Status of Resolution in Model Abstraction: TSPAI Issues

NRC/DOE Technical Exchange on Total System Performance Assessment (TSPA) for Yucca Mountain

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Areas of Review

- Data and Model Justification*
- Data Uncertainty*
- Model Uncertainty*
- Model Support*
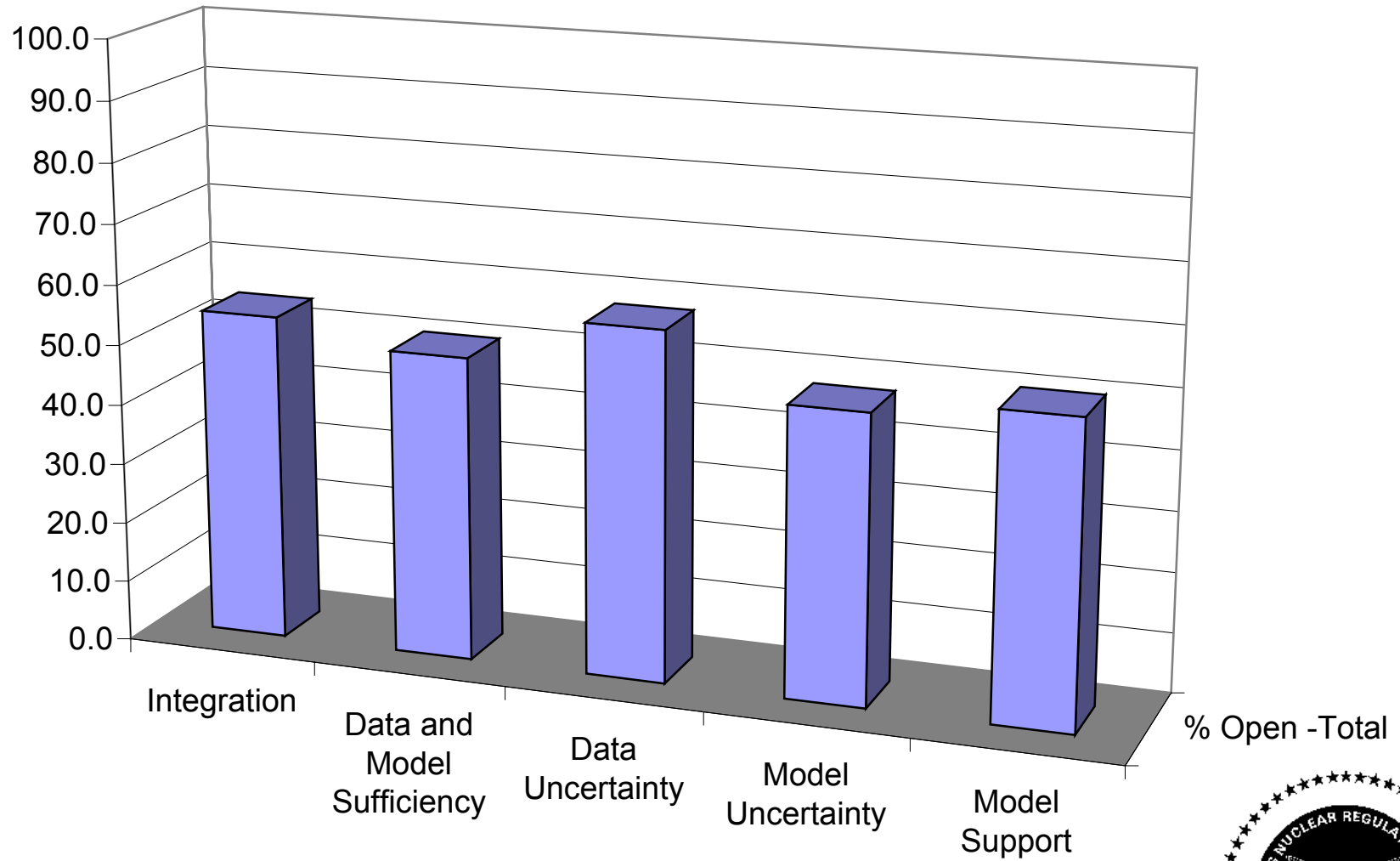- Integration**

* Process KTI's primarily responsible
** TSPAI KTI primarily responsible

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Status of Resolution: Model Abstraction

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Areas of Review - Data and Model Justification

Sufficient Data: Are (field, laboratory, or natural analog) data available to support the conceptual models, assumptions, and boundary conditions? (commensurate with importance to performance)

Use of Expert Elicitation: Has expert elicitation been used appropriately?

Review Results - Data and Model Justification

Sufficient Data:

- Every KTI (9 of 9) has open items related to
  data and model sufficiency.

- Commitments to collect more data will address some data
  sufficiency concerns. (amount of data, unsupported conceptual
  models, unsupported assumptions, improper boundary conditions, etc.)

