Astrimar

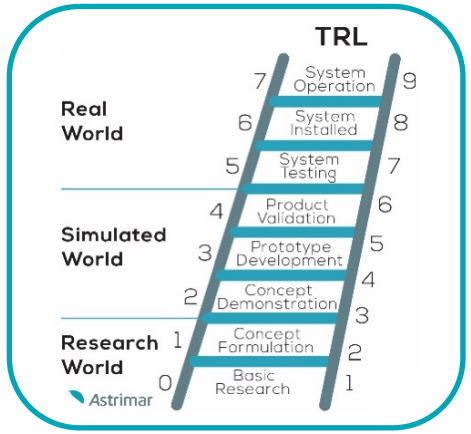
Risk-based Well P&A
ALARP Demonstration

PACE Meeting
14 April 2021

Brian Willis

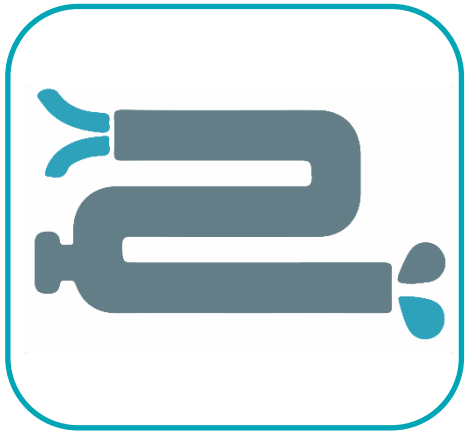
About Astrimar

Technology qualification



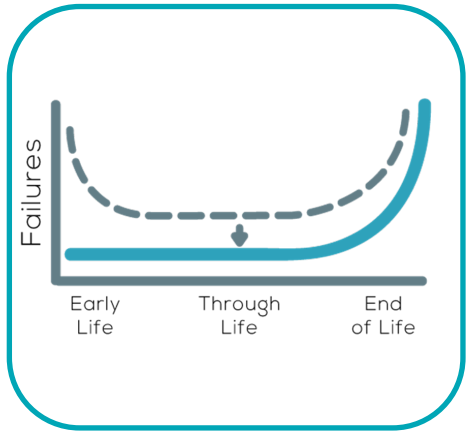
Projects and design

Operations integrity management



Life extension, decommissioning & re-use

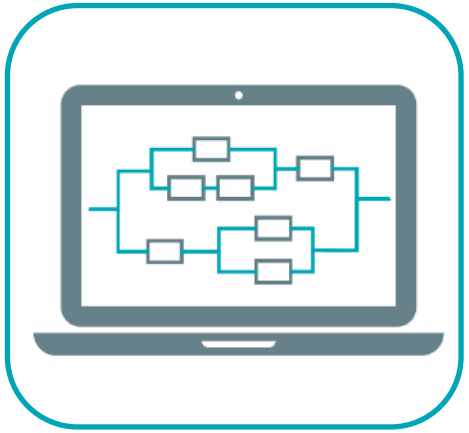
Reliability best practice guidance



Data analysis

Risk and reliability engineering analysis

Specialist reliability tools



Astrimar's experience at supporting better P&A

2012
- Supporting qualification of alternative plugging materials
- Development of reliability models for well plugs

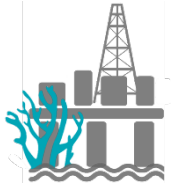
2017
- Supporting qualification of bismuth alloy casing plug and bismuth alloy wellbore plug
- Development of initial STEM-flow barrier reliability models

2019
- STEM-flow plug and barrier reliability models and material database
- Assessment of cement barrier design options, including annulus cement logs for NS operator

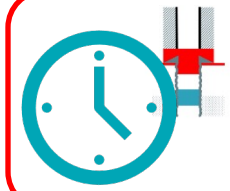
2020
- Creation of risk-based well P&A guidance for NS Major
- Multiple non-routine barrier design comparisons with recharge and cross-flow potential
- Workgroup member to update OGUK guidance

2021
- Multiple potential projects on plug deployment toolstring qualification and risk-based well P&A assessments alongside developers and operators
- Leading member on DNS guidance on Risk-Based Decision Making for Well Decommissioning

