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Office of Civilian Radioactive Waste Management
Program Management System

Performance Assessment Strategy Plan for the Geologic Repository Program

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DISCLAIMER

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1 INTRODUCTION

Performance assessment is a major constituent of the program being conducted by the U.S. Department of Energy (DOE) to develop a geologic repository. Performance assessment is the set of activities needed for quantitative evaluations to assess compliance with the performance requirements in the regulations for a geologic repository and to support the development of the repository. The strategy for these evaluations has been documented in the Performance Assessment Strategy Plan (DOE, 1989). The implementation of the performance assessment strategy is defined in this document. This section discusses the scope and objectives of the implementation plan, the relationship of the plan to other program plans, and the structure of this document.

1.1 SCOPE

This Performance Assessment Implementation Plan (PAIP) encompasses the preclosure safety and postclosure performance assessment activities for the geologic repository program. The activities listed are for fiscal year (FY) 1990. Future year efforts will be described in subsequent plans.

The performance assessments for the Monitored Retrievable Storage and for the transportation system are not considered in this plan.

1.2 OBJECTIVES

The general objective of this PAIP is to provide the DOE Office of Systems Integration and Regulations (OSIR) and the Yucca Mountain Project Office (YMPO) of the Office of Civilian Radioactive Waste Management with a management tool to plan, schedule, and monitor performance assessment activities. This goal is achieved by: (1) identifying major technical activities and products, (2) identifying the responsible organizations, principal investigators, and levels of effort for each of the activities, (3) defining the interfaces between activities and organizations, and (4) developing an integrated schedule and milestone list for those performance assessments. The PAIP can therefore be used to help determine progress in the development and application of performance assessment methodologies.

1.3 RELATIONSHIP TO OTHER PERFORMANCE ASSESSMENT PLANS

The Performance Assessment Management Plan (PAMP) outlines the organization and management of the DOE's performance assessment activities for the repository program. The PAMP assigns responsibilities and identifies the procedures for the conduct of the performance assessments by the various participants in the program. This information provides a framework for the Performance Assessment Strategy Plan (PASP).

The PASP provides the general strategy and methodology of the performance assessments in sufficient detail to provide guidance to those who conduct the assessments, who supply the information for the assessments, and who receive guidance from the assessments. The strategy is to provide a consistent foundation for the planning and conduct of performance assessment activities. The development of the PASP draws upon the Site Characterization Plan (SCP), which describes the site, the preliminary designs for the repository and the waste package, and the waste-emplacement environment. It presents a strategy for resolving the issues, plans for obtaining the information for issue resolution, and a general plan for the performance assessments that will be conducted in support of issue resolution. The performance assessment strategy currently presented in the PASP is an expansion of the strategy presented in the SCP.

The implementation of the strategy presented in the PASP and the activities required to accomplish the performance assessments are described in the PAIP. Where appropriate, more-detailed activity plans have been and will continue to be prepared to identify the data, models, codes, and resources required to conduct the activities laid out in the PAIP. These activity plans are prepared by the persons within the program who are responsible for conducting the work. The activity plans that are available have been used in the preparation of this PAIP.

1.4 STRUCTURE OF THE PAIP

Chapter 1 of this document discusses the scope and objectives of the PAIP and its relationship to the other performance assessment plans. Chapter 2 discusses the performance assessment areas, the participants and contractors, and the organization of the performance assessment program. Chapter 3 presents an overview of the performance assessment strategy, describes the relationship of the performance assessment activities to the program milestones, and summarizes the FY 1990 activities in each of the performance assessment areas.

Chapter 4 identifies the specific performance assessment activities that are to be conducted in FY 1990. The chapter briefly describes the objective and technical approach for each activity, organizational participants, principal investigators, levels-of-effort, schedule, milestones, and linkages with other activities. Each activity is described on a one-page form.

Appendices are provided to summarize information from the activity sheets of Chapter 4. Appendix A lists the activities along with the participants. Appendix B provides spreadsheets summarizing the levels-of-effort for the activities. Finally, Appendix C lists the milestones and milestone dates for the activities.

2 ORGANIZATION OF THE PERFORMANCE ASSESSMENT PROGRAM

This chapter summarizes the performance assessment areas, the roles of the Office of Systems Integration and Regulations (OSIR) and the Yucca Mountain Project Office (YMPO) with respect to activities in these performance assessment areas, and the participants who support OSIR and YMPO in these roles. Finally, this section defines the organization of the program for the conduct and oversight of the performance assessments.

2.1 PERFORMANCE ASSESSMENT AREAS

The performance assessment program focuses on four areas of assessment corresponding to the performance measures specified in the technical criteria of 10 CFR Part 60: total system postclosure performance, engineered barrier system performance, natural barriers performance, and preclosure safety. Each of these areas of performance assessment involves problem definition, methodology development, conceptual model development and validation, calculational model development and verification, and sensitivity and uncertainty analyses associated with the performance measures for that area.

In addition to these four areas, performance assessment includes general implementation and oversight activities and activities to interface with the design, licensing, and testing programs. The general implementation and oversight activities have the objective of providing assistance to the DOE in performance assessment planning, coordination, integration, and review. The activities to interface with the design, licensing, and testing programs have two main objectives: (1) to ensure that the information and requirements developed in the design, licensing, and testing programs are taken into account in the performance assessments, and (2) to ensure that the results produced from the performance assessments are provided to these programs as they are needed. Therefore, these activities are conducted as a part of the development of design requirements, as part of the efforts to understand site characteristics and develop conceptual models, and as part of the coordinated effort to produce documents to support the licensing process.

The decomposition of performance assessment activities into these areas requires special attention to address those activities of one area which are very closely related to those of another area. In these cases, it is important to ensure that the activities are closely coordinated and integrated. Particularly important cases include scenario development, the evaluation of environments for the engineered barrier system, the evaluation of

transport processes in the host rock, and in the development of computer codes that can be applied to more than one performance assessment area.

With respect to scenario development, scenarios are needed to evaluate the performance measures for total system performance. The scenarios will also be needed to evaluate engineered barrier system performance. It will be important to coordinate the scenario development in these two cases to ensure that the scenarios are consistent.

With respect to the evaluation of environments, the thermal, thermomechanical, fluid flow, geochemical, and radiation environments evaluated for the engineered barrier system are directly related to those evaluated for the natural barrier system. Again close coordination is needed for these evaluations.

With respect to computer codes, there are several codes that are currently being used for evaluations in more than one area. For example, the ORIGEN2 code provides radionuclide inventories for the evaluation of the engineered barrier system performance and for total system performance. The EQ3/EQ6 geochemical codes support evaluation in all the performance assessment areas. The multiphase fluid flow code, TOUGH, is useful for analyses of the engineered barrier system and the natural barriers. There are other examples as well.

There are other activities that also need close coordination. The evaluation of source terms for the total system performance assessment must be closely coordinated with the evaluations of engineered barrier system performance. Likewise, the evaluations of fluid velocities for total system performance analysis should be closely coordinated with the development of information for the calculation of ground-water travel time for the natural barriers evaluation.

2.2 PERFORMANCE ASSESSMENT PARTICIPANTS AND CONTRACTORS

The Office of Civilian Radioactive Waste Management (OCRWM) is responsible for the performance assessments throughout the program. The responsibility for the geologic repository performance assessment analyses has been delegated to the Yucca Mountain Project Office (YMPO), and the responsibility for the oversight of these analyses has been given to the Office of Systems Integration and Regulation (OSIR). YMPO utilizes national laboratories and contractors to perform the analyses, and OSIR also maintains a set of contractors to support its oversight role. The two sets of participants and their technical roles are discussed in the next two subsections.

2.2.1 Yucca Mountain Project Office

The Yucca Mountain Project Office (YMPO) has the primary responsibility to implement the performance assessment strategy described in the PASP. It is responsible for the development of analytical tools for the performance assessments, development of scenarios, identification and manipulation of data from site characterization and design activities, and performance assessment analyses to determine site suitability and to demonstrate regulatory compliance. In addition, YMPO conducts activities to support the performance assessment activities, including model validation, sensitivity and uncertainty analyses to guide the site characterization and testing activities, and quality assurance of PA activities.

