

# Discussion of acceptance criteria for risk-based P&A design

P&A Seminar October 18<sup>th</sup> 2018 Quality Airport Hotel, Sola

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# Introduction

- A risk-based approach in the P&A well design phase has gained ground the last years;
  - Oxand, DNV GL and NORCE have published methods for how to quantify «containment failure» related to permanent P&A
  - Several operators have performed such risk quantification in-house
- The implementation of a risk-based approach to permanent P&A requires that acceptance criteria are established

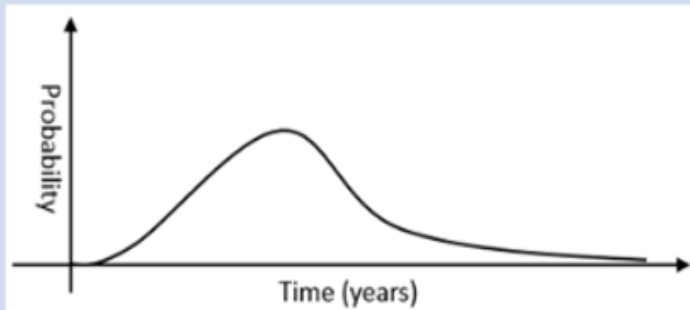


# Introduction

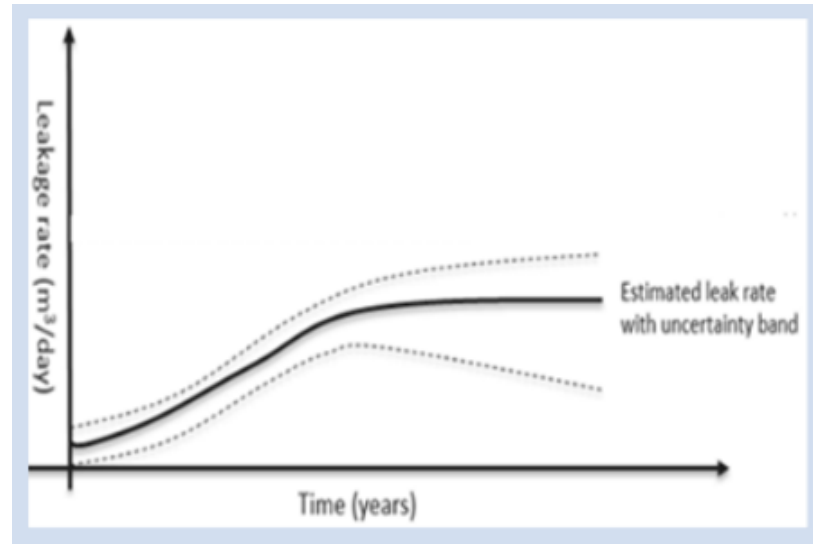
One possible way of expressing the risk picture with respect to «containment failure» is to use two main quantities:

## «Probability»

1% that the well will leak within 200 years.



## «Consequence»



# Possible risk acceptance criteria for P&A

1. Well consistency criterion

2. Environmental criterion

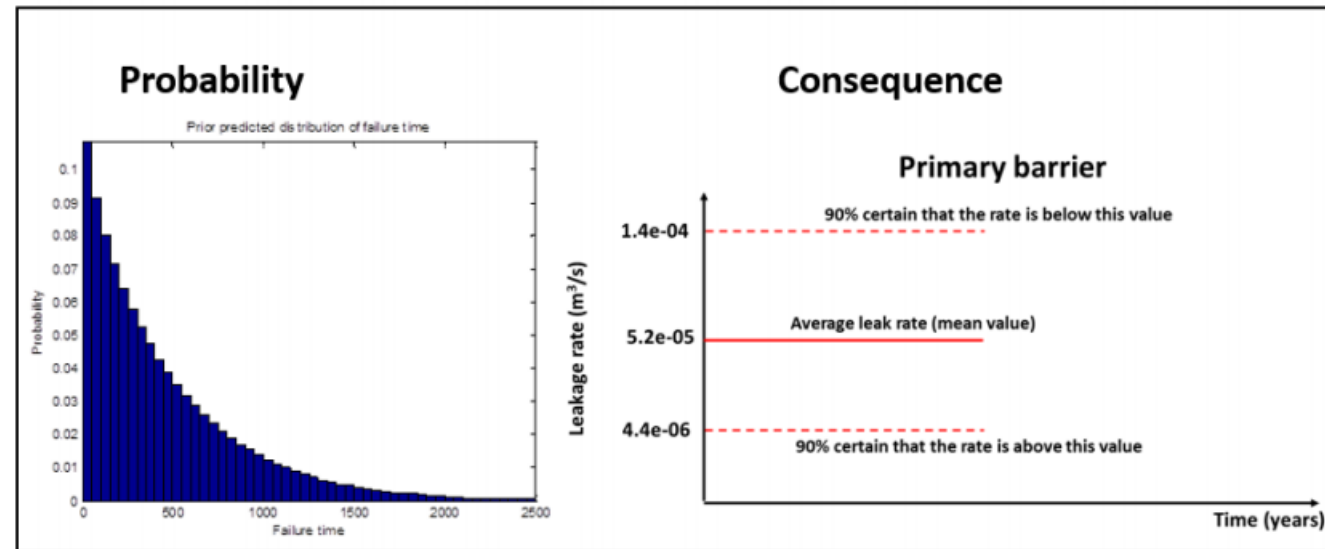
3. ALARP (As Low As Reasonably Practicable)