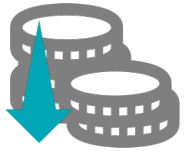
P&A challenges and opportunities for operators



Many fields reaching EOL
1000s of wells

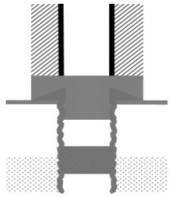


Difficult to optimally
plan P&A campaigns



Billions to be spent
44% directly on P&A

Future use of reservoirs
Invention post P&A



Limitations of cement ->
New, better plug materials

Simpler, better, more
efficient processes

Benefits of risk-based well
P&A

Reduce risk and costs
35% reduction (UK OGA)

Risk-based decision making - What it is and isn't

FMECA
Operational risk assessment
Heavy lift risk assessment
Gas plume model
Environmental
Oil drift models
Cross-flow risk
H&S risk assessment
Decommissioning
Reservoir recharge assessment
Barrier integrity assessments

Purpose and consequences across assessments do not align or support decision making

Risk based well P&A

- Integrated decision-making framework
- Flexible approach
- Combines risk assessment methods

Well abandonment design risk management process

In alignment with OGUK risk-based decision making guidance

Identify abandonment options

Agree risk acceptance criteria

Categorise design risks for each option

Low risk
Routine design and process

- Design follows good practice
- Standard processes and tools
- Qualitative risk assessment

