

DEMONSTRATION OF THE OVERALL PERFORMANCE OBJECTIVE

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

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AREAS OF REVIEW

- Calculation of Expected Annual Dose
- Treatment of Alternative Conceptual Models
- Sensitivity Analyses and Uncertainty in Results
- Confidence in Results
- Human Intrusion
- Comparison of Alternative Design Features

REVIEW SCOPE

- Documents Reviewed:
 - TSPA-SR Methods and Assumptions Report
 - Repository Safety Strategy, Rev. 3

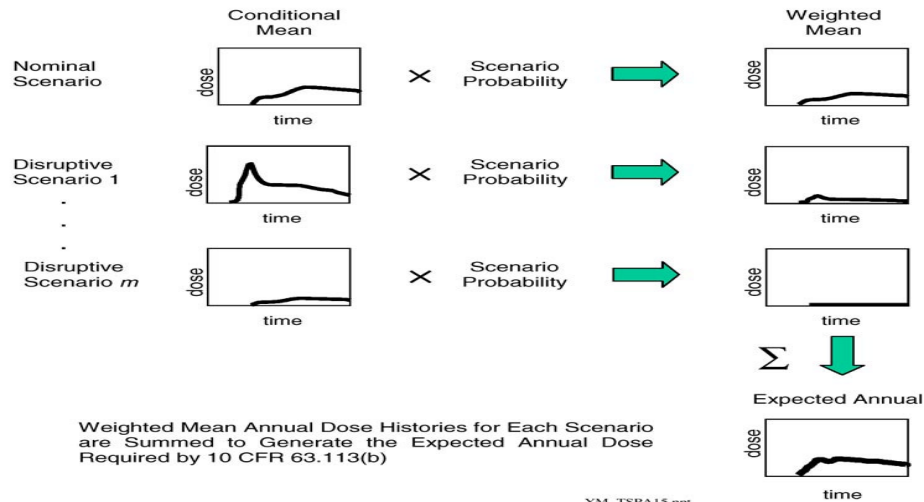
AREAS OF REVIEW – CALCULATION OF EXPECTED ANNUAL DOSE

- Have adequate TSPA calculations been performed for all scenario classes that were not screened from the TSPA?
- Has the expected annual dose as a function of time, including the undisturbed scenario class and all disruptive scenario classes, been appropriately calculated?
- Does the sum of the probabilities of occurrence of all scenario classes included in the expected annual dose curve equal 1?

AREAS OF REVIEW – CALCULATION OF EXPECTED ANNUAL DOSE (cont.)

- Have a sufficient number of realizations been run for each scenario class?
- Is the critical group being used in the calculations appropriate?
- Does the sampling scheme being used ensure that all sampled parameters are sampled across their range of uncertainty?
- Has the behavior of the expected annual dose curve at times shortly after the end of the compliance period been provided?

REVIEW RESULTS – CALCULATION OF EXPECTED ANNUAL DOSE



- No results have been presented for any disruptive events
- Methodology presented for calculating the expected annual dose for disruptive events seems appropriate
- Further evaluations will be made when the methodology is implemented

REVIEW RESULTS – CALCULATION OF EXPECTED ANNUAL DOSE (cont.)

- DOE has indicated that a sufficient number of realizations will be run to provide stable results
 - Methodology in TSPA-VA of running more realizations and comparing resulting dose measures is appropriate
 - Must demonstrate that sufficient realizations have been run for all process level models used to develop probability distributions that are sampled in the TSPA
- DOE has indicated that doses from the repository will be calculated for at least 100,000 years after closure
 - NRC has no numerical limits on the results of the calculation of dose beyond 10,000 years. However, all additional information on the behavior of the repository system, including doses beyond 10,000 years, is useful for NRC staff evaluation

AREAS OF REVIEW – TREATMENT OF ALTERNATIVE CONCEPTUAL MODELS

- Are the effects that ACMs of features and processes would have on the performance of the repository adequately considered in the DOE TSPA?

REVIEW RESULTS – TREATMENT OF ALTERNATIVE CONCEPTUAL MODELS

- Assigning weights to alternative conceptual models based on the probability of the model being correct makes it difficult to determine how each model affects performance
- Combinations of significant alternative conceptual models have not been considered
- Parameter ranges that covered alternate conceptual models in TSPA-VA made it difficult to understand how the different models affected performance
- It is unclear how alternative conceptual models analyzed in the AMRs and PMRs will be transferred to the TSPA analyses

AREAS OF REVIEW – SENSITIVITY ANALYSES AND INTERMEDIATE OUTPUTS

- Is the total system behavior reasonable based on the estimated performance of individual components or subsystems of the repository?
- Has an estimate of the uncertainty in the DOE TSPA results been provided?
- Is the estimate of uncertainty in the PA results reasonable considering the uncertainty in modeling assumptions and parameter values?