# Well consistency criterion

## Recipe:

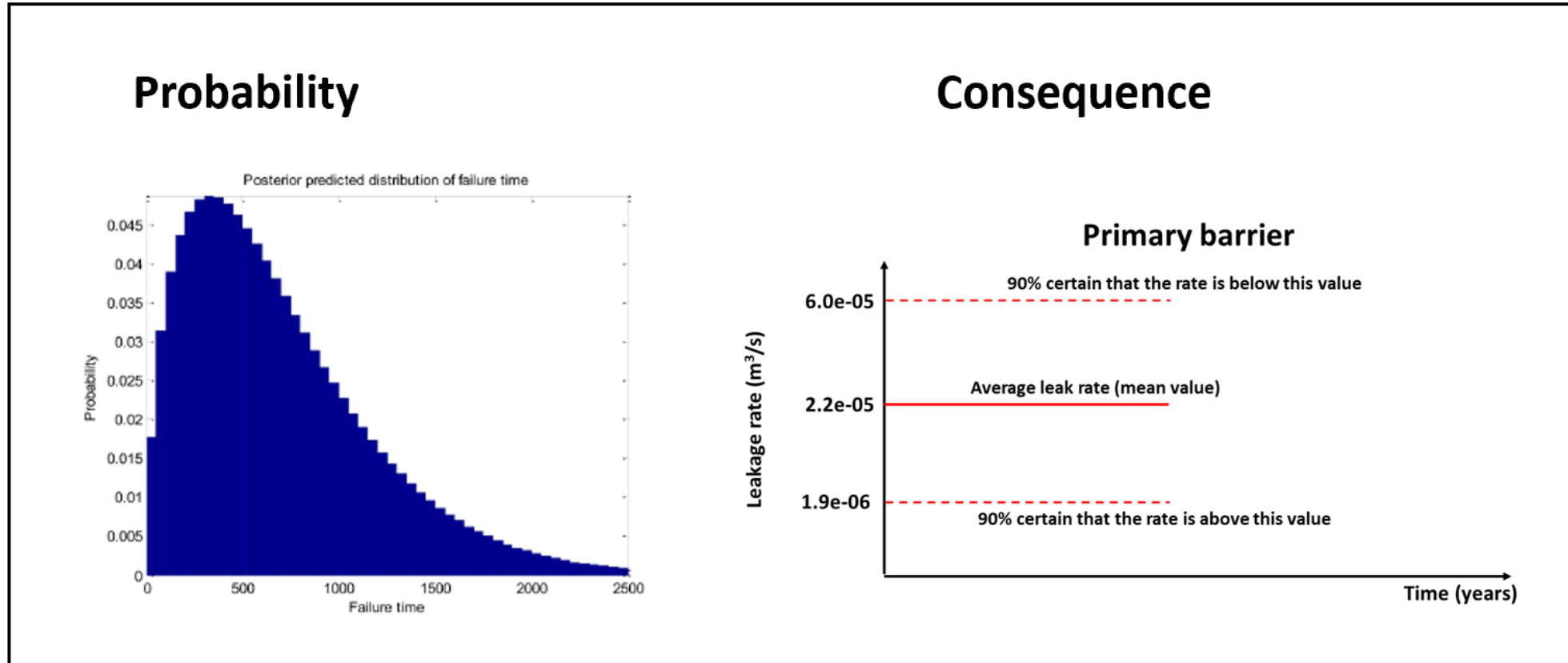
1. Select a reference level, for example NORSOK D-010 or UK Guidelines for the abandonment of wells.
2. Choose a barrier system as prescribed in the standard and establish a «worst case» scenario
3. For any well that is subject to the same reference level as chosen in 1, calculate the the leakage probability and the leakage rate and compare it to the reference level.

