ATTACHMENT 3

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

YUCCA MOUNTAIN PROJECT

Use of Risk Information to Address Key Technical Issue Agreements

Presented to:
NRC/DOE Technical Exchange and Management Meeting on Risk Information

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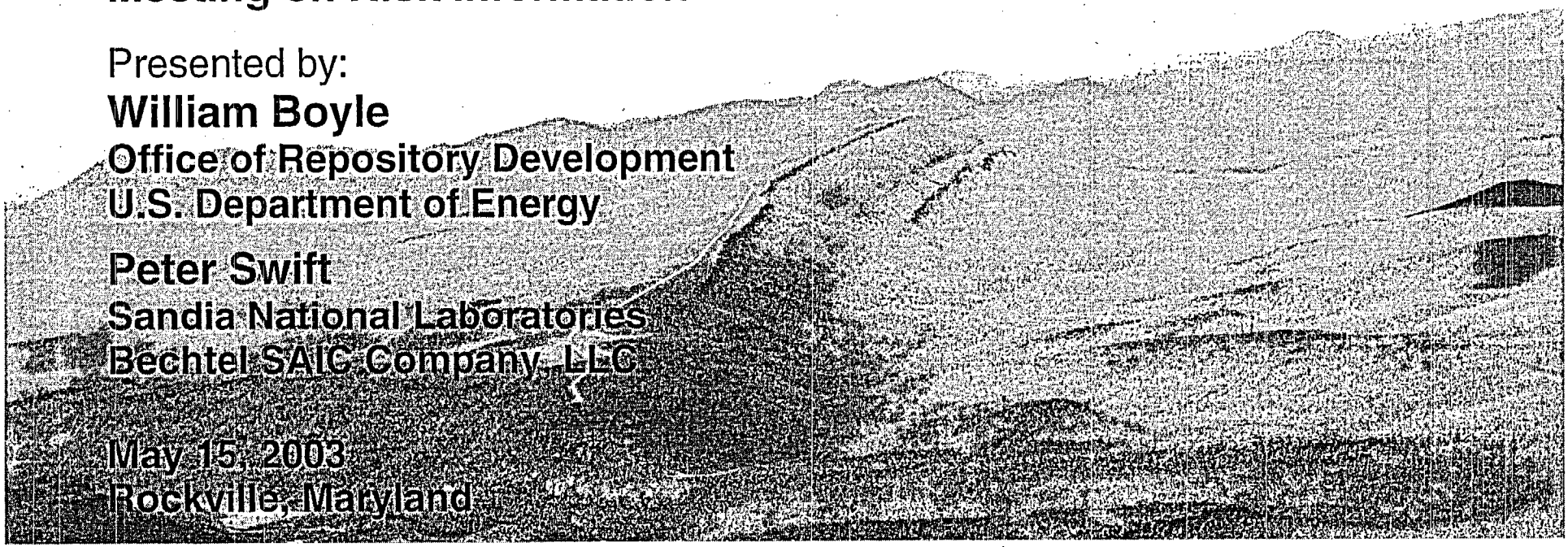
Rockville, Maryland



DOE Approach to Using Risk Information

- Basis in 10 CFR Part 63
  - "DOE must demonstrate ... reasonable expectation of compliance ... based upon the mean of the distribution of projected doses..." (10 CFR 63.303)
  - "Reasonable expectation ... focuses performance assessments and analyses on the full range of defensible and reasonable parameter distributions rather than only upon extreme physical situations and parameter values" (10 CFR 63.304)
- Goal
  - Focus resources on those Key Technical Issue Agreements for which unresolved technical issues could impact the repository's ability to meet postclosure compliance standards
  - Identify those agreements for which uncertainty associated with the technical issue will not affect compliance with the standards
  - Document the technical basis for closing agreements that do not affect compliance with the standards, using appropriate modeling studies that are available now

