintegritet i boring og brønnoperasjoner

Example:

Cement plug across a section milled interval

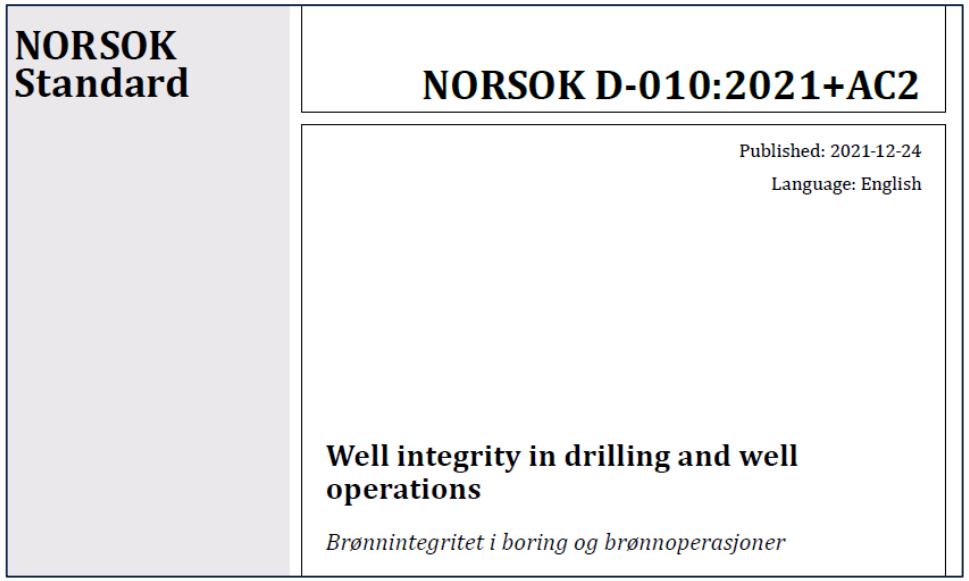
Design,construction, and selection

For a section-milled window in casing located in OH:

i) shall be 50m MD minimum for the element to act as a single barrier;

ii) shall be 100m MD minimum for the element to act as a combined primary and secondary barrier.

NORSOK D-010 – prescriptive-based regulation - II



NORSOK Standard

NORSOK D-010:2021+AC2

Published: 2021-12-24

Language: English

Well integrity in drilling and well operations

Brønnintegritet i boring og brønnoperasjoner

Similar examples for:

- **Perforate/wash/cement (PWC) cement plug**
- **Creeping formation**

NORSOK D-010 – resource and further development

The sharing of experience and expertise leads to **best practice in the form of standards**
Participants: Industry; experts from the operators, suppliers, service companies, HAVTIL and the maritime industry.

Ambition, well integrity & NORSOK:

Prescriptive - based **regulation**

⇩

Knowledge - based **regulation**

Case: Alternative barrier materials, role of SWIPA

SWIPA

- Barrier material properties
- Operational envelope performance vs. temperature, pressure, sour environment
- 3rd party role

Operational concerns

- Barrier material selection
- Performance testing barrier length
- Placement of barrier material

Impact

- Vehicle /vessel / rig
- Resources / manning
- CO2 footprint

Operators` statements on role of SWIPA

- *"A more scientifically based understanding of what is necessary as well barrier, including safety margins, both as a whole and as individual barrier elements will be very valuable. It is within this segment, more fundamental research within P&A, well barriers and integrity, that SWIPA has the potential to play a major role ".*

- *"With regards to innovation-based technologies, the results from the work could be directly used by the operators in their P&A operations, also in connection with implementing new technology from vendors. In addition it can be relevant to test and perform quality assurance for technology developments on behalf of the industry."*

SWIPA aspects – project execution and deliverables

Check points, performance and documentation

- Measurement accuracy
- Repeatability
- Bulk properties
- Interfacial/ surface properties
- Degradation, long term
- Envelope pressure and temperature exposure
- Prediction capability of performance estimate/ extrapolating performance

Key deliverables:

- Publications,
- Scientific papers peer reviewed Alliances network industry – researchers
- Technology reviews

Concerns:

- Industrial relevance and implementation
- Confidence to new technology, risk assessment
- Downhole process conditions

SWIPA on the Technology Readiness Level scale

Spin- off: DEMO project

Spin- off: Innovation project

SWIPA

Concept validation	Technology validation	System validation
Knowledge development	*Technology development*	*Business development*

0	1	2	3	4	5	6	7
Unproven concept - Basic research and development (R&D) in papers	**Demonstrated concept**- Proof of concept as desk study or R&D experimentation	**Validated concept**- Experimental proof of concept using physical model tests	**Protype tested**- System function performance, and reliability tested.	**Environment tested** - Preproduction system and environment tested	**System tested** - Production system interface tested	**System installed** - Production system installed and tested	**Proven in the field**- Production system field-proven

