

Risk-based Approach to Well P&A Qualification of New Technologies

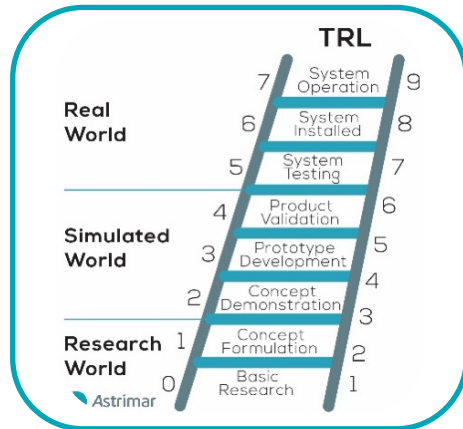
SPE Aberdeen Well Decommissioning
April 2022

Brian Willis

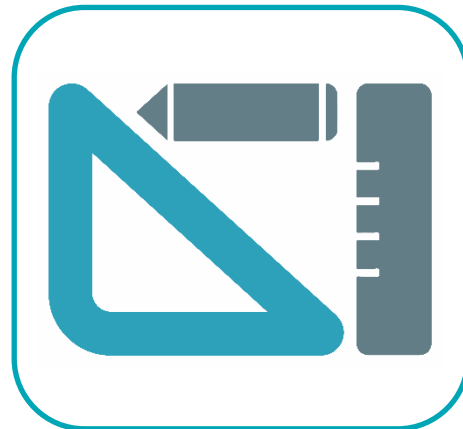
About Astrimar



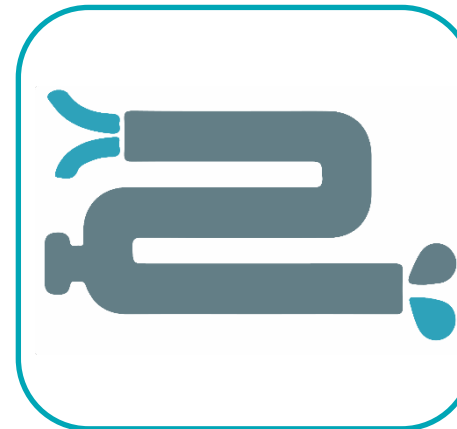
Technology qualification



Projects and design



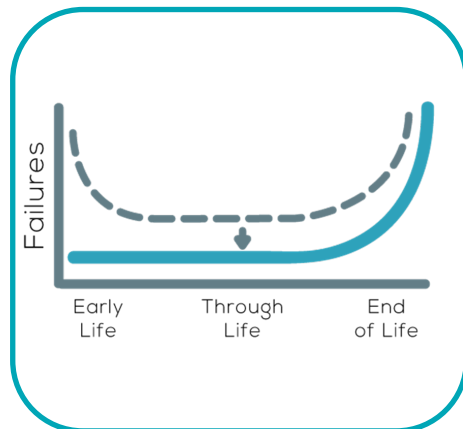
Operations integrity management



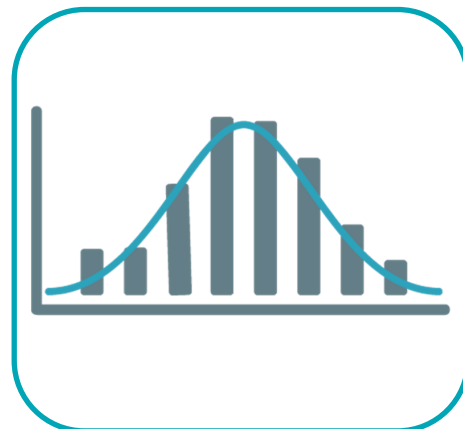
Life extension, decommissioning & re-use