The performance assessment activities are performed for YMPO by two participating organizations, Sandia National Laboratories (SNL) and Lawrence Livermore National Laboratory (LLNL), together with their subcontractors. In addition, Los Alamos National Laboratory (LANL) and the United States Geological Survey (USGS) provide direct support to the performance assessment program.

These organizations are managed and integrated by the Yucca Mountain Project Office (YMPO) with technical and management assistance from Science Applications International Corporation (SAIC). Table 2-1 summarizes the YMPO participants and their functions in the performance assessment areas.

SNL is responsible for the repository performance assessment, which includes the total system PA, ground-water travel time evaluation, and the preclosure safety assessment. They are supported by several subcontractors in the performance assessment area. Lawrence Berkeley Laboratory (LBL) provides support to the development and application of models for near-field and far-field fluid flow in the unsaturated zone. Disposal Safety, Inc. provides support in the areas of scenario development and gaseous radionuclide release model development for Yucca Mountain. Oak Ridge National Laboratory (ORNL) provides support in the development of the radionuclide inventory generation and depletion code ORIGEN2 and its validation. Development of the TOSPAC code is supported by Spectra, Inc. In fiscal year (FY) 1990, Division 6416 of the SNL which supported OSIR in FY 1989 will support YMPO in both postclosure and preclosure performance assessment. Their activities will be fully integrated with those of other SNL Divisions which have been directly supporting the YMPO in the past. For the total system performance assessment, SNL is responsible for the development of release scenario models, development and testing of computer codes, code verification and model validation, and sensitivity and uncertainty analyses.

Table 2-1
YMPO PERFORMANCE ASSESSMENT CONTRACTORS

Sandia National Laboratories

Total System Performance Assessment
Repository design
Repository performance assessment
Contractors: LBL; Disposal Safety, Inc.; ORNL; Spectra, Inc.

Lawrence Livermore National Laboratory

Waste package testing
Waste package performance assessment
Contractors: NIST, Joan Delaney, ORNL

Los Alamos National Laboratory

Geochemistry
Volcanism studies
Radionuclide retardation

United States Geological Survey

Geology
Hydrology
Climatology
Seismotectonics

Science Applications International Corporation

Management and Integration Support

LLNL is responsible for the waste package performance assessments. They are responsible for the evaluation of waste package environments, for the development of EBS performance models, and the development of associated computer codes. LLNL is also responsible for the development of the EQ3/6 geochemical codes and the thermodynamic data base for these codes. LLNL is supported by the National Institute of Standards and Technology (NIST) and Joan Delaney (Consultant) in the development of the thermodynamic data base for EQ3/6 and by the Oak Ridge National Laboratory (ORNL) for development of EQ3/6 for sensitivity studies.

The USGS is responsible for site characterization activities associated with the development of geohydrologic conceptual models. This information is needed for the validation of the models that will be used as the basis for the ground-water travel time evaluations and for the understanding of the flow system for the total system performance assessments.

LANL is responsible for the evaluation of radionuclide retardation, a factor in the evaluation of radionuclide transport. In this capacity, LANL evaluates sorption, precipitation, and colloid formation. These retardation studies are done both experimentally and analytically. LANL is also responsible for studies of volcanism which will provide input to scenario and scenario-probability development for scenarios involving volcanism.

SAIC, as the YMPO technical and management support service (T&MSS) contractor, assists YMPO in the development and implementation of detailed performance assessment activity plans and in integration and monitoring of activities.

2.2.2 Office of Systems Integration and Regulations

The Office of Systems Integration and Regulations (OSIR) is responsible for oversight of the geologic repository performance assessment program. In this role, OSIR is responsible for developing guidance for the performance assessments and for review of the developments and analyses. OSIR maintains a number of contractors who support it in this role. Table 2-2 summarizes these contractors and their technical areas of expertise relevant to the performance assessments.

Pacific Northwest Laboratories (PNL) provides general support to OSIR's performance assessment oversight role through the Performance Assessment Scientific Support (PASS) program. The PASS program's primary functions are to

- Develop and maintain an integrated, interdisciplinary team of scientists for performance and safety assessments and capable of operating together to execute and review performance assessments.

- Provide direct assistance to OSIR by reviewing programmatic documents, participating in technical review meetings, and providing expert advice.

- Keep up with the state-of-the-art in performance assessment by critically reviewing methods and their application, including detailed evaluations and comparisons of quantitative analytical tools and validation of models.

- Develop needed analytical methods and perform other development to support OSIR's performance assessment oversight role.

In addition to the PASS program, PNL provides management support to OSIR in the area of performance assessment and regulatory compliance.

The Nuclear Engineering Department at the University of California at Berkeley (UCB) provides support to OSIR in the areas of Engineered Barrier System (EBS) performance and conceptual model development for radionuclide transport. This work supports the EBS computational model development of the PASS program and supports the review of the EBS and total system performance assessments conducted by YMPO.

Argonne National Laboratory (ANL) provides consultant support to OSIR for technical reviews of YMPO performance assessments. In particular, ANL consultants support the evaluation of corrosion models and the development of advanced computational techniques for treating waste package containment failures. ANL consultants also support OSIR in the development of performance assessment plans and guidance.

RE/SPEC, Inc. supports OSIR in the oversight of the performance assessments for special design, licensing, and site characterization evaluations. In addition, RE/SPEC, Inc. provides technical integration support to the geologic repository performance assessment program.

The WESTON technical support team provides general management support and technical integration support to OSIR. In particular, WESTON provides this type of support to OSIR's performance assessment oversight role.

Table 2-2
OSIR PERFORMANCE ASSESSMENT CONTRACTORS

Pacific Northwest Laboratories

Total system performance assessment
Engineered barrier system performance assessment
Natural barriers performance assessment
Preclosure safety assessment
Management and integration support

University of California at Berkeley

Engineered barrier system performance assessment
Radionuclide transport conceptual models

Argonne National Laboratory

Technical reviews
Corrosion models
Performance assessment plans

RE/SPEC, Inc.

Performance assessment, oversight support to specific tasks
Technical integration support

WESTON Technical Support Team

Management support
Technical integration support

2.3 PERFORMANCE ASSESSMENT WORKING GROUPS

As discussed in Section 2.2, the responsibility for the implementation of the performance assessments to support the design, licensing, and site characterization programs lies with the Yucca Mountain Project Office (YMPO), and the responsibility for oversight of these assessments rests with the Office of System Integration and Regulation (OSIR). The coordination of the performance assessments within YMPO and OSIR is carried out through seven performance assessment Working Groups. Working groups 1 through 4 focus on the activities in each of four performance assessment areas described in Section 2.1.4.

Working Group 1 coordinates a set of activities associated with total system performance assessment. In addition, Working Group 1 has the lead for scenario development and screening for all postclosure performance assessment areas. Working Group 1 is also responsible for the development of radionuclide retardation models and the evaluation of radionuclide transport for total system performance.

Working Group 2 coordinates the activities associated with engineered barrier system performance assessment. In addition, Working Group 2 has the lead for the model development and evaluation associated with thermal and thermomechanical conditions for all postclosure performance assessments and for evaluation of the extent of the disturbed zone. Working Group 2 also has the lead for the development of the EQ3/EQ6 geochemical codes and the data base for these codes. Working Group 2 also provides the information that serves as the basis for the source terms for the total systems performance assessments coordinated by Working Group 1.

Working Group 3 is responsible for the natural barriers performance assessment, in particular, the evaluation of the ground-water travel time performance measure. This Working Group is responsible for the conceptual and computational model development for the evaluation of the fluid flow in the natural barriers. This working group is also responsible for the information that serves as the basis for the fluid velocities for the total system performance assessments coordinated by Working Group 1 and the boundary conditions for the fluid environment assessments coordinated by Working Group 2.

Working Group 4 coordinates the preclosure safety assessment activities. In addition, the development and documentation of the radionuclide inventory generation and depletion code, ORIGEN2, is assigned to Working Group 4.

Working Groups 5, 6, and 7 coordinate the performance assessments that directly support design, licensing, and testing.

