Offshore Norge P&A Forum
History of P&A RoadMap and the future of P&A RoadMap

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THE BEGINNING OF THE P&A FORUM

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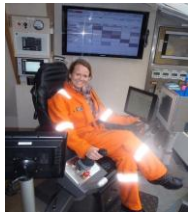
P&A Forum started in 2009 after a technology day at ConnocoPhillips hosted by Jan Roger Berg
- with participation from BP, ENI, Shell, StatoilHydro and Total and eleven vendors.

- **"the intention was to promote development of robust and cost efficient solutions to the current & upcomming challenges of the forthcomming P&A scope in the NCS - together with the service industry"**

First PAF Seminar was hosted in 2011 at the Quality Airport hotel with 124 people present

First P&A Forum Chair was Nina Ringøen



Martin Straume elected as chair in 2012 untill 2017
- during this period the PAF Seminar managed to find it`s path and number of attendees increased annually up to over 400

Egil Thorstensen elected as chair in 2017

The PAF Seminar has now become – by far - the largest one-day P&A event in Norway

THE BEGINNING OF THE P&A FORUM

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THE FIRST DRAFT P&A ROADMAP

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P&A Roadmap for implementation of New Technology

2015	2016	2017	2018
Optimize Perf Wash & Cement	Well Intervention technology for P&A	LWI P&A - SWAT tool - CT	Plasma Milling
Verification of PWC (JIP)	Alternatives to cement - Creeping shale - Subsidence	Reservoir Pressure - Virgin pressure ? - Eternal perspective ? Overburden zones ?	
Tubing left in hole	Alternatives to cement bond logging/ Pressure testing	Sharing of knowledge - NORSOK D-010 - ISO - NOROG Guideline - UK Guideline	
Ctrl line left in hole			
LWI: CT drilling/cementing			

Dual string cement bond logging

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THE FIRST P&A ROADMAP

Roadmap for New P&A Technologies

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Optimize Perf Wash & Cement

Optimize Milling

Tubing left in hole

Alternatives to cement
- Creeping shale / Formation effects
- Sand/Rock/Natural materials
- Chemical materials
- Steel

Rigless P&A
- High Capacity CT System
- High Energy Solutions (Melt/Burn)/Extreme Concept

LIV CT Pilothole drilling/cementing

Well Intervention technology for P&A

Wireless technology (subsea wellheads)

Improved Verification / Logging methods

Rig/Process optimization

Dual string: Cement bond logging Perf, Wash & Cement, Milling

Ctrl line left in hole

Tender Support P&A rigs/Modular Rigs

Focus areas for 2015 - 2016 | Futuristic Technologies

P&A ROADMAP

Roadmap for New P&A Technologies

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Optimize Perf Wash & Cement

Optimize Milling

Tubing left in hole

Alternatives to cement:
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Dual string: Cement bond logging Perf, Wash & Cement, Milling

