



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



Status of Quality Assurance Issues

Presented to:
Nuclear Waste Technical Review Board

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Outline

- **Summary of Quality Issues**
 - **Apparent errors and/or inconsistencies in Total System Performance Assessment - Site Recommendation (TSPA-SR) documents (NRC letter 17 May 2001)**
 - **Validation of models in support of TSPA-SR (QA Corrective Action Request CAR-001)**
 - **Configuration Management of Software in support of TSPA-SR (CAR-002)**
- **Path Forward**
- **Summary**

Summary of NRC-Identified Concerns with TSPA-SR and DOE Response

- **Technical errors/inconsistencies in some tables**
 - *Response: One table in error, a remnant of earlier versions of document. One table used inconsistent time intervals for intermediate results of model. One table with round-off differences at 4th significant figure. No impact on TSPA-SR model or results*
- **Input discrepancy in model input file**
 - *Response: One input relationship had wrong exponent. No impact on TSPA-SR results*
- **Models may have been run outside their intended range**
 - *Response: One model run outside the range of analysis model report (AMR). Model still applicable. No impact on TSPA-SR model or results*

Summary of NRC-Identified Concerns with TSPA-SR and DOE Response

(Continued)

- **Apparent discrepancies in informal (e-mail) data transmittal**
 - *Response: Informal transmittals used different time intervals for intermediate results. No impact on TSPA-SR model or results*
- **Run log errors in model file**
 - *Response: Warning messages were evaluated and numerical precision determined sufficient. No impact on TSPA-SR model or results*
- **Typographical error in TSPA-SR Report**
 - *Response: Typo in document did not affect TSPA-SR results, nor was it used in any subsequent document*



Actions to Address NRC-Identified Concerns with TSPA-SR

- **Evaluate technical aspects of NRC findings and provide response to NRC (status: completed response sent to NRC; see backup slides)**
- **Conduct internal assessment to determine if other errors or inconsistencies exist in TSPA-SR Model (status: completed)**
- **Initiate vertical review of TSPA-SR and related documents (status: completed, see following slides)**
- **Initiate formal root cause evaluation (status: completed)**

Results of TSPA-SR Vertical Review

- **Review resulted in identification of additional discrepancies, such as**
 - **Incomplete referencing**
 - **Editorial (typo, style)**
 - **Document discrepancy**
 - **Transparency**
 - **Conceptual model**
 - **TSPA model discrepancy**
 - **Software/data traceability**

Results of TSPA-SR Vertical Review

(Continued)

- **None of these discrepancies were significant, however, 6 items were rerun with TSPA-SR base case model**
 - **None were found to have any discernible impact on dose**
 - ◆ **One had a small impact on dose at times between 40,000 and 100,000 years**
- **Status: Review completed; documentation of objective evidence being reviewed**

Root Cause Evaluation of TSPA-SR Document Deficiencies

- **Root Cause conducted in July/Aug 2001**
- **Four Root Causes identified**
 - **Checking and review process performed in a compressed time period**
 - **Check and review process cut short**
 - **Lack of lower level integrated schedule with realistic activity durations to perform work (especially check and review)**
 - **Ineffective issue management program**
- **Status: Root cause recommendations being addressed in Performance Improvement Transition Plan**



Model Validation and Software Management Corrective Actions



Model Validation Corrective Action

Corrective Action Request (CAR) BSC-01-C-001

- **QA Deficiency - Model validation procedural requirement is not being consistently implemented; previous corrective actions have not been effective**
- **Actions taken**
 - **Revise QA procedure (incorporate, as applicable, NRC comments made in August, TSPA Key Technical Issue (KTI) Technical Exchange) (status: draft in review)**
 - **Develop guidelines manual including best practices (status: in progress)**
 - **Conduct survey and review of model validation in all Analysis Model Reports (AMRs) (status: draft, in review, see following slide)**
 - **Conduct root cause evaluation (status: completed)**

Summary of Model Validation Review

- **Review of 125 AMRs used over 30 independent off-Project technical specialists (128 models identified)**
- **Review divided model documentation into 3 bins**
 - ◆ **Bin 1 - documentation meets procedural requirements (17)**
 - ◆ **Bin 2 - documentation does not meet procedural requirements, but is sufficient to demonstrate adequate confidence in model (77)**
 - ◆ **Bin 3 - more work is needed to provide additional confidence in the model (34)**
- **Bin 3 models have been correlated to enhanced confidence identified in NRC KTI agreements**
- **Status: Impact assessment for Bin 3 models completed; no impact on TSPA-SR conclusions; document in review**