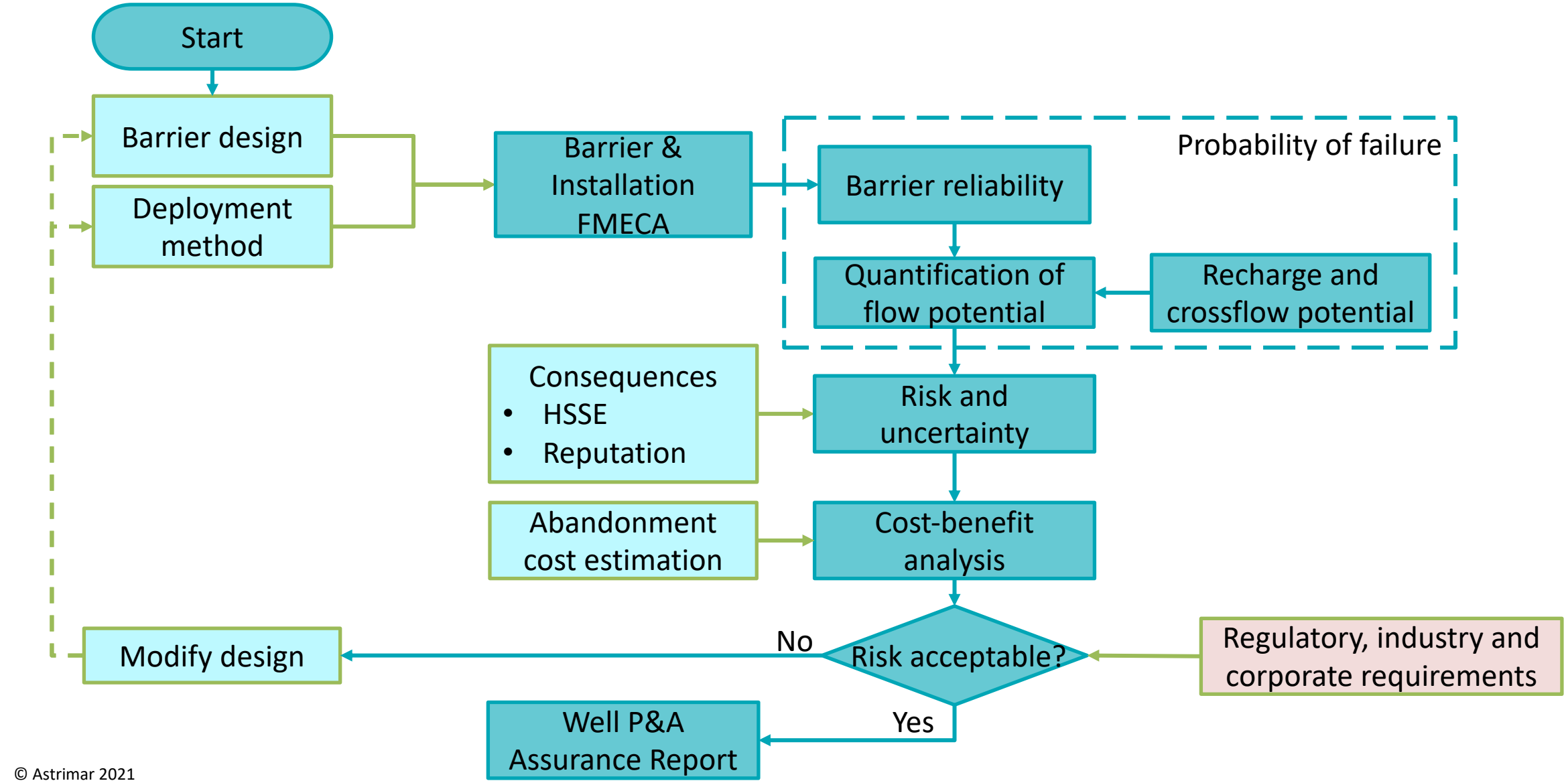
Moderate to high risk
Non-routine

- Reduced barrier strategies
- Cross-flow risks
- Shallow barriers
- Quantitative risk assessments, e.g.
  - Event tree analysis

High risk and risk uncertainty
Non-routine

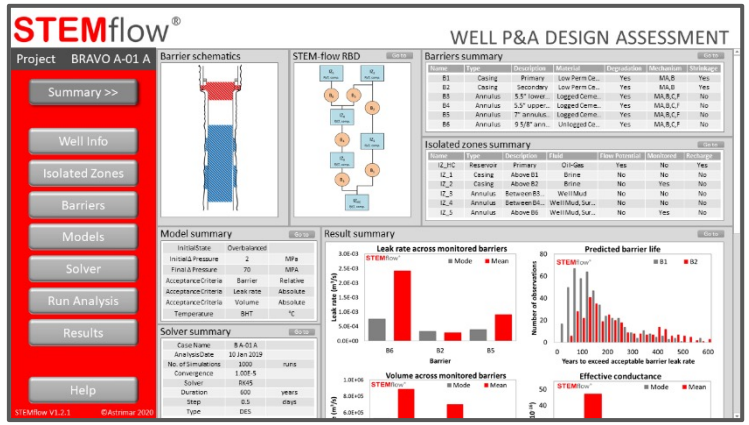
- New barrier materials
- New deployment methods
- Combined risks & uncertainty, e.g.
  - Cross-flow
  - Shallow barriers

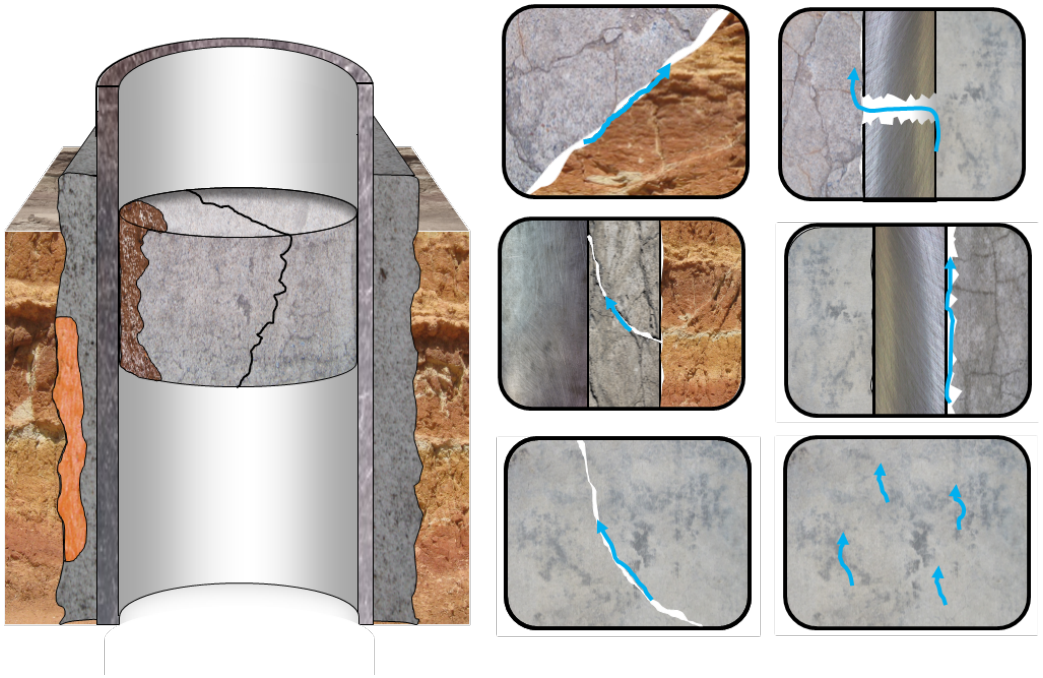
Process for a non-routine well P&A design assessment

