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

Integration of Supplemental Science Analyses and Models into the Supplemental TSPA Model

Presented to:
Nuclear Waste Technical Review Board

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YUCCA MOUNTAIN PROJECT

Outline

- **Goals of supplemental Total System Performance Assessment (TSPA) analyses**
- **Approach for integration of supplemental science and analysis into the TSPA-Site Recommendation (SR) model**
- **Examples of supplemental science and analysis <u>not</u> included in the supplemental TSPA model**
- **Examples of supplemental science and analyses included in the supplemental TSPA model**

Goals of Supplemental TSPA Analyses

- **Evaluate significance of uncertainty and degree of conservatism/optimism that was not quantified in TSPA-SR Rev 00 ICN 01**
- **Evaluate significance of new information available since completion of TSPA-SR Rev 00 ICN 01**
- **Incorporate additional thermal dependencies to more fully evaluate effect of coupled processes and thermal operating mode on system performance**
- **Conduct comparative TSPA analyses over a range of possible thermal operating modes**

Approach to Evaluating Significance of Uncertainty and Conservatism/Optimism

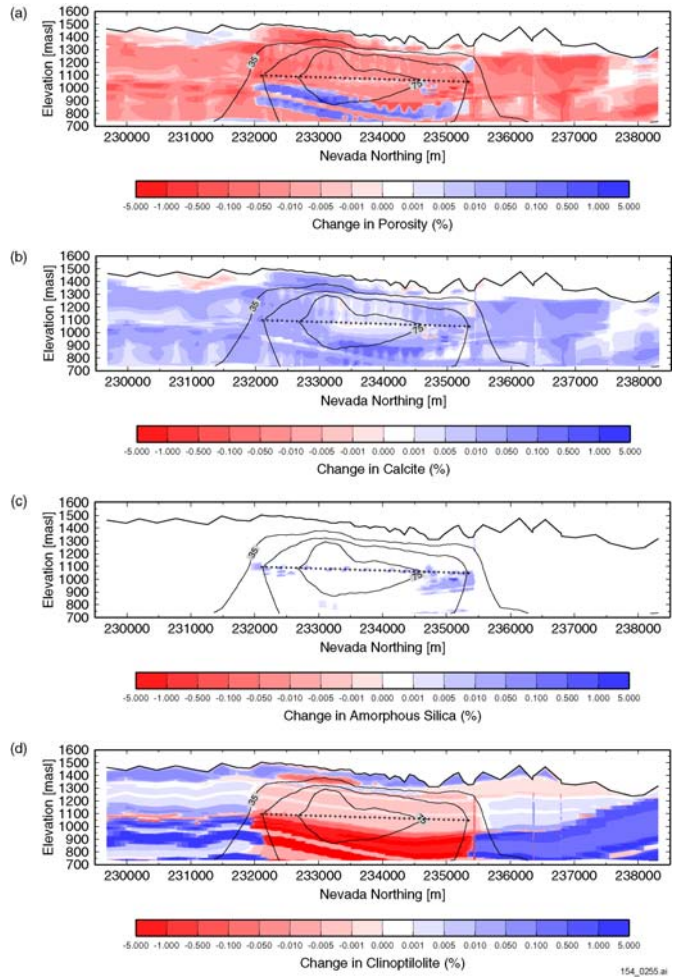
- **Conduct component-level sensitivity analyses**
  - **Documented in Volume 1**
  - **Include other lines of evidence, as appropriate**
- **Conduct system-level one-off sensitivity analyses**
  - **Variants of the sensitivity and barrier importance analyses documented in TSPA-SR Rev 00 ICN 01**
  - **Use the Rev 00 ICN 01 TSPA-SR Model, i.e., the warm thermal operating mode, as the basis for comparison (Mike Wilson talk)**
- **Combine component models into a supplemental TSPA model**
- **Evaluate sensitivity to thermal operating mode by using different thermal-hydrologic analyses inputs**

Reasons for Not Including Supplemental Science in the Supplemental TSPA

- **Revised model determined to have low probability of occurrence (examples in previous talks)**
- **Model is determined to be insignificant at the component level (examples in earlier talks)**
- **Model is determined to be insignificant at the system level (examples follow in Mike Wilson's talk)**
- **Model is sufficiently uncertain and inclusion would be non-conservative**
  - **Drift shadow concentration boundary**
  - **Ex-package transport to invert**
  - **UZ transport model**
- **Model is still conceptual**