## Reference case (HPHT well)



# Example – a well under consideration in the P&A planning phase

## Example case (LPLT well)



# Well consistency criterion – example case

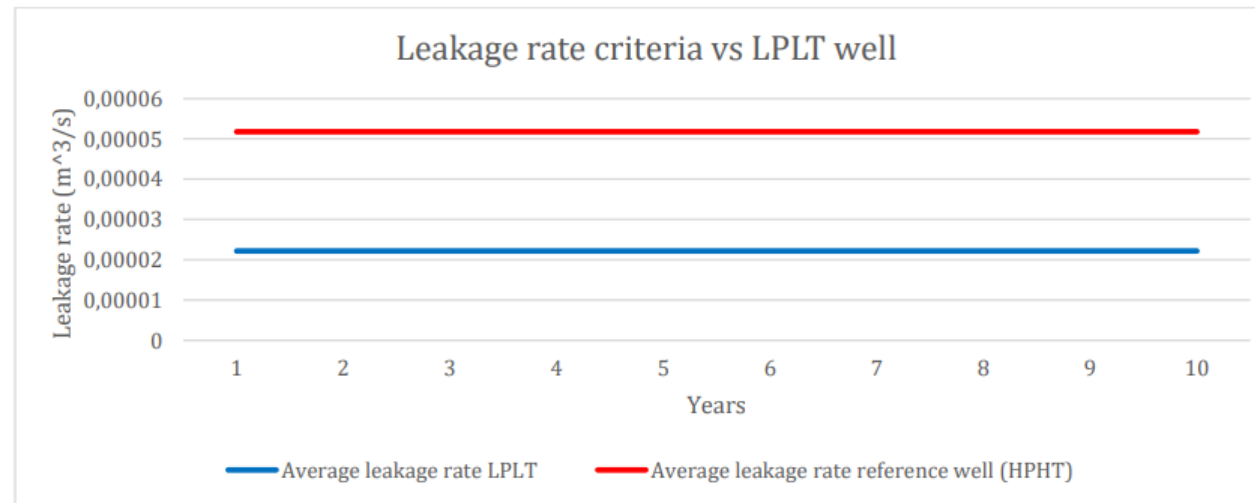


Figure 9: Leakage rate comparison reference vs LPLT.