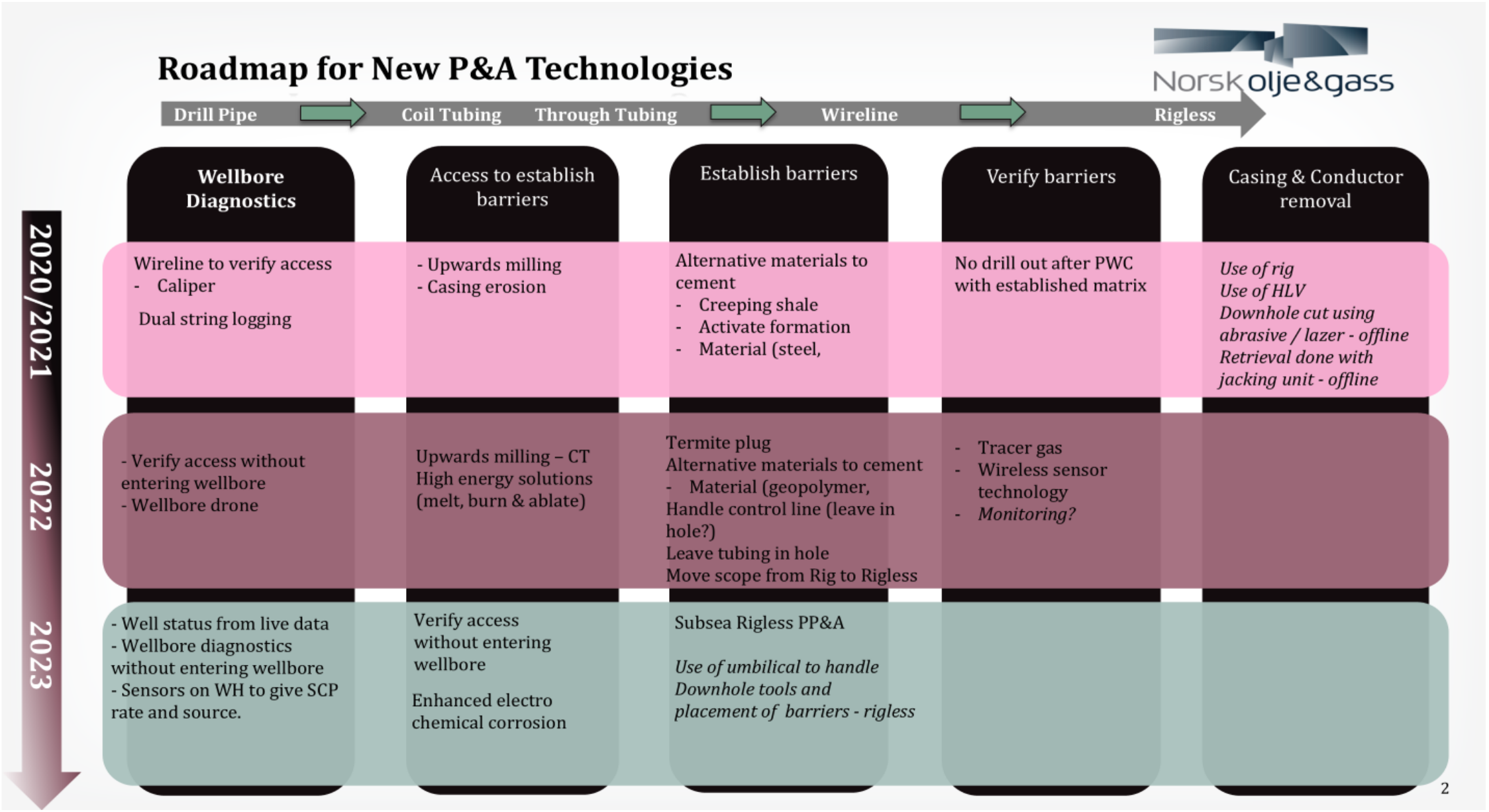
Ctrl line left in hole

Tender Support P&A rigs/Modular Rigs

Focus areas for 2017 – 2020
Many projects - ongoing

Focus areas for 2017 – 2020
Work started

THE SECOND VERSION P&A ROADMAP



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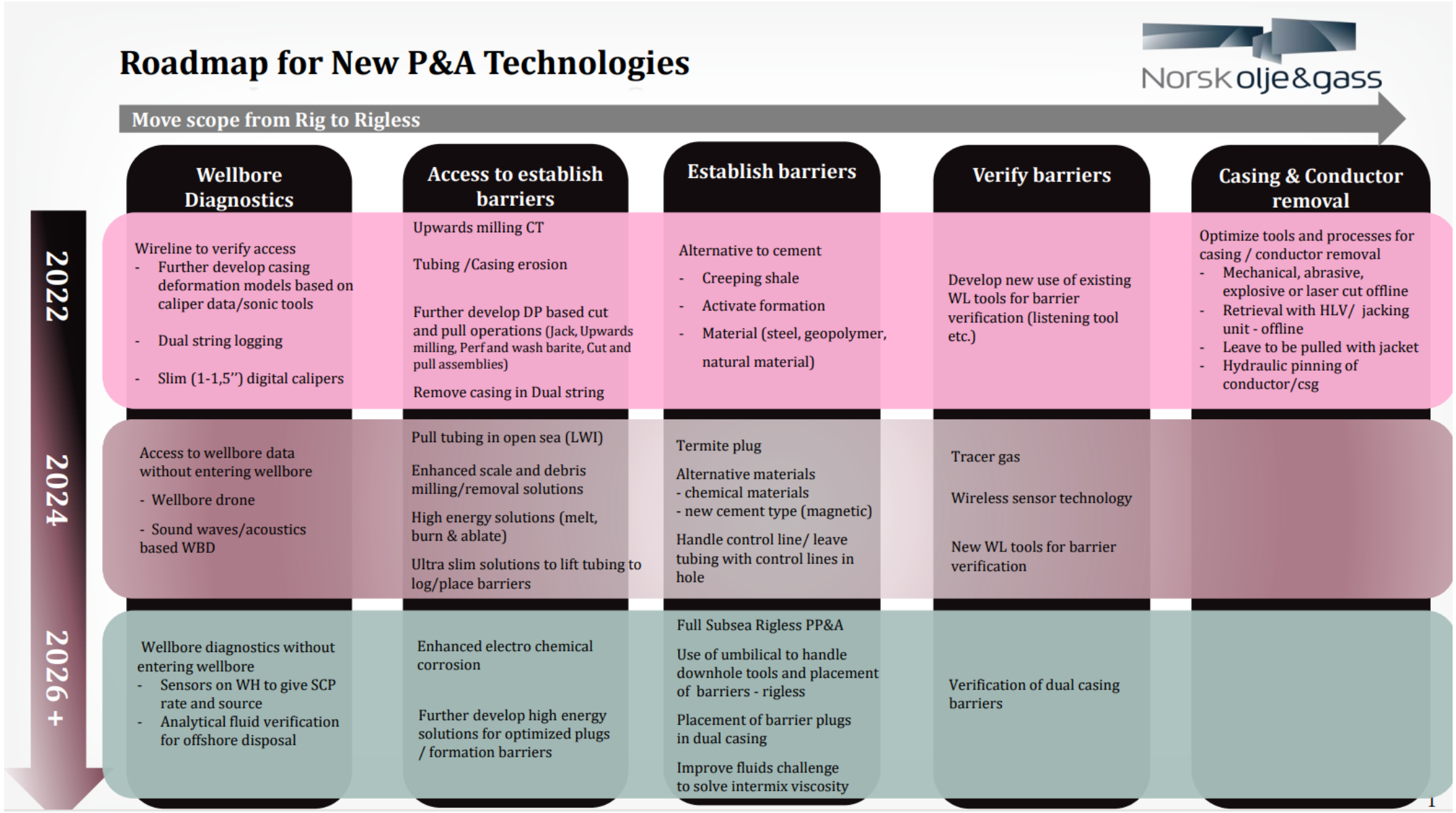
P&A ROADMAP



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THE FIRST P&A TECHNOLOGY NEEDS

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Estimated P&A- Norwegian Continental Shelf: 2022 – 2027
March 2022

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Company	Estimated number of P&A 2022 → 2027	Estimated number of Slot Recovery 2022 → 2027	Estimated number of Sub Sea P&A 2022 → 2027	Contact person
AkerBP	17	29		Egil Thorstensen
ConocoPhillips	45	47	0	Birgit Vignes
Equinor	+/- 24 cessation	+/-70 pr. år	+/- 5 cessation	Tormod Fossdal
Neptune Energy	1-2 /year	0	0	Bjørn Schmidt
DNO Norge	3-5	0	subsea P&A	Grethe Lønø
Lundin Energy	0	2	4 subsea P&A	Jakob Mo
Norske Shell	9	0	subsea P&A, LWI	Knut Hals
Repsol Norge	3	0	3	Øystein Østerhus
TotalEnergies	3	0	Subsea P&A	Johan Kverneland
Sval Energi(Spirit E)	1	0	Subsea P&A	Stian Brevik
Wintershall Dea	+/-11	+/-20	0	Frode Angell-Olsen
Vår Energi	0	5	0	Jan Terje Svendsen