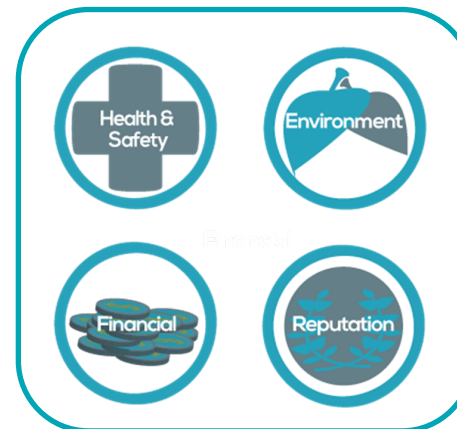
Reliability best practice guidance



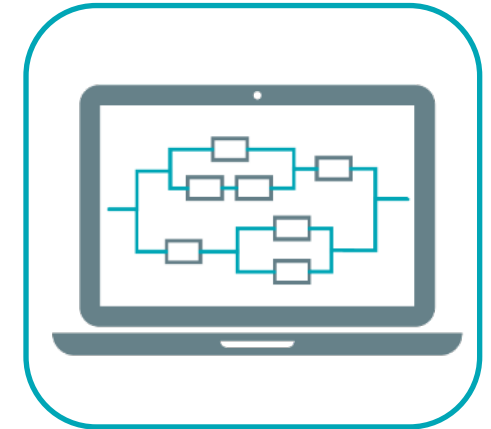
Data analysis



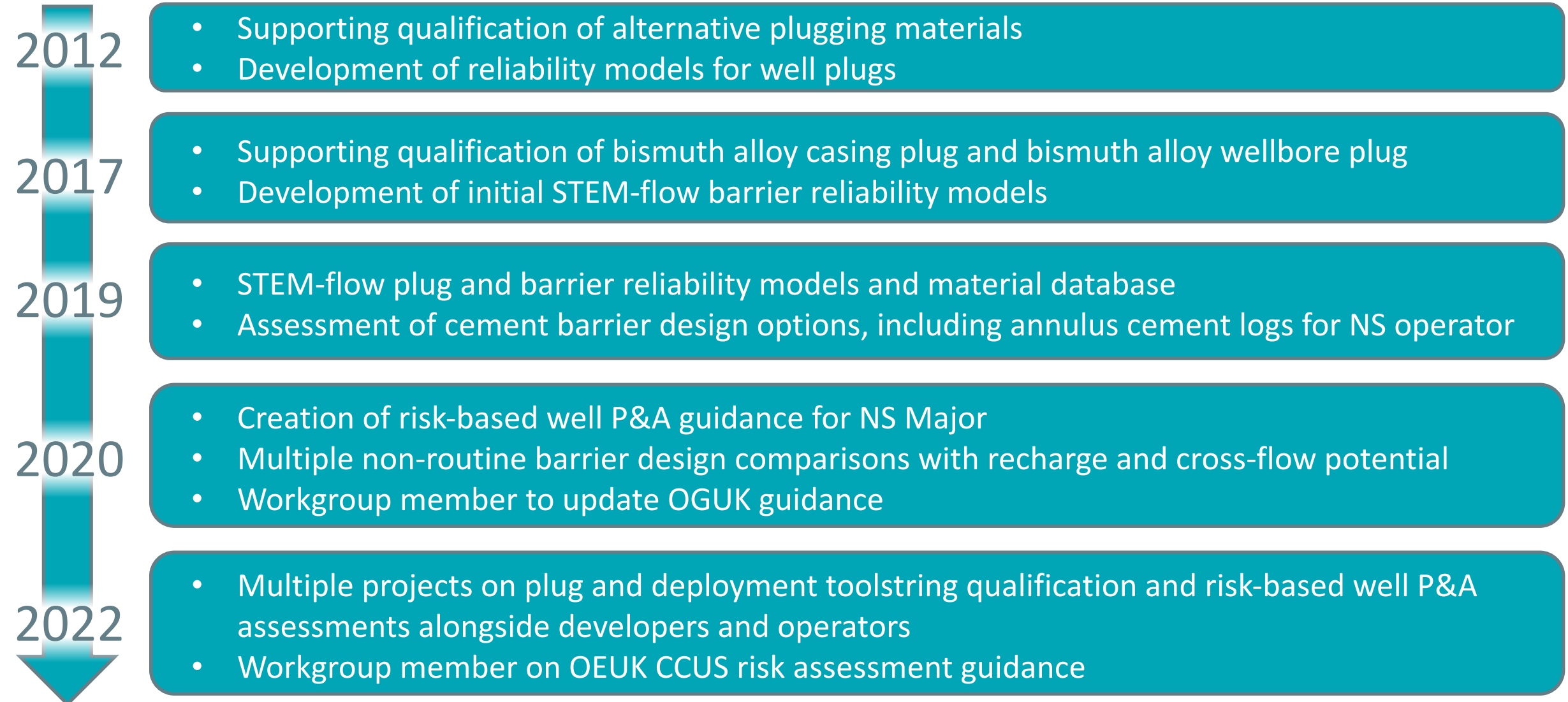
Risk and reliability engineering analysis