REVIEW RESULTS – SENSITIVITY ANALYSES AND INTERMEDIATE OUTPUTS

- Information presented in TSPA-VA was very useful
- DOE has indicated that a similar amount of information will be available for TSPA-SR

AREAS OF REVIEW – CONFIDENCE IN RESULTS

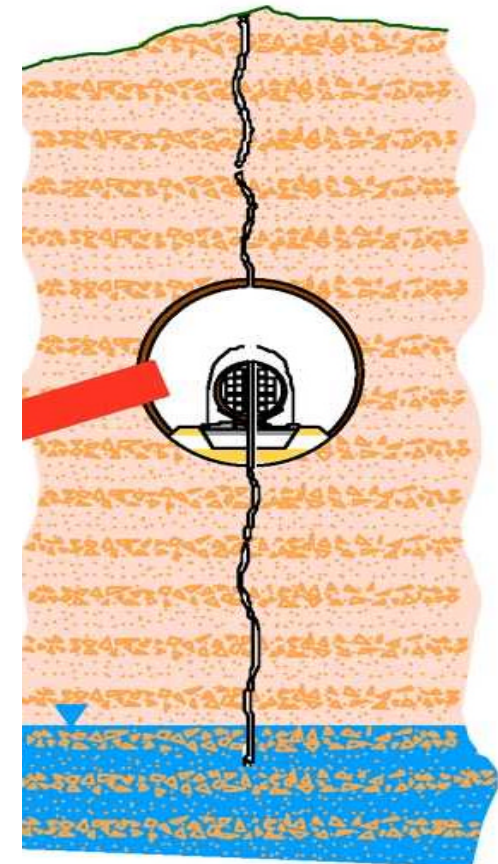
- Has the TSPA code been properly verified to provide confidence that the models are implemented in the DOE TSPA code as intended?
- Is there adequate support to provide confidence that the DOE TSPA code results provide an acceptable representation of the actual performance of the repository system?
 - Comparison of results to other available TSPA codes
 - Sufficient transparency to allow for confirmatory hand calculations

REVIEW RESULTS – CONFIDENCE IN RESULTS

- DOE indicates that the code should be sufficiently transparent and traceable to allow the results to be reproducible
- Comparison of results to other available TSPA results would provide additional assurance that the results are reasonable
- Sufficient information should be available to allow reviewers to conduct ‘back-of-the-envelope’ calculations to confirm that the results are reasonable
 - Use of GOLDSIM software may provide this level of transparency

AREAS OF REVIEW – HUMAN INTRUSION

- Has the TSPA for human intrusion been performed separately from the overall TSPA?
- Is the TSPA for human intrusion performed in the same manner as the overall TSPA?
- Does the human intrusion TSPA use the same critical group?
- Is the DOE modeling of human intrusion consistent with the stylized scenario specified in 10 CFR Part 63?



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REVIEW RESULTS – HUMAN INTRUSION

- DOE has proposed two scenarios to model the effects of human intrusion
 - First scenario assumes increased water flow through waste package, compromise of invert and unsaturated zone barriers, and advective release of radionuclides
 - Second scenario assumes that waste package is damaged, but there is little damage to other barriers and release of radionuclides is due to diffusion through the breach
- Clarifications on scenario in proposed rule
 - Not intended to indicate that particulate waste would be transported directly to saturated zone
 - Advective releases would be able to travel through a fast pathway in the unsaturated zone

REVIEW RESULTS – HUMAN INTRUSION (cont.)

- Failure to consider the effects of other disruptive events in the human intrusion TSPA is inconsistent with the analyses performed for the overall TSPA

AREAS OF REVIEW – COMPARISON OF ALTERNATIVE DESIGN FEATURES

- Does DOE provide an adequate comparative evaluation of alternatives to the major design features that are important to repository performance?
- Has DOE provided the rationale for not selecting alternative designs that would provide longer containment and isolation of radioactive materials?

REVIEW RESULTS – COMPARISON OF ALTERNATIVE DESIGN FEATURES

- DOE has indicated that the following design features could be analyzed to meet this requirement:
 - Different thermal loadings
 - The presence or absence of backfill
 - Alternative invert designs
 - Alternative waste package and drip shield designs
 - Ventilation options
- Limited analyses were presented in TSPA-VA
- Items being considered for alternative design features seem reasonable
- Further evaluations will be made when more analyses comparing these design options are available

SUMMARY

- No major deficiencies have been identified in the methodologies presented in the available documents
- More information is needed to ensure that some issues will be properly addressed
- Implementation in TSPA-SR will be evaluated for consistency with NRC requirements