Use of Expert Elicitation:

- NRC has concerns that there may be over-reliance on expert
  elicitation

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Areas of Review - Data Uncertainty

Accounting for Uncertainty and Variability: Does the variability in the output of the process-level model represent all of the uncertainties?

Selection of Data: Are the parameter values, assumed ranges, probability distributions, and bounding assumptions technically defensible?

Review Results - Data Uncertainty

Accounting for Uncertainty and Variability:

- In some instances, process-level parameters that aren't sampled have not been demonstrated to have a minimal impact on the results of the process-level model.

Example: Seepage threshold modeling

Review Results - Data Uncertainty

Selection of data:

- Instances where data fall outside of the range of results of a process model.

- Need to have a technical basis for not including this information in the PA.

Examples:
- pH measurements in the drift-scale test
- permeability/porosity changes during thermal testing
- 'memory effect' during seepage testing

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Areas of Review - Model Uncertainty

Alternative Conceptual Models: Have alternative modeling approaches consistent with available data and current scientific understanding been investigated?

Alternative Conceptual Models: Have results and limitations of alternative modeling approaches been appropriately considered?

Review Results - Model Uncertainty

Alternative Conceptual Models:

- Alternatives to the selected model(s) are discussed in the PMR's.

- It is unclear that the discussion satisfies that the alternative models
  have been appropriately considered.

Example:
- UZFT PMR has a table called 'Summary of Current Understanding'
- There are about 20 alternate views (ACMs), roughly

       4 selected would be conservative
       11 selected would be non-conservative
       5 would be ? to performance

There is little information (comparably) addressing selection
of ACM's.

Areas of Review - Model Support

TSPA Model to Process Models: Are TSPA intermediate results consistent with the output of detailed process models?

TSPA Model to Empirical Observations: Are TSPA intermediate results consistent with empirical observations?

Review Results - Model Support

TSPA Model to Process Models:

- GoldSim and TSPA-SR will allow detailed evaluation of this subset of model support.

- Evaluation of TSPA-VA yielded favorable results.

TSPA Model to Empirical Observations:

- Not necessary if the above condition is met and data/model uncertainty concerns are addressed.

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Areas of Review - Integration

Integration Completeness: Has TSPA incorporated important design features, physical phenomena, and couplings?

Integration Consistency: Has TSPA used consistent and appropriate assumptions throughout the abstraction process?

Calculational Integration: Is information generated by a component or process model appropriately transferred to other components or models?

Averaging: Has appropriate (or inappropriate) averaging been utilized?

Review Results - Integration

Integration Completeness:

- Important design features are included in the PA.

- However, evolving design makes it difficult to evaluate that important couplings between the natural and engineered systems (rockfall laterally displacing the drip-shield) or components within the engineered system (carbon steel interaction with Ti drip-shield) have been included.

Review Results - Integration

Integration Consistency:

- Because the TSPA is primarily a serial model, it will be straightforward to evaluate that consistent assumptions have been used.

- GoldSim will help with further evaluation.

- Integration consistency at the AMR- and PMR-level is under evaluation.

Summary - Path Forward

- Bulk of Path Forward contained (or being developed) by the process KTI's

- TSPAI KTI will continue review of AMR's/PMR's and start review of TSPA-SR and GoldSim (as appropriate) to provide more specifics to DOE on Model Abstraction issues

- Cooperation between TSPA and process-level staff facilitates issue resolution (for both NRC and DOE)

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Review Results - Integration

Calculational Integration/Averaging:

- Because we did not have access to the actual calculation, a general concern is raised at this time.

- Threshold type calculations and peak dose can be very sensitive to the amount of averaging completed between components during information transfer.

Examples:

Infiltration -> 30 m X 30 m X ? (via time-scale)
Mountain scale UZ -> 5 km X 9 km X 800 m (? X ? X ? cells)
Seepage into drifts -> Grid-spacing of 0.5 m or less

Temperature calculations (cladding failure)

Model Abstraction: Acceptance Criteria

Criterion T1:   Data and Model Justification

Sufficient data (field, laboratory, or natural analog data) are available to adequately support the conceptual models, assumptions, and boundary conditions and to define all relevant parameters implemented in the TSPA. Where adequate data do not exist, other information sources such as expert elicitation have been appropriately incorporated into the TSPA.

Criterion T2:   Data Uncertainty

Parameter values, assumed ranges, probability distributions, and bounding assumptions used in the TSPA are technically defensible and reasonably account for uncertainties and variability.

Criterion T3:   Model Uncertainty

Alternative modeling approaches consistent with available data and current scientific understanding are investigated and results and limitations appropriately considered in the abstractions.

Criterion T4:   Model Support

Models implemented in the TSPA provide results consistent with output of detailed process models or empirical observations (laboratory testing, natural analogs, or both).

Criterion T5:   Integration

TSPA adequately incorporates important design features, physical phenomena, and couplings and uses consistent and appropriate assumptions throughout the abstraction process.

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