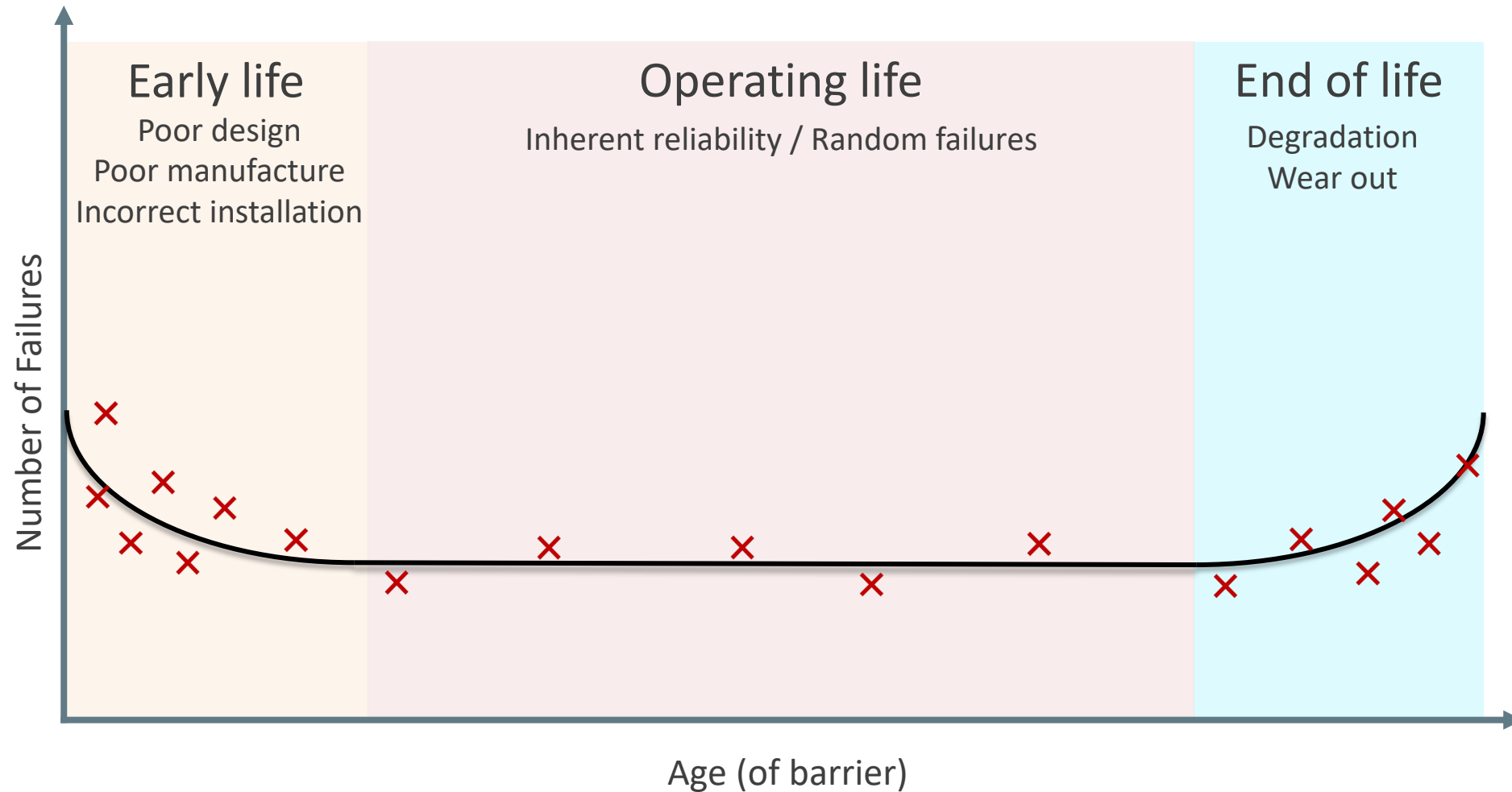
Specialist reliability tools



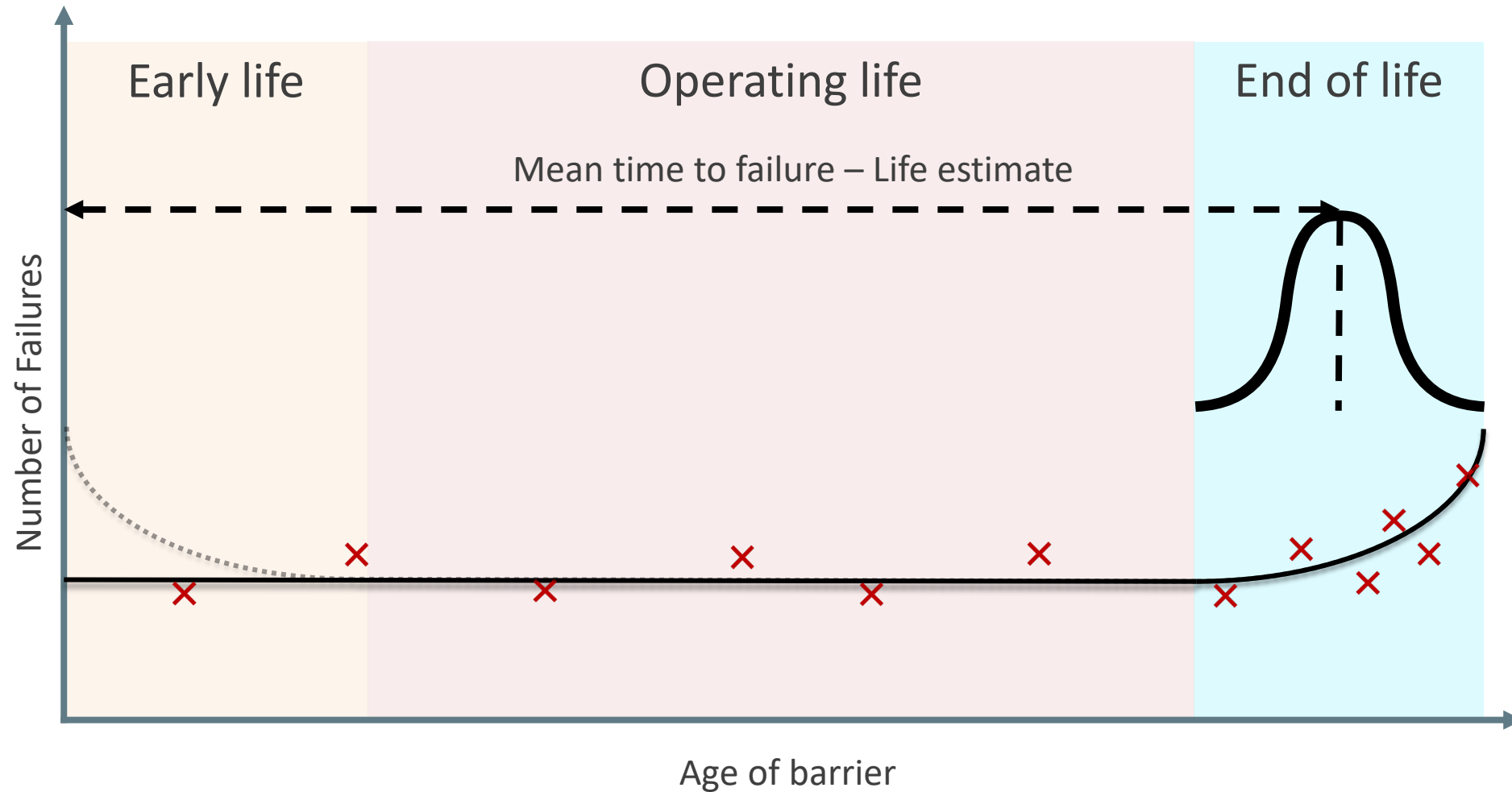
Astrimar's experience at supporting better P&A



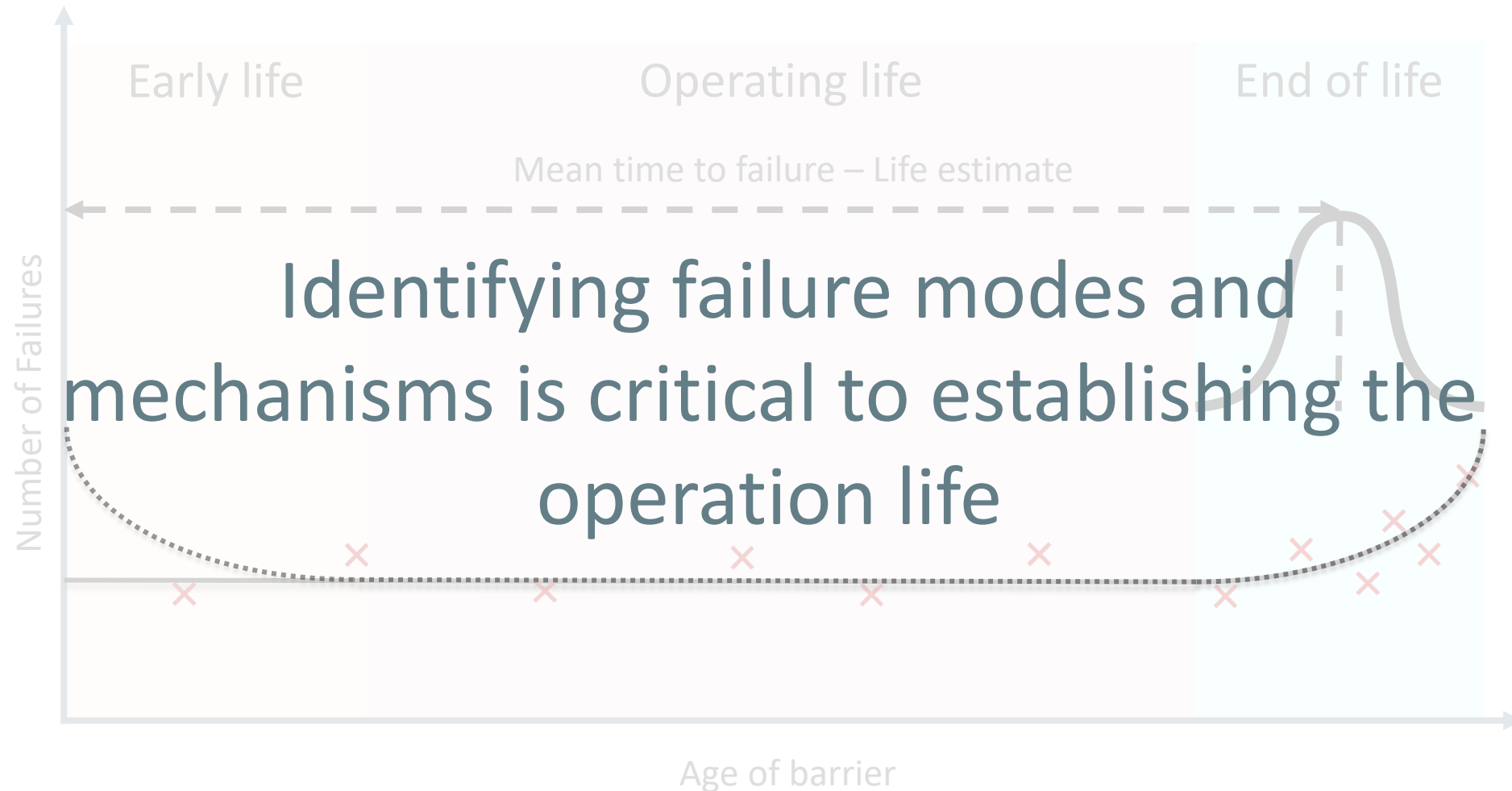
New technologies – Generic typical experience