Examples of Supplemental Science Not Included in Supplemental TSPA

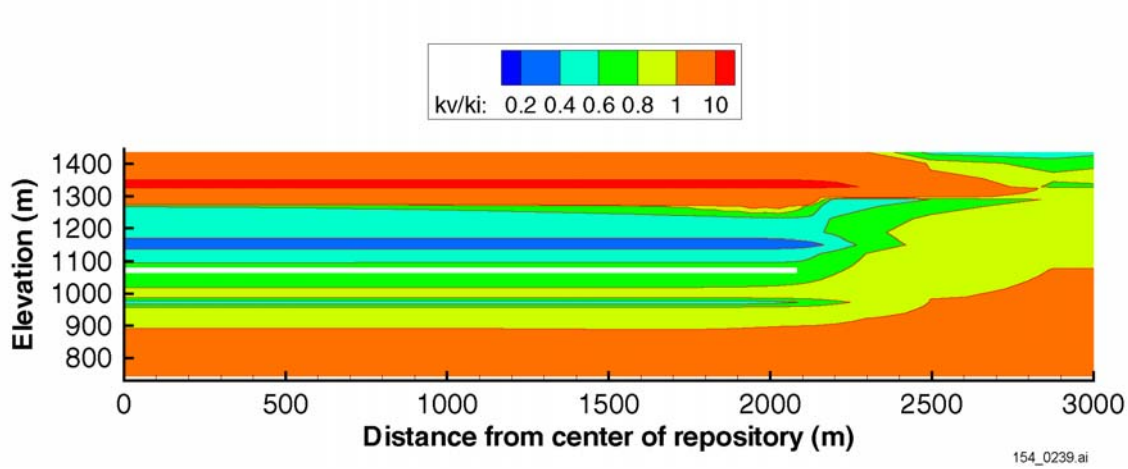
- **Thermo-hydro-chemical (THC) effects on UZ fracture porosity are less than 1% for high thermal operating mode**
- **These changes are within the degree of uncertainty in this parameter and are therefore insignificant**
- **These changes are expected to be less for a low thermal operating mode**



Examples of Supplemental Science Not Included in Supplemental TSPA

(Continued)

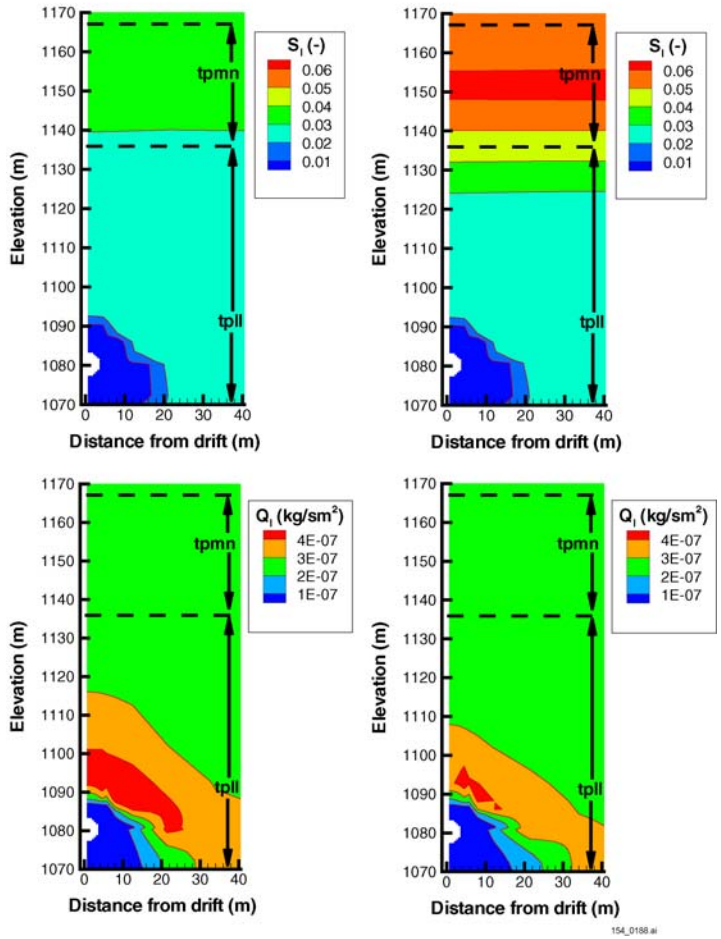
- **Thermo-hydro-mechanical (THM) effects for high thermal operating mode at 1,000 years**
  - **Vertical permeability (kv) increase less than 10 x in upper ~ 100 m and decrease less than 10 x ~ 100 m above repository**
  - **Vertical permeability range is several orders of magnitude**
  - **This change is not significant to overall Unsaturated Zone (UZ) water flow**
  - **Change is less for low thermal operating mode**



Examples of Supplemental Science Not Included in Supplemental TSPA

(Continued)