Status – some activities to date…

- Robustness testing of 9 **barrier materials**: geopolymers, other polymers and cements with additives
- Avoidance of **leakage from shallow gas** zones – impact from type cementitious barrier material at low temperature
- Characterisation of **Bi-alloys** as barrier material
- **In-line measurement** system for **slurry** properties of barrier material
- Spin-off project - CCUS application: **self-healing** of barrier material

NorPALabs
Norwegian P&A Laboratories

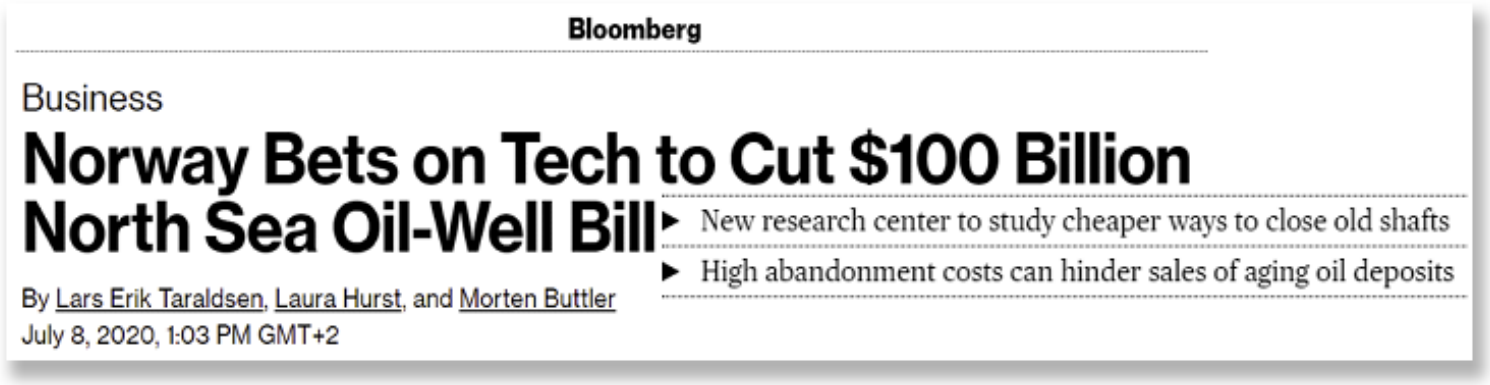
SWIPA – ambitions and expectations

SWIPA aims to obtain a scientific understanding of permanent well barriers allowing for improved well barrier design methodologies.

Key parameters:

costs, materials, barrier lengths and operations

50% cost reductions target for P&A operations
Including impact from revised standards and regulations, new operations and well barrier materials.



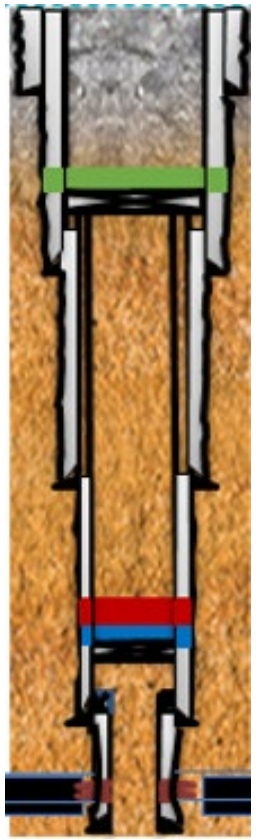
Bloomberg

Business

Norway Bets on Tech to Cut $100 Billion North Sea Oil-Well Bill

- New research center to study cheaper ways to close old shafts
- High abandonment costs can hinder sales of aging oil deposits

By Lars Erik Taraldsen, Laura Hurst, and Morten Buttler
July 8, 2020, 1:03 PM GMT+2



SWIPA - Collaboration

- The national team in well integrity www.swipa.no

- International collaboration; universities and industry

  Australia, Brazil, Canada, Japan, Netherlands, UK, USA

- National & international authorities

Partners

R&D partners:

SINTEF NORCE NTNU IFE University of Stavanger

Financial industry partners:

AkerBP equinor Harbour Energy

In-kind industry partners:

Baker Hughes Archer CANNSEAL Disruptive Value Group eDrilling elogix logical minds...

EXEDRA TYRFING Innovation as GCE NODE AN INDUSTRY-DRIVEN CLUSTER FOR OCEAN TECHNOLOGIES Funzionano Huisman

HydraWell MAERSK DECOM Innovation Energy Net Zero Technology Centre Technology Driving Transition RESTONE

PETROLEUM SAFETY AUTHORITY NORWAY WellGuard® STRATUM RESERVOIR Prores marwell

Saferock wellcem slb WELLSTRØM FloPetrol WELL BARRIER

CODA CENTRE OF DECOMMISSIONING AUSTRALIA PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA NET-ZERO GEOSYSTEMS

www.swipa.no

sfi Centre for Research-based Innovation
The Research Council of Norway

Swipa Subsurface Well Integrity Plugging and Abandonment

SINTEF

NORCE

NTNU
Norwegian University of Science and Technology

IFE

Universitetet i Stavanger