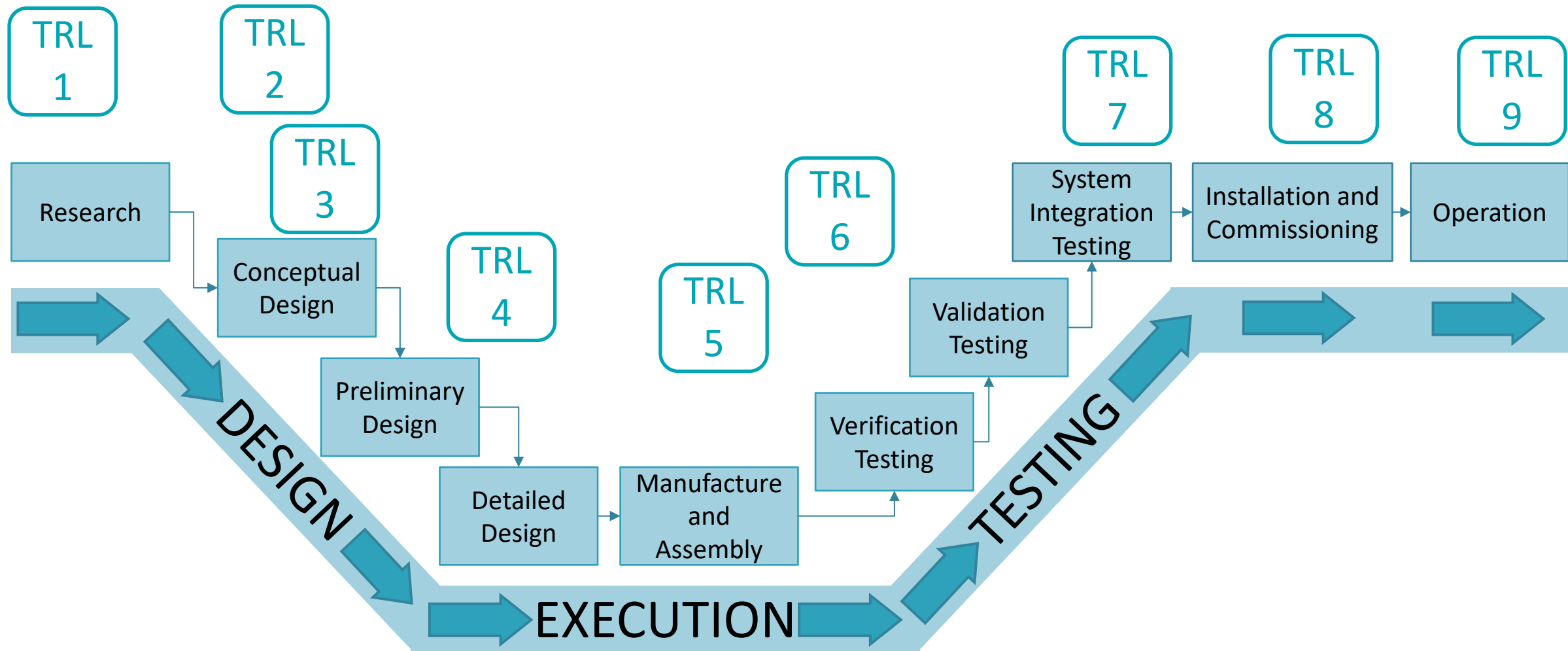
New technologies – The goal for alternative barriers



