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

Total System Performance Assessment for the Site Recommendation - Introduction

Presented to:
Nuclear Waste Technical Review Board

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August 1, 2000

YUCCA MOUNTAIN PROJECT

Outline

- Regulatory Requirements for TSPA-SR
- TSPA-SR Objectives
- Major Improvements in TSPA-SR
- Engineered Barrier Design for TSPA-SR
- Basis for Process Models Comprising TSPA-SR
- Current Status of TSPA-SR Analyses

Regulatory Requirements for TSPA-SR

- **Proposed DOE, NRC and EPA regulations require a total system performance assessment (TSPA) to evaluate the Yucca Mountain repository system**
- **The TSPA must include all relevant features, events and processes that could significantly affect performance**
- **The TSPA must analyze performance in terms of the individual protection requirement, the groundwater protection requirement and the potential consequences of human intrusion**
- **The TSPA for individual protection (dose) must include both the probable behavior as well as the effects of potentially disruptive low-probability, high consequence events**

Regulatory Requirements for TSPA-SR

(Continued)

- **Proposed DOE, NRC and EPA regulations require a total system performance assessment (TSPA)**
- **The US EPA in its proposed 40 CFR 197 states (pp. 85-86) concerning that assessment: ". . . we are proposing the concept of 'reasonable expectation' to reflect our intent regarding the level of 'proof' necessary for NRC to determine whether the projected performance of the Yucca Mountain disposal system complies with the standards . . . . We intend for this term to convey our position and intent that unequivocal numerical proof of compliance is neither desirable nor likely to be obtainable".**
- **The EPA (pp. 86-87) then suggests a reasonable approach to selecting "all parameters that significantly affect performance" and assigning distributions for these parameters "to the limits of confidence possible for the expected conditions in the natural and engineered barriers and the inherent uncertainties involved in estimating those values." The focus should be on the "full range of defensible and reasonable parameter distributions" and not on the tails of distributions, since the goal is to evaluate "likely performance" and not unrealistic or low probability performance**

TSPA-SR Objectives

- **TSPA-SR is the next in a series of TSPA iterations conducted by DOE for the Yucca Mountain site**
  - **TSPA-91**
  - **TSPA-93**
  - **TSPA-95**
  - **TSPA-VA**
  - **TSPA-SR**
- **TSPA-SR is derived from and integrates the underlying models of individual process components to evaluate total system performance**
  - **Individual dose**
  - **Groundwater protection**
  - **Human intrusion**
  - **Peak dose (for FEIS)**
- **TSPA-SR evaluates the significance of the quantified uncertainty in the underlying process components**

Major Improvements in TSPA-SR

Technical Improvements

- Enhance models to address review comments on TSPA-VA
- Models with major enhancements include:
  - Climate and seepage
  - Coupled thermal processes
  - Waste package degradation
    - Stress corrosion cracking
    - Initial defects/weld flaws
  - Saturated zone transport
  - Volcanism
- TSPA approach modified to address NRC and EPA requirements

Process Improvements

- Analyses, models, data, software controlled under common QA procedures
- Analysis/Model Reports used to trace information flow
- Explicit evaluation of features, events and processes (FEPs)
- TSPA-SR model developed to assure use of traceable data sets
- Track Q-status of all data, models, and software

Engineered Barrier Design for TSPA-SR

- **TSPA-SR is based on the Site Recommendation Design**
- **Repository design considers**
  - **Average thermal load of ~ 62 MTHM/acre (lower than VA)**
  - **No performance impact from liquid water removed through heating**
  - **50 years of ventilation**
  - **Blending of fuel at surface to levelize thermal load**
- **Engineered barrier system design considers**
  - **Titanium drip shield placed over waste packages**
  - **No backfill**
  - **Waste packages placed end-to-end (average line load of ~ 1.4 kW/m)**
- **Waste package design considers**
  - **Waste packages for CSNF (21-PWR/44-BWR) and co-disposed DSNF and DHLW**
  - **Outer layer of corrosion resistant Alloy 22 (20 mm) and inner layer of stainless steel (100 mm)**
  - **Dual-Alloy 22 lid closure weld, outer lid closure weld stress mitigated by solution annealing, inner lid closure weld stress mitigated by laser peening**

Integrated Technical Bases for TSPA-SR

Process Model Category	Process Model Report (PMR)
Geologic Setting	Integrated Site Model
Unsaturated Zone Flow	Unsaturated Zone Flow and Transport
Engineered Barrier System Environment	Near Field Environment
	Engineered Barrier System Degradation, Flow and Transport
Waste Package and Drip Shield Degradation	Waste Package Degradation
Waste Form Degradation	Waste Form Degradation
Engineered Barrier System Transport	Engineered Barrier System Degradation, Flow and Transport
Unsaturated Zone Transport	Unsaturated Zone Flow and Transport
Saturated Zone Flow and Transport	Saturated Zone Flow and Transport
Biosphere	Biosphere
Disruptive Events	Disruptive Events

Current Status of TSPA-SR Analyses

- **TSPA-SR calculations are underway**
  - **Results presented today are preliminary and subject to change**
  - **They are intended to be used for general discussions of sensitivities and barrier importance analysis**
  - **They are not suitable for making regulatory compliance judgments**
- **TSPA-SR calculations support the TSPA-SR Rev 00 Technical Report, the Repository Safety Strategy Rev 04, and the SRCR**
- **Some updates of these calculations (TSPA-SR Rev 01) are expected to support the SR**