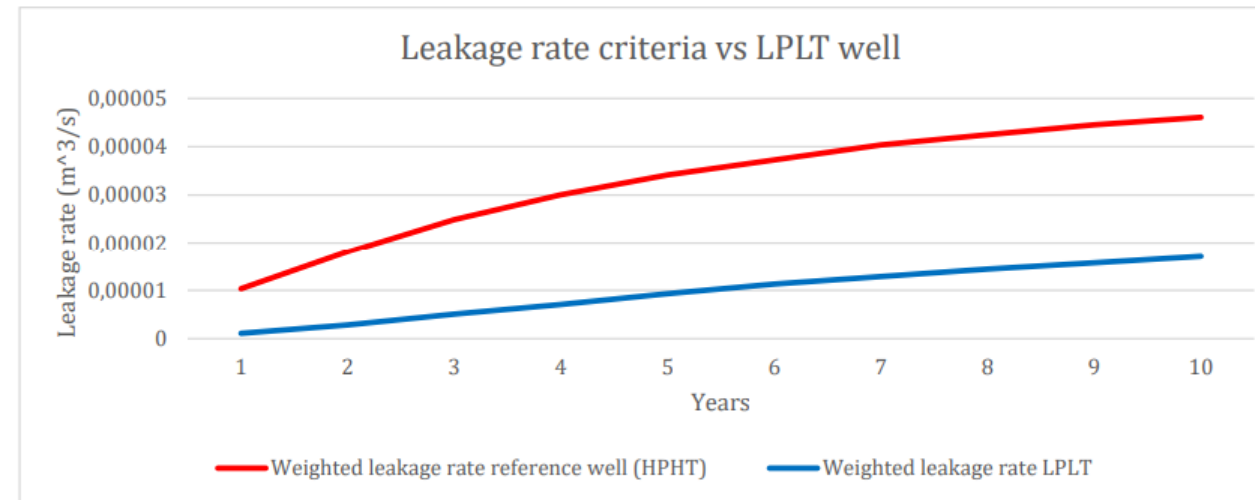


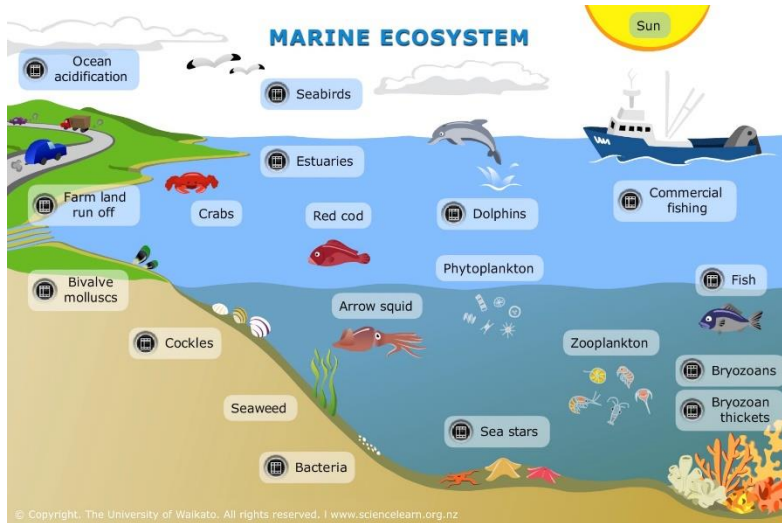
Figure 10: Probability-weighted criterion for the well consistency criterion.



# Environmental criterion

## Recipe:

1. Use measured data and knowledge from the area where P&A will be performed to either assess
  - a. The natural seepage rate, or
  - b. The maximum tolerable hydrocarbon concentration based on valued ecosystem component analysis
2. For wells to be P&A-ed in the area, compare the (probability weighted) leakage rates to either 1a or 1b.




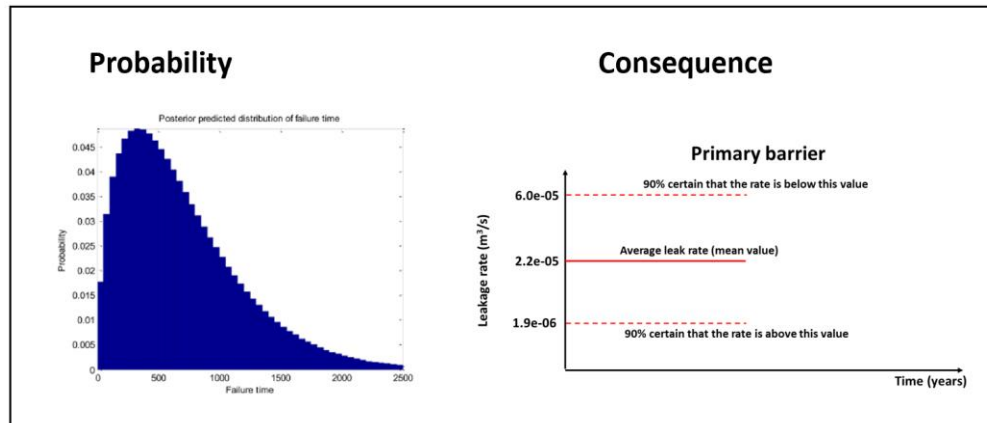


# Environmental criterion – example case

- Data on natural leakages in the northern Gulf of Mexico has been reviewed in a recent Master's thesis at UiS
- By averaging over 357 natural seeps in this region, the natural seepage rate was estimated to  $1.1 \cdot 10^{-2} \text{ m}^3/\text{s}$ .

The LPLT well under consideration has a predicted leakage rate of  $2.2 \cdot 10^{-5} \text{ m}^3/\text{s}$  if it starts to leak, so **this design is clearly acceptable under the environmental criterion.**

