

# **Perspectives on Developing Independent Performance Assessment Capability to Support Regulatory Reviews of the Safety Case**

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# Overview

- Purpose of Performance Assessment (PA)
- Deciding whether to develop independent performance assessment capability
- Considerations during development
- Use of independent PA capability to risk inform the regulatory review process

# Purpose of Performance Assessment in U.S. High-Level Waste Repository Program

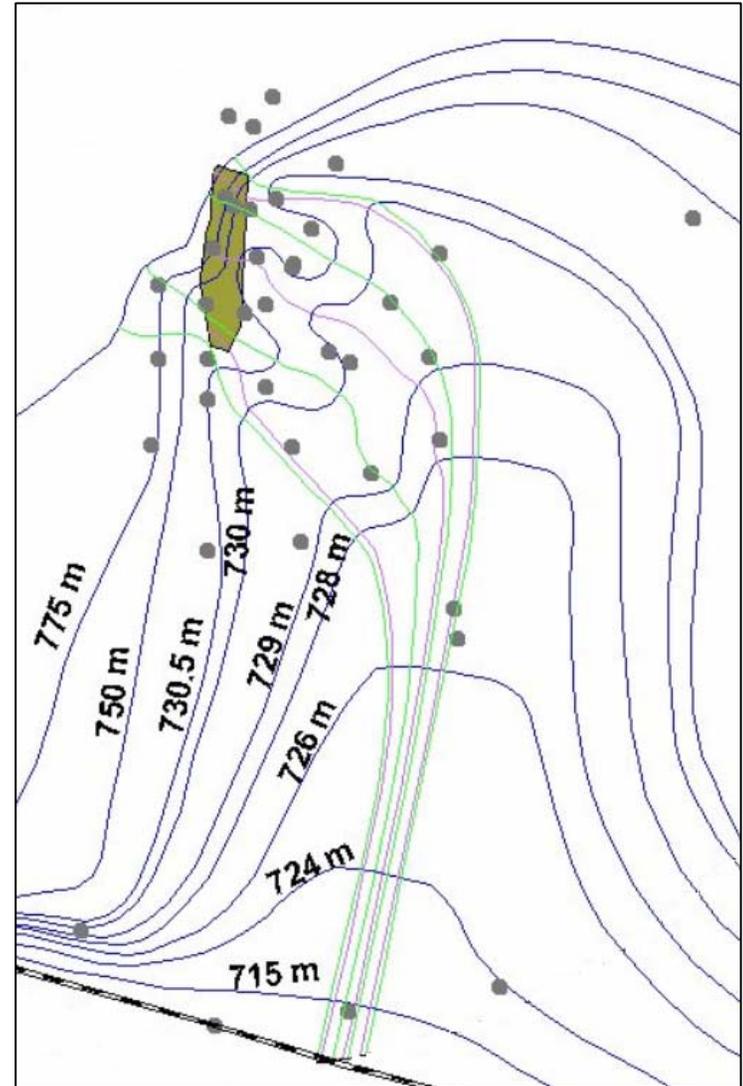
- Implementor: U.S. Department of Energy (DOE)
  - Required by Part 63 of Title 10 of the U.S. Code of Federal Regulations (10 CFR Part 63)
  - *“Demonstrating compliance with the postclosure performance objective... requires a performance assessment to quantitatively estimate radiological exposures to the reasonably maximally exposed individual at any time during the compliance period”*
- Regulator: U.S. Nuclear Regulatory Commission (NRC)
  - NRC developed independent PA capability to improve understanding of how various features, events, and processes affect repository performance
  - Independent PA capability supports:
    - Meaningful prelicensing consultations with DOE
    - Development of risk-informed approach for review of a potential license application
    - Preparations and training of staff for regulatory reviews
    - Integration of information across technical disciplines

# Deciding Whether to Develop Independent Performance Assessment Capability

- Prospective benefits
  - Provides benefit of improved staff understanding of how integration of complex and nonlinear processes may affect repository system behaviour
- Site complexity and nature of uncertainties
  - For sites that are well characterized, an independent total-system PA model may not be warranted
  - Regulator could choose to explore uncertainties at the process level and leave total-system modeling to the implementor
- Implementor's model
  - If the implementor's site conceptual model, modeling approach, and treatment of uncertainty are thoroughly developed, a regulator may not gain much benefit by developing an independent model

# Considerations During Development of Independent Performance Assessment Capability by a Regulator

- Choosing the right level of detail
  - Simpler models are often better suited to exploring alternative concepts and uncertainties
  - For Example:
    - NRC TPA Code uses one-dimensional streamtube model (right) for radionuclide transport, compared to DOE three-dimensional model
    - The less complex model is more easily adapted for evaluating different conceptual models for flow and transport characteristics
- The regulator also may choose to include features, events, or processes not considered by the implementor in order to independently evaluate their significance

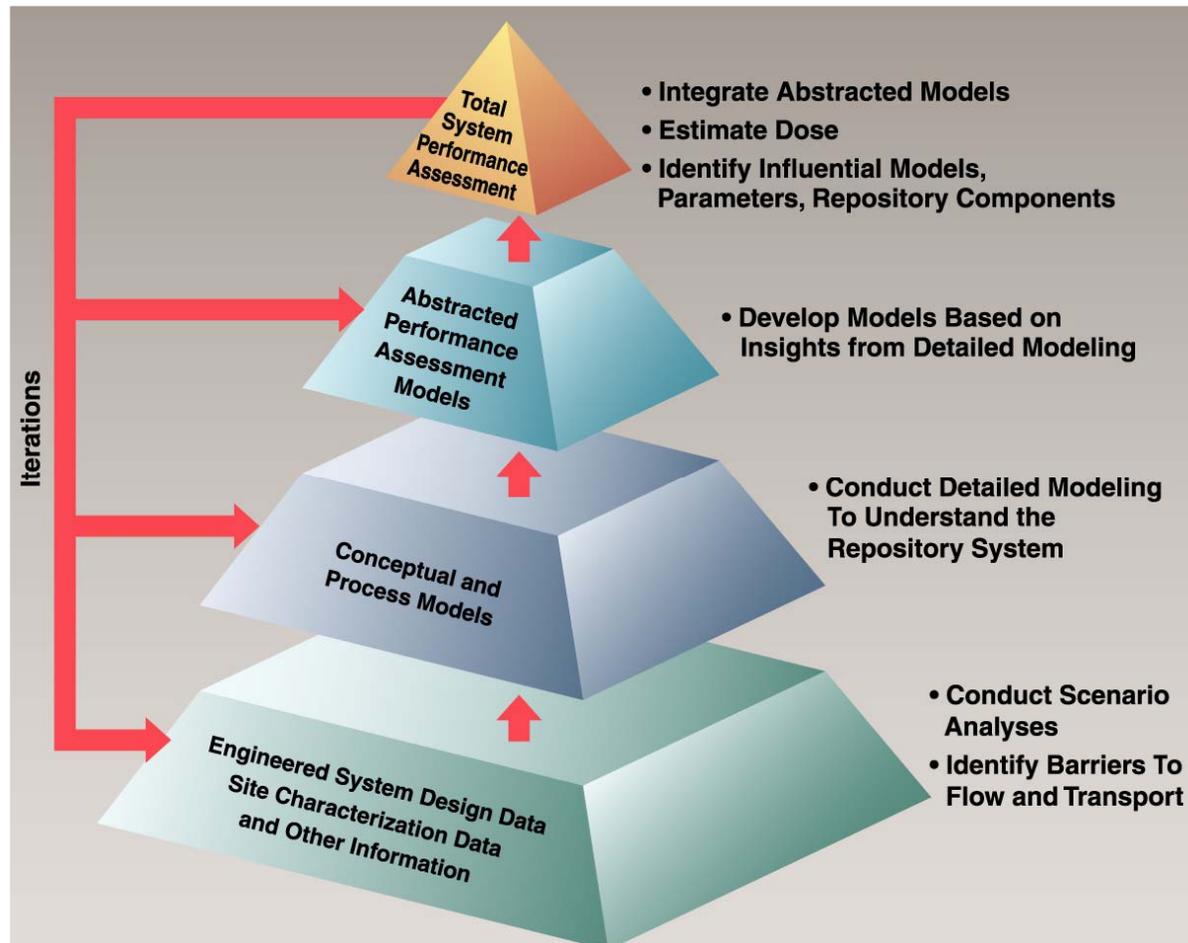


Source: Mohanty, et al., 2002

# Handling and Understanding Uncertainties

- NRC has conducted several iterations of independent PA development and probabilistic PA sensitivity analyses to improve understanding of important process and parameter uncertainties
- Example of Iterative Approach:
  - Conservative or bounding assumptions often used initially when process or parameter uncertainties are not fully understood
  - Not always clear whether a simplifying assumption or bounding estimate is conservative
  - Conservative assumptions are explored in sensitivity analyses to ensure PA results are not biased in unrealistic ways
  - If model results are dominated by conservative or bounding assumptions, a need for increased model complexity or additional data collection to support parameter estimates may be indicated
  - Improved understanding of uncertainties is an iterative process

- Risk insights from PA analyses provide valuable insights by identifying influential models and parameters (top of PA pyramid)
- These insights help to focus reviews of site data and models during the precicensing period and to identify which features or processes to refine in the iterative PA development process (feedback to development process)



# Example of a Risk Insight Gained from Independent Performance Assessment

- Early risk insight: presence of a passive oxide film acting as a corrosion inhibitor on waste package surfaces identified as having high significance to barrier capability (NRC, 2004)
- Following this initial risk insight:
  - Independent laboratory experiments were focused on corrosion processes for Alloy 22 (proposed canister material)
  - Potential susceptibility to crevice corrosion under certain chemical environments was identified in experiments
  - Experimental results were used as the basis for more detailed representation of localized corrosion processes in an update of the NRC TPA code
  - The updated TPA code identified a localized corrosion on waste package welds as potentially significant, depending on the chemistry of water contacting waste package surfaces (Mohanty, et al., 2005)
  - Risk insights suggest crevice corrosion processes and the quantity and chemistry of water contacting waste packages are topics on which to focus staff reviews and prelicensing analyses

# Role of Independent Performance Assessment in Developing Risk Insights

- For any feature, event, or process, the level of focus in NRC review will be based on whether it is identified as a barrier by DOE, and the relative significance inferred from NRC's independent analyses (see table below)
- Independent PA capability provides NRC with a tool for assessing overall significance to repository performance

<b>NRC Relative Significance</b>	<b>Identified by the DOE as Barrier?</b>	<b>Level of Focus in NRC Review</b>
High	Yes	High
High	No	Moderate
Low	Yes	High
Low	No	Low

Source: Leslie, 2006

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This presentation is an independent product of CNWRA and does not necessarily reflect the views or regulatory positions of the NRC. The NRC staff views expressed here are preliminary and do not represent a final judgment or determination of the matters addressed or of the acceptability of a license application for a geologic repository at Yucca Mountain.

# References

Mohanty, S., et al. “Risk Analysis for Risk Insights Progress Report.” San Antonio, Texas: Center for Nuclear Waste Regulatory Analyses. 2005.

Leslie, B. “Risk Insights Baseline Report: A Basis for Risk-Informed Decision Making in the U.S. Nuclear Regulatory Commission’s High-Level Waste Repository Safety Program for the Proposed Yucca Mountain Repository.” Proceedings of the 8th International Conference on Probabilistic Safety Assessment and Management (PSAM 8), New Orleans, Louisiana, May 14–19, 2006.

NRC. “Risk Insights Baseline Report.” Washington, DC: U.S. Nuclear Regulatory Commission. 2004.