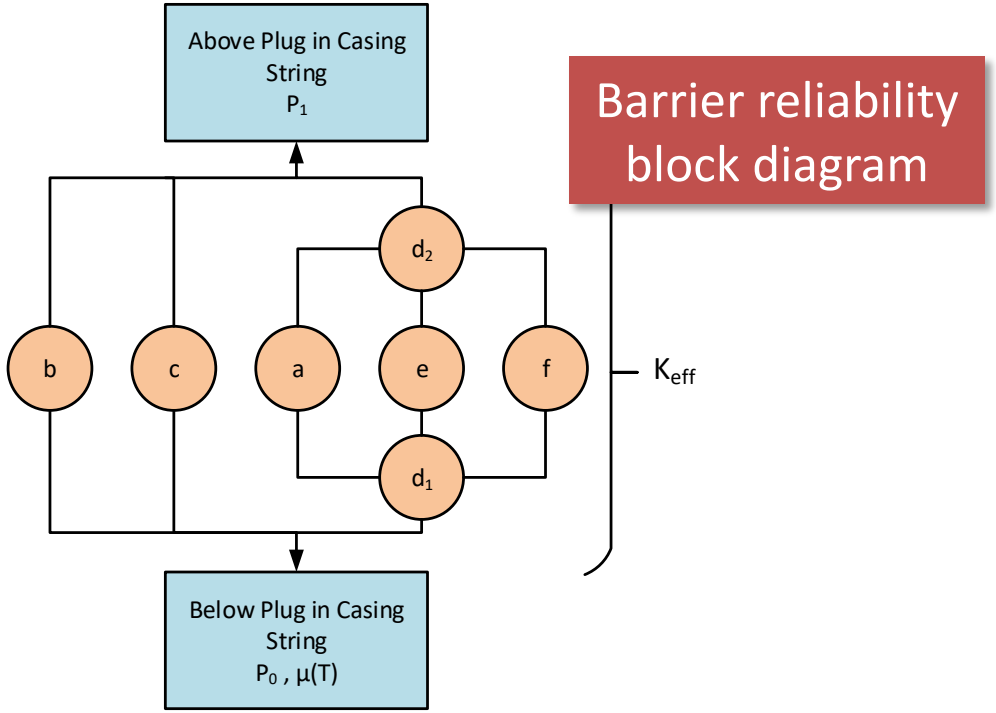


STEM-flow® barrier models

- Leakage requires a failed barrier element with a pressure differential
- Barrier isolation failures caused by leak paths
- Barrier failure mechanisms represented as reliability block diagram
- Assesses flow potential for each leak path between isolated zones







Anonymised case study : Cross-flow risks

Challenge

Source well
- Collapsed tubing
- Multiple failed fishing attempts
- Unable to access and set lower reservoir isolation plug

Well risks identified:
- Reservoir with recharge potential
- Formations identified which can support cross-flow
- Neighbouring receiver wells within a zone of cross-flow influence