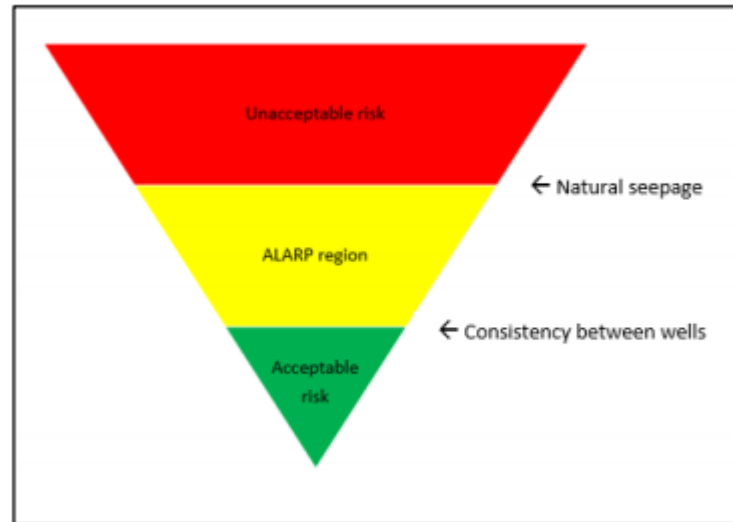
 University of Stavanger Faculty of Science and Technology <b>MASTER'S THESIS</b>	
Study program/Specialization: Industrial economics/ Project Management & Contract Administration	Spring semester, 2018  Open
Writer: Marianne Nielsen	<i>Marianne Nielsen</i> (Writer's signature)
Faculty supervisor: Fatemeh Moenikia External supervisor: Øystein Arild (IRIS - NORCE)	
Thesis title:  <b>Risk Assessment of Plugged and Abandoned Wells</b>	
Credits (ECTS): 30	
Key words: Plug and abandonment Risk assessment Leakage risk Leakage acceptance criteria Natural leakage rate Acceptable leakage rate Leakage rate / leakage probability for P&A wells	Pages: 79 + enclosure: 5  Stavanger, 11.06.18



