ROLE OF INDEPENDENT STUDIES TO ADDRESS UNCERTAINTY AND THEIR IMPACT ON REGULATORY INTERACTIONS

S. Mohanty[1], **G. Wittmeyer**[1], **G. Peters**[2], **S. Whaley**[2]
[1]Center for Nuclear Waste Regulatory Analyses, [2]U.S. Nuclear Regulatory Commission, USA

Objectives

- Discuss the role of independent studies in regulatory interactions during the prelicensing period of a potential High-level Waste proceedings in the United States.
- Illustrate through examples how independent studies help address uncertainty during regulatory interactions.

Background

- The U.S. Nuclear Regulatory Commission (USNRC) staff with assistance from the Center for Nuclear Waste Regulatory Analyses (CNWRA) may review a license application for a potential geologic repository at Yucca Mountain, Nevada, USA.
- USNRC staff is undertaking various activities during the prelicensing period:
  - Reviewing preliminary U.S. Department of Energy (USDOE) data and analyses that are potentially relevant to the safety analysis in the license application.
  - Preparing for the safety review.
  - Conducting public outreach activities.
- The reviews of USDOE data and analyses during the prelicensing period enhance USDOE capability to submit a *high-quality* license application to USNRC.
  - High quality: well-formulated analysis and technical bases provided in a manner that is suitable for making a regulatory decision within the time mandated in the Nuclear Waste Policy Act.
- Toward reaching this goal, USNRC
  - Interacts with USDOE to gain clarification of evolving repository design, performance assessment, and supporting analyses.
  - Enhances regulatory staff review capabilities by:
    - Improving staff understanding of the proposed USDOE approach.
    - Carrying out activities, including independent studies that will enable staff to focus on key aspects of potential repository performance.

Pre-licensing interactions for issue resolution

- Intends to ensure that the USDOE has assembled enough information about a given issue for USNRC to accept a license application for review.
- Considers an issue resolved when the USNRC has no further questions about how USDOE is addressing an issue.

- Does not preclude raising related issues during the licensing review.
- Does not prejudge evaluation of the issue during the licensing review.
- Pertinent new information could raise new questions about a previously resolved issue.

Independent analyses

- USNRC and CNWRA staff conducted independent scientific and engineering studies including:
  - Field and laboratory investigations of physical processes.
  - Development of conceptual and mathematical models.
  - Scoping calculations of risk to evaluate relative importance to safety.
  - Development and updating of a total-system performance assessment computer code.
  - Review of relevant literature.
- Three examples are presented to illustrate the use of independent analyses in prelicensing interactions of the USDOE analyses:
  - Drift degradation.
  - Characterisation of extreme peak ground accelerations.
  - Transportation, ageing and disposal canister.

Example 1: drift degradation

- USDOE assessments concluded that:
  - During the postclosure period, the emplacement drifts will remain largely stable for thousands of years, unless the site experiences a strong seismic event.
  - A drip shield will withstand mechanical loading from potential rockfall impact and rubble accumulation.
  - Mechanical failure of drip shields could be excluded from the assessment of engineered barrier performance in the USDOE total system performance assessment (TSPA) model.
  - The effects of accumulated rubble on thermal-hydrological parameters could be excluded from the TSPA model nominal case.
- USNRC staff and CNWRA independent analyses indicated that:
  - Drift degradation could
    - Occur in the first several hundred years.
    - Affect the response of the repository over the expected performance period.
  - Repository thermal loading alone could degrade the emplacement drifts during the first several hundred years.
  - Accumulated rubble under static and seismic loading conditions may cause drip shields to collapse and mechanically interact with waste packages.
  - USDOE may not have fully considered some potential failure modes of the drip shields and waste packages in its current design and performance assessments.

