



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

Simplified Total System Performance Assessment

Presented to:

Nuclear Waste Technical Review Board (NWTRB)

Presented by:

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YUCCA
MOUNTAIN
PROJECT

Overview

- **Background**
- **Objective of the simplified TSPA effort**
- **Software**
- **Current status**
- **Ongoing efforts**

Background

- **TSPA Models can be difficult to communicate, both to technical experts and the general technical audience**
 - **Complexity of the total repository system**
 - **Complexity of the model itself - necessary for “compliance type” calculations**
 - **Representation of uncertainty and alternative conceptual models**
 - **Limitations of the system assessment software and additional linkages**

Background

(Continued)

- **The Project has received constructive criticism regarding model transparency**
 - USGS, NWTRB, others
- **Necessary to thoroughly understand models to conduct appropriate technical review of TSPA models and products**

Objective of the Simplified TSPA Effort

- **Develop a tool to help communicate to the general technical audience**
 - High school graduates to college professors - multiple levels
 - What is TSPA
 - How does the TSPA model work
 - How do we expect the total repository system to perform
- **Enhance technical review capability**
 - Ensure transparency of the TSPA model to underlying documentation (can the model, analyses, and calculations be reproduced)
- **Two-phased approach; prototype based on VA followed by simplified SR model**

TSPA Software - GoldSim

- **Simplified TSPA model built on same platform as TSPA-SR model: GoldSim**
 - Evolution of the RIP software
 - Same analytic capabilities as RIP; improved user interface and presentation capabilities
- **Features - “technical”**
 - Ability to link to external codes and/or “routines”
 - Model and results are self contained
 - Ability to link to external data sources (database and/or spreadsheet)
 - Model can be documented internally and with hyperlinks to supporting documentation

TSPA Software - GoldSim

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- **Features - “user interface”**
 - **Graphical, object-oriented**
 - **Model can be structured on a component basis**
 - **Hierarchy can be used to “push” details down**
 - **Ancillary text, figures, and pictures can be included in the model to help explain**
 - **Result elements can be added in any location**

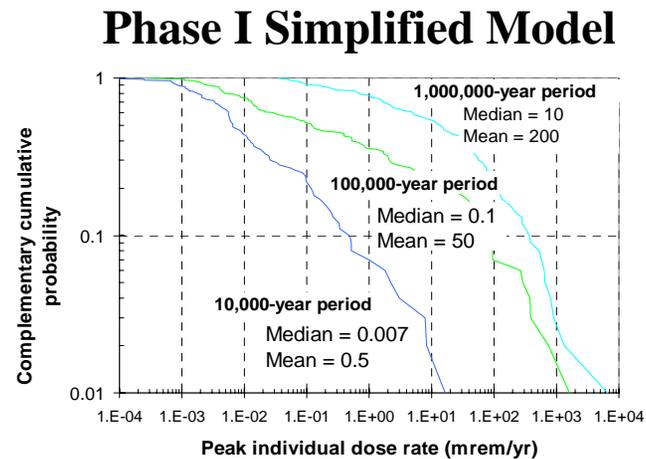
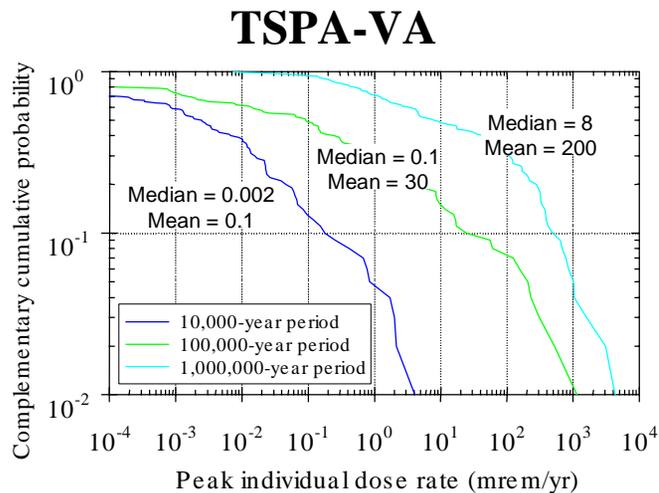
Phase I Model - Technical