Model Validation Root Causes

- **Root cause conducted from May - August**
- **Root cause identified 6 root causes**
 - **Lack of clear expectations for model validation**
 - **Inadequate definition of roles, responsibility, authority and accountability model validation**
 - **Integrated schedule did not include adequate time for model validation and checking**
 - **Self-identification of problems was ineffective**
 - **Procedure interpretation is ad hoc**
 - **Classroom training was insufficient**
- **Status: Root cause recommendations being addressed in Performance Improvement Transition Plan**

Software Management Corrective Action

Corrective Action Request (CAR) BSC-01-C-002

- **QA Deficiency -**
 - Lack of independent verification of software by software installation tests
 - Failure to fully implement Configuration Management
- **Actions taken**
 - Implemented management-directed software stand-down on continued use and development of unqualified software (status: still in effect)
 - Procedure being revised (status: in review)
 - Procuring an automated software configuration management system (status: in procurement)
 - Conduct root cause evaluation (status: completed)

Software Process Root Causes

- **Root cause conducted May - August**
- **3 root causes identified**
 - **Inadequate definition of roles, responsibilities, authority and accountability for software management**
 - **Development and communication of software management procedure was inadequate**
 - **Inadequate training of users of procedure**
- **Status: Root cause recommendations being addressed in Performance Improvement Transition Plan**

Path Forward —

Performance Improvement Transition Plan

- **Objective - Provide joint DOE/BSC comprehensive plan to transition to desired “Nuclear Culture”**
 - **Specifically address the Root Cause Analysis recommended corrective actions**
 - **Additionally, address**
 - ◆ **Potential adverse quality trends associated with in-process reviews**
 - ◆ **Self assessment results performed over last 6 months**
 - ◆ **Lessons learned from previous corrective actions**
 - ◆ **Quality Assurance Management Assessment review results**
 - ◆ **Integrated Safety Management System deficiency**

Path Forward —

Performance Improvement Transition Plan

(Continued)

- **Plan is modeled after proven performance improvement plans associated with NRC “watch list” plants**
- **Plan will include metrics to evaluate effectiveness of implementation**
- **Interim status of plan development to be discussed with NRC staff**
- **Status: Plan under development, completion expected mid December**

Summary

- **Quality assurance implementation concerns have been identified by DOE and NRC**
- **Concerns have been determined to have no impact on TSPA-SR results or conclusions**
- **Concerns are indicative of need for significant process improvements and change to a licensing-type culture**
- **Performance Improvement Transition Plan being developed to address concerns**
- **Expect completion of plan by December 2001**

Backup



NRC Findings in May 17 Letter and DOE Response

(Slides presented at DOE-NRC QA Quarterly Meeting June 2001)

Background

1. In-package chemistry
2. Cladding degradation model
3. Dissolution rate model
4. Dissolved concentration limits
5. Volcanic releases
6. GoldSim error messages
7. Use of conditions outside of range
8. Intrusive igneous event probability



Background — NRC Findings on TSPA-SR

- **December - Completed TSPA-SR**
 - January - Provide copies of TSPA-SR documents, software and model input files to NRC
 - February - April - Informal discussions (and e-mails) with NRC staff on software, model input files and documents
- **May 4 - NRC informs DOE/BSC of apparent errors in model document**
 - May 9 - DOE/BSC informs NRC of initial evaluation of apparent errors
- **May 17 - NRC writes formal letter describing apparent errors and/or inconsistencies**
 - June - DOE/BSC inform NRC of completed evaluation
- **July - DOE formally responds to NRC**



1. Section 6.3.4.2 In-Package Chemistry

1.1 Page 265, Table 6-42

- **NRC Finding**

- Calculated pH fell outside of expected range
- pH bounds and pH values, though correct, apply to different time periods
- Potential error in in-package chemistry abstraction for “early” chemistry conditions

- **DOE Response**

- Calculated pH values for co-disposal waste packages are correct for calculation times indicated (98,000 and 100,000 years) but are incorrectly labeled as “early” time phase; should be “late” time phase

1. Section 6.3.4.2 In-Package Chemistry

1.1 Page 265, Table 6-42

(Continued)

- Correct pH range for this “late” time should be as follows:

<u>Seepage environment</u>	<u>pH range</u>
Always Drip (t=98,000 yrs)	8.5 - 9.2
Intermittent Drip (t=100,000 yrs)	8.5 - 9.2
No Drip (t=98,000 yrs)	8.6 - 9.2

- Calculated and observed values are within this range

1. Section 6.3.4.2 In-Package Chemistry

1.1 Page 265, Table 6-42

(Continued)

● DOE Response (Continued)

- **Weighted-/moving-average of in-package chemistry was selected to assure the chemistry was appropriate at times when the rate of waste package failure is increasing; these are of greater significance during the 10,000 year compliance period**
- **At long times (~100,000 years) this may be a non conservative representation**
- **Further discussion of this is planned for the TSPA I KTI Technical Exchange**
- **Table will be revised with next version of document**