DOE Approach to Using Risk Information

- The DOE proposes addressing Key Technical Issue Agreements with results of model sensitivity analyses in lieu of specific new technical information if and when
  - Information requested in the agreement is shown to have limited significance to risk based on importance to repository performance or waste isolation (i.e., mean annual dose or radionuclide concentrations in groundwater during the 10,000-year regulatory period); or
  - Information requested in the agreement is not needed to support the technical basis for the treatment of uncertainty regarding the relevant processes that will be included in the Total System Performance Assessment (TSPA) for the License Application (LA) (i.e., current treatment of uncertainty is defensible); and
  - Information requested in the agreement is not needed to support the description of barrier capability that will be included in the License Application

DOE Approach to Using Risk Information
(Continued)

- Two broad types of agreements for which risk information is believed to be an appropriate approach
  - Agreement calls for additional technical work to reduce uncertainty from that currently included in the TSPA, and DOE can document that performance is insensitive to the current treatment of uncertainty
  - Agreement calls for additional technical work to defend current treatment of uncertainty (i.e., NRC staff believes DOE's treatment of uncertainty is not supported by available information); and DOE can document that performance is insensitive to a broader range of uncertainty that the NRC staff agrees is consistent with available information or is conservatively bounding

DOE Approach to Using Risk Information
(Continued)

- All analyses to date are based on existing information and models
  - Starting point is the TSPA for Final Environmental Impact Statement and Site Suitability Evaluation
  - Primary reference is Risk Information to Support Prioritization of Performance Assessment Models (TDR-WIS-PA-000009 REV 01 ICN 01)
- Models will be updated for the TSPA for the LA
  - If risk information from current models can not be confirmed by results of final models used in the LA, the DOE will develop revised approaches for any impacted agreements

Implementation

- **Analysis techniques include**
  - Extreme value one-off analyses
    - Show that mean performance is insensitive to the assumption of extreme values for possible conditions associated with the component related to the issue, with other components treated probabilistically
  - Neutralizations
    - Show that mean performance is insensitive to the presence or absence of the entire component related to the issue, with other components treated probabilistically
  - Combined effect analyses
    - Show that mean performance is insensitive to the assumption of extreme values occurring simultaneously in multiple components for which the DOE proposes to use risk information to resolve agreements
    - Example in Risk Information Report is deterministic (fixed extreme values): alternative approaches could be probabilistic (sampled over expanded uncertainty ranges)

Implementation

(Continued)

- None of the risk-informed analyses is realistic
  - All use an unrealistic assumption that the particular combination of conditions has a probability of one of occurring
  - Some assume physically impossible conditions (i.e., neutralizations)
  - Some assume highly unlikely conditions (i.e., extreme value cases)
    - Extreme values may be within the range of uncertainty supported by available information, and therefore have a quantifiable probability (e.g, 95th percentile)
    - Extreme values may be outside the range of physically reasonable uncertainty, and therefore should have a probability of zero

Implementation

(Continued)

- **The probability of extreme values occurring in multiple components simultaneously (i.e., the combined effects analysis) is very small**
  - **For example, the probability of the 95 percentile performance occurring in 9 independent model components simultaneously is $(0.05)^9 = 2 \times 10^{-12}$**
  - **For overall risk (mean dose) associated with this example to exceed the standard, calculated doses to the reasonably maximally exposed individual would have to be on the order of 10^{12} mrem/yr**
    - **This hypothetical dose is greater than what can be calculated assuming the entire radionuclide inventory of the repository could be dissolved in 3000 acre-ft of water in a single year**

Implementation
(Continued)

- Results are presented as information to be considered in evaluating the status of the agreements, and are not appropriate for comparison to regulatory limits
- DOE has identified to date approximately 20 Key Technical Issue Agreements for which it proposes using risk information in lieu of additional technical work
  - List may change as work progresses
- DOE does not propose to use extreme-value sensitivity analyses to resolve agreements specific to waste package performance