Working Group 5 coordinates the interface between performance assessment and the design program. In addition, Working Group 5 coordinates with Working Groups 1-4 to ensure that the activities in those areas satisfy the needs of the design program. Working Group 6 coordinates the activities that interface with licensing, for example, the support to the DEIS and SAR. Working Group 7 coordinates the performance assessments conducted to guide the testing program. Working Group 7 also coordinates the activities to evaluate the adequacy of data from the testing program for the performance assessments.

Each Working Group is composed of the following individuals:

- A representative of YMPO
- A representative of OSIR
- Representatives from each of the organizations involved in the activities coordinated by the Working Group

The YMPO and OSIR representatives provide the tie to DOE line management. The representatives of each of the participating organizations provide ties to their respective management. For the sake of conduct of meetings and other such matters, the YMPO representative is designated as the lead for each Working Group.

The specific representatives to each Working Group are summarized in Figure 2-1. Working Group 1 includes representatives from SNL, PNL/PASS, UCB (for gas transport activities), and LANL (for transport and retardation).

Working Group 2 includes representation from LLNL, PNL/PASS, UCB, and Roger Staehle of the University of Minnesota, an ANL consultant. Working Group 3 includes representation from SNL, LBL, PNL/PASS, and the USGS. Working Group 4 is composed of representatives from SNL, ORNL, and PNL.
Working Group 5 includes representation from SNL, who has responsibility for ESF design, and PNL and RE/SPEC, who support OSIR's oversight of the performance assessments that support ESF design. Working Group 6 includes representation from SNL and from RE/SPEC, Golder Associates (an ANL consultant firm), and PNL. Working Group 7 includes representatives of each of the YMPO participants and PNL, who supports OSIR.

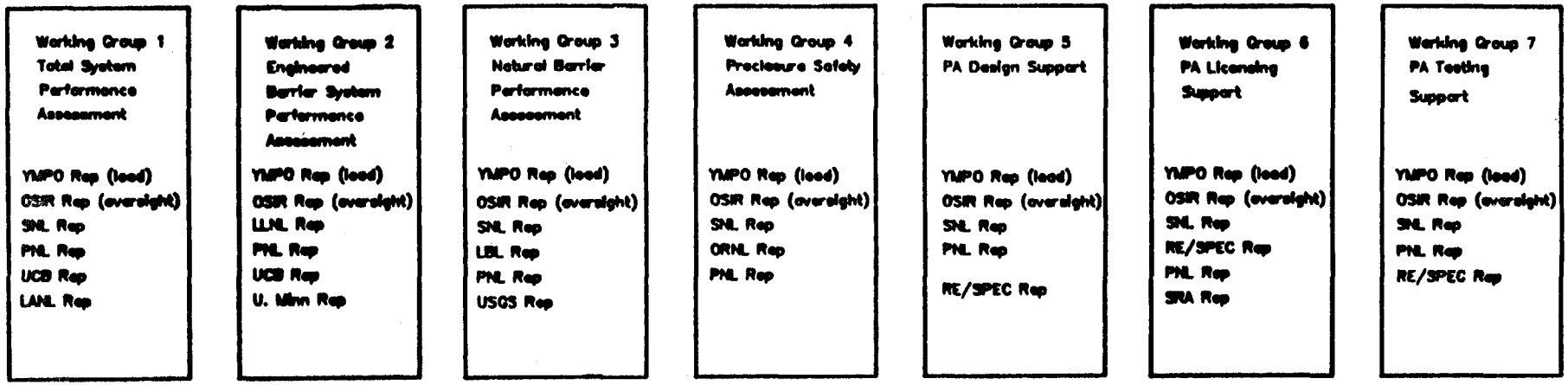

Figure 2–1. Performance Assessment Working Groups.

3 PERFORMANCE ASSESSMENT STRATEGY IMPLEMENTATION

This section summarizes the general, integrated strategy that is presented in the PASP, outlines the major performance assessment objectives and milestones for fiscal year (FY) 1990, relates these objectives to the performance assessment objectives beyond FY 1990, and introduces the types of performance assessment activities to be conducted during FY 1990.

3.1 OVERVIEW OF THE PERFORMANCE ASSESSMENT PROGRAM

3.1.1 Overview of the Performance Assessment Schedule Leading to the License Application

The Performance Assessment Strategy Plan (PASP) lists the major milestones of the geologic repository program leading to the License Application and outlines the performance assessments needed to support these milestones. The PASP describes how the current schedule of geologic repository program milestones defines three phases to the performance assessment program leading to a License Application in October of 2001: the "early site investigation PA" phase, the "EIS PA" phase, and the "SAR PA" phase. The early site investigation PA phase extends through the early part of site characterization until issuance of the EIS Implementation Plan. Advanced Conceptual Design studies will be completed and scoping of the EIS will be conducted during this period. During this phase, preliminary performance assessments will be conducted to support design, licensing, and testing evaluations that will be conducted during this period and to support the development of performance assessment capabilities for the EIS and SAR performance assessments that will be conducted later. The EIS PA phase extends from the time of issuance of the EIS Implementation Plan until the completion of the performance assessments for the DEIS. The SAR PA phase extends from the completion of the DEIS performance assessments to the completion of the performance assessments for the SAR. During the latter two phases, all of the performance assessments to support the Site Recommendation Report and the License Application will be completed.

The primary goals of the performance assessments in the early site investigation PA phase are to

- Improve existing performance assessment capabilities through preliminary performance assessment exercises, scoping analyses, and sensitivity studies.
- Evaluate the significance to waste isolation and containment of potentially adverse features and

conditions at the site as a part of the early evaluations of site suitability.

- Support planning for and evaluation of the site investigations testing to ensure that the data needed for the performance assessments are obtained.

- Support ESF design efforts by contributing to the development of design requirements and by evaluating the ESF design against those requirements.

- Perform evaluations of the potential impacts of surface-based and in situ testing programs on the waste isolation capability of the site.

- Support the ACD studies by analyses to derive design requirements consistent with the performance objectives for waste isolation and containment.

- Review the ACDs for the repository and the waste package to ensure compliance with the design requirements and to provide input to the LAD design requirements.

- Assist in the preparation for EIS scoping by evaluating performance assessment issues related to the EIS.

- Improve methodologies, conceptual models , and computational models for the DEIS and SAR performance assessments.

The performance assessment goals for the EIS PA phase include

- Complete the methodology, conceptual model, and computational model development and the performance assessment analyses for the DEIS.

- Continue the analyses to support the early site evaluations of potentially adverse features and conditions.

- Complete preparations for the performance assessments for the SAR, for the comprehensive site-suitability analyses, and the assessments of the repository and waste package LADs.

The goals of the performance assessments during the SAR PA phase include:

- Support response to public comments for the FEIS.
- Complete the analyses for the SAR and the repository and waste package LADs.
- Complete conceptual model validation (including any software validation) needed for the License Application.

A summary of the specific performance assessment needs at various times during these phases is summarized in Table 3-1. This table shows the need to integrate the performance assessments to support the multiple efforts throughout these phases.

Table 3-1 suggests that preliminary performance assessments and sensitivity studies will be conducted in the early site investigation PA phase on a repeated basis to support a variety of evaluations. Early in this phase, the performance assessments will be designed to support the efforts of the review of the prioritization of the surface-based testing program, the development of alternative licensing strategies, and the evaluation of alternative ESF configurations and design features. The performance assessments and sensitivity studies conducted for these early milestones will also contribute to the preparations for the EIS and SAR.

Later in the early site investigation PA phase, the performance assessments will be used to evaluate the adequacy of the early results of the site characterization studies. As information is obtained from the testing program regarding the potentially adverse features and conditions at the site, the performance assessments will support the evaluation of the features and conditions. The analyses will also be used for the preparations for the EIS and SAR performance assessments.

Still later in this phase, the focus of the performance assessment analyses will be to develop input to the ACD design requirements for the repository and the waste package. Analyses will also continue with respect to the suitability of the site and, to the extent possible, these analyses will be integrated with those for the design. The methodology development for these analyses is scheduled to be completed by March, 1991, and the development of computational models by the end of 1991. The assessments for the ACD analyses are scheduled from March, 1991, until June, 1992.