Abandonment Options

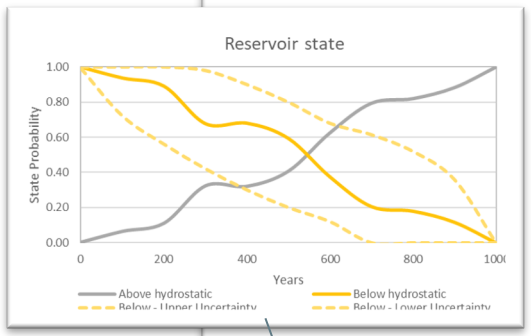
Option 1 – Standard practice
Continue fishing operations till success and set lower reservoir isolation barrier in source well

Need to understand:
- Additional time required to ensure success – Cost/Delays
- Long term benefit of following good practice

Option 2 – Alternate approach
Set shallow isolation barriers against competent formations in both source and neighbouring wells within zone of influence for cross flow risks

Need to understand:
- Reservoir recharge potential
- Formations supporting cross-flow
- Long term barrier integrity (supporting reduced isolation strategy)
- How the above may change with time

Case study – Dynamic Event Tree Analysis



Lateral extent (ft)	Thickness (ft)	Likelihood	Enables Cross-flow?	B/T time (years)
1000	10	0.05	0	-
1200	10	0.05	0	-
1400	10	0.05	0	-
1000	20	0.05	1	200
1200	20	0.1	1	275
1400	20	0.2	1	300
1000	50	0.1	1	350
1200	50	0.2	1	400
1400	50	0.2	0	-

Does the reservoir enable flow?

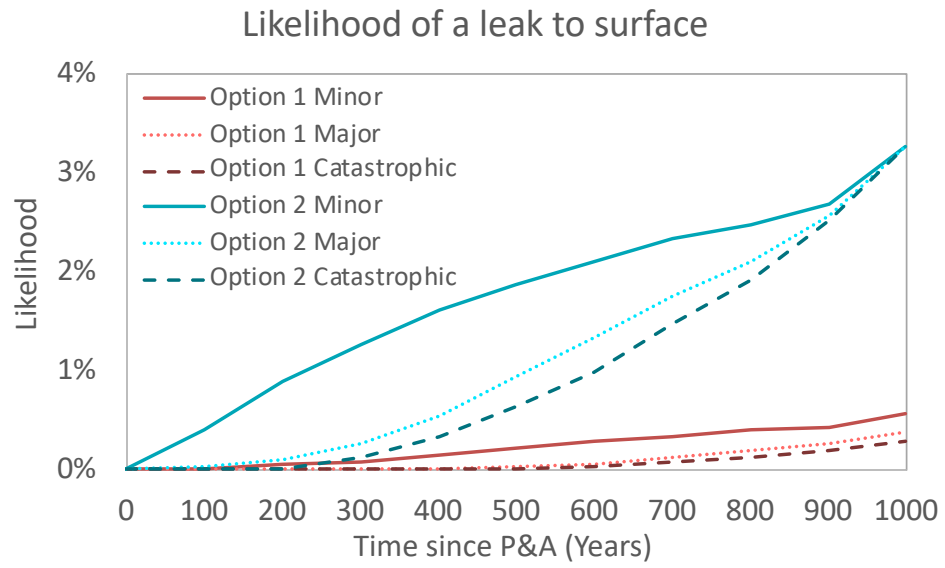
Does the formation enable cross-flow? When is hydrocarbon breakthrough?

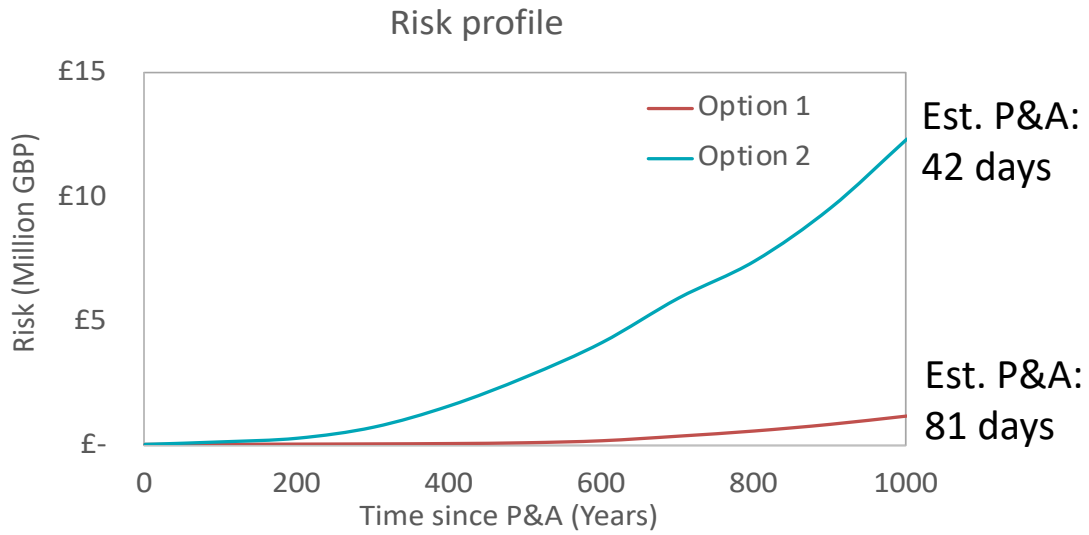
If cross-flow enabled, what is the state of the source and receiver well barriers?

If no cross-flow, what is the state of the source well barriers?

What is the likely severity of a leak to surface?

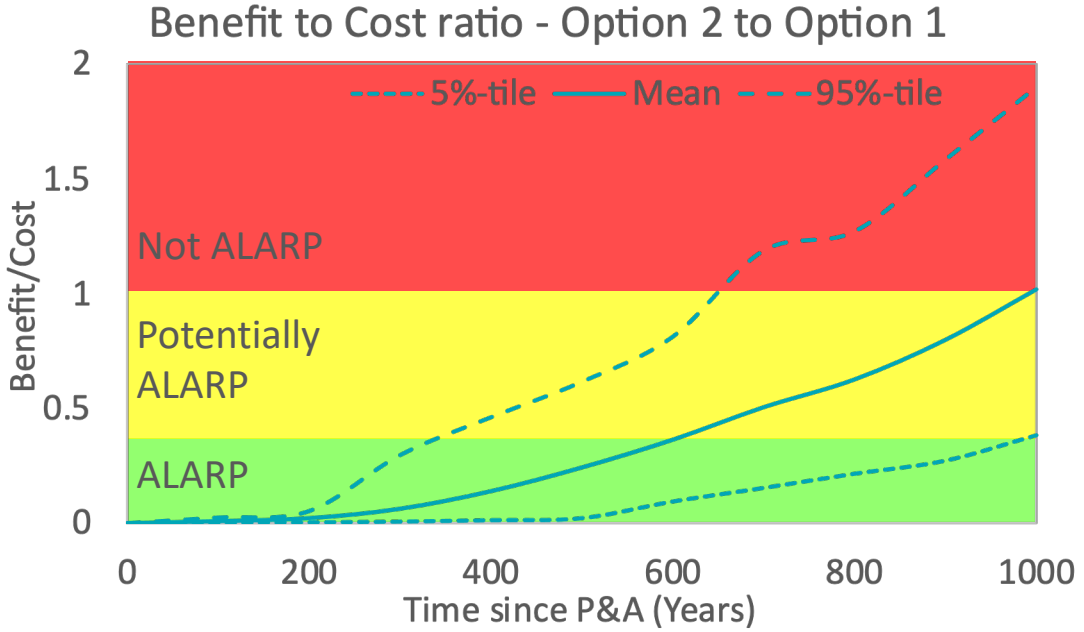
Case study – Results





Est. P&A: 42 days

Est. P&A: 81 days



- Reduced isolation strategy of Option 2 has
  - A lower overall system reliability across both wells (Fault tree analysis)
  - Greater likelihood of failure compared to Option 1
  - Tends towards scenarios with greater severity
  - Greater overall risk
- Consider Option 2 design modifications to reduce the likelihood and uncertainty of a significant leak to surface

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

Astrimar

Thank you for listening

Questions ?

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