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A Division of Southwest Research Institute®
6220 Culebra Road • San Antonio, Texas, U.S.A. 78228-5166
(210) 522-5160 • Fax (210) 522-5155

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U.S. Nuclear Regulatory Commission
ATTN: Mr. James Firth
Office of Nuclear Material Safety and Safeguards
Division of Waste Management
Performance Assessment and High-Level Waste Integration Branch
Mail Stop 7C–18
Washington, DC 20555

Subject: Transmittal of "A Plan for Risk Analysis by the Total System Performance Assessment and Integration Key Technical Issue" (IM 06002.01.112.400)

Dear Mr. Firth:

The purpose of this letter is to transmit the Center for Nuclear Waste Regulatory Analyses (CNWRA) Report entitled "A Plan for Risk Analysis by the Total System Performance Assessment and Integration Key Technical Issue" in fulfillment of IM 06002.01.112.400 (Risk Analysis Plan) as an attachment to this letter. This report proposes a plan for conducting analyses to (i) improve staff understanding of the repository system in specific key areas important to postclosure system performance and (ii) generate and synthesize risk information that may be used to update and refine the risk baseline and, thus, support license application review. The analyses results and their subsequent reporting are intended to be used by the U.S. Nuclear Regulatory Commission (NRC) and the CNWRA management and staff engaged in prelicensing activities, license application review, and other regulatory activities associated with the high-level waste program.

This plan was developed under close supervision and guidance from James Danna who has already read numerous draft versions provided for comments. We will be pleased to make additional modifications to the report if new concerns are identified during the formal concurrence and acceptance process. If you have questions, please contact Dr. Sitakanta Mohanty, at (210) 522-5185 or me at (210) 522-5082.

Sincerely yours,

Gordon Wittmeyer

Gordon Wittmeyer, Ph.D.
Manager, Performance Assessment

GW: rm

cc:
M. Leach
B. Meehan
D. DeMarco
E. Whitt
J. Greeves
W. Reamer
L. Kokajko
J. Schlueter
A. Campbell
L. Campbell
K. Stablein
M. Thaggard
C. Grossman
J. Danna
R.K. Johnson
R. Codell
D. Esh
T. McCartin
C. McKenney
J. Peckenpaugh
W. Patrick
B. Sagar
S. Mohanty
CNWRA Directors
CNWRA Element Managers

Washington Office • Twinbrook Metro Plaza #210
12300 Twinbrook Parkway • Rockville, Maryland 20852-1606

A Plan for Risk Analysis by the Total System Performance Assessment and Integration Key Technical Issue

Project Management:

Title:	Risk Analysis Progress Report—Technical Report
U.S. Nuclear Regulatory Commission (NRC)	
Program Element Manager:	James Firth
Project Manager:	James Danna
Center for Nuclear Waste Regulatory Analyses (CNWRA)	
Cognizant Manager:	Gordon Wittmeyer
Principal Investigator(s):	Sitakanta Mohanty
Tracking number:	IM 06002.01.112.420

Introduction:

In 1995, the Commission formalized, in the Probabilistic Risk Assessment Policy Statement (60 FR 42622, August 16, 1995), its commitment to risk-informing regulations and the NRC regulatory reviews through the expanded use of probabilistic risk assessment in regulatory activities. In its staff requirements memorandum for COMSECY–96–061 (April 15, 1997), the Commission envisioned a risk-graded approach to focus on those licensee activities that pose the greatest risk to the public health and safety, thereby accomplishing the NRC principal mission in an efficient and cost-effective manner. The Commission recognized that the risk-informing approach to regulations and the risk-graded approach to licensing can be met through the use of risk insights obtained from probabilistic risk assessments, together with other factors such as engineering experience and consensus standards. Risk (or performance) assessment can help identify issues important to public health and safety.

As part of its long-standing effort to use risk information in its high-level waste regulatory activities, the staff is conducting a risk insights initiative to improve documentation of existing risk information related to the high-level waste program, and synthesize the information in a way that supports a risk-informed program. A risk insights baseline report is currently being developed that will summarize the staff understanding of how the proposed repository at Yucca Mountain, Nevada, might function to isolate waste and the current thinking of how the principal features, events, and processes that may be present at Yucca Mountain following permanent closure of the repository could affect the estimated postclosure risks to an individual in the vicinity of Yucca Mountain. These risk insights are drawn from previous quantitative results of risk assessments, subsystems analyses, and auxiliary calculations. The quantitative results are key to identifying and understanding the important components from a technical viewpoint. Development of the risk insights is based primarily on quantitative, system-level performance assessment calculations. However, supporting analyses used to build an understanding of the system and for developing confidence in the system models is equally important. Such evidence includes information from laboratory and field experiments, natural or man-made analogs, sensitivity analyses, and other specialized analyses at a subsystem level.

The risk insights baseline document being developed reflects a snapshot of the staff understanding of the key aspects of the proposed repository, based on existing analyses and evidence. This plan outlines the activities to improve understanding of system behavior in several key areas.

Objectives:

The objectives of the analyses proposed in this plan are to (i) improve staff understanding of the repository system in specific key areas important to postclosure system performance and (ii) generate and synthesize risk information that may be used to update and refine the risk baseline and, thus, support License Application review.

The analyses results and the subsequent reporting are intended to be used by the Nuclear Regulatory Commission (NRC) and the Center for Nuclear Waste Regulator Analyses (CNWRA) management and staff engaged in prelicensing activities, License Application review, and other regulatory activities associated with the high-level waste program.

Scope:

The risk analysis exercise will consist of the following:

- Specific analyses identified during development of the risk insights baseline

- Quantitative system-level analyses and auxiliary analyses to support and evaluate the assumptions, data, and modeling approaches in specific key areas important to postclosure system performance

Auxiliary analyses will be conducted on those repository features, events, and process that have the greatest effect on repository performance or the uncertainty regarding its performance, as identified by the risk insights effort currently underway. The results from the auxiliary analyses will be used to examine the sufficiency of the information used to develop the model abstraction, the degree to which model and data uncertainties have been characterized and propagated through the model abstraction, and the extent to which the output of the model abstraction is supported by objective comparisons. Assumptions, conservatism, and the likelihood of scenarios (especially the key processes) represented in the abstracted model will be examined.

The Total-system Performance Assessment code (Mohanty, et al., 2002b) and detailed computer codes such as MULTIFLO (Lichtner, et al., 2000), ABAQUS (Hibbitt, Karlsson and Sorensen, Inc., 1994), MODFLOW (Harbaugh and McDonald, 1996), and UDEC (Itasca Consulting Group, Inc., 1996) will be used in auxiliary analyses. Published data and newly-collected CNWRA and U.S. Department of Energy (DOE) data also will be used in determining the appropriateness of data currently used in the analyses.

The specific auxiliary analyses to be conducted are being identified through the risk insight initiative. The types of analyses that may be conducted are shown next. As needed, additional process-level modeling studies may be conducted as needed to understand adequately the physical behavior of the repository components important to waste isolation, subject to schedule and resource constraints.

- Evaluate the appropriateness of using (modified) J–13 Well water as a basis for DOE simulation of the water chemistry contacting the waste package.

- Establish the temperature ranges on the engineered barrier surfaces and the boundaries of the salt hydration process (i.e., possible salt mixtures and their deliquescence points, relative humidity, and temperature) that could lead to accelerated corrosion of the drip shield and the waste package. Evaluate their significance to waste package performance.

- Evaluate the extent to which waste packages and the drip shield will fail from natural and seismic-augmented rockfall.

- Estimate the hydrological and chemical consequences of increases in the waste package and drip shield temperatures as a result of self-backfilling from natural rock collapse.

- Evaluate the extent to which the presence of a backfilled drift from natural rockfall would tend to decrease the dose contribution from volcanic disruption of waste packages by limiting the number of damaged waste packages.

- Evaluate the stability of a passive film on the surface of the waste package that ensures very slow corrosion rates of the waste package. Specifically, evaluate the effects of high temperatures and aggressive water chemistry conditions on the stability of the passive film.

- Evaluate the disposal of spent nuclear fuel with a wide variation in the degree of burn-up, and compare peak expected dose with the estimates from the use of an average representative inventory. Current industry trends show increasing degree of burn-up, which could increase the inventory of radionuclides in the waste form.

- Evaluate the effect of oxidation of the waste form and reduction in pH from corrosion of internal metallic components of the waste package on the waste form dissolution rates (e.g., fuel assembly baskets).

- Evaluate the dose consequence of increased waste package and drip shield temperatures resulting from natural backfilling by drifts collapse.

- Reassess the credit attributed to the alluvium unit in delaying movement of radionuclides that tend to sorb onto mineral surfaces of the porous and fractured media (e.g., Np-237, Am-241, and Pu-240).

- Reexamine the probability of future volcanic events from the latest information on the constraining parameters such as number, age, and location of past igneous features.

- Reexamine the current assessment of the concentration of radionuclides in ash by relaxing the current constraint that the number of waste packages affected during an igneous event is related to the size of the event (i.e., volume of ash released during the event). Higher concentration of radionuclide release could occur from volcanic events releasing small volumes of ash.

- Verify assumptions regarding the amount of fine ash particles resuspended in the air and their significant influence on the calculated dose. Currently, inhalation of resuspended volcanic ash dominates the total dose for the igneous scenario.

- Evaluate the relative conservatism of using preferential wind velocities as a substitute for remobilization of contaminated ash particles. Calculate, if needed, ash deposition/distribution for variable wind direction.

In addition to auxiliary analyses, system-level analyses also will be conducted to update understanding of the system behavior. The new analyses will be conducted using the Total-system Performance Assessment Version 5.0 code that reflects the new and updated models and revised data developed since the last iteration of performance assessment. Sensitivity, uncertainty, and barrier importance analyses similar to those documented in the revised Total-system Performance Assessment Version 4.1 Sensitivity Studies report will be conducted (Mohanty, et al., 2002a). Risk information from the sensitivity, uncertainty, and barrier analyses will be used to identify parameters, models, repository components, and scenarios important to waste isolation.

In addition to the system-level assessment, a range of other quantitative analyses will be conducted using the Total-system Performance Assessment Version 5.0 code to explore issues such as stability in the model results, effect of conservatism on sensitivity studies, new scenarios that should be explicitly included in performance assessment calculations, and the appropriateness of the representation of parameter uncertainty.

- Address the statistical stability of the results for the nominal scenario.

- Perform groundwater protection calculations using the latest version of the Total-system Performance Assessment code. The groundwater concentration standards in 40 CFR Part 197 and 10 CFR Part 63 are relatively recent additions.

- Explore the effect of conservatism in the TPA process models and the extent to which it influences results of the sensitivity studies.

- Develop additional technical bases for those features, events, and processes that may be risk-significant, but currently are not included in the performance assessment.

- Systematically review the total system performance assessment model to ensure consistency in (i) model abstraction, (ii) selection of conservatism in components, and (iii) representation of uncertainty.

- Evaluate the behavior of the mean dose from extrusive igneous events relative to the number of samples (realizations) used. The shape of the parameter distributions could affect the number of realizations needed to have a stable prediction of the mean.

- Calculate risk of extrusive volcanism taking into account realistic assumptions of wind speed and direction and ash redistribution and mobilization.

- Develop defendable technical bases for the data distributions used in the total system performance assessment needed to support mathematical representation of data uncertainty in the total system performance assessment.

- Develop better quantitative and visualization methods to present the results (e.g., probabilistic analysis of major barriers and factorial design of multiple barrier performances).

CNWRA will confirm and prioritize the final set of analyses with the NRC staff, as indicated in Table 1.

Planned Accomplishments:

At the end of the project, the staff is expected to have

- Addressed areas considered at this time to be highly uncertain (e.g., the amount of water entering a waste package)

- Determined the key areas, based on the latest understanding of the proposed repository, that NRC should focus on during the licensing review

- Significantly improved their ability to focus the review of the License Application by increasing the availability of quantitative risk information to support risk insights

- Greatly bolstered their detailed technical understanding of the features, events, and processes likely to result in contentions during the hearing process

Related Activities:

Analysis results from the risk analysis project will be used in various other key activities such as the Risk Insights Initiative, Total-system Performance Assessment code development, Integrated Issue Resolution Status Report update, Key Technical Issues agreement activities, and License Application review. The relationship between the risk analysis proposed in this plan and the other key activities is shown in Figure 1. The Total-system Performance Assessment code modification will be frozen before completion of the risk analysis project, hence, major modifications to the Total-system Performance Assessment code based on the findings are not envisioned. The staff, however, may use their findings during the early part of the risk analysis project to spearhead model changes in the Total-system Performance Assessment code, if warranted. At the end of the project, the staff could use new information to update Total-system Performance Assessment input data, if warranted. Because the tasks pursued for this project are derived directly from the risk insights initiative currently underway, the findings from the project are expected to make substantial contribution to this initiative either via confirmation of the existing hypotheses or via new understanding that could lead to downgrading some of the high-significance items to medium or low significance. The information presented in the risk analysis report may be used directly as the technical bases or used indirectly to develop technical bases for NRC staff positions in the Integrated Issue Resolution Status Report (NRC, 2002). The Key Technical Issue agreement-related activities can then draw information from the Integrated Issue Resolution Status Report for issue closure.

Table 1. Schedule for Submitting a Draft Report, Input from NRC, CNWRA Review, and Final Delivery		
Items	**Due Date**	**Remarks**
Confirm/prioritize the final set of analyses	October 21, 2003	• NRC staff to provide guidance on prioritization and recommend the analysis approach
Provide an outline of the analysis scope and approach (by the task leads)	November 7, 2003	• Task leads to provide a one-half to one-page description • NRC staff to review and approve the approach
Discuss the analysis scope and approach and reporting format	November 14, 2003	• Meetings with staff associated with the various Key Technical Issues may be needed to finalize the details
Develop an outline for the report	January 15, 2004	• Guidance from the NRC staff on the outline of mini-reports to be prepared by the task leads
Report the interim results	March 1, 2004	• Task leads to prepare a two-page summary of the findings • NRC/CNWRA staffs to review and provide comments and recommend mid-project corrections if needed
Submit the final report	May 25, 2004	• Task leads to prepare the final five- to six-page report • NRC/CNWRA staffs to review and provide comments
Complete the NRC Performance Assessment staff review	June 4, 2004	
Prepare author-final for the formal CNWRA review	June 18, 2004	
Send report to NRC	July 30, 2004	• Delivery to NRC on 7/30/2004

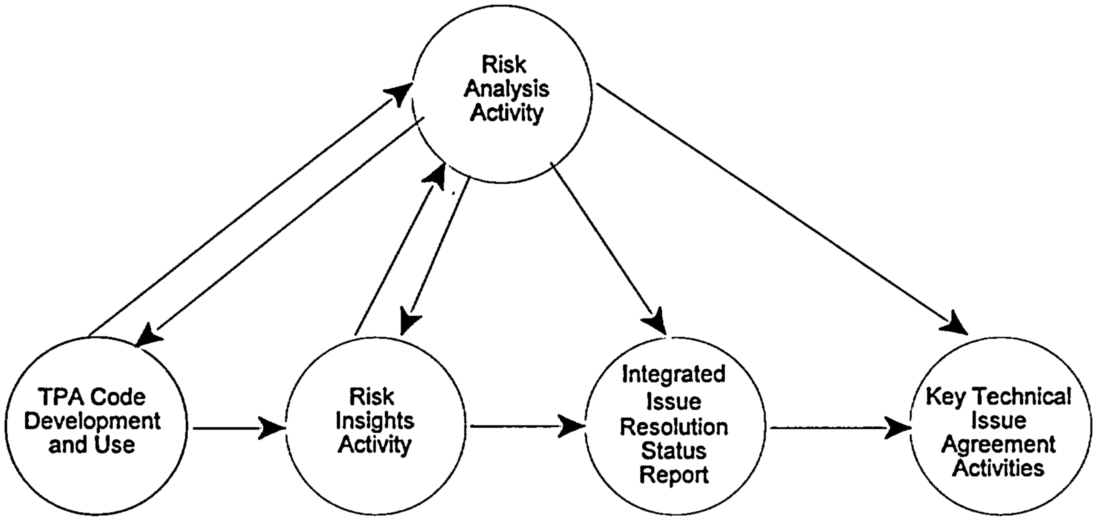

Figure 1. Flow Diagram Showing Information Flow from the Risk Analysis Activity to Other Activities.

Schedule and Deliverable:

The schedule for completion of all tasks is presented in Table 1. The final report is planned to be delivered on July 30, 2004.

The deliverable for this activity will be an intermediate milestone that concisely reports the final findings of the process-level, system-level, and auxiliary analyses. The final report will be a compilation of mini-reports prepared by the task leads. It is suggested the report follows a format that will facilitate its use during the License Application review process.

Project Management:

After the approval of the plan, the proposed set of analyses will be grouped together to form a short list of tasks. Task leads will be identified among the CNWRA and NRC Performance Assessment staffs to spearhead successful completion of each task. Each task lead will form a team consisting of CNWRA and NRC staffs from relevant Key Technical Issues and Integrated Subissues and will be responsible for the successful completion of the task in a timely manner. For the assigned task, each task lead will prepare an outline stating the objective of the task, the approach for conducting the analysis, the input/assumptions, and the anticipated interactions with the NRC staff. The task leads will frequently communicate their findings and the constraints to the project lead. To ensure a clear understanding between the NRC and the CNWRA staffs, NRC mentors will be identified for each task at the beginning of the project and the level and type of technical contribution from the NRC will be identified.

Unanticipated Problems:

Because system-level analyses will be conducted for the proposed plan, it is imperative the final version of the Total-system Performance Assessment code is readily available. The final version of the code, however, will not be available until several of the proposed tasks are completed during the early part of the project. For example, if the analysis will result in the development and finalization of the rockfall waste package failure model during the early part of the project, the model can be incorporated into the Total-system Performance Assessment code and the revised Total-system Performance Assessment code can be used then to conduct the proposed system-level analyses. On the other hand, if the model will not be available until the later part of the project, risk insights cannot be gained in a timely manner.

References:

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