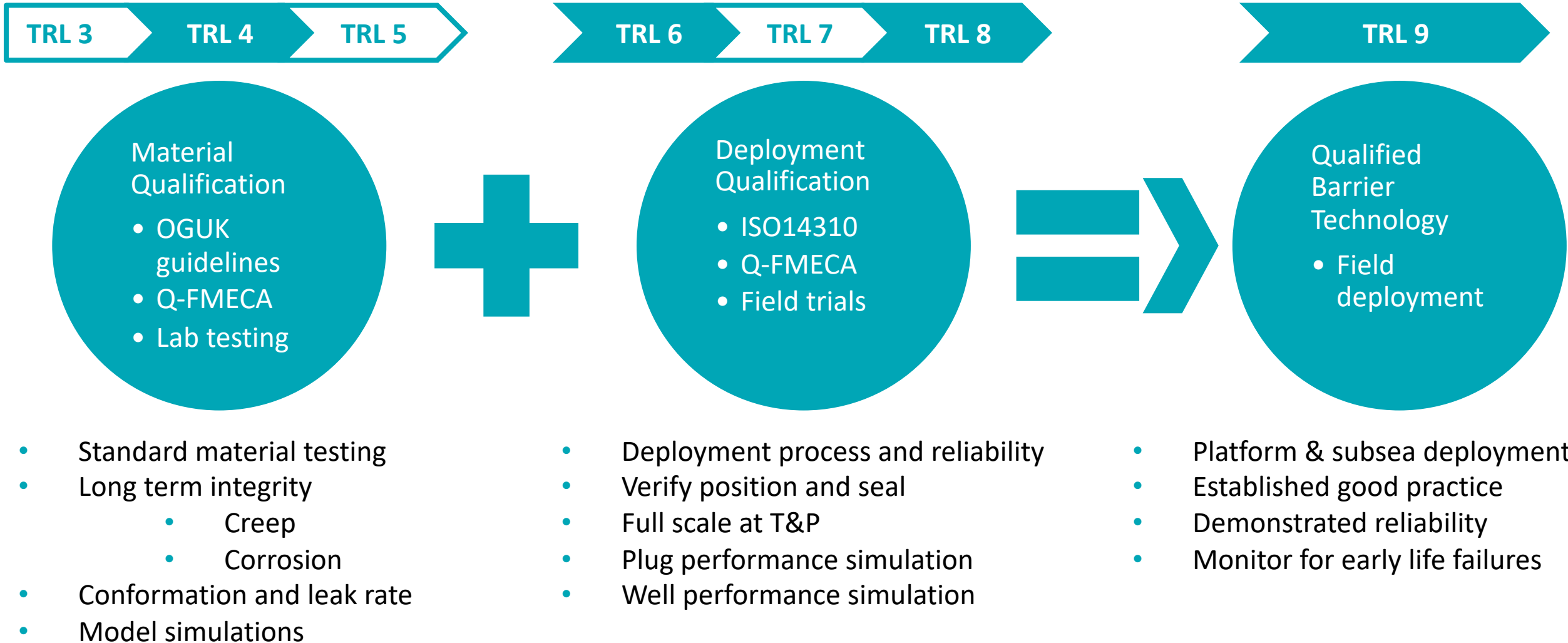
New technologies – The goal for alternative barriers



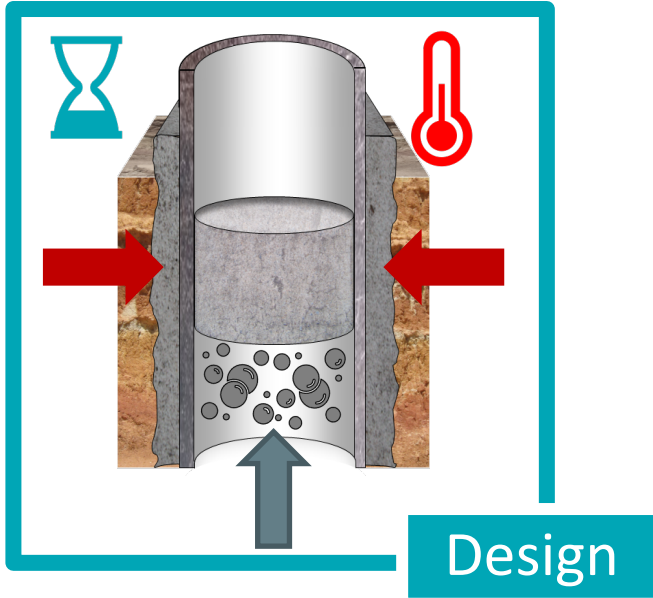
Technology road map - System approach – V diagram



What is a “Qualified” well P&A technology?



Case study: Qualification of alternative barrier materials



		Increasing likelihood				
		1	2	3	4	5
Increasing Consequence	5	0	0	0	0	0
	4	1	7	2	0	0
	3	9	14	8	4	0
	2	8	13	3	2	0
	1	6	1	0	0	0

HIGH LEVEL TRL	TRL DISTRIBUTION				
OVERALL TRL	TRL 1	TRL 2	TRL 3	TRL 4	TRL 5
TRL 2	Completed	Completed	In progress	In progress	Not started

TRL PROFILE	TRL 1	TRL 2	TRL 3	TRL 4	TRL 5
Percentage of elements completed towards achieving each TRL	100%	100%	60%	0%	0%
Elements not started	0	0	0	2	5
Elements in progress	0	0	2	3	0
Elements completed	5	5	3	0	0

Initial TRL 2

Material

- OGUK Guidelines
- Corrosion
- Creep

Functional

- Leak
- Pull out
- Conformity

Deployment

- Robustness
- Reliability
- Verification



Case study: Qualification of alternative barrier materials



Interpret

Leak rate & micro annulus

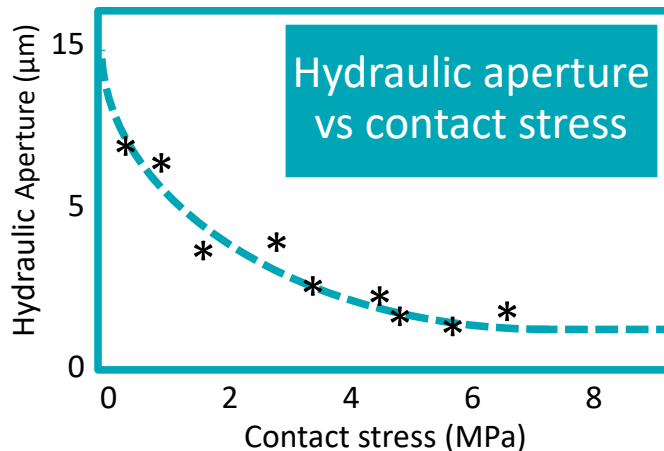
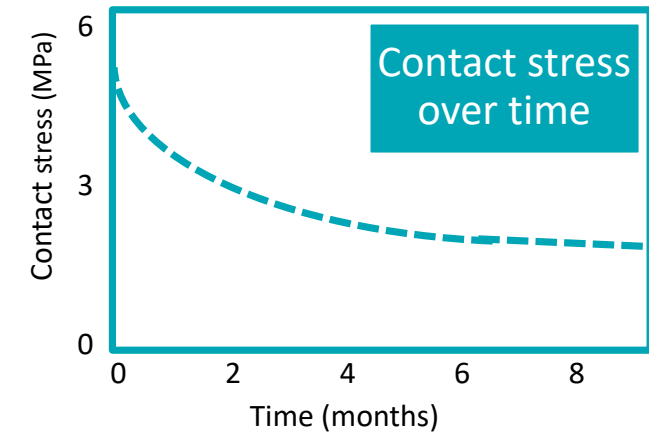


