U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Implementing a Consistent Treatment of Uncertainty in the TSPA-LA

Presented to:
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Presented by:
Peter Swift
Manager, Performance Assessment Strategy and Scope
Sandia National Laboratories
Bechtel SAIC Company, LLC

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Conservatism vs. Realism

- **Many Total System Performance Assessment (TSPA) reviewers have criticized the lack of realism in TSPA models**
  - **Nuclear Waste Technical Review Board, Performance Assessment Peer Review Panel, U.S. Nuclear Regulatory Commission (NRC) staff, International Atomic Energy Agency/Nuclear Energy Agency, Advisory Committee on Nuclear Waste, etc.**
  - **Reviewers do not, in general, distinguish between TSPA and process models. For them, TSPA is a window for looking at process models**

Conservatism vs. Realism

(Continued)

- **NRC requirements (final 10 CFR 63.304)**
  - **Reasonable expectation means that the Commission is satisfied that compliance will be achieved based upon the full record before it. Characteristics of reasonable expectation include that it:**
    - **Does not exclude important parameters from assessments and analyses simply because they are difficult to precisely quantify to a high degree of confidence, and**
    - **Focuses performance assessments and analyses on the full range of defensible and reasonable parameter distributions rather than only upon extreme physical situations and parameter values**

Uncertainty Strategy Guidance

- **Key points**
  - **Goal should be some version of a realistic analysis, rather than a bounding one**
    - **Pragmatically, some conservatisms will remain, but the project must be clear about where they are, what the basis is for them, and what their impacts are**
  - **Focus on realistic treatment of uncertainty, which is not the same as a full understanding of realistic performance**
    - **Simplified models are okay in the TSPA**
    - **Broad uncertainties are okay if justified and explained**
    - **Project scientists and performance assessment (PA) analysts need to work together to incorporate uncertainty in TSPA models and parameter distributions**
  - **Focus on clear explanation of what we did**
    - **Mathematical and conceptual descriptions**
    - **Traceability**

Implementation

- **Guidance document in preparation to address**
  - **Consistent treatment of abstractions in TSPA**
  - **Consistent treatment of alternative conceptual model uncertainty**
  - **Consistent treatment of parameter uncertainty**
- **Guidance document addresses NRC Key Technical Issue agreements**
- **Implementation planned as Analysis and Model Reports (AMRs) are updated for License Application (LA)**

Abstractions

- **Goal is to capture aspects of process model important to system interactions, with appropriate representation of uncertainty**
- **Developed by subject matter experts, reviewed by PA analysts**
  - **Development documented in AMRs**
  - **Various forms of abstractions are acceptable; e.g., simplified numerical models, simple functions, response surfaces, parameter distributions**
- **Implemented by PA analysts, reviewed by subject matter experts**
  - **Implementation documented in TSPA model AMR**

Alternative Conceptual Models

- **Alternative conceptual models (ACM)**
  - **For each process of interest, identify alternative conceptual models (if any) consistent with the available information**
    - **If only one conceptual model is consistent with all information, ACM uncertainty is not significant**
  - **Evaluate impacts of alternatives on the subsystem component performance**
    - **If ACMs result in the same subsystem performance, ACM uncertainty is not significant**
    - **If two or more ACMs show different subsystem performance, develop abstractions for both and deliver to TSPA**
      - **If abstractions for ACMs are not straightforward, conservatism is an option**
    - **TSPA evaluates system-level impact of ACMs**
      - **If impacts are significant, options are to carry multiple ACMs in TSPA with weighting, or to consider conservative choice**

Parameter Uncertainty

- **Formal process for selecting parameter values and distributions for TSPA**
  - **Identify and categorize TSPA parameters**
  - **For uncertain parameters that are important to system performance, goal is to represent "full range of defensible and reasonable parameter distributions rather than only upon extreme physical situations and parameter values"**
    - **Establish uncertainty distribution considering**
      - **Available data**
      - **Use of the parameter in the TSPA model (e.g., scaling issues, variability, application in model)**
    - **Distribution developed jointly by subject matter expert, PA analyst, and statistician**
    - **Documented in AMRs**
  - **Parameters implemented in TSPA through a controlled database**

Summary

- **Regulators and reviewers are not asking for the impossible**
- **They are asking for a commitment to shift our aim from conservatism to a realistic treatment of uncertainty**
- **The project needs a shift in its thinking and rhetoric, as well as in its actual methodology**
- **Our ability to explain our approach is key**
  - **Can we explain what we did and why?**
  - **There is no unique solution, so our credibility comes from our ability to explain and convince, rather than from proof**
- **Process issues (e.g., quality assurance, configuration management, and data/parameter transformations) will be critical**