

A Risk-based Framework for Evaluating Well Plug and Abandonment Designs

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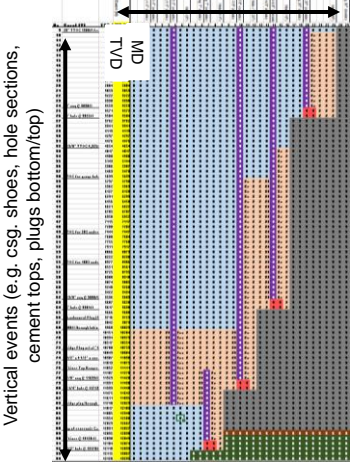
1

Heriot-Watt University Risk-based Well P&A Modelling Framework

- Provides long-term performance modelling of P&A system for **risk-based** comparison of alternative design scenarios to support cost-saving via fit for purpose well P&A design.

1- P&A System Model

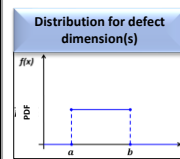
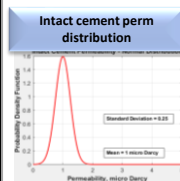
Radial events (holes sizes, casings OD/ID)



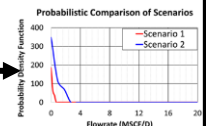
- Using grid-based numerical modelling approach.
- Well components and any possible defects (micro-annuli, cable encapsulation degradation, channels or fractures in cement, casing leak) are explicitly defined.

0	Annular
1	PoorCement
2	GoodCement
3	InactiveCells
4	Casing
5	CapRock
6	Formation

2- Probabilistic Add-ons



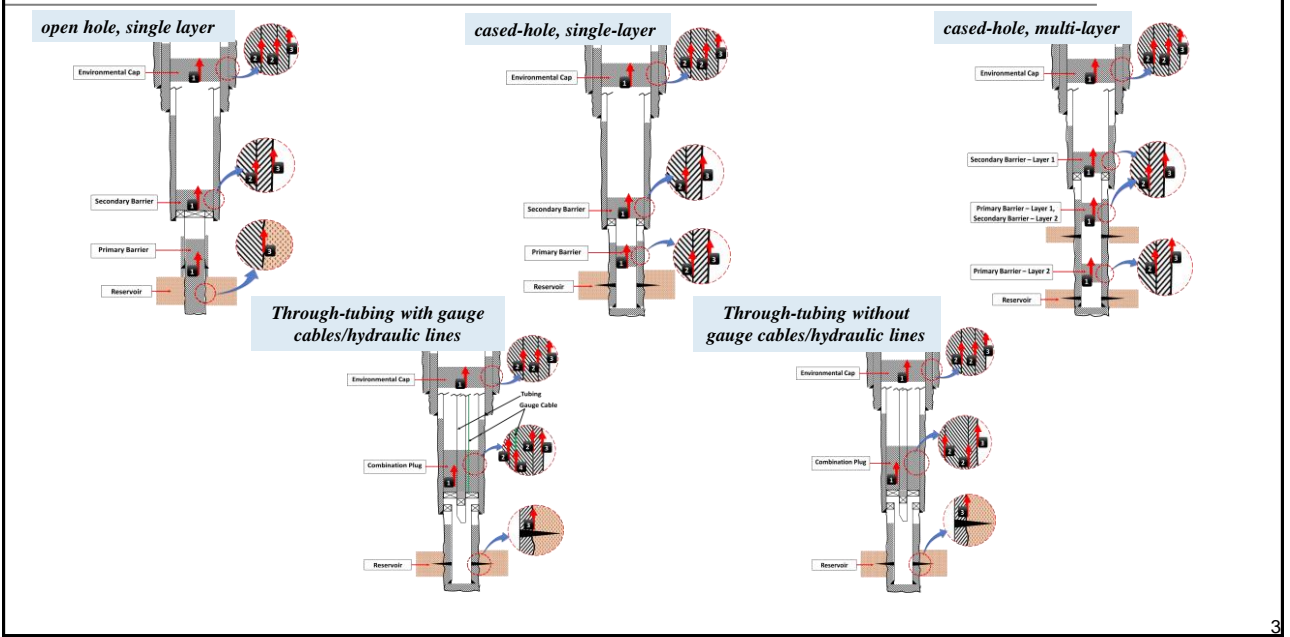
P&A System Model



✓ Probabilistic evaluation and comparison of alternative P&A design scenarios

2

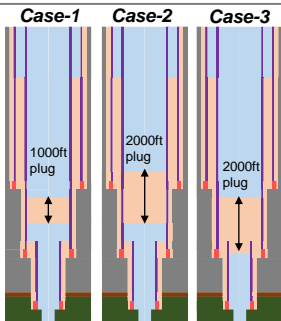
P&A Scenarios Considered



3

Probabilistic comparison of alternative P&A designs

Conventional P&A Example – Importance of Case Specific Analysis



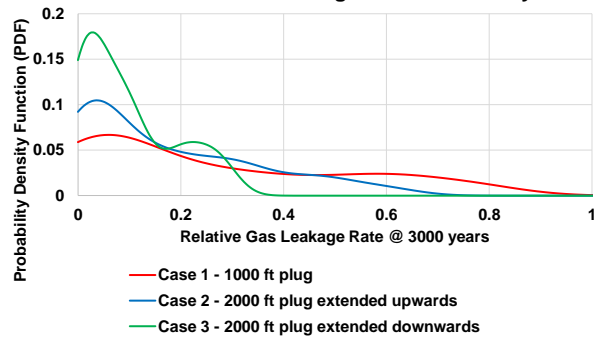
Synthetic example

Assumptions:

- Over-pressured reservoir – recharged to virgin pressure
- 100 Monte-Carlo simulations

Uncertain Parameter	Range	Probability distribution
Bulk cement Permeability	0.001mD - 0.02mD	Normal distribution
Micro-Annuli size – Constant across the entire section	3-75 μm	Uniform distribution

Risk-based decision making under uncertainty



Conclusions:

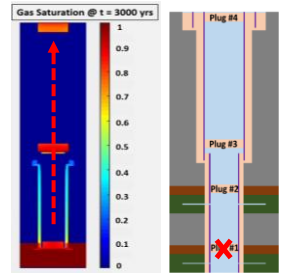
1. Longer plug reduces risk of leakage
2. Location of plug is important
Gas accumulation under plug
Cement across liner top reduces leakage in annular B micro-annuli

4

Key Applications & Current Status

Applications of the Well P&A Modelling Framework, with potential cost savings:

- ◆ **Fieldwide (multi-well):** Probabilistic comparison of risk of leakage from different wells, to identify high/low risk wells, for a well specific P&A design.
- ◆ **Well-based:** Support risk-based P&A design by probabilistic comparison of alternative design scenarios.
 - Fit-for-purpose, through-tubing P&A design
 - Identifying critical leak paths to support optimal P&A design or remedial operations.
 - Optimize number, location and length of barriers (model also quantifies cross-flow situations)
 - Value of new technologies and probabilistic analysis of alternative barrier materials



For more information see: SPE-200608-MS and SPE-200608-PA

Status:

- ◆ The model has been successfully used to support decision making in P&A of four candidate wells in North Sea.
- ◆ Current and upcoming field applications in North Sea and globally.

5

5

Acknowledgements

This work is sponsored by the Oil and Gas Technology Centre and supported by the following North Sea operators.



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For more information and to discuss field applications please contact Morteza H. Sefat (m.haghighatsefat@hw.ac.uk).

6