- **Prototype (proof of principle), simplification of TSPA-VA**
- **Simplified does not mean simple**
 - **Constraint to reproduce results of TSPA-VA (overall and sub-system)**
 - **Model is still quite complex; all components included**
- **Some VA models were simplified**
 - **Some sufficiently simple (climate, biosphere)**
 - **Some could not be simplified without affecting results (EBS transport, seepage)**
 - **Others significantly simplified (EBS representation, UZ & SZ flow and transport)**

Phase I Model - Technical

(Continued)

- **Self contained model, results consistent with TSPA-VA**



- **It is a functioning model**

- **Single realization simulation requires one minute of run-time**

Phase I Model - Communication

- **Introductory page to “set the stage”**
 - Overview of geologic disposal and the Yucca Mountain Project, primer on PA, primer on risk in the context of geologic disposal, brief summary of design
 - Hyperlinks to semi-interactive presentations
- **Results toward “top” of model, concise**
 - Presented on component-by-component basis
- **Sub-component model structure used hierarchy to “push” detail down**
 - Importance at the top (mass transport, general model structure)
 - Detailed calculations that drive model “underneath”
 - Allows user to browse model at level desired

Phase I Model - Examples

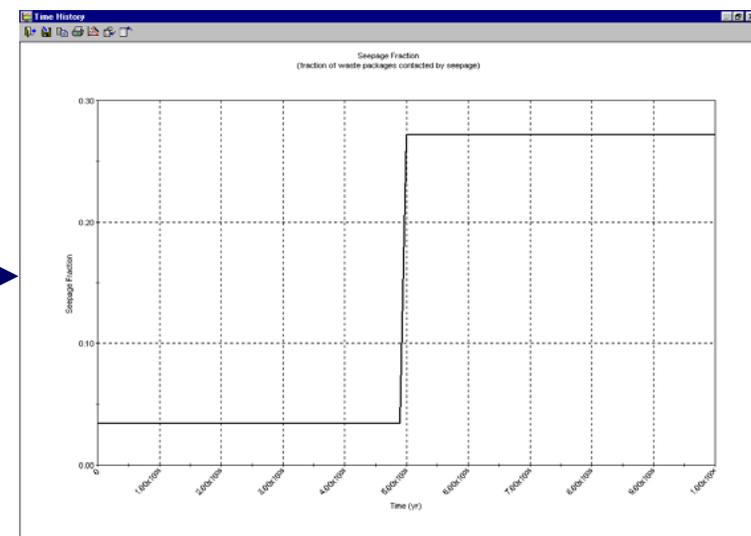
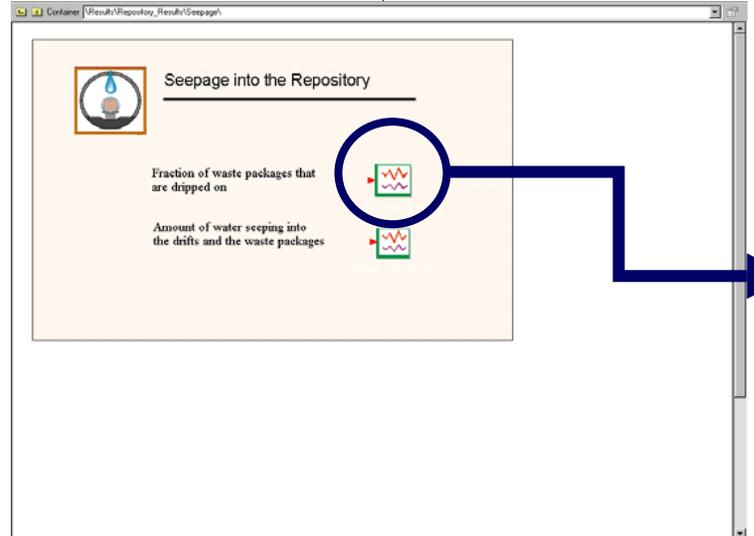
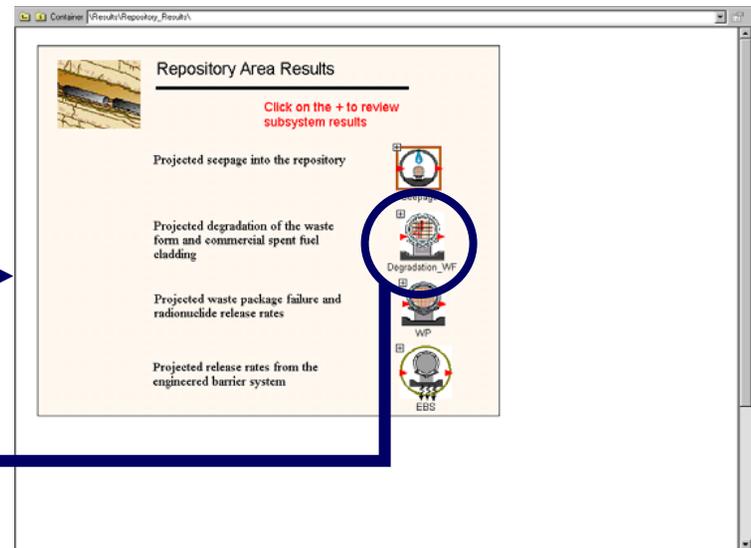
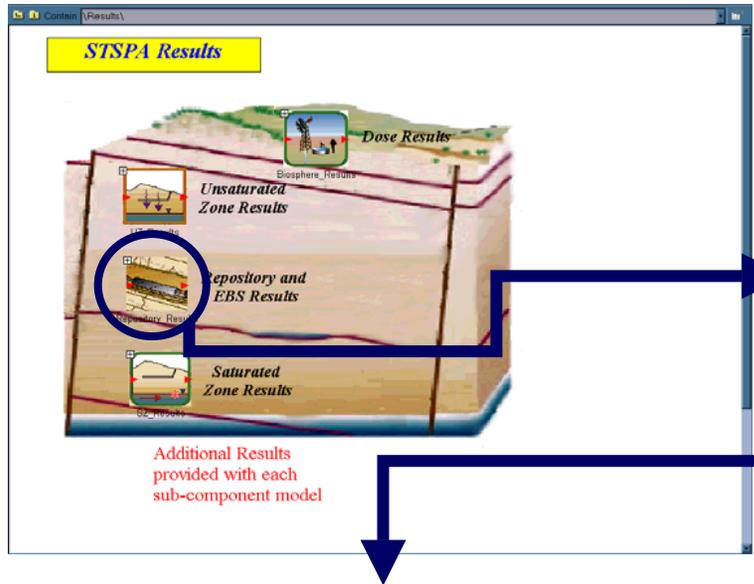
1. Contain \Introduction\

INTRODUCTION

1. **YUCCA MOUNTAIN PROJECT OVERVIEW:** To view a PowerPoint presentation with an overview of TSPA, double click on the icon to the right. 
2. **RISK:** Double click on the icon to the right to read a short discussion regarding the risk of geologic disposal of high-level radioactive waste. 
3. **PERFORMANCE ASSESSMENT:** To learn the basics about performance assessment modeling for the proposed repository at Yucca Mountain, double click the icon to the right. 
4. **REFERENCE REPOSITORY DESIGN:** The STSPA model is based on the Viability Assessment repository design. Double click on the icon to the right to learn more about this design. 
5. **HOW TO NAVIGATE IN THIS SOFTWARE:** The software used to develop the STSPA model is called GoldSim. Double click on the icon to the right to learn how to navigate in GoldSim. 