Key technical challenges:
Subsea P&A, Platform P&A, Dual casing strings across P&A zone, Slot recovery, Rigless P&A, Verification of cement / formation outside casing, Removal of tubing / casing, Challenge to set 50m plugs, Tubing access/collapse, verification methods, corroded tubulars, cross-department. Through tubing PWC, Logging through two strings, Deformed casing/tubing
COP do rig/DP based P&A. Key challenge is dual casing over P&A zone. Typically, 7" casing inside 9 5/8" csg. Also: See presentation"CasingDeformation" held in 2018

Technical needs:
Dual string cross sectional plugging, Cutting/milling in large casing, Pull tubing, Logging challenges, PWC, Reliable and efficient barrier verification methods, Dual casing bond logging, Alternative plugging solutions, Rigless P&A
CoP: A dual string cross sectional technique which (dual string logging) can be verified or effective fishing of inner string.

ROADMAP FOR NEW P&A TECHNOLOGIES

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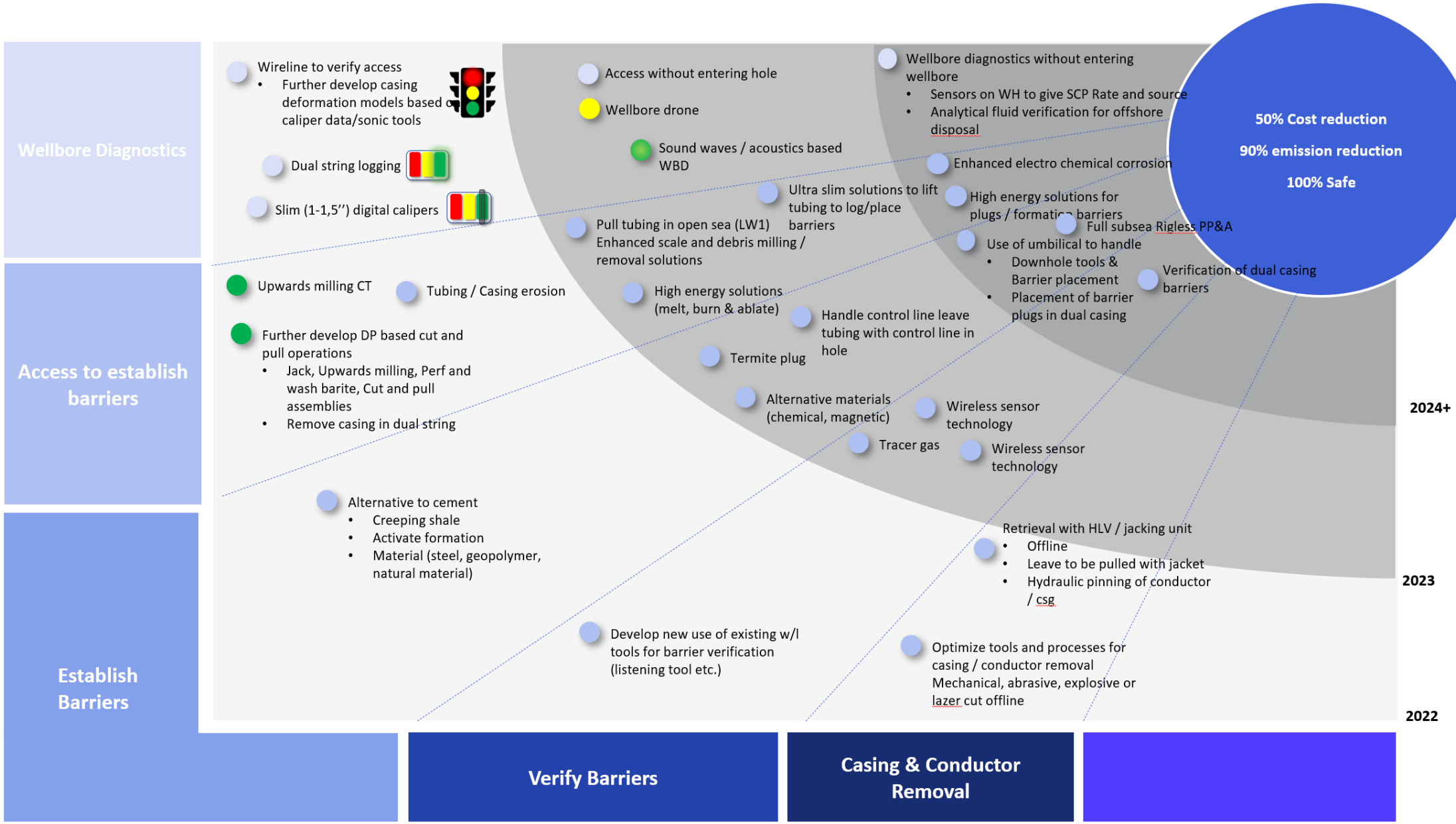