Controlling creep

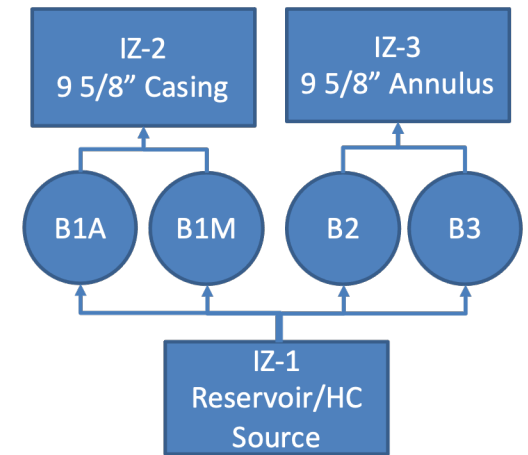
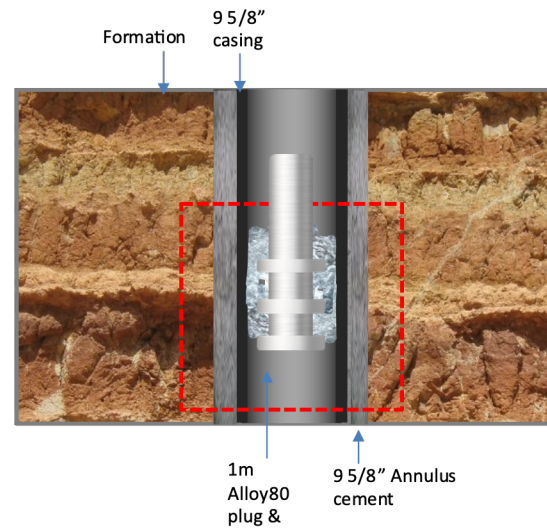


Deployment
Settling
Long - term

Translate



Assurance with STEMflow®



Barrier reliability models –all leak pathways and relevant failure mechanisms

Case study: Qualification of alternative barrier materials



Interpret

Leak rate & micro annulus

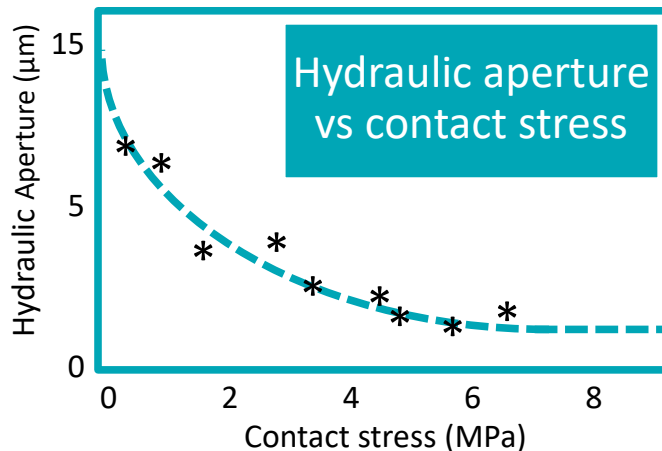
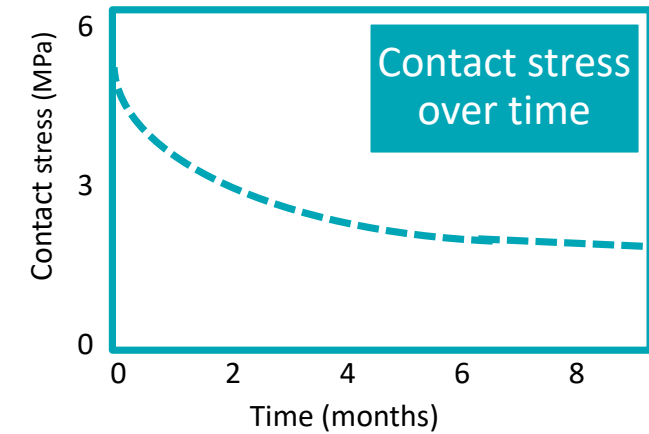


Controlling creep

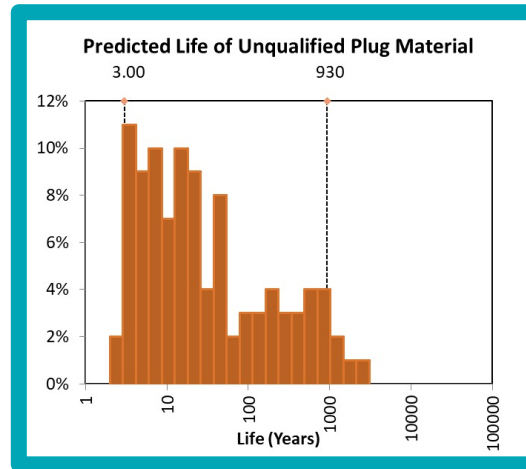


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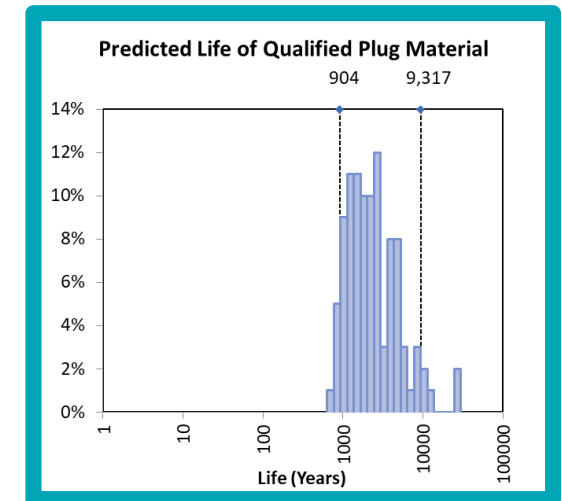


Assurance with **STEMflow**[®]