Table 3-1
GENERAL SEQUENCE OF PERFORMANCE ASSESSMENTS

Early Site Investigation PA Phase

FY 1990

Support to prioritization of surface-based testing
Support to evaluation of alternative licensing strategies
Support to evaluation of alternative ESF designs
Preliminary preparations for SAR and DEIS assessments

FY 1991

Support to early site-suitability evaluations
Analyses of data needs to support site characterization
Support to development of ESF design requirements
Preliminary preparations for SAR and DEIS assessments

FY 1992

Support to early site-suitability evaluations
Review and assess results of surface-based testing program
Analyses of data needs to support site characterization
Evaluation of ESF design against ESF design requirements
Preliminary preparations for SAR and DEIS assessments

FY 1993-FY 1994

Support to early site-suitability evaluations
Review and assess results of surface-based testing program
Analyses of data needs to support site characterization
Support to development of ACD design requirements
Preliminary preparations for SAR and DEIS assessments

FY 1995

Support to early site-suitability evaluations
Review and assess results of surface-based testing program
Analyses of data needs to support site characterization
Analysis of ACD against ACD design requirements
Support to development of LAD design requirements
Preliminary preparations for SAR and DEIS assessments

Table 3-1 (Continued)
GENERAL SEQUENCE OF PERFORMANCE ASSESSMENTS

FY 1996-Mid 1998

Evaluate LAD against LAD design requirements
EIS scoping
Support to early site-suitability evaluations
Review and assess results of surface-based testing program
Analyses of data needs to support site characterization
Preliminary preparations for SAR and DEIS assessments

EIS PA Phase

Mid 1998-FY 1999

Evaluate LAD against LAD design requirements
Assessments for EIS
Support to early site-suitability evaluations
Review and assess results of surface-based testing program
Review and assess results of in situ testing program
Analyses of data needs to support site characterization
Preliminary preparations for SAR assessments

SAR PA Phase

FY 1999-FY 2001

Evaluate LAD against LAD design requirements
Assessments for SAR
Support to comprehensive site-suitability evaluations

Finally, assessments to assist in defining the appropriate content for the EIS will be completed in the last part of the early site investigation PA phase. Such assessments must be performed so that not only will the scoping determine an appropriate set of performance measures to represent environmental impacts of the geologic repository, but the participants in the scoping process will have information to know the performance measures that can be calculated using available data and performance assessment technology.

In the EIS PA phase, the performance assessment calculations are those needed for the EIS. Although the types of analyses that will be conducted at this time are defined during the EIS scoping that takes place earlier, finalization of the methodology and the models needed for the assessments cannot be completed until later, i.e., during the EIS PA phase. Review of the results of site characterization, in particular the results of tests related to the potentially adverse features and conditions, will continue in this period. Preparations for the SAR performance assessments will also continue.

In the SAR PA phase, the primary goal of the assessments is the support the SAR and these assessments must be completed in time for submittal of the LA in October of 2001. At the same time the comprehensive site-suitability analyses will be completed. Certification of the models used for the SAR analyses will also be completed in this phase.

3.1.2 Overview of the Performance Assessment Areas

The activities required to accomplish the objectives in these phases are structured into eight areas: general implementation and oversight and seven areas corresponding to the Working Groups discussed in Section 2. The general implementation and oversight activities include direct assistance to DOE in performance assessment planning, coordination, integration, and review of the performance assessment activities. The functions of the performance assessment Working Groups and the Technical Integration Group (TIG) are accounted for under this area.

Activities in the first four of the technical areas address the four performance areas: (1) total system performance, (2) engineered-barrier system performance, (3) natural barriers performance, and (4) preclosure safety; these activities are coordinated by Working Groups 1 through 4, respectively. The performance assessment activities under each of these working groups involve methodology development, conceptual model development and validation, computational model development and certification, calculation of performance measures, and sensitivity and uncertainty analyses.

The activities under Working Groups 5, 6, and 7 are to assure the coordination of performance assessment activities with the design, licensing, and testing programs, respectively. The activities under these Working Groups will require integration with the activities under Working Groups 1, 2, 3, and 4.

3.1.3 Overview of the Performance Assessment Activities

The performance assessment activities in each area generally serve one or more purposes. One purpose the identification of critical processes and elements of the system that must be accounted for in the performance assessments. Another purpose is the support of current design, licensing, and testing evaluations in the geologic repository program. These purposes are accomplished through calculational exercises and sensitivity studies. Other purposes include the development of methodology, conceptual models, and computational models to address the needs identified through the calculational exercises and sensitivity studies. Another purpose of the activities is to integrate and coordinate the performance assessment analyses and to provide appropriate review and oversight of the efforts. The purposes of each of the eight areas will be accomplished by the following categories of activities:

1) Performance assessment calculational exercises. These are specially designed analyses, tailored to focus on specific technical issues.

2) Development of performance assessment codes and models. These activities initiate or continue specific code and model development in support of out-year milestones such as the SAR and the EIS.

3) Direct support to current program technical evaluations. These activities involve the coordination of the objectives of the evaluations with the sensitivity studies conducted by performance assessment and the conduct of other analyses and reviews.

4) General performance assessment implementation and oversight support.

3.2 1990 OBJECTIVES OF THE GEOLOGIC REPOSITORY PROGRAM

The performance assessment activities during FY 1990 are structured to support the objectives of the geologic repository program; these include the preparations for the EIS, determination of suitability of the site, and, if the site is found to be suitable, submittal of a License Application to the

Nuclear Regulatory Commission. Therefore, many of the activities in the performance assessment program in FY 1990 are directed toward preparations for the assessments needed for these efforts. These preparations include development of capability to calculate the system performance measures such as the complementary cumulative distribution function (CCDF) for cumulative releases to the accessible environment, to understand the data needs for this calculation, to understand the sensitivity of the CCDF to the representations of the characteristics and features of the site, and to understand the significance of unanticipated processes and events. Other preparations for these performance assessments include the development of computational models, including a total system simulator and an engineered-barrier system simulator. Perhaps most important of all, because of the uncertainties involved, development of conceptual models of flow and transport and the sensitivity of the performance measures to these models needs attention this year.

In addition to these long-term development concerns, performance assessments will be needed to support several evaluations that will be conducted in the geologic repository program this year. These evaluations include:

- Review of the surface-based testing program and prioritization of studies to focus on potentially adverse conditions and features at the site.
- Development of alternative licensing strategies that address alternatives to testing priorities, design, licensing considerations, and performance assessment.
- Evaluation of alternative approaches to the characterization of the Calico Hills unit at the Yucca Mountain site.
- Evaluation of alternative design features and configurations for the Exploratory Shaft Facility.
- Preliminary developments for the specification of ESF design requirements.
- Evaluation of glass and other material as a high-level waste form.

Each of these efforts will need support of performance assessments and the performance assessment activities in FY 1990 are also structured to provide this support. In general, these efforts will require (1) development of methodologies for various technical strategies and comparison of these methodologies and (2) sensitivity studies to identify critical process, elements, features, and conditions at the site. The performance assessment activities for FY 1990 have been designed to meet these needs.

3.3 1990 PERFORMANCE ASSESSMENT ACTIVITIES

The activities in each of the performance assessment areas fall into a one of several categories designed to address the FY 1990 geologic repository program objectives; these categories are (1) PACE exercises, (2) development, (3) direct support to short-term milestones, and (4) general implementation and oversight.

The PACE exercises (Performance Assessment Calculational Exercises) are specially designed analyses, tailored to focus on specific technical areas to identify critical processes and elements, to develop computational facility, and to provide sensitivity studies generally supporting current program evaluations. The PACE analyses in FY 1990 have three principal milestones:

1. Calculation of performance measures for expected performance. These analyses are to be completed in April of 1990. The analyses are to provide insights into the nature of these calculations, provide results that can be referred to in the program efforts, and provide part of the basis for the disturbed-performance calculations and the sensitivity studies to be completed later.

2. Calculation of performance measures for disturbed performance scenarios. These analyses are to be completed in July of 1990. They are to provide insights into the treatment of unanticipated processes and events and potentially adverse conditions and features of the site in the performance assessments, to provide information for the site-suitability considerations in FY 1990 and in the future, and to provide part of the basis for the sensitivity studies to be completed later.

3. Sensitivity studies. These analyses are to be completed in September of 1990. They are to provide insight into the nature of these analyses and to provide information for the future developments and for the program evaluations.