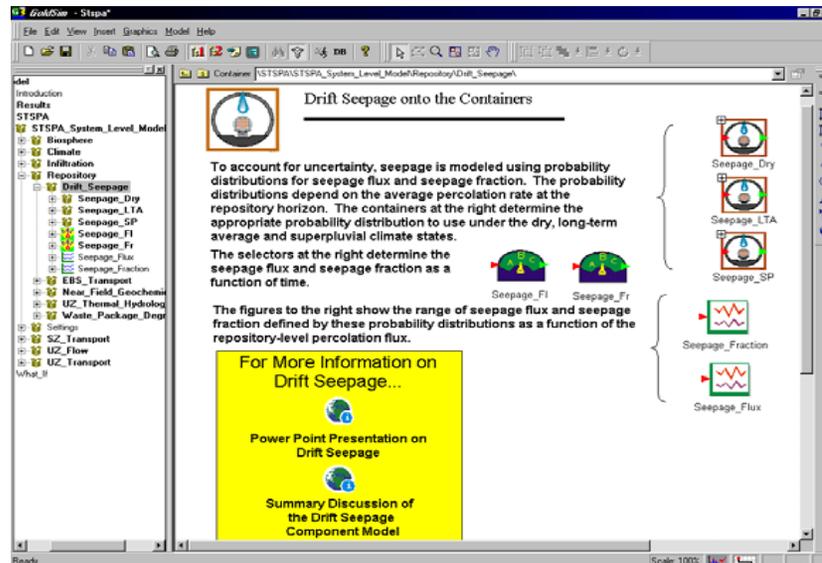
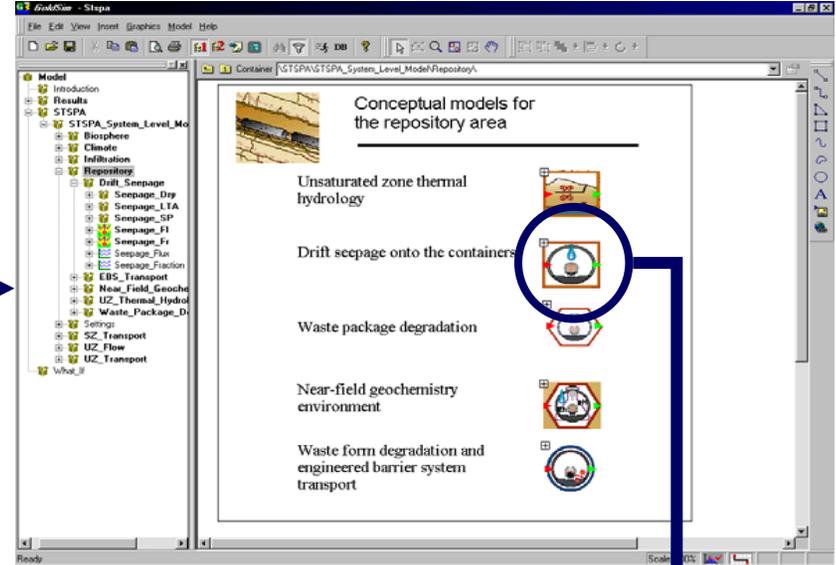
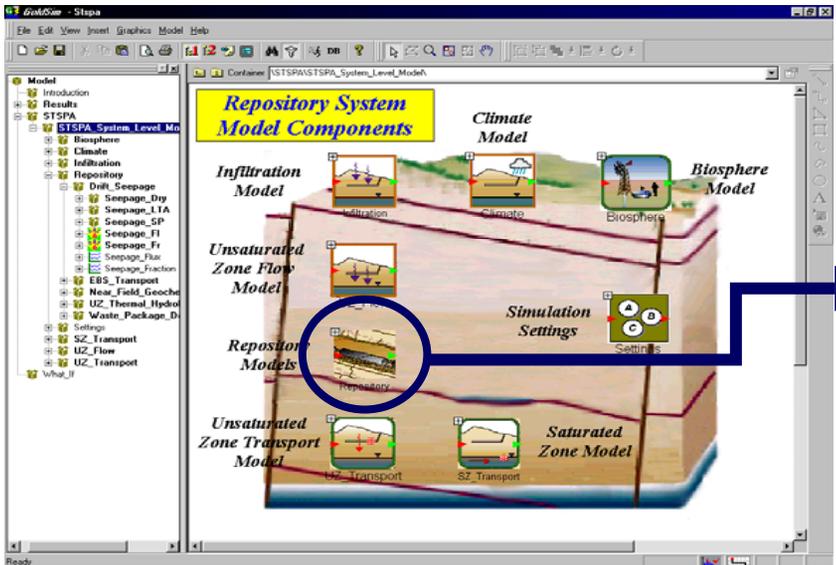
Phase I Model - Examples