DOE's Proposed Path Forward

- DOE will continue to provide documentation to the NRC for agreements identified as candidates for risk informed resolution
  - Explanation of the technical basis for the conclusion that overall performance is not sensitive to the information requested
  - Explanation of the technical basis for the conclusion that the requested information is not needed for demonstrations of barrier capability
  - Sensitivity analysis results demonstrating that overall performance is not sensitive to the information requested
    - Risk Information Report is the primary source document
    - Additional information about analyses (e.g., traceable documentation of models and inputs, displays of uncertainty in results) will be provided

DOE's Proposed Path Forward
(Continued)

- The DOE does not propose to update the combined effects analysis
  - NRC's concerns primarily relate to components for which the DOE does not propose to use risk-informed approaches
  - Full probabilistic TSPA-LA will provide information on combined effects of uncertainties and will focus "on the full range of defensible and reasonable parameter distributions rather than only upon extreme physical situations and parameter values." (10 CFR 63.304(4))

References

- "Total System Performance Assessment - Final Environmental Impact Statement and Site Suitability Evaluation"
  - Williams, N.H. 2001. "Contract No. DE-AC08-01RW12101 – Total System Performance Assessment – Analyses for Disposal of Commercial and DOE Waste Inventories at Yucca Mountain – Input to Final Environmental Impact Statement and Site Suitability Evaluation REV 00 ICN 02." Letter from N.H. Williams (BSC) to J.R. Summerson (DOE/YMSCO), December 11, 2001, RWA: cs-1204010670, with enclosure. ACC: MOL.20011213.0056 (SL986M3, Rev. 00)
- "Risk Information Report"
  - BSC (Bechtel SAIC Company) 2002. Risk Information to Support Prioritization of Performance Assessment Models, TDR-WIS-PA-000009 Rev. 01 ICN 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20021017.0045

United States Nuclear Regulatory Commission

Overview of NRC Perspective on Risk-informed Issue Resolution

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Risk Information Technical Exchange **May 15, 2003**

"The NRC encourages the use of risk assessments and sensitivity analyses to help identify data, models, and barriers that are most important to repository performance and to focus available resources on those items."

Schlueter to Ziegler, January 27, 2003

Elements of Risk-informed Issue Resolution:

- Technical bases for quantitative analyses.
- Adequate documentation of the analyses.
- Consideration and representation of uncertainties.
- Understanding and explanation of the quantitative results.
- Confirmatory analyses with qualified TSPA model.

Technical Basis for Quantitative Analysis

- Amount of technical basis for the analysis should be commensurate with the uncertainty, risk-significance, and pessimism introduced into the analysis.
- The treatment of model and parameter uncertainty is the focus of the risk-informed agreement resolution process.
- The NRC expects a reasoned argument why the analysis appropriately represents the uncertainty or is sufficiently bounding.

Technical Basis for Quantitative Analysis-Example

- TSPAI 3.19 – "DOE will provide justification for the use of its evapotranspiration model, and defend the use of the analog site temperature data (UZ1.3.1). ...."

  - The agreement addresses infiltration rates. The infiltration rate in TSPA-FEIS base case model averaged 12 mm/yr over the next 10,000 years.

  - What is an appropriate range in infiltration rate to address TSPAI 3.19?

- In response to agreement USFIC.3.02, DOE provided an appropriate justification for the distribution of infiltration rates used in the sensitivity analysis.

Adequate Documentation of the Analysis

- Provide enough information to allow for adequate understanding of the analysis without recourse to the author.
- Some models and assumptions within the TSPA may not be integrated such that changes in one model would be automatically reflected in other associated models.

Consideration and Representation of Uncertainties

- Analysis should appropriately consider and represent uncertainties.
  - Have related potential effects been considered?
  - If not directly included in the analysis, related potential effects should be discussed in at least a qualitative manner.
- TSPA is a system model designed to integrate abstractions (process models) and to address uncertainties. The combined effect of uncertainties should be quantitatively assessed*.

* Addressed in detail in the next NRC presentation.

Understanding and Explanation of the Quantitative Results

- Quantitative results should be explained, in particular when results may be counter-intuitive.
- Demonstration of understanding of the model and results is essential to developing confidence in the conclusions.
- Simple physical arguments and presentation of intermediate outputs can enhance confidence in the results.