Development of performance assessment codes and models will be conducted to prepare for the long-term milestones including the DEIS and the SAR. The milestones for the FY 1990 development activities are generally set to be completed in September of 1990.

Activities are planned to provide direct support to the design, licensing, and testing efforts to be conducted in FY 1990. This work generally involves the coordination of the objectives of the evaluations with the sensitivity studies for the PACE exercises. In addition, specific, special-purpose analyses and reviews will be conducted for these efforts. The milestones for these activities are those specified for the specific evaluations they support.

General implementation and oversight activities will be conducted to support the management, integration, coordination, and review of the technical activities. A product of these activities will be plans for FY 1991 performance assessments by the end of this fiscal year. These plans will take into account the results and progress of the FY 1990 activities and the needs of the geologic repository program in FY 1991.

Section 4 provides details on each of the FY 1990 performance assessment activities. The PACE calculations and the development of codes and models will be coordinated by Working Groups 1, 2, 3, and 4 and the activities in support to the FY 1990 program technical efforts will be accomplished under Working Groups 5, 6, and 7.

Both YMPO participants and contractors and OSIR contractors will contribute to the PACE exercises and to the long-term development activities in order to assure the development of capabilities for the evaluations to be conducted in future years and to provide appropriate oversight of these future assessments. The detailed analyses in support of FY 1990 site characterization, design, and regulatory activities will be conducted by the YMPO participants, while the OSIR contractors will support its oversight and review responsibilities.

The following sections introduce the FY 1990 objectives in each of the performance assessment areas and relate specific activities in each of these areas to those objectives.

3.3.1 General Implementation and Oversight

The general implementation and oversight activities include the assistance given by contractors to OSIR and YMPO in planning, coordinating, and reviewing other performance assessment activities. Specific FY 1990 activities include the staffing of the performance assessment Technical Integration Group (TIG), participation in performance assessment Working Group meetings and work, assistance to OSIR and YMPO in developing overall performance assessment plans and guidance, and technical management of the performance assessment activities by the contractors.

3.3.2 Working Group 1 Activities

As discussed in Section 2, Working Group 1 responsibilities include total system performance assessments, including the analysis of retardation processes as they affect the transport of radionuclides in the far field. The objectives of this Working Group during FY 1990 are (1) continued development of the total system performance assessment model including the evaluation of data and conceptual models for such a total system model, (2) scenario development and, through a series of PACE problems, evaluation of the consequence analysis methodology, (3) sensitivity and uncertainty analyses to assist in methodology development, and (4) through Working Groups 5 and 7, guidance to the ESF design program and the surface-based testing program.

Working Group 1 PACE activities include a review of the PACE data base in order to assure consistency and accuracy in the use of the data by all participants in the exercises, the definition and characterization of scenarios for the PACE assessments, the conduct of consequence analyses for expected and disturbed performance scenarios, and the conduct of sensitivity analyses for system performance. The sensitivity analyses will include evaluation of dependence of the performance measures, including the CCDF, on radionuclide inventory, waste age, and associated heat generation rate, containment time and release rate, chemical and non-chemical retardation effects, and key site parameters.

To assist in providing support to the site characterization program by Working Group 7, Working Group 1 will conduct preliminary analyses with emphasis on understanding the possible impacts and importance of potentially adverse conditions whose existence cannot be ruled out by the existing site data. To facilitate the evaluation of the Yucca Mountain site with respect to potentially adverse conditions, a set of PACE problems considering such conditions will be defined based on the set of scenarios identified in the Site Characterization Plan with possible changes in the set to account for changes in the understanding of the site environments, the processes acting at the site, and possible future events at the site. Initial evaluations may be conducted using assumed releases from the engineered-barrier system; however, as the associated engineered-barrier system assessments are completed, the total system assessments will be evaluated considering using the releases projected by the EBS assessments. These analyses of the potentially adverse conditions will assist in the identification of appropriate data (parameters and locations) to be collected by the surface-based testing program.

The continued development of the total system performance assessment model during FY 1990 includes the following activities: (1) the development, verification, and documentation

of SUMO system-level code, (2) the development, verification, documentation and validation of the TOSPAC system-level code and the STRESS-3D code needed for the ESF evaluations, and (3) the development of a model for gas-phase radionuclide transport through partially-saturated tuff (with emphasis on C-14).

Specific milestones for FY 1990 which are the responsibility of Working Group 1 are summarized in Appendix C.

3.3.3 Working Group 2 Activities

Working Group 2 has responsibility for analyzing the performance of the engineered-barrier system (EBS), for estimating near-field environments, and for providing the information to define the source term for total system performance assessments. The objectives for Working Group 2 during FY 1990 focus on (1) improving the understanding of near field environments and, through sensitivity analyses, their importance to EBS performance, (2) continuing the development of models for evaluation of EBS performance measures, (3) exercising the EBS evaluation methodology and technology considering the scenarios defined for total system performance assessments, (4) developing models of EBS performance appropriate for use in total-system performance assessment and supplying information to define the source term for the total system performance assessments, and (5) through Working Groups 5 and 7, provide guidance to the design program and the surface-based testing program.

Much of the EBS performance assessment effort for the PACE exercises will be to improve the understanding of the environments in the vicinity of the waste packages, the processes acting on those environments, and the effects of the environments on waste package performance. This understanding is most important in the development of appropriate EBS models. To assist in defining the environments and processes that are most important, site and design data will be reviewed to assure that the data needed to support these calculation will be available and sensitivity analyses will be conducted.

The EBS PACE activities also include the definition of EBS release modes for the scenarios defined for the total system performance assessments, the calculation of container failures and release rates for the scenarios, and assistance in the definitions of appropriate source terms for the total system performance assessments of the selected scenarios.

Specific EBS code and model development activities during FY 1990 include the following:

- o A model of container failure frequency to interface with the total system performance assessment model, considering correlations of such failures with system parameters

- o A model of mass transfer through rubble within the EBS.

- o A model of radionuclide release caused by solid-phase alterations of the waste form.

- o A model of coupled transport of colloids and solute.

- o A model of air and water movement in non-isothermal, fractured, porous media, including the effects of post-emplacement temperature fields.

- o Continue development, verification, and documentation of the AREST code, including participation in benchmarking the test problem set, adding the most recent UCB mass-transfer models and spacial variability of the repository source term, model maintenance, and code distribution/installation at other DOE contractors.

- o Continue development, verification, and documentation of the PANDORA code.

- o Development of uncertainty methods for source term models.

- o Continue development, verification, and documentation of the EQ3/EQ6 codes.

- o Continue development and documentation of the TOUGH code.

Specific milestones for FY 1990 which are the responsibility of Working Group 2 are summarized in Appendix C.

3.3.4 Working Group 3 Activities

Working Group 3 has responsibility for the assessment of the natural-barrier performance, including the development of conceptual models for liquid and gas flow through the saturated and unsaturated systems, evaluation of the effect on the flow by the repository and the waste packages, and the calculation of pre-waste-emplacement ground-water travel time. The FY 1990 objectives for Working Group 3 focus on: (1) analyses to assist in the development of models appropriate for natural barrier performance assessment, (2) the development of model validation

strategy and methodology, (3) the definition of a set of problems to exercise the natural barrier performance assessment methodology and technology, and (4) initiation of those exercises. The performance measure of most interest for the natural barrier system is the pre-waste-emplacement ground-water travel time (GWTT); however, the analyses conducted under this area of performance assessment also provide an understanding of the post-emplacement hydrology and provide information to support the specification of appropriate fluid velocity fields for the total system performance assessments.

Specific analyses to be conducted as a part of the PACE exercises include:

- A review of the available data base.
- An analysis to relate statistical properties of fracture networks to the geohydrologic properties of the host rock, with specific emphasis on the effects of variable aperture properties on effective permeability.
- An analysis of intra-layer and inhomogeneity effects on the flow field.
- A study of the sensitivity of the flow models to the site geohydrologic properties including permeability, porosity, saturation, and initial and boundary conditions.
- An investigation of the perching of water at the contact various rock units at the site.
- Sensitivity studies of postclosure hydrology to define the geohydrologic parameters most important to total system performance.
- An analysis of the postclosure hydrology at the site considering the effects of waste-generated heat, excavations, and ventilation.
- An assessment of the postclosure hydrology with emphasis on the effects of the various scenarios defined for total system performance assessments, to support the definition of velocity fields for the scenarios to be used in the total system assessments.