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Phase I Model - Examples

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Phase I Model - Communication

- **Sub-component models heavily documented**
 - **Summary notes included on each graphic pane**
 - **Hyperlinks to detailed explanatory text with hyperlinks to VA documentation**
 - **Hyperlinks to semi-interactive discussions of various sub-components**
 - ◆ **What, how affects repository performance, how modeled, results - at two levels (summary and more detailed)**
 - ◆ **Hyperlinks to TSPA-VA and supporting documentation**
 - ◆ **Emphasis on “how” with limited discussion of the underlying basis (“why”)**

Phase I Model - Examples

Explanatory summary notes in graphic pane

Drift Seepage onto the Containers

To account for uncertainty, seepage is modeled using probability distributions for seepage flux and seepage fraction. The probability distributions depend on the average percolation rate at the repository horizon. The containers at the right determine the appropriate probability distribution to use under the dry, long-term average and superpluvial climate states.

The selectors at the right determine the seepage flux and seepage fraction as a function of time.

The figures to the right show the range of seepage flux and seepage fraction defined by these probability distributions as a function of the repository-level percolation flux.

For More Information on Drift Seepage...

- Power Point Presentation on Drift Seepage
- Summary Discussion of the Drift Seepage Component Model

Selectors: Seepage_Dry, Seepage_LTA, Seepage_SP, Seepage_Fraction, Seepage_Flux, Seepage_FI, Seepage_Fr

Hyperlink to supporting documentation

The uncertainty in the seepage flux is represented by a beta probability distribution. These are the parameters that define that probability distribution for the long-term average climate state: the mean, standard deviation, and maximum. The values of the mean, standard deviation, and maximum depend on the percolation flux at the repository horizon for the long-term average climate state. The maximum is set to one.

The uncertainty in the seepage fraction is represented by a beta probability distribution. These are the parameters that define that probability distribution for the long-term average climate state: the mean and standard deviation. The values of the mean and standard deviation depend on the percolation flux at the repository horizon for the long-term average climate state. The minimum and maximum are

Parameters: Seepage_Flux_Mean_LTA, Seepage_Flux_SD_LTA, Seepage_Flux_Max_LTA, Seepage_Fraction_Mean_LTA, Seepage_Fraction_SD_LTA

Notes: The beta probability distribution for seepage flux. This distribution depends on the percolation flux at the repository horizon for the long-term average climate state. The beta probability distribution for seepage fraction. This distribution depends on the percolation flux at the repository horizon for the long-term average climate state.

Element: Seepage_Flux_SD_LTA

Table 2-56 of Chapter 2 of the TSPA-VA Analysis Technical Basis Document

Notes showing data source

Phase II - Development of the Simplified SR Model

- **Simplified SR model refinement based solely on analysis and model reports (AMRs)**
 - Support transparency of AMRs (feedback to authors)
 - May simplify at multiple levels
 - Refine documentation of the model (how the simplified model works)
- **Parallel effort to enhance communication capabilities**
 - Enhance discussions of sub-components based on current understanding
 - ◆ Consistent with PMRs
 - ◆ Bring PMR discussions up to another audience level

Phase II - Development of the Simplified SR Model

(Continued)

- **Investigate “what-if” capability for user**
 - Allow user to change uncertain parameter values (within pre-defined ranges) and execute model
 - Remainder of model “locked”
- **Develop animated simulation of repository performance**
 - How the repository system works and illustrated importance of various components
 - Investigate dynamic linking to model
- **Work in progress; feedback from NWTRB and others would be appreciated**