TECHNOLOGY DEVELOPMENT TO A FINISHED PRODUCT

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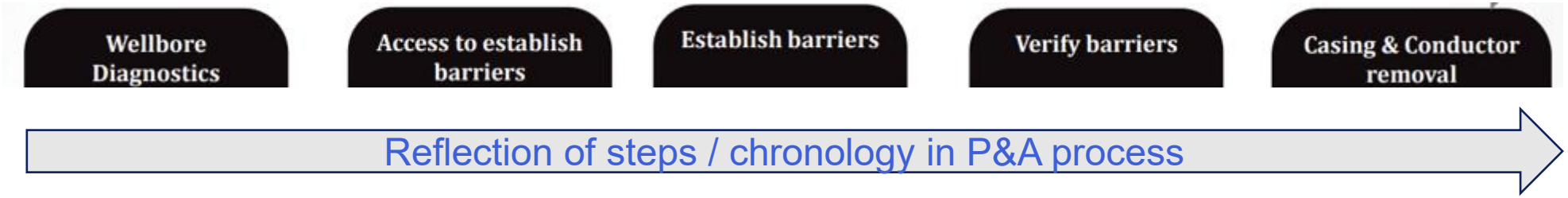
- 2012 first time Thermite plug was discussed – still not commercialized in NCS
- 2014 Initial discussions to remove control lines – 2025 successful test at Ullrig
- 2015 - Dual String Logging – on P&A RoadMap already in 2015 – still not qualified for all applications
- 2016 - New barrier material (bismuth) installed in 2020 (as shallow P&A barrier and Environmental plug – field specific)

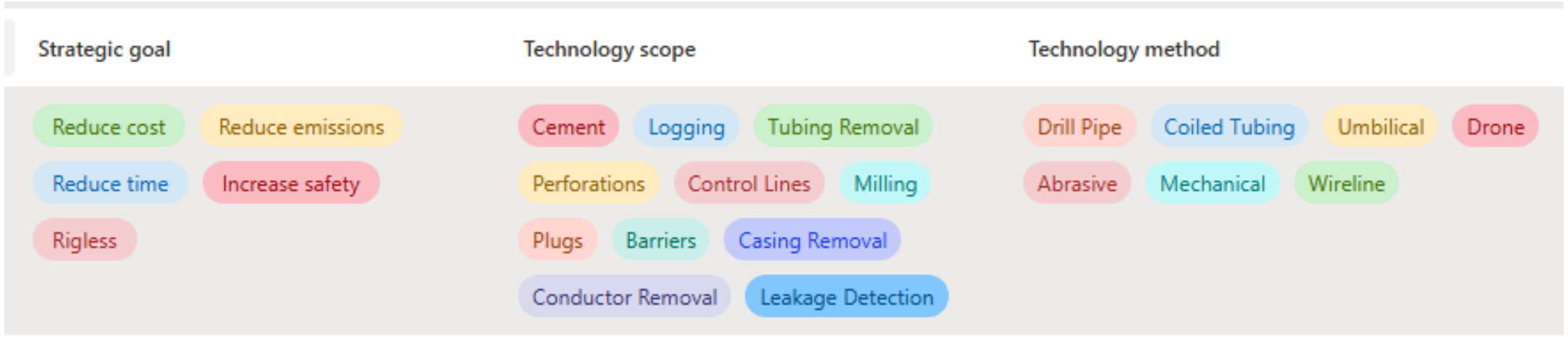
P&A ROADMAP – PREVIOUS VERSIONS

- The previously published roadmap(s) were typically limited to a singel <html> page/picture (www.offshorenorge.no)
- No interaction or filtering has been possible, also little room to kick around ideas and provide more context and explanation
- There was little distinction between subsea and dry wellheads, though there are large differences in terms of frame conditions ; e.g. cost, availabilty, sensors et.c
- Linear planning axis relevant to P&A project thinking