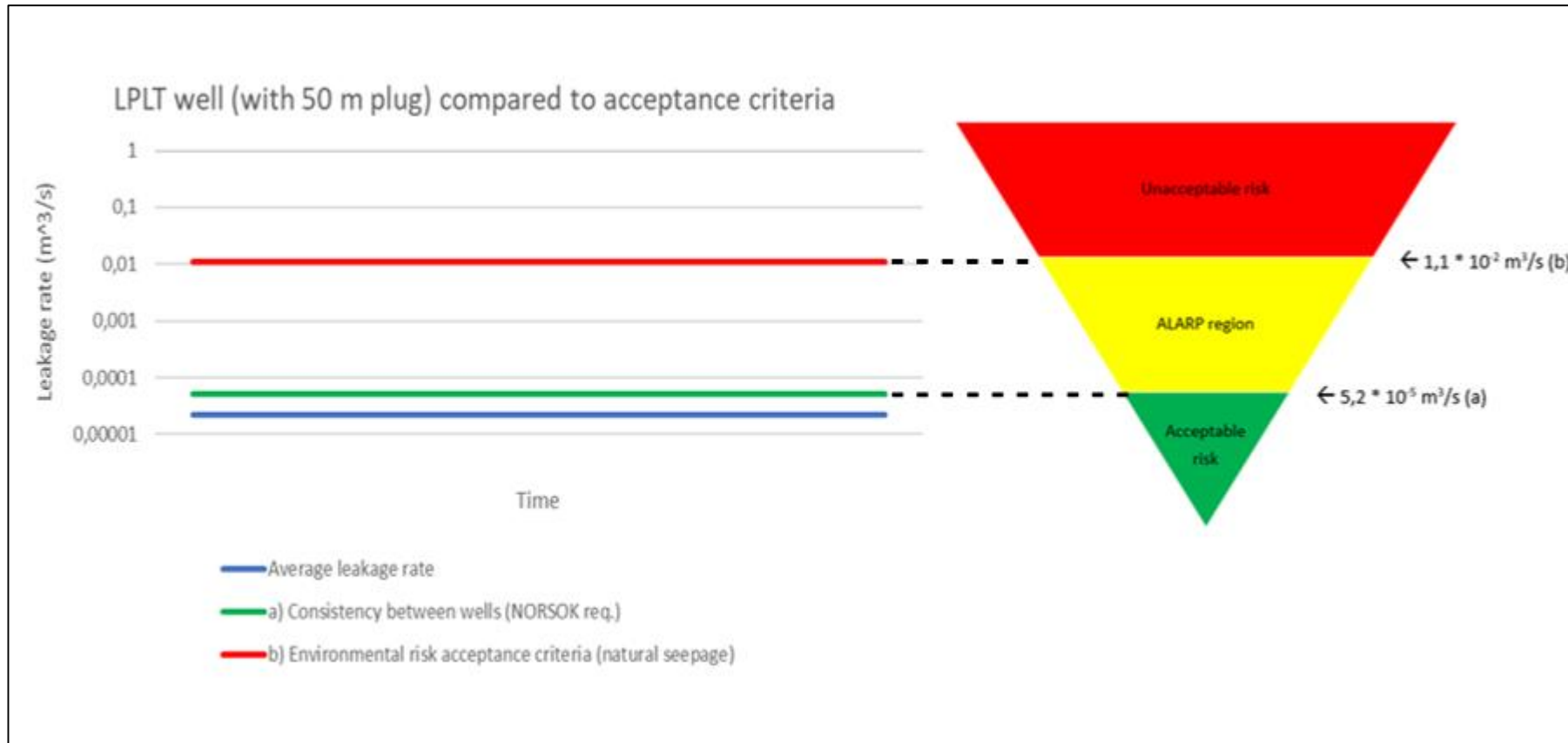
# ALARP

## Recipe:

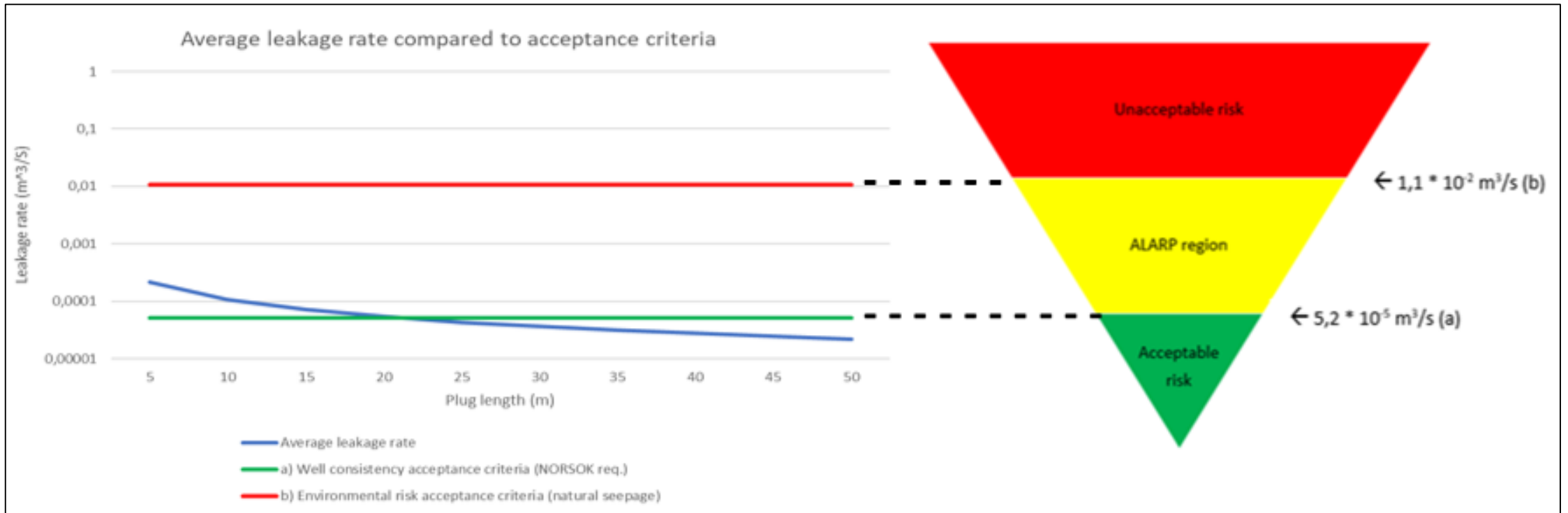
1. Choose the limit for the «red region». This could for example be the environmental criterion.
2. Choose the limit for the «green region». This could for example be the consistency criterion.
3. If the (probability weighted) leakage rate is in the ALARP region («yellow region»), apply cost benefit analysis on the P&A design to evaluate «reasonability».



# ALARP – example case



# ALARP - example case



# Summary

- A risk-based approach is an alternative to a prescriptive approach
- In order to use a risk-based approach for decision making, i.e. if a P&A design is acceptable or not, a risk acceptance criterion will have to be used
- There is a variety of different risk acceptance criteria that can be used, the industry and the authorities should establish consensus on useful acceptance criteria
- It should be an ambition to agree on a set of criteria that can be a part of future revisions of NORSOK D-010

# Thanks for your attention!

## Acknowledgement

The authors acknowledge the Research Council of Norway, Eni Norge and AkerBP, ConocoPhillips, Equinor and Wintershall for financing the work through the research centre DrillWell – Drilling and Well Centre for Improved Recovery, a research cooperation between NORCE, NTNU, SINTEF and UiS.

This presentation is based on the conference paper SPE 191414-MS.