1. Section 6.3.4.2 In-Package Chemistry

1.2 Page 266, Table 6-43

- **NRC Finding**

- Hand and model predicted total carbonate concentrations are the same, but inconsistent with equation in Table 6-38
- TSPA model input file used the wrong equation
- Equation in Table 6-38 is correct based on input AMR
- Impact to risk is unknown

1. Section 6.3.4.2 In-Package Chemistry

1.2 Page 266, Table 6-43

(Continued)

● DOE Response

- Equation used to calculate in-package carbonate concentration in the model input file should be that presented in Table 6-38
- Using correct equation would decrease carbonate concentration by ~ 1,000
- Based on relationship between carbonate concentration and CSNF dissolution rate given in eqn. 6-2, this would decrease the dissolution rate by ~ 10% (~ 0.4 mg/m²/day) - - this is insignificant and conservative
- Correct exponent used in subsequent analyses and will be documented in next revision of report

2. Section 6.3.4.3 Cladding Degradation Model

- **NRC Finding**

- **Triangular distribution noted states minimum, mean and maximum values**
- **GoldSim triangular distribution uses minimum, most likely, and maximum values**
- **Information in the document appears incorrect**

- **DOE Response**

- **Text in the document is incorrect**
- **Input triangular distributions use minimum, most likely and maximum values**
- **Correct terminology will be used in next revision of document**

3. Section 6.3.4.4

Dissolution Rate Model

- **NRC Finding**

- Calculated values of glass dissolution rate in Table 6-54 are not identical to observed values
- Differences cannot be explained by round off error

- **DOE Response**

- Difference is due to fact that R value used in hand calculation was 8.314×10^{-3} kJ/(mol K), while R value in GoldSim is 8.31451×10^{-3} kJ/(mol K); when using the R value to 6 significant figures, the table is correct to 5 significant figures
- Difference is insignificant
- Clarification regarding round off error will be added in next revision of document

4. Section 6.3.4.5

Dissolved Concentration Limits 4.1

- **NRC Finding**

- **Calculated concentration limits are not identical to observed values**
- **Informal hand calculations provided by DOE had different environmental parameters**
- **Degree of precision required during model component verification is unknown**

4. Section 6.3.4.5

Dissolved Concentration Limits 4.1

(Continued)

- **DOE Response**

- **Discrepancy is in the 5th significant figure**
- **Informal hand computations used slightly different water chemistries**
- **Precision at the 5th significant figures is not required for verification**
- **Clarification of degree of significance required for verification will be presented in the next revision of the document**

4. Section 6.3.4.5

Dissolved Concentration Limits 4.2

Page 316, Table 6-60

- **NRC Finding**
 - Hand calculations could not be verified
- **DOE Response**
 - Informal hand computations provided electronically to NRC used different environmental conditions; they do not correspond to the conditions identified in Table 6-60
 - Further examination conducted during the project review reverified the values in Table 6-60 as being correct

5. Volcanic Releases —Table 6-133

- **NRC Finding**
 - Values in Table 6-133 could not be verified and are inconsistent with those in Table 6-132
- **DOE Response**
 - Table 6-133 is incorrect; it was a remnant of a previous version of the table that was not discovered in the checking process as the document was revised
 - Analyses conducted for TSPA-SR correctly weight the risk of volcanic release by probability of occurrence
 - Figure 6-193, which contains the probability-weighted doses, correctly shows the probability-weighted dose from the unweighted doses illustrated in Figure 6-192
 - Table 6-133 will be revised in next version of document

6. GoldSim Error Messages

- **NRC Finding**

- **GoldSim run log file contains numerous error messages that need to be addressed**
- **Error messages do not appear to be addressed in the TSPA-SR documents**

- **DOE Response**

- **Run log error messages were known and examined by analysts; however they were not documented**
- **Some errors relate to slight numerical non-convergence that was evaluated by analysts and determined to be insignificant**
- **Non-convergence errors create mass and thus, although small, conservatively increase the dose**
- **Evaluation of the error messages and their significance will be documented in the next revision of the document**



7. Use of Conditions Outside of Intended Range

- **NRC Finding**

- Staff identified several cases where model was using physical-chemical conditions outside the range of the observation

- **DOE Response**

- Instances of this were noted in the text and were discussed with the AMR authors to assure the appropriateness of the abstraction, even if not documented in the AMR
- Deficiency documented as BSC-01-D-078
- Supporting AMRs will be revised to extend range of applicability

8. Intrusive Igneous Event Probability

● NRC Finding

- Probability over 50,000 years incorrectly reported as 8×10^{-3} rather than the correct value of 8×10^{-4}
- It is unclear if this is a typographical error or was used to calculate the results

● DOE Response

- This is a typographical error
- Correct values were used in the analysis
- Correct values will be included in the next revision of the report
- Incorrect value has not been cited elsewhere