Figure 1. **Drip shield and waste package in emplacement drift** (SNL, 2007)

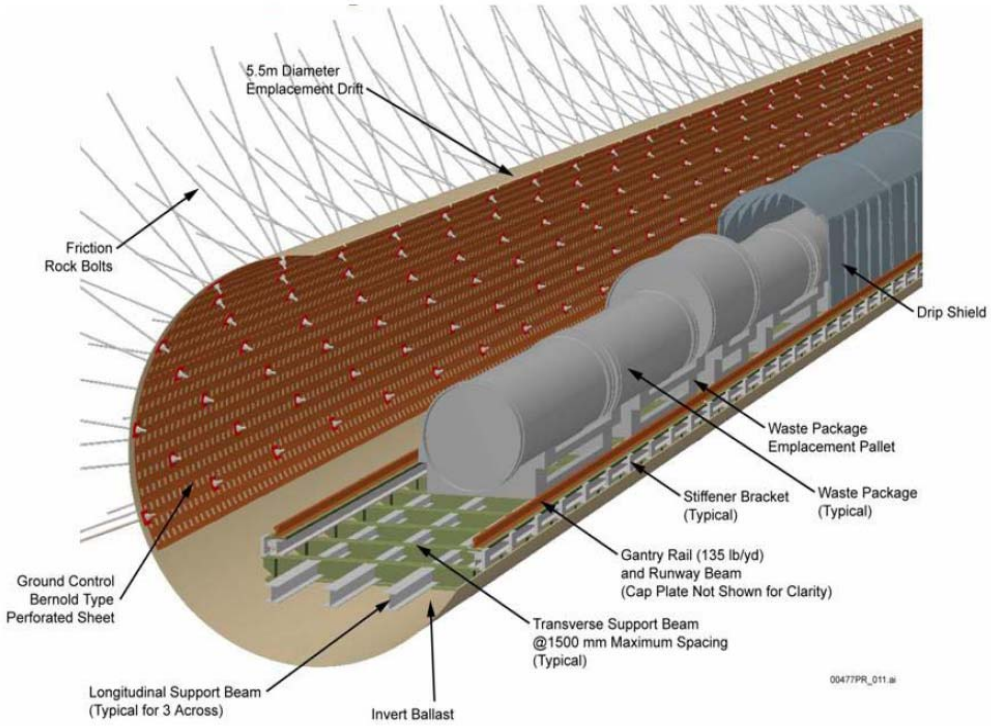
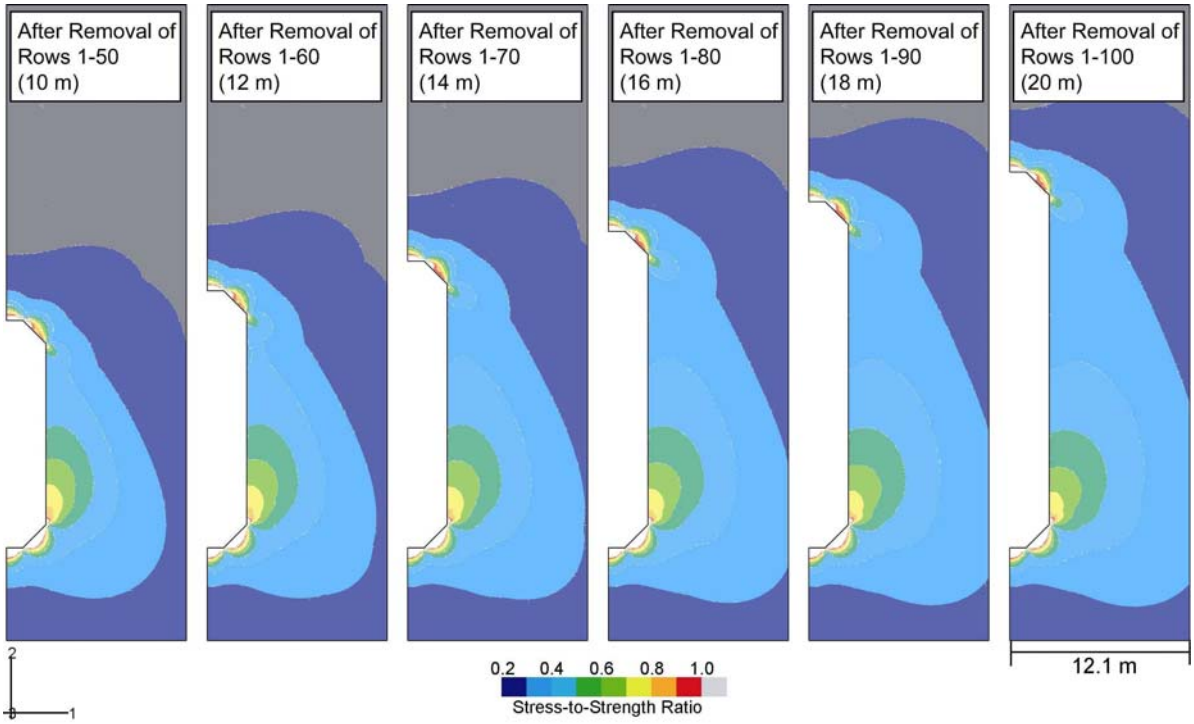


Figure 2. **Modelling of rubble formation** (Ofoegbu *et al.*, 2008)

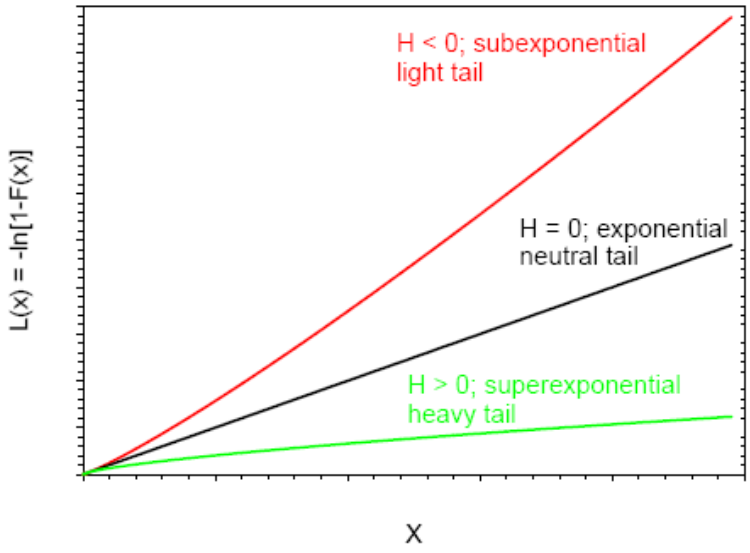


Effects of Progressive Spallation on Overstress Distribution Around A Thermally Loaded Drift.
Spallation was Simulated Through Removal of Rows of Rock Elements in the Roof, One Row at a Time

Example 2: characterisation of extreme peak ground accelerations

- Regulations require:
  - Identification and analysis of naturally occurring hazards and human-induced hazards during the preclosure period.
  - Evaluation of repository postclosure performance for seismicity, including the range of credible earthquakes in the seismic event class.
- USDOE used a probabilistic hazard curve in which data were extrapolated to represent small annual exceedance probabilities (< 10^{-6}/year):
  - Extrapolation into the tail of a lognormal distribution led to possibly overestimated ground motions.
  - CNWRA and USNRC reviewed the appropriateness of the lognormal assumption for low-probability ground motions, especially the tail behavior of the peak ground acceleration (PGA).
  - The CNWRA and USNRC developed method indicated that the tail portion of the PGA data can be better characterised (Figure 3).
  - USDOE acknowledged that the severity of low-probability ground motion at Yucca Mountain was overestimated.

Figure 3. **Three types of tail distributions** (Huyse, *et al.*, 2008)



Example 3: transportation, ageing, and disposal (TAD) canister

- USDOE plans to use TAD canister for transportation, ageing, and ultimate disposal in a potential geologic repository.
- Type 300-series stainless steel is proposed for the TAD canister and structural internals, except for thermal shunts and criticality control materials.
- Staff assessed the impact of this change on risk insights and regulatory requirements.
- Based on independent assessment, USNRC staff requested that USDOE provide information on whether the latter components have any potential sources of carbon steel or aluminum alloys, which may affect in-package chemistry.

Summary and conclusion

- USNRC and CNWRA staffs have provided quality and timely feedback to USDOE on numerous technical issues.
- Using results from its independent analyses, USNRC staff has provided numerous comments including the range of uncertainty not considered, possibly non-representative assumptions, and unaccounted for scenarios or processes.
- USNRC and CNWRA staff will continue prelicensing interactions with USDOE to prepare for NRC independent review of the license application.

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References

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