Large uncertainty in predicted leak rate and life

Qualification results demonstrate improvement in predicted life



Case study: Qualification of alternative barrier materials



Interpret



Translate



Assurance with



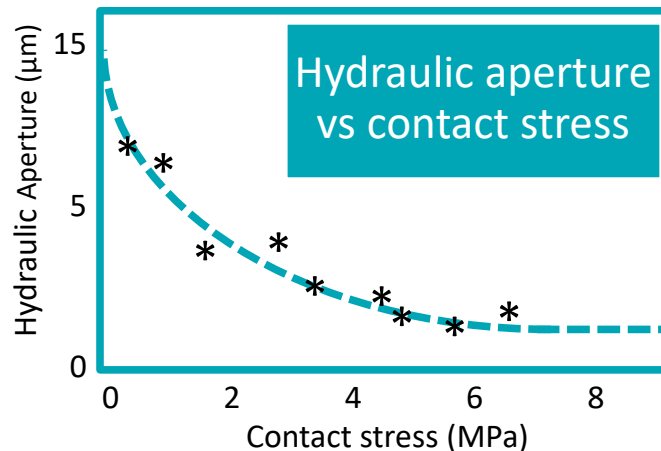
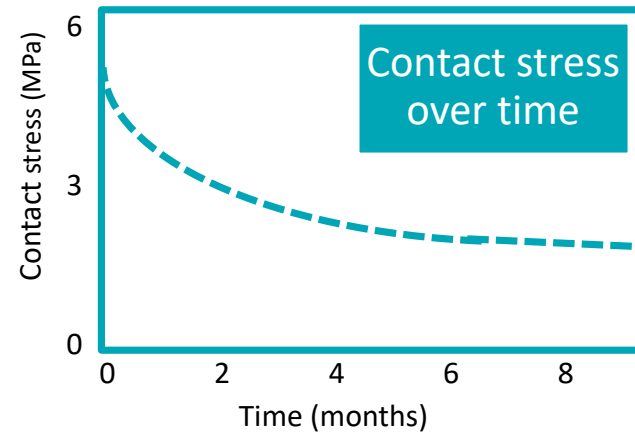
Leak rate & micro annulus



Controlling creep



Deployment
Settling
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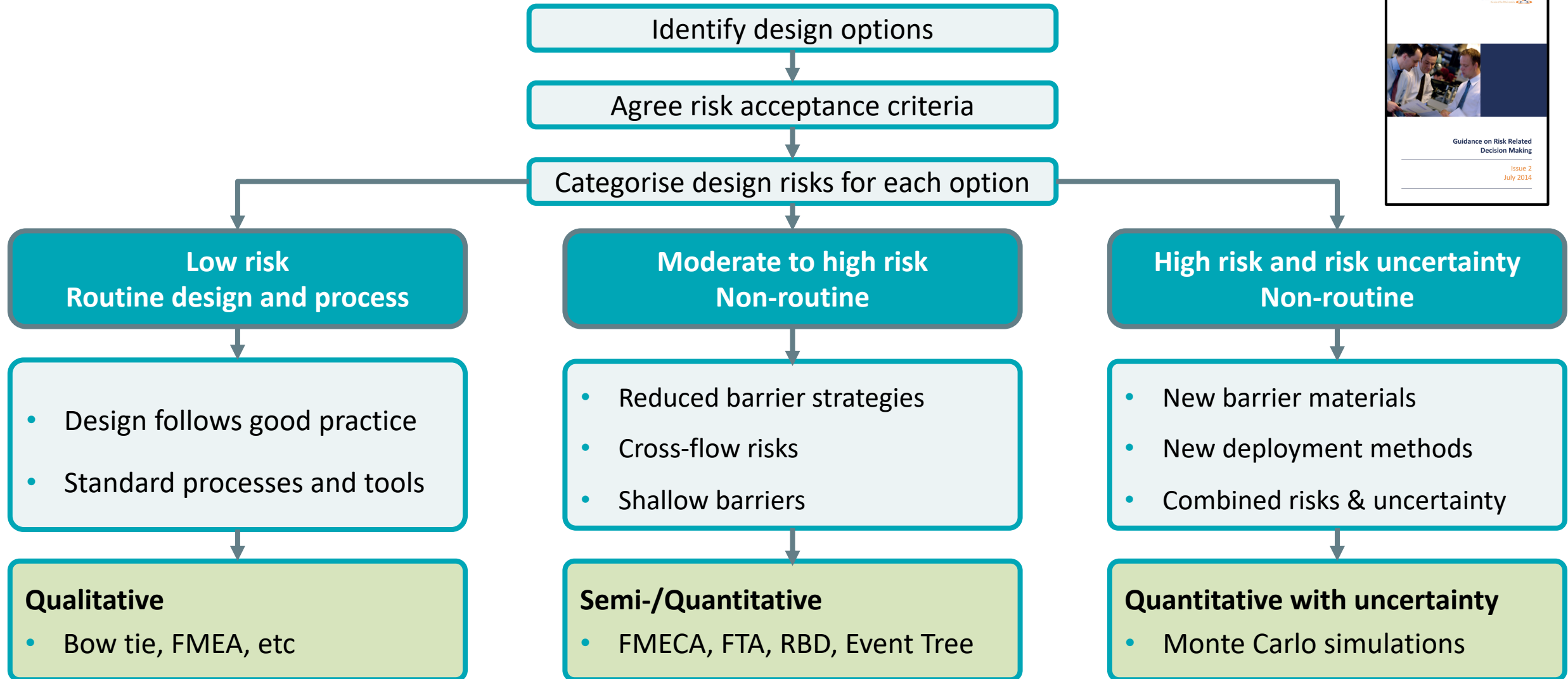


HIGH LEVEL TRL	TRL 1	TRL 2	TRL 3	TRL 4	TRL DISTRIBUTION			
TRL 5	Completed	Completed	Completed	Completed	Completed	In progress	In progress	Not started
TRL PROFILE	TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8
Percentage of elements completed towards achieving each TRL	100%	100%	100%	100%	100%	0%	0%	0%
Elements not started	0	0	0	0	0	2	2	5
Elements in progress	0	0	0	0	0	2	3	0
Elements completed	5	5	5	5	5	0	0	0