Conclusions

- Risk-informed issue resolution can be done in lieu of original agreement when uncertainties are considered appropriately.
- The technical analyses must appropriately consider the system-nature of the performance assessment model (e.g., the combined effect of uncertainty).
- Confidence in the supporting analyses and resulting conclusions is an essential aspect to risk-informed issue resolution.

Proposed Areas of Agreement for NRC/DOE :

- DOE evaluation of the combined effect of uncertainty associated with the Bin 3 agreements.
- Confirmatory analyses with the final, fully-qualified TSPA model that supports conclusions made with preliminary models.

United States Nuclear Regulatory Commission

NRC Perspective on the Combined Effect of Uncertainties

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Risk Information Technical Exchange **May 15, 2003**

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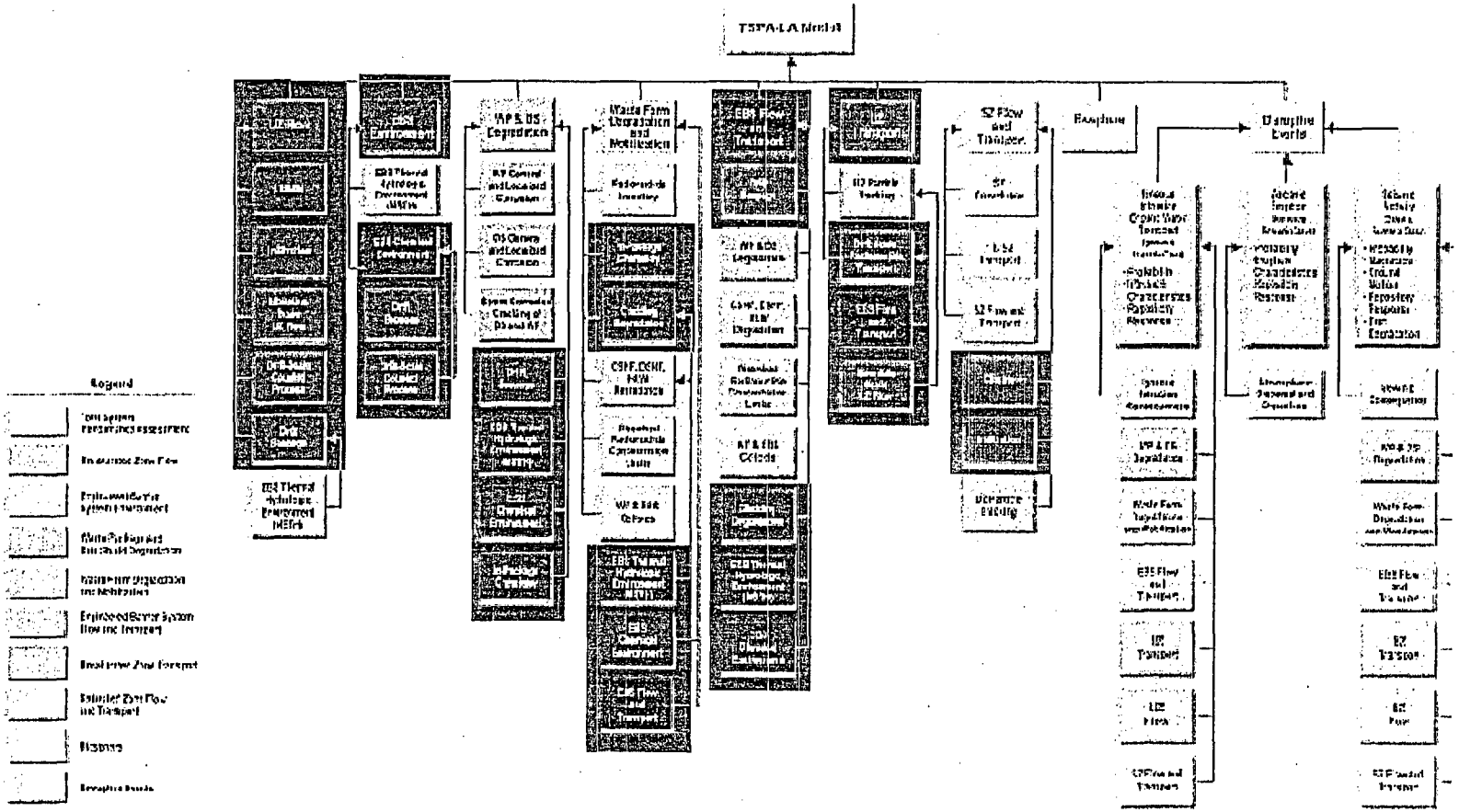
Overview of Risk-Informed Agreement Resolution:

- Status as of 9/21/02 had 31 proposed agreements (termed Bin 3 by DOE).
- Nine of those agreements have been received by the NRC.
- Agreements cover multiple areas of the TSPA.
- Quantitative analysis must address the system-nature of the TSPA model.

Risk-Informed Agreements:

- Proposed risk-informed (bin 3) agreements cover:
  - infiltration
  - seepage
  - unsaturated zone flow and transport
  - drip shield performance
  - in-drift chemistry
  - in-package chemistry
  - cladding performance
  - THC effects on seepage
  - THM effects on permeability

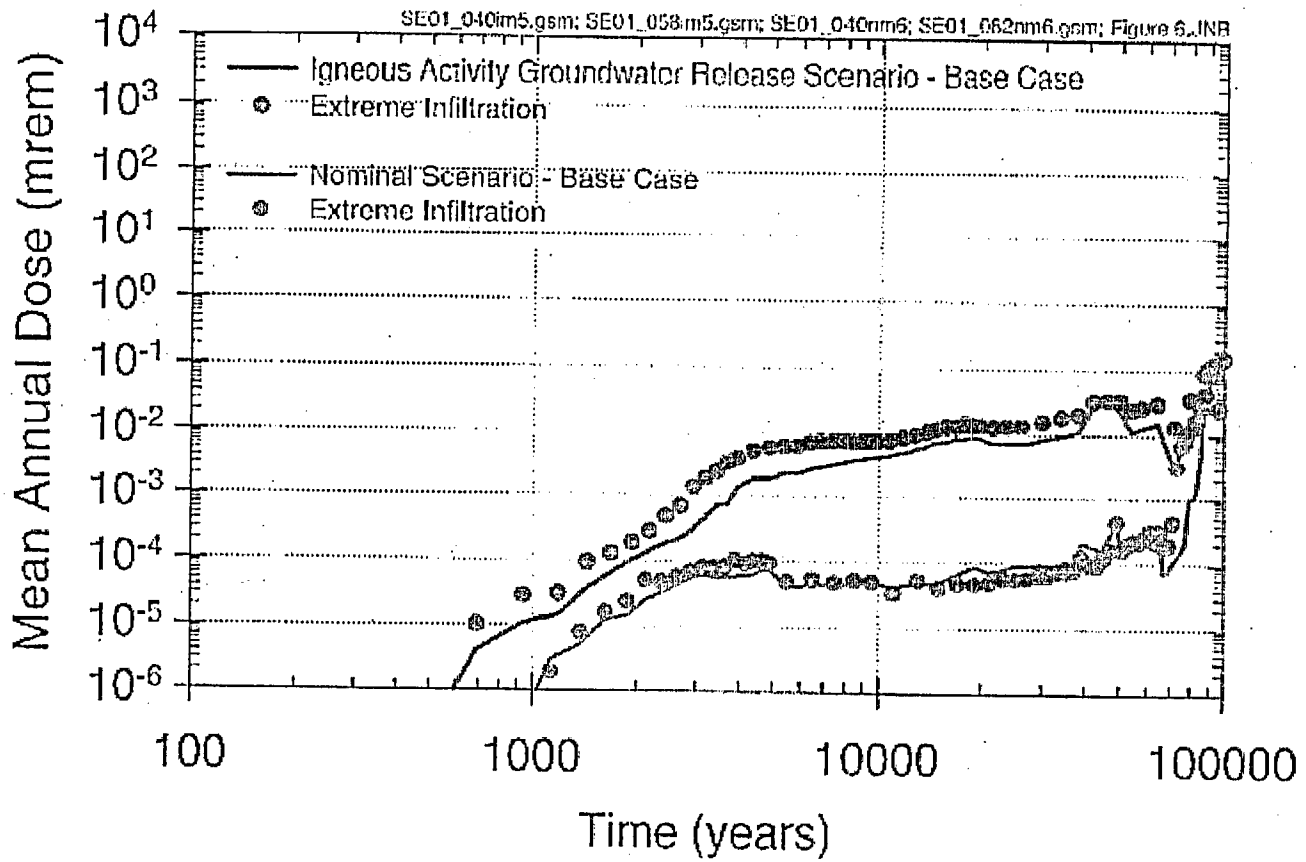
United States Nuclear Regulatory Commission



Overview of DOE Analysis:

- DOE has performed sensitivity analysis using the TSPA model.
- Uncertainty associated with an agreement item is evaluated.
  - An analysis is typically performed where the behavior of a model is set to a (very?) pessimistic state (compared to the base case).
  - DOE concludes if the absolute change in dose rate results in less than 1.0 mrem/yr, then the agreement is not important to meeting the performance objectives.

Overview of DOE Analysis:



Insights from NRC Performance Assessment (PA):

- Stochastic performance assessment used to evaluate impact of uncertainty on performance (risk) for the repository system.
- For the TPA4.1j base case, 10% of the realizations represent 95% of the peak mean dose.
- Usually, propagation of uncertainty (combined effects) drives the risk in a PA model.

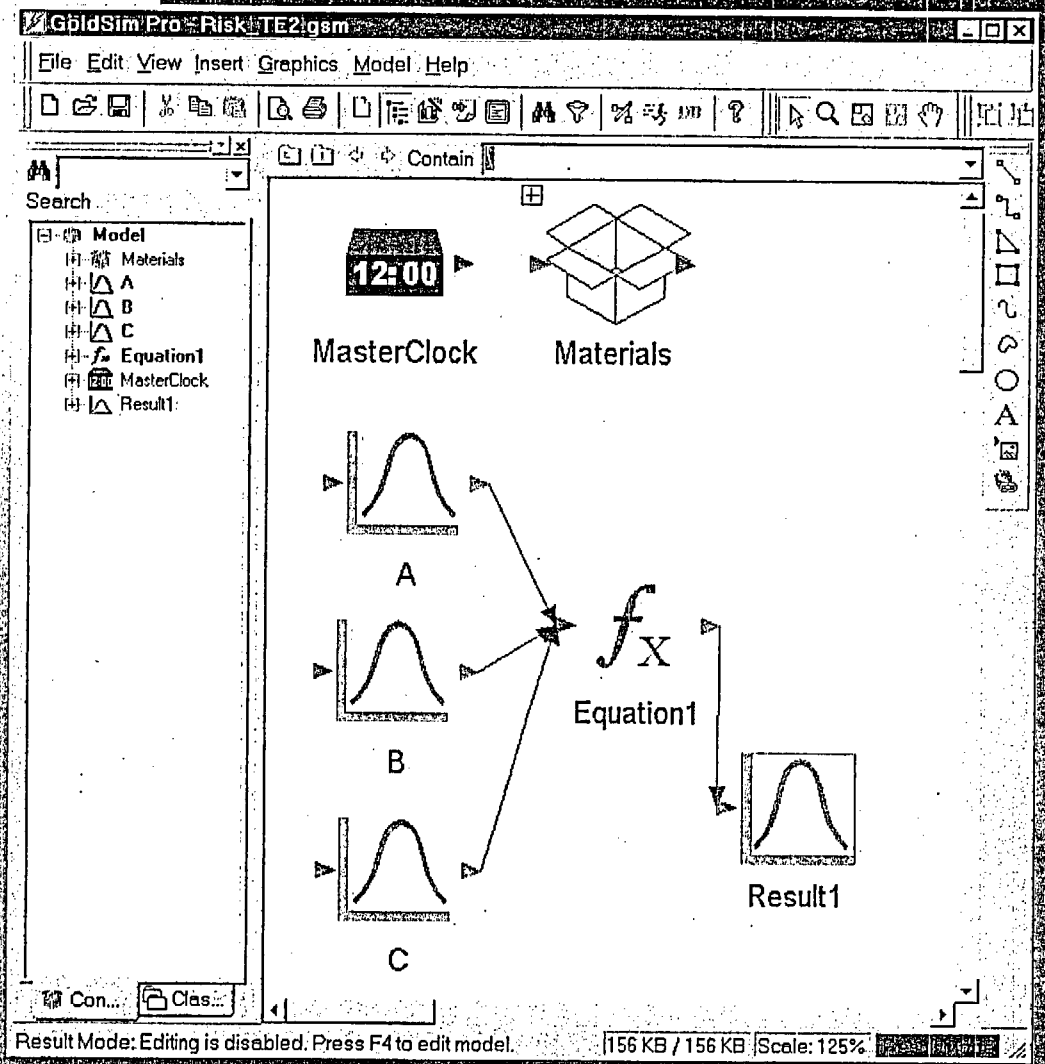
Analysis of TPA 4.1J High Realizations

Parameter name	Highest Realization	2nd Realization	3rd Realization	4th Realization	5th Realization	mean
WPFlowMF	84	82	91	86	90	87
SbArWt%	70	92	79	32	85	72
WP-Def%	91	64	88	74	32	70
PSFDM1	81	67	87	94	98	85
InitRSFP	63	56	50	98	70	67
DSFailTi	53	64	27	55	37	47

Percentiles of Sampled Parameter Uncertainty Ranges

- The highest realization contributed 16% to the mean.
- It is not necessary for key parameters to be at the extremes in order to have a meaningful contribution to risk.
- Propagation of uncertainty significantly influences the risk.

Hypothetical Uncertainty Evaluation Example:



Base Case:

$A_b = N[\mu=5, \sigma=1]$

$B_b = N[\mu=5, \sigma=1]$

$C_b = U[-1, 1]$

$Equation1 = (A*B)^C$

Result:

Mean(Equation1)=3.84

Limit = 15.0

Hypothetical Uncertainty Evaluation Example:

- Agreements (unrepresented uncertainty) associated with A_b, B_b, C_b
- To evaluate uncertainty1, uncertainty2, uncertainty3 (e.g., agreement1, agreement2, agreement3), three analyses:

1) $A_b = A_n = N[\mu=6, \sigma=1.5]$, B_b and C_b unchanged
2) $B_b = B_n = N[\mu=6, \sigma=1.5]$, A_b and C_b unchanged
3) $C_b = C_n = U[-1.5, 1.5]$, A_b and B_b unchanged

- From this sort of local sensitivity analysis, one might conclude that none of the individual uncertainties are important to meeting the limit

  Result1: Mean(Equation1) = 4.35
  Result2: Mean(Equation1) = 4.35
  Result3: Mean(Equation1) = 13.0

- However, a combined effect analysis that probabilistically represents all three uncertainties gives a result that the combined effect of the uncertainties is important to meeting the hypothetical limit

  Result: Mean(Equation1) = 20.3

Conclusions: NRC Perspective on Combined Effects

- Extremely pessimistic analyses for individual uncertainties are not required by the NRC.
- NRC agrees that the margin between the analysis results and the performance objective can be considered when risk-informing.
- However, the potential combined effect (propagation of uncertainty) on risk of the Bin 3 agreements can be important.
- Technical analysis should appropriately consider the system-nature of the performance assessment model (e.g., the combined effect of uncertainty).