P&A ROADMAP – NEXT VERSION

- Main axis, P&A chronological approach has been preserved but must be enabled by filtering functionality
- Distinct sorting can be enabled for platform wells vs subsea wells
- All posting are organized in a matrix, sorting/filtering functionality achieved by pre-populated categories
- Free text ; Problem statement | Description | Usage examples | Remaining challenges



P&A ROADMAP – EXCERPT FROM NEXT VERSION

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Wash free casing	Subsea, Platform	Access to establi	Field Proven	System Qualified	Casing retrieval can be challenging and time consuming. Stuck tubulars are challenging to pull by axial forces alone, and casing milling is ultimately required. By gaining access to the annulus outside the casing, it is possible to wash the settlements and free the casing. By use of mechanical punching to gain access behind the casing and use of specialized designed washing fluids to effectively wash/clean settled barite while slotting will help pulling casing more efficient.	Pull and retrieve tubulars more effectively.	Reduce cost, Reduce time, Reduce emis..., Increase saf...	Perforations, Milling, Tubing Removal, Casing Removal	Coiled Tubing, Drill Pipe, Wireline	Several service providers: Titan Torque / Baker Hughes - Archer Oil Tools - AX. Stavanger Well Service - Gato E-Plug - TorcPuncher
Electrochemical steel removal	Platform, Subsea	Access to establi	Validated Concep	Prototype Qualification	Need a tool that can remove tubulars offline to create a window to place a P&A barrier. The window created needs to long enough to log for placement of a proper P&A barrier. This can be done with wireline operations (offline). Power restriction to generate an efficient removal speed needs to be looked into as well as removal of any deposits during this operation.	Use of electro-chemical processes to dissolve tubing/casing. Tool can be customized to cater for different patterns, hole sizes, shapes and more.	Reduce time, Reduce cost, Rigless	Tubing Removal, Perforations, Casing Removal	Wireline	
Casing Jack	Subsea, Platform	Access to establi	Field Proven	System Qualified	Pulling stuck casing requires high axial forces. Rig and or work string can be the limiting factor.	Technology used to increase pulling capacity when removing tubulars.	Reduce time, Reduce cost	Tubing Removal, Casing Removal, Milling	Drill Pipe	
Multistring Conductor Cutter	Platform	Casing and cond	Field Proven	System Qualified				Conductor Remo	Mechanical	Control cutter delivers a tool can cut and pin a multi string during retrieval.
Pull tubing/casing using crane/wire	Subsea	Access to establi	Unproven concep	Idea	Craneification of wellhead tooling ; TH pulling , Seal assy removal, casing retrieval. Using crane /wire rather than workstring. This has been developed for	Replace tradtional rig, derrick and drwawork for pulling tubing and casing	Reduce cost, Reduce emis...	Casing Removal, Tubing Removal	Mechanical	Functional tooling for pulling casing. Methods for exploiting long strands, buoy of, lay dow vessel outboard. Water depth

The Matrix

Currently approx 100 unique postings in P&A roadmap

P&A ROADMAP – NEXT VERSION

- «Invisible» axis is overarching ambition of Offshore Norge P&A forum
- «Rig to Rigless»; Leaner solutions at less cost and less emissions footprint
- Other reasons for publishing P&A Roadmap
  - Transparency/Equal opportunity to display technology / methodology
  - Interaction with industry and stakeholders
  - Alignment and common way of thinking
  - Spark ideas and incentivise vendors accordingly
  - Challenge prevailing practices
- Some ideas, new technologies and new methodologies may be in partial conflict with normative standards and legislation, e.g. plug lengths, logging principles, vessel definitions et.c. – Evolution and risk based approach will be required