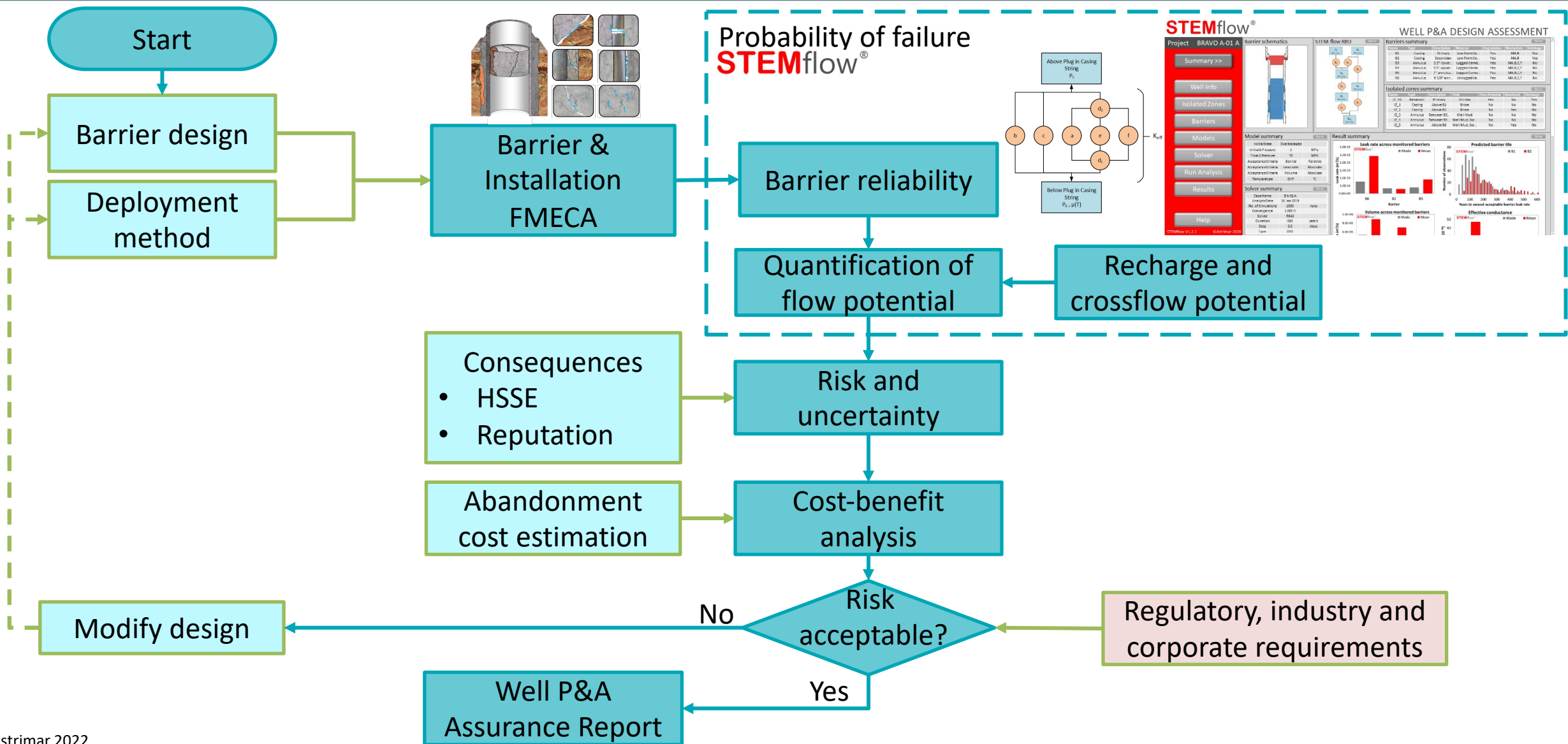
TRL 4 achieved: Technology concept demonstrated to be valid Validated but Untested Technology Proposed								
Physical and/or virtual prototype constructed to demonstrate form, fit and functional performance. Software to challenge prototype developed for realistic testing with simulated hardware/software system interfaces.	Completed	Functional performance, durability and life tests undertaken to confirm performance, reliability, operating at design limits and degradation rate for life or appropriate.	Completed	All analysis completed including e.g. FEA, engineering calculation and reliability analysis.	Completed	Require in-service life performance monitoring defined.	Completed	Risks from manual assembly process tested for installation, identified and addressed.
TRL 5 achieved: Technology is prototype tested for robustness and reliability Technology Product Proposed								
Manufacturing specification for production hardware created.	N/A	Toxicological assessment (e.g. FMECA) updated to reflect product manufacture/assembly through storage for future completion and delivery.	In progress	Manufactured product (or prototype) tested in simulated or intended operating environment to confirm function/performance within acceptable limits. Software to challenge/verify tests and fully scale realistic problems, partially integrated with underlying hardware/software.	In progress	Operational performance data collection process established.	Not started	Require manufacture/assembly acceptance testing defined (e.g. stress corrosion).
TRL 6 achieved: Technology product validated in realistic environment Technology Product Ready for System Integration								
Toxicological assessment (e.g. FMECA) updated to ensure interface with underlying system are addressed.	In progress	Functional performance tests to be conducted and integrated with underlying system, not necessarily in full operational environment. Software to challenge fully integrated and tested with operational hardware/software systems.	In progress	Mechanical, hydraulic, optical, electronic, software, testing and human interface addressed to confirm product/software/processor does not impact performance of underlying system and underlying system does not impact performance of product/software/processor.	In progress	Operational performance/Reliability data collection initiated.	Not started	Require manufacturer/assembly acceptance testing confirmed for manufacture/product completion/drafting of approved process.
TRL 7 achieved: System integration testing completed Actual System Ready for Installation and Commissioning								
Toxicological assessment (e.g. FMECA) updated to ensure installation/commissioning/deployment risks addressed.	Not started	Installation/testing/commissioning undertaken with underlying system ahead of actual deployment/operation/mission phase. Software to challenge fully integrated with operational hardware/software with functionality tested in simulated and operational scenarios.	Not started	Any remaining interface/function qualification completed that could not be done before start of deployment/operation/mission phase (e.g. testing with actual fluids or environmental loads).	Not started	Detailed in-service inspection/monitoring/trimming defined and verified.	Not started	Confirmation that product/software/processor is able to work as intended/Reliability not compromised by installation/commissioning/deployment process.
TRL 8 achieved: Actual system installed, tested and commissioned								

Current TRL 5

Well abandonment design risk management process



Process for a non-routine well P&A design assessment



Outcomes and benefits of a risk-based approach



COST EFFECTIVE
WHILE MANAGING
ACCEPTABLE RISK



ENABLES ALTERNATE
DESIGNS AND
SOLUTIONS



SUPPORTS RISK
MANAGEMENT OF NEW
MATERIALS AND
DEPLOYMENT METHODS



OPTIMISES USE OF DATA
TO PREDICT BARRIER
PERFORMANCE



UNDERSTANDS IMPACT
OF UNCERTAINTY OVER
TIME



RISK ASSESSMENTS TO
DEMONSTRATE ALARP

Thank you for listening

Questions ?

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