

PHASE I REVIEW  
RETARDATION SENSITIVITY ANALYSIS  
STUDY PLAN 8.3.1.3.7.1

by

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Introduction

This study plan describes the methods that will be used to analyze the effects of geochemical, and coupled processes, as well as particulate transport on radionuclide transport from the proposed repository at Yucca Mountain to the accessible environment. A conceptual geochemical/geophysical model of the Yucca Mountain site will be developed based on available geochemical, hydrologic, and other site characterization data, and on the analyses done under this study. Computational models simulating processes in the conceptual model will be constructed. The computational models will be used to perform integrated transport calculations to estimate radionuclide migration rates from the repository to the accessible environment and to determine the sensitivity of such transport calculations to retardation processes and parameters included in the codes. The results of the sensitivity analyses will be used to guide site characterization activities, focusing efforts on the characterization of processes that most strongly affect radionuclide migration. The study is subdivided into three activities:

- o Sensitivity analysis using a geochemical transport model of Yucca Mountain and integrated geochemical transport calculations (SCP Section 8.3.1.3.7.1.2)
- o Analysis of physical/chemical processes affecting transport (SCP Section 8.3.1.3.7.1.1)
- o Transport models and related support (SCP Section 8.3.1.3.7.1.3)

The work under the first activity will involve the construction of a computational model of the geochemical transport system at Yucca Mountain that represents the conceptual model of the effects of site geochemistry on radionuclide transport. The

conceptual model of site geochemistry will consist of the integration of site mineralogy and petrology, ambient water chemistry, models for radionuclide sorption and solubility, and other geochemical processes affecting transport to the accessible environment. The conceptual model will continuously be updated as new information is gathered in the characterization of the site.

The initial modeling efforts will utilize the coupled flow and transport code TRACRN. Calculations will supply sensitivity analyses of the effects of retardation on transport, address the effects of spatial distribution of hydrologic parameters, geochemical parameters, and mineral assemblages on retardation of radionuclides, and help ensure geochemical characterization activities are efficiently applied to repository performance assessment.

The work under the second activity will focus on modeling alternative processes that could affect radionuclide transport. These alternative processes include (1) transport of radionuclides in the form of colloids; (2) effects of geochemical processes on transport; (3) effects of physical processes on transport, in particular, the effects of fracture flow in the unsaturated zone and of dispersion and diffusive behavior on transport; and (4) effects of coupled processes, in particular, the effects of regional stress and heat on transport and geochemistry.

The work under the third activity will be to provide documentation, verification, validation and software support for the transport codes to be applied to the retardation sensitivity analyses. Most of the codes to be used in this study are modified versions of existing computer codes.

A Phase I review of Revision I of the study plan was done with respect to (A) DOE/NRC agreements on the content of study plans, (B) Identification of objections, (C) Closure of NRC open items, and (D) The Need for a Detailed Review (See Review Plan for Staff Review of DOE Study Plans, Revision I, 12/6/90).

Evaluation of Study Plans Relative to the Agreement and to the Responsible DOE-Contractor's QA Program (Objectives 1 and 5)

Criterion 1 The content of the study plan under review is reasonably consistent, as appropriate for the activities, tests and analyses described, with the Agreement (NRC-DOE meeting on the level of detail for site characterization plans (SCP) and study plans, May 7-8, 1986)

Staff Review: In general, the content of the study plan is reasonably consistent with the NRC/DOE agreements on the content of study plans (See Attachment 1).

Criterion 2 All study plan references have been provided when the study plan was issued.

Staff Review: All references have not been provided. The study plan lists 99 references and of these 32 are considered not readily obtainable by the U.S. NRC library. Attachment 2 is a copy of the list of references from the study plan with all references marked either AA (assumed to be available), or NAA (not assumed to be available). Only those references marked with an asterisk need be obtained from DOE at the present time. However, other references may be requested later if they turn out to be not readily obtainable and are needed for future reviews or technical exchanges.

Criterion 3 Open items relative to the QA program of the DOE contractor responsible for the study plan that could call into question the quality of the study plan have been resolved.

Staff Review: Based on a note on October 13, 1992 from K. Kalman to C. Abrams, there currently are no QA inadequacies that have to be resolved before the work begins.

Identification of Objections (Objectives 2 through 6)

Criterion 1 Potential adverse effects on repository performance;

Staff Review: The analytical activities described in this study plan will have no impact on the natural-state site conditions, and no adverse effect on the ability of Yucca Mountain to isolate waste. The proposed work should not affect the site in terms of either exploratory shaft or repository design.

Criterion 2 Potential significant and irreversible/unmitigatable effects on characterization that would physically preclude obtaining information necessary for licensing;

Staff Review: No effects of this type have been identified.

Criterion 3 Potential significant disruption to characterization schedules or sequencing of studies that would substantially reduce the ability of DOE to obtain information necessary for licensing.

Staff Review: No significant disruption in schedules is expected. The schedule of this study has taken into account how the study will be affected by contributions of data or interferences from other studies, and also how the present study will contribute or may interfere with other studies.

Criterion 4 Inadequacies in the QA program which must be resolved before work begins.

Staff Review: Based on a note on October 13, 1992 from K. Kalman to C. Abrams, there currently are no QA inadequacies that have to be resolved before the work begins.

Closure of NRC Open Items (Objectives 8 and 11)

Criterion 1 If DOE has proposed that one or more NRC open items be closed on the basis of the material in the study plan, determine whether those items can be closed.

Staff Review: The DOE has not proposed to close any open items with this study plan.

Need for Detailed Technical Review

A study plan is a candidate for detailed technical review if it meets any of the following criteria from step 6 of part 4.2 of the Review Plan. This study plan is a candidate for a detailed technical review based on criteria 1, 2, and 5.

Criterion 1 The study plan may be related to one or more key site related issues.

Staff Review: This study plan may provide information to address key site-specific issues. Results from the integrated transport calculations will be used to resolve Issues 1.1 and 1.8.

Criterion 2 The study plan pertains to some NRC open items.

Staff Review: In this review, open items are defined as SCA comments and questions and comments and questions from other study plan reviews. This study plan describes activities that could pertain to Questions 1 and 3 generated in the Detailed Review of the Study Plan 8.3.1.3.2.1 on Mineralogy, Petrology, Geochemistry along Flowpaths. Question 1 concerns how the methods of characterization were selected, given that the accuracy of the data needed has yet to be determined. The work in the retardation sensitivity analysis study is intended to provide information on the needed accuracy of site parameters. Question 3 concerns how the parameters collected in the Mineralogy/Petrology Study will correlate with those in the Batch Sorption Study. Again the work in the retardation sensitivity analysis study plan which uses data from both of these other studies may provide information to address this question.

Criterion 3 The study plan describes unique, state-of-the-art tests or analysis methods that therefore do not have a supportive scientific history of providing data usable in licensing.

Staff Review: The analyses to be performed under this study involve methods generally accepted by the scientific

community.

**Criterion 4** The study plan describes a study critical to the evaluation of site performance that cannot be repeated for a number of years due to its disruption of the natural baseline.

**Staff Review:** There should be no disruption of the natural baseline by performing this study.

**Criterion 5** The study has some other critical relationship to potential licensing concerns.

**Staff Review:** Although the study plan describes general relationships between this and other studies including performance assessment, there is no explicit discussion of an overall program of iterative performance assessment, or discussion of the timing of this study relative to such a program. This kind of assessment is a systematic, iterative approach to identifying the information and analyses needed to support a license application. Such an approach was recommended in NRC's SCA Comment #1.

ATTACHMENT 1  
Phase I Checklist for Study Plan 8.3.1.3.7.1

Retardation Sensitivity Analysis

I. Purpose and Objective

Is the information to be obtained in the study described?  
Yes  No  N/A

Is the rationale for information to be obtained provided?  
Yes  No  N/A

II. Rationale for Study/Investigation

Does the study plan provide the rationale for tests and analysis, indicating alternatives considered and options, advantages, and limitations?  
Yes  No  N/A

Does the study plan provide the rationale for the number, location, duration, and timing of tests, considering uncertainty, and identify obvious alternatives?  
Yes  No  N/A

Does the study plan describe the constraints for the study?  
Yes  No  N/A

In describing the constraints for the study, does the study plan consider potential site impacts?  
Yes  No  N/A

In describing the constraints for the study, does the study plan consider the need to simulate repository conditions?  
Yes  No  N/A

In describing the constraints for the study, does the study plan consider the required accuracy and precision?  
Yes  No  N/A

In describing the constraints for the study, does the study plan consider the limits of analytical methods?  
Yes  No  N/A

In describing the constraints for the study, does the study plan consider the capability of analytical methods?  
Yes  No  N/A

The phrase "capability of analytical methods" has not been located in this section.

In describing the constraints for the study, does the study plan consider the time required vs. time available?  
Yes  No  N/A

In describing the constraints for the study, does the study plan consider the scale of phenomena and parameters?

Yes  No  N/A

In describing the constraints for the study, does the study plan consider the interference among tests?

Yes  No  N/A

In describing the constraints for the study, does the study plan consider the interference between tests and ES?

Yes  No  N/A

### III. Description of Tests and Analysis

For each type of test does the study plan describe the general approach that will be used?

Yes  No  N/A

For each type of test does the study plan describe key parameters that will be measured in the test and the experimental conditions under which the test will be conducted?

Yes  No  N/A

For each type of test does the study plan indicate number of tests and locations?

Yes  No  N/A

For each type of test does the study plan summarize the test methods if non-standard procedure, summarize steps of test, how it will be modified, and reference technical procedure?

Yes  No  N/A

For each type of test does the study plan indicate the level of QA and provide rationale for any tests not QA level one?

Yes  No  N/A

For each type of test does the study plan reference the applicable specific QA requirements applied to the test?

Yes  No  N/A

For each type of test does the study plan specify the tolerance, accuracy, and precision required in the test?

Yes  No  N/A

For each type of test does the study plan indicate the range of expected results and the basis for those results?

Yes  No  N/A

For each type of test does the study plan list the equipment requirements, briefly describing special equipment?

Yes  No  N/A

For each type of test does the study plan describe the

techniques to be used for data reduction and analysis?  
Yes \_\_\_ No \_\_\_ N/A

For each type of test does the study plan describe the representativeness of test, indicating limitations and uncertainties that apply to use of results?  
Yes \_\_\_ No \_\_\_ N/A

For each type of test does the study plan provide illustrations of test locations?  
Yes \_\_\_ No \_\_\_ N/A

For each type of test does the study plan discuss the relationship of the test to set performance goals and confidence levels?  
Yes \_\_\_ No \_\_\_ N/A

For each type of analysis does the study plan state the purpose of analysis, indicate conditions to be evaluated and describe any uncertainty analysis?  
Yes  No \_\_\_ N/A \_\_\_

For each type of analysis does the study plan describe the methods of analysis, including analytical expressions and numerical models to be used?  
Yes  No \_\_\_ N/A \_\_\_

For each type of analysis does the study plan reference the technical procedures document that will be followed during analysis?  
Yes \_\_\_ No  N/A \_\_\_

However, user manuals for the various codes are listed in the references.

For each type of analysis does the study plan indicate levels of QA applied?  
Yes  No \_\_\_ N/A \_\_\_

This study plan was reviewed by K. Kalman from the Quality Assurance Section and found to adequately address this question.

For each type of analysis does the study plan identify data input requirements?  
Yes  No \_\_\_ N/A \_\_\_

For each type of analysis does the study plan describe the expected output and accuracy?  
Yes  No \_\_\_ N/A \_\_\_

For each type of analysis does the study plan describe the representativeness of analytical approach, indicating limitations and uncertainties that apply to results?  
Yes  No \_\_\_ N/A \_\_\_



#### IV. Application of Results

Does the study plan briefly discuss where results from study will be used for support of other studies?

Yes  No  N/A

Does the study plan refer to specific performance assessment analyses?

Yes  No  N/A

Does the study plan describe where information from the study will be used in construction equipment and engineering system design and development?

Yes  No  N/A

Does the study plan describe where information from study will be used in planning other characterization activities?

Yes  No  N/A

#### V. Schedules and Milestones

Does the study plan provide durations of and interrelationships among principal activities associated with this study?

Yes  No  N/A

Does the study plan list key milestones including decision points associated with study activities?

Yes  No  N/A

Does the study plan describe the timing of the study relative to other studies and other program activities?

Yes  No  N/A

Does the study plan provide dates for activities for the study plans: reference section 8.5 in SCP?

Yes  No  N/A

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