EXAMPLES (I)

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Topic		Problem statement	Strategic goal				Description		Remaining challenges
Control Line Removal	Full Scale Qualificatic	Modern wells have control lines installed outside the production tubing. These lines are potential leak paths which must be considered when evaluating through tubing P&A solutions, e.g. placing cement around the tubing.	To remove the control line, completely or partially so that it does not represent a leakpath in the P&A design. This may be an important enabler in rigless ambition.	Reduce cost Reduce time Rigless	Control Lines	Wireline Coiled Tubing Abrasive Mechanical	WL (or CT) tool that can remove parts of the control line; remove, dispose or pull to surface.	Axter prototype	Time consuming operations. Need to be able to verify what is behind the tubing /casing in order to place an effective P&A barrier (e.g. dual string logging is also required).
Dual string logging	Full Scale Qualificatic	Detect and diagnostic of production casing barriers during pre-P&A/intervention P&A. For better planning rig P&A scope (the costly part).	Enable the industry to log for production casing barrier through the production tubing. This is also an important enabler for rigless ambition.	Reduce time Reduce cost	Logging	Wireline	Dual string logging will be an enabler for considering to leave tubing or parts of the tubing in hole. Assurance of annular barrier will is prerequiste for placing barrier through tubing and leave behind.	Dual string logging 7" x 9 5/8"	Ensure quality and verification of result of logging and need for having candidate/pilot wells to qualify/test this on. How to verify results of machine learning against actual real data? Variation of tubing/casing configuration versus log quality is still a challenge.

EXAMPLES (II)

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Topic		Problem statement	Strategic goal				Description		Remaining challenges
Bismuth	Field Qualification	Short Bismuth plugs deployed by leaner tools may replace longer cement plugs. Applies to all sections of a well (deep, intermediate, environemental plug). Short plugs deployed by WL can be an important enabler to fulfill rigless ambition.	Qualify as well barrier element for higher temperature and pressure environment. Enable installation and activation by means of WL. Qualify as alternativer barrier material, also for shorter crossectional plugs.	Reduce time Reduce cost Reduce emissions Rigless	Plugs Barriers	Drill Pipe Wireline Umbilical Coiled Tubing	High penetration molten Bismuth alloy that form crossectional barrier. Activated by heat source (chemical or electrical).	Used as an alternative to open hole to surface plug and qualified for shallow overburden P&A barrier (field specific). Valhall shallow gas application.	Deep application, higher P/T. Verification of barrier. Longevity of materials. Length of plugs.
High energy melt solutions for removal of steel / placement of barrier	Prototype Qualificati	Short barrier plugs that can be deployed by lean methods (e.g.WL). Removal of steel and/or inclusion of molten steel as part of crossectional barrier.	Develop a tool to create a window for placement of a downhole P&A barrier. Combined steel/additeve melt to constiute barrier or part barrier.	Reduce time Reduce cost Increase safety Rigless	Tubing Removal Cement Casing Removal	Wireline Coiled Tubing Mechanical Drill Pipe	Method to use high energy to efficiently melt / remove tubular downhole: Melt residue could form part of a barrier plug. Termite can be used a high energy source.	Interwell has developed the RockSolid technology. This has been used outside NCS several times with success. This technology needs to be qualified for NCS.	Qualify the technology on NCS. Need more vendors to look into this type of technology.

P&A ROADMAP- USE AND EXPECTED INTERACTION

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- The P&A Roadmap does not offer a «plug and play» planning tool for P&A projects
- It is technology mapping tool that competent organizations can use to their benefit
- Invitation to list technology/methods, ongoing qualification processes and reference documentation, will come from Offshore Norge
- Will be regarded as a live document, and intention is to publish updates and proceedings continuously

P&A ROADMAP- ROLL OUT

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- New P&A Roadmap is going through final stages of construction before roll-out
- Norwegian oil industry is a beacon internationally, setting the highest standards. Offshore Norge has a global outreach
- Ambition to broadcast P&A roadmap to every corner of the world
- Technology development and implementation takes time – need for catalysation
- Please visit Offshore Norge Stand #37 for demonstration, discussions and questions

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