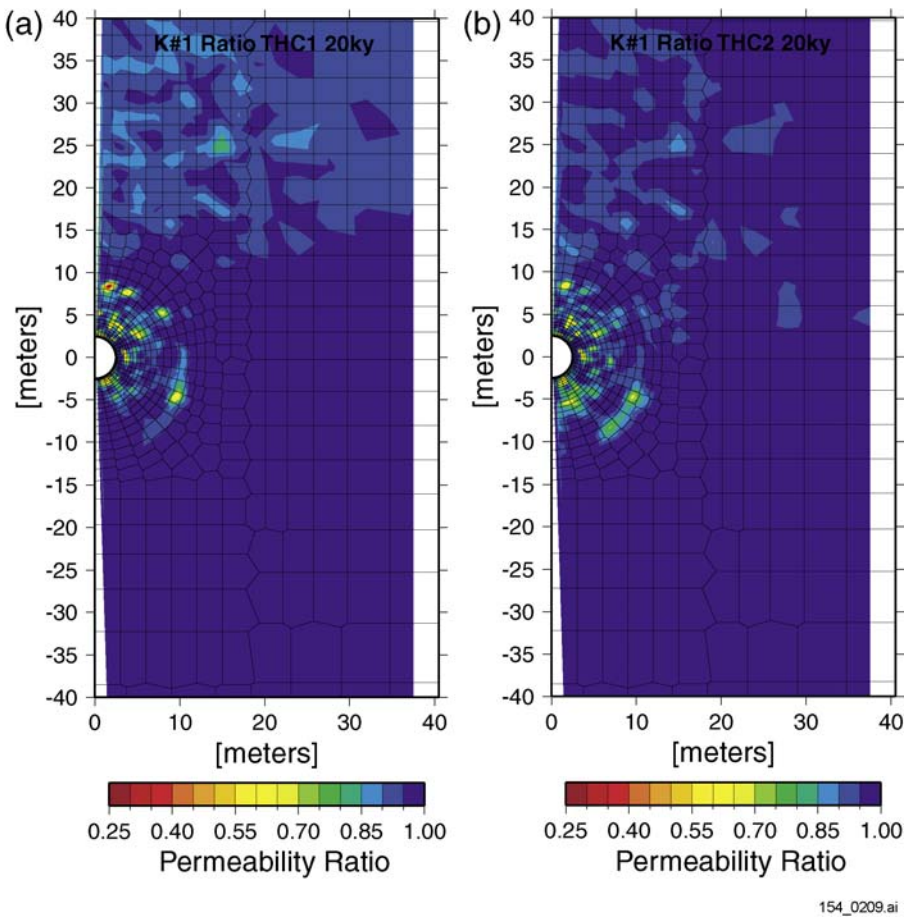
- **THM effects on fracture flux and liquid saturation for TH processes only (left hand) and THM processes (right hand) for high temperature operating mode**
- **Changes are insignificant and within the uncertainty/variability of this parameter**
- **Low temperature operating mode would have even less change**



Examples of Supplemental Science Not Included in Supplemental TSPA

(Continued)

- **THC effects on drift-scale permeability at 20,000 years for high thermal operating mode (2 conceptual models are illustrated)**
- **Changes are insignificant and within the uncertainty/variability of permeability used for seepage**
- **Effects are less for low thermal operating mode**



Other Examples of Supplemental Science Not Included in Supplemental TSPA

- **UZ flow fields**
- **Uncertainty in aging and phase stability of Alloy 22**
- **Defense High-Level Waste degradation rate**
- **Colloid mass concentration**
- **Drift degradation effects on seepage**
- **UZ transport model**

Examples of Supplemental Models Included in Supplemental TSPA (see Table)

- Long-term climate and net infiltration
- Seepage (including lower lithophysal model)
- Waste package (WP) degradation
  - Stress corrosion cracking model
  - Weld stress, stress state and defect geometry
  - Improper heat treatment
- In-package chemistry
- Cladding
- Solubility
- In-package transport
- In-package and Engineered Barrier System retardation
- Saturated zone alluvial properties and matrix diffusion

Supplemental Thermally-Dependant Models Included in Supplemental TSPA

- **TH effects on seepage**
- **TH effects on seepage evaporation and liquid saturation**
- **TH effects on in-drift chemistry**
- **TH effects on corrosion rates**
- **In addition, other models in Rev 00 ICN 01 were already thermally-dependent, such as**
  - **Cladding degradation**
  - **Waste form (esp. glass) alteration**
  - **Seepage chemistry**

Supplemental Thermal Hydrologic Models Included in Supplemental TSPA Analyses

- **Revised TH models and analyses of high and low thermal operating modes used to generate range of near field and in-drift environments**
  - **Temperature on drip shield (DS) and WP**
  - **Relative humidity on DS and WP**
  - **Evaporative flux from DS and WP**
  - **Seepage fraction during dry-out**
  - **Liquid saturation in invert**

Summary

- **Supplemental TSPA analyses are being performed to evaluate the effect of uncertainties that were not quantified in TSPA-SR Rev 00 ICN 01**
- **The TSPA model was revised to allow a more complete evaluation of the potential effects of different thermal operating modes**
- **The supplemental performance analyses were designed to provide decision makers with a more complete set of analyses upon which to base their decisions**