The code development activities during FY 1990 will focus on the development, verification, and documentation of the PORFLO-3, NORIA, LLUVIA and FEMWATER codes. In addition, NORIA will be validated for use in the ESF design assessments.

Specific milestones for FY 1990 which are the responsibility of Working Group 3 are summarized in Appendix C.

3.3.5 Working Group 4 Activities

As discussed in Section 2, Working Group 4 is responsible for all preclosure safety assessment activities. The preclosure safety assessment objectives for FY 1990 are limited to studies to validate the ORIGEN2 isotope generation and depletion code. Other activities are being deferred until the designs for the ACD for the repository begins. Specific milestones for the activities that will be conducted are summarized in Appendix C.

3.3.6 Working Group 5 Activities

As discussed in Section 2, Working Group 5 is responsible for supporting design evaluations. The FY 1990 objectives for this working group are to (1) conduct analyses of existing designs to support the development of ESF design requirements and (2) conduct an assessment of alternative ESF features and configurations.

3.3.7 Working Group 6 Activities

Working Group 6 has the responsibility for supporting licensing evaluations. This includes coordination with the licensing strategy and identifying the performance assessment efforts required to support the EIS and the SAR.

The FY 1990 activities for this Working Group include providing direct support to the evaluation of alternative licensing strategies in the area of performance assessment methodology and to support the review of the analyses by the EPA in support of the repromulgation of the EPA environmental standards for high-level waste.

3.3.8 Working Group 7 Activities

Working Group 7 has the responsibility to provide direct support to the testing programs. At this time, the focus is on coordination with the surface-based testing program and laboratory testing. Specific activities during FY 1990 to be conducted by this Working Group include:

- Coordinating the performance assessment evaluation of the surface-based testing program to support the prioritization of the studies within this testing program.

- Conduct performance assessments to support the evaluation of alternatives to characterization of the Calico Hills unit.

- Coordinate the review of FY 1990 study plans to ensure that the data being obtained are consistent with performance assessment needs and communicate these findings to the project.

- Develop a methodology for the evaluation of the site qualifying/disqualifying and favorable/potentially-adverse conditions and the determination of site suitability.

3.3.9 Related Activities

There are many activities of the geologic repository program that are not managed within performance assessment Work Breakdown Structure elements, but which are closely related to performance assessment. They include the participation by LANL and the USGS in the PACE exercises and the coordination of performance assessment model development activities with the site and laboratory work by LANL, the USGS, and LLNL. Within this plan, these activities have been given activity numbers that begin with 90-8 and are presented at the end of Section 4.

4 ACTIVITIES

This section identifies the specific activities to be conducted in the performance assessment program in fiscal year (FY) 1990. The activities are generally described and summarized in Chapter 3. This chapter provides a brief description of each activity on an individual summary sheet. Each summary sheet specifies the title of the activity, assigns an identification number, and gives the activity area, the objective and technical approach for the activity, the participating organizations and principal investigators, the level of effort, the milestones and schedule, and the linkages of the activity with any of the other FY 1990 activities. A summary listing of the entire set of activities is given in Appendix A.

The activity area specified on an activity sheets is one of the following:

- o General implementation and oversight.
- o Total system performance assessment.
- o Waste package performance assessment.
- o Repository performance assessment.
- o Site performance assessment.
- o Code development and verification.
- o Model development and validation.
- o Performance assessment support to design programs.
- o Performance assessment support to licensing programs.
- o Performance assessment support to testing.
- o Site and waste package support to performance. assessment.

These areas are loosely related to performance assessment Work Breakdown Structure elements that are similarly named and to the Working Group areas of responsibility described in Chapter 3.

The activity identification number is given by three digits, II, JJ, and KK, in the format, II-JJ-KK. In this format, II is the year, (e.g. "90"), JJ is the working group that coordinates the activity, and KK is a sequential index for the activity.

The levels of effort on each activity sheet are given in full-time equivalent personnel (FTE). These numbers are summarized on spread sheets in Appendix B.

Milestones are given for each activity on the activity sheet. These milestones are always in the form of delivery of a data package or a report to the cognizant DOE managers at YMPO and OSIR. Charts that summarize these milestones are presented in Appendix C.

PERFORMANCE ASSESSMENT ACTIVITY 90-0-1

Activity Area: General Implementation and Oversight

Activity Title: PA Technical Integration Group (TIG)

Activity Objective & Technical Approach:

Provide advice to PA Program Overview Group (POG) regarding overall PA program integration needs.

Participate in meetings of the TIG, PA Working Groups, and POG. Review geologic repository PA program and PA interfaces with other programs (e.g., Transportation, Defense High-Level Waste). Provide summaries of activities. Provide recommendations regarding integration of PACE exercises, PA development, and geologic repository program technical support by PA.

Organization (Principal Investigator):

RE/SPEC	(P. Gnirk)
SAIC	(J. Younker)
WESTON	(L. Rickertsen)

Level of Effort (FTE's): 1.5

RE/SPEC	1.5
SAIC	Not funded by performance assessment
WESTON	Not funded by performance assessment

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-0-2

Activity Area: General Implementation and Oversight

Activity Title: PA Working Group (WG) Support

Objective & Technical Approach:

Coordinate performance assessment efforts of program participants.

Review program PA efforts in WG areas. Attend WG meetings. Provide summaries of activities. Develop PACE cases for analysis so as to identify gaps, focus development, and conduct sensitivity studies. Coordinate YMPO and OCRWM PA efforts in WG areas. Develop FY 91 PA activity plans.

Organization (Principal Investigator):

PNL (P. Doctor) Working Groups 1, 2, 3, 7
UCB (T. Pigford) Working Group 2
SNL (F. Bingham, T. Bonano) Working Groups 1, 3, 5
LLNL (L. Jardine) Working Group 2
LBL (C. Tsang) Working Group 3
LANL (K. Eggert) Working Group 1
USGS (D. Hoxie) Working Group 3

Level of Effort (FTE's) 2.2

PNL	0.8
UCB	0.2
SNL	0.8
LLNL	0.2
LBL	0.2
LANL	Not funded by performance assessment
USGS	Not funded by performance assessment

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-0-3

Activity Area: General Implementation and Oversight

Activity Title: Management Support

Objective & Technical Approach:

Provide direct support to the Regulatory Compliance Branch PA activity management. Help develop PA plans and guidance. Review PA program and deliverables.

Organization (Principal Investigator):

WESTON	(D. Michlewicz)
PNL	(A. Van Luik)
ANL/RAEC	(R. Wilems)

Level of Effort (FTE's): 4.3

PNL	3.7
ANL/RAEC	0.6
WESTON	Not funded by performance assessment

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-0-4

Activity Area: General Implementation and Oversight

Activity Title: Management Support

Objective & Technical Approach:

Provide direct support to Performance Assessment Branch PA activity management. Help develop PA plans and guidance. Review PA program and reports.

Organization (Principal Investigator):

SAIC (U. Park)

Level of Effort (FTE's):

SAIC Not funded by performance assessment

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-0-5

Activity Area: General Implementation and Oversight

Activity Title: Technical Management of PNL/PASS PA activities

Activity Objective & Technical Approach:

Provide technical management of PNL/PASS PA activities.

Organization (Principal Investigator):

PNL (P. Doctor)

Level of Effort (FTE's): 3.0

PNL 3.0

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-0-6

Activity Area: General Implementation and Oversight

Activity Title: International performance assessment activities and Validation Oversight Group

Objective & Technical Approach:

Participate in Validation Oversight Group and international performance assessment programs and projects, e.g. INTRAVAL, PAAG.

Organization (Principal Investigator):

PNL/PASS (P. Doctor)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-1-1

Activity Area: Total System Performance Assessment (TSPA)

Activity Title: PACE data base review for TSPA

Objective & Technical Approach:

Review existing information to ensure that the conceptual models and data bases used for the PACE TSPA activities are integrated and consistent with activities addressing other PA areas.

Review will be conducted on an ongoing basis but will provide specific data packages for the TSPA consequence and sensitivity analyses.

Organization (Principal Investigator):

SNL (F. Bingham)
PNL/PASS (P. Doctor)

Level of Effort (FTE's): 0.6

PNL/PASS	0.3
SNL	0.3

Milestones and Schedule:

PNL data package for TSPA exp. perf analyses	2/90
PNL data package for TSPA dist perf analyses	4/90
PNL data package for TSPA sensitivity studies	6/90
SNL data package for TSPA exp. perf analyses	2/90
SNL data package for TSPA dist perf analyses	4/90
SNL data package for TSPA sensitivity studies	6/90
SNL report on issues and data needs for PA	9/90

Linkages with Other Activities:

This activity defines the data set that will be used in activities 90-1-3 through 90-1-6.

PERFORMANCE ASSESSMENT ACTIVITY 90-1-2

Activity Area: Total System Performance Assessment (TSPA)

Activity Title: PACE scenario and probability development

Objective & Technical Approach:

Identify and screen significant release scenario classes and define the probabilities of their initiation as a function of time. Also, develop a methodology for systematically selecting and assigning probabilities to scenarios to be addressed in mature system assessments. Review past work and recommend scenario classes and probabilities for FY 1990 use. Longer term efforts would involve methodology development for scenarios selected for work beyond FY 1990. Construct mathematical models of the scenario classes including a radionuclide source term and pathways, as appropriate, and to provide simplified, computationally efficient models of the final scenario classes representing the significant processes and events.

Organization (Principal Investigator):

PNL/PASS (P. Doctor)
SNL (G. Barr, T. Bonano)

Level of Effort (FTE's): 3.0

SNL	2.0	PNL/PASS	1.0

Milestones and Schedule:

PNL rept. on scenario set for TSPA exp. perf. analyses	1/90
PNL rept. on scenario set for TSPA dist. perf. analyses	2/90
PNL rept. on methodology for scenario selection	8/90
SNL rept. on scenario set for TSPA exp. perf. analyses	1/90
SNL rept. on scenario set for TSPA dist. perf. analyses	2/90
SNL rept on volcanism & human intrusion	9/90
SNL report on screening of scenarios vs consequences	9/90

Linkages with Other Activities:

Input to : 90-1-3,4,5,6; 90-2-2,5,6,7; 90-3-4,5,6,7

PERFORMANCE ASSESSMENT ACTIVITY 90-1-3

Activity Area: Total System Performance Assessment (TSPA)

Activity Title: PACE expected performance analyses

Objective & Technical Approach:

Develop simplified calculational models and analyze the consequences for the expected performance scenarios. Consequences to be evaluated include radionuclide travel time, cumulative radionuclide release to the accessible environment, the CCDFs for the expected performance scenarios, ground-water concentrations of released radionuclides, and doses to a maximally exposed individual. Both ground-water and gaseous pathways will be evaluated. Conduct sensitivity studies to investigate the dependence of releases to the accessible environment on (1) radionuclide inventories; (2) design parameters (e.g., waste age and areal thermal loading); (3) source term (containment time and release rate); (4) retardation factors; (5) retardation models; and (6) site parameters.

Organization (Principal Investigator):

PNL/PASS (P. Eslinger); SNL (F. Bingham, T. Bonano); UCB (T.Pigford)

Level of Effort (FTE's): 5.4

PNL/PASS	2.0;	SNL	3.0;	UCB	0.4

Milestones and Schedule:

PNL report on expected performance	4/90
UCB report on expected performance	4/90
SNL report on expected performance	4/90
SNL report on water pathways	9/90
SNL report on gas pathways	9/90

Linkages with Other Activities:

Output needed from: scenarios from 90-1-2, waste package information for source terms from 90-2-7, and information from ground-water modeling for velocity fields 90-3-7. Input to: 90-1-5 and 90-1-6.

PERFORMANCE ASSESSMENT ACTIVITY 90-1-4

Activity Area: Total System Performance Assessment (TSPA)

Activity Title: PACE disturbed performance analyses

Objective & Technical Approach:

Develop calculational models and assess the consequences of disturbed performance scenarios. Consequences include releases to the accessible environment and the CCDF's for each scenario.

Modify the models used for the expected case to reflect changes resulting from the unexpected events.

Organization (Principal Investigator):

PNL/PASS (P. Doctor)
SNL (F. Bingham, T. Bonano)

Level of Effort (FTE's): 3.0

PNL/PASS	2.0
SNL	1.0

Milestones and Schedule:

SNL report on analysis for disturbed performance	7/90
PNL report on analysis for disturbed performance	7/90

Linkages with Other Activities:

Input to: 90-1-6. Need output of 90-1-2 and 90-1-3.

PERFORMANCE ASSESSMENT ACTIVITY 90-1-5

Activity Area: Total Systems Performance Assessment (TSPA)

Activity Title: PACE CCDF sensitivity analyses

Objective & Technical Approach:

Assess ability to calculate overall CCDF from available information and to determine information most important to evaluation of the CCDF. The analyses will include: (1) Evaluation of techniques for organizing scenarios and for estimating probabilities; (2) Evaluation of sampling and variance reduction techniques (e.g. Latin Hypercube Sampling); (3) Evaluation of the sensitivity of the CCDF to the scenario probabilities; (4) Evaluation of the sensitivity of the CCDF to key site parameters for disturbed performance scenarios; (5) Evaluation of sensitivity of the CCDF to conceptual models; and (6) Evaluation of the sensitivity of the CCDF to potentially adverse conditions and features at the site.

Organization (Principal Investigator):

PNL/PASS (P. Doctor)
SNL (F. Bingham, T. Bonano)

Level of Effort (FTE's): 3.0

PNL/PASS	2.0
SNL	1.0

Milestones and Schedule:

PNL report on sens. anal. of system performance	9/90
SNL report on sens. anal. of system performance	9/90

Linkages with Other Activities:

Analyses depend upon output of activities 90-1-1 through 90-1-4.

PERFORMANCE ASSESSMENT ACTIVITY 90-1-6

Activity Area: Code Development and Verification

Activity Title: Develop SUMO

Objective & Technical Approach:

Develop a total system performance assessment code (SUMO).

SUMO will be an integrated code that includes EBS performance, flow and transport, as well as biosphere transport and dose calculations. The approach in developing SUMO is similar to that used in the AECL code, SYVAC. The executive is probabilistic and drives the major submodels: source term, geosphere transport, biosphere transport, and dose/uptake.

SUMO will be documented for general use within the program.

Organization (Principal Investigator):

PNL/PASS (P. Eslinger)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

PNL documentation of SUMO	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-1-7

Activity Area: Model Development and Validation

Activity Title: Develop model for gaseous radionuclide transport

Objective & Technical Approach:

Develop a model of gaseous C-14 transport in the far-field.

Transport of C-14 is particularly important, because for many hundreds of years after waste emplacement the waste causes upward buoyant flow of air past the waste packages. We have developed analytical techniques to predict the airborne transport of C-14 through the rock matrix and fractures, retarded by absorption of carbon dioxide in ground water in cooler rock away from the waste. Gas flow is expected to occur principally in fractures. However, in the cooler rock, away from the emplacement zone, carbon dioxide transport is retarded by absorption in liquid in rock pores and by diffusion of those absorbed species into the rock matrix. The pH and bicarbonate content in the cooler rock are particularly important. During FY 1990 we will test these analyses of C-14 transport and will extend them to include the space-time-dependent properties of air flow, pH, and bicarbonate content. Release of gaseous C-14 that originates from the liquid release of C-14 into ground water followed by isotopic exchange with CO_2 will also be studied.

Organization (Principal Investigator):

SNL (F. Bingham)

Level of Effort (FTE's): 1.5

Milestones and Schedule:

SNL report on model of gas-phase releases 9/90

Linkages with Other Activities:

Input to: 90-1-3 and 90-1-5.

PERFORMANCE ASSESSMENT ACTIVITY 90-1-8

Activity Area: Site Performance Assessment

Activity Title: Develop site suitability methodology

Objective & Technical Approach:

Assess site-performance characteristics under the favorable and potentially adverse conditions listed in 10 CFR 60.122 and for the qualifying and disqualifying conditions described in 10 CFR part 60.

Organization (Principal Investigator):

SNL (G. Barr)

Level of Effort (FTE's): 0.6

Milestones and Schedule:

SNL report on site suitability methodology	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-1-9

Activity Area: Code Development and Verification

Activity Title: Develop TOSPAC

Objective & Technical Approach:

Organization (Principal Investigator):

SNL (F. Bingham)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

SNL documentation of TOSPAC, volume 2	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-1-10

Activity Area: Code Development and Verification

Activity Title: Develop STRESS-3D

Objective & Technical Approach:

Organization (Principal Investigator):

SNL (A. Stevens)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

SNL documentation of STRESS-3D	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-1-11

Activity Area: Model Development and Validation

Activity Title: Develop global climate model

Objective & Technical Approach:

The last of a series of three hindcast experiments will be conducted using a low-resolution general circulation model in order to generate past regional temperature and precipitation fields for the Yucca Mountain site. The results will then be validated using long-term paleoclimate records developed from the analysis of ice and pollen core-sand loss deposit records. The modeling effort will then utilize scenarios and boundary conditions from the hindcast experiments to forecast possible temperature fields on the earth's surface for the next 100,000 years. From these results, a subset will be selected as boundary conditions for precipitation simulations with the low-resolution general circulation model. Also, during FY 1990, the global ice-sheet modeling will be completed and the results turned over to the general circulation modeling team for their use in the forecasting experiments.

Organization (Principal Investigator):

PNL/PASS (W. Walters)

Level of Effort (FTE's): 5.3

Note that approximately 2.5 FTE will be funded by OSIR and the remaining effort will be funded by YMPO after being transferred to the Project.

Milestones and Schedule:

PNL documentation for global climate modeling study plan	1/90
PNL report on FY 90 global climate modeling	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-1-12

Activity Area: Code Development and Verification

Activity Title: Develop Total System Simulator

Objective & Technical Approach:

Organization (Principal Investigator):

SNL (F. Bingham)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

SNL report on total system simulator	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-1

Activity Area: Waste Package Performance Assessment

Activity Title: PACE data base review for EBSPA

Objective & Technical Approach:

Review existing information to ensure that the conceptual models and data bases used for the PACE EBSPA activities are integrated and consistent with activities addressing other PA areas. Review will be conducted on an ongoing basis, but specific data packages will be provided for container failure, release rate, sensitivity, and TSPA source item analyses.

Organization (Principal Investigator):

LLNL	(L. Jardine)
PNL/PASS	(M. Apted)
UCB	(T. Pigford)

Level of Effort (FTE's): 0.9

LLNL	0.3
PNL/PASS	0.3
UCB	0.3

Milestones and Schedule:

PNL data package for TSPA source term for exp. perf.	2/90
PNL data package for TSPA source term for dist. perf.	4/90
PNL data package for TSPA source term for sens. anal.	6/90
PNL data package for EBSPA containment failure anal.	2/90
PNL data package for EBSPA sens. anal.	4/90
LLNL data package for TSPA source term for exp. perf.	2/90
LLNL data package for TSPA source term for dist. perf.	4/90
LLNL data package for TSPA source term for sens. anal.	6/90
LLNL data package for EBSPA containment failure anal.	2/90
LLNL data package for EBSPA sens. anal.	4/90
UCB data package for EBSPA sens. anal	6/90

Linkages with Other Activities:

This activity defines the data set that will be used in activities 90-2-2 through 90-2-9.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-2

Activity Area: Waste Package Performance Assessment

Activity Title: PACE near-field environments

Objective & Technical Approach:

Evaluate the thermal, fluid, geochemical, retardation, and radiolytic environments in the vicinity of the waste packages. The region to be simulated is several meters in size and contains a single waste package situated in a vertical borehole beneath an emplacement tunnel. The tunnel and borehole will distort the natural infiltration. This will be further affected by the heating and desaturation. Temperature, saturation, and radiolysis distributions around the waste package will be estimated.

Organization and Principal Investigator:

LBL (K. Pruess)
LLNL (J. Nitao)

Level of Effort (FTE's): 1.0

LBL 0.5
LLNL 0.5

Milestones and Schedule:

LLNL report on near-field environments for EBSPA	3/90
LLNL report on near-field env. for EBSPA sens. anal.	5/90
LBL report on near-field environments for EBSPA	3/90
LBL report on near-field env. for EBSPA sens. anal.	5/90

Linkages with Other Activities:

Analyses provide input to activities 90-2-6 and 90-2-7.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-3

Activity Area: Waste Package Performance Assessment

Activity Title: PACE thermal and thermomechanical analyses

Objective & Technical Approach:

Provide repository and far-field thermal and thermomechanical environments that can be used in the TSPA and NBPA PACE exercises.

The analyses will rely on existing repository design information and will provide temperature distributions in the formation. Stresses induced by radioactive waste heat generation, and by excavation will be evaluated. Where available, existing information will be used. Where necessary, calculations using standard thermal and thermomechanical codes will be applied. Effects of vaporization and convection of vapor and air in the unsaturated zone will be taken into account.

Organization (Principal Investigator):

Level of Effort (FTE's):

Not funded in FY 90

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-4

Activity Area: Site Performance Assessment

Activity Title: PACE disturbed zone

Objective & Technical Approach:

Determine the extent of the disturbed zone to be used in the evaluation of the GWTT performance objective.

Existing analyses of the disturbed zone will be reviewed. PACE exercises that calculate thermal, thermomechanical, and geochemical changes will be evaluated to estimate the extent of the disturbed zone.

Organization (Principal Investigator):

Level of Effort (FTE's):

Not funded in FY 90

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-5

Activity Area: Waste Package Performance Assessment

Activity Title: PACE EBS release modes

Objective & Technical Approach:

Define the various release modes that will be evaluated in the PACE activities for each of the expected performance scenarios. The scenarios will be reviewed and the applicability of the "dry", "wet-drip", and "wet-continuous" modes will be determined. The scenarios and modes will then be defined appropriately for the analyses.

Organization (Principal Investigator):

PNL/PASS (M. Apted)
LLNL (L. Jardine)

Level of Effort (FTE's): 0.6

PNL/PASS	0.3
LLNL	0.3

Milestones and Schedule:

PNL report on release modes for EBSPA analyses	2/90
LLNL report on release modes for EBSPA analyses	2/90

Linkages with Other Activities:

Results will be used in activities 90-2-6 through 90-2-8.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-6

Activity Area: Waste Package Performance Assessment

Activity Title: PACE containment failure analyses

Objective & Technical Approach:

Evaluate distribution of containment failure times for each of the expected performance scenarios. The analyses will consider the performance of both the container and the cladding for the range of environmental conditions that have been defined. Existing deterministic failure models will be treated stochastically to determine failure distributions. In addition, failure correlations in terms of environmental parameters will be developed and used to evaluate the failure distribution. The two methods will be compared to define the failure distribution.

Organization and Principal Investigator:

PNL/PASS (M. Apted)
ANL/U. Minnesota (R. Staehle)
LLNL (L. Jardine)

Level of Effort (FTE's): 1.7

ANL/U. Minnesota	0.7
PNL/PASS	0.5
LLNL	0.5

Milestones and Schedule:

LLNL report on WP failure rates for TSPA src. terms	2/90
LLNL report on WP failure rates for EBSPA anal.	3/90
LLNL report on WP failure rates for EBSPA sens. study	6/90
PNL report on WP failure rates for TSPA src. terms	2/90
PNL report on WP failure rates for EBSPA anal.	3/90
PNL report on WP failure rates for EBSPA sens. study	6/90
UMinn report on WP failure rates for TSPA src. terms	2/90
UMinn report on WP failure rates for EBSPA anal.	3/90
UMinn report on WP failure rates for EBSPA sens. study	6/90

Linkages with Other Activities:

Information will be used in activities 90-2-7 and 90-2-8. Analyses depend on results of activities 90-2-1 and 90-2-2.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-7

Activity Area: Waste Package Performance Assessment

Activity Title: PACE EBS release rate analyses

Objective & Technical Approach:

Evaluate EBS release rates for the various release modes (e.g. dry, wet-drip, and wet-continuous) for each of the expected performance scenarios. Evaluate sensitivities of EBS release rates. Evaluate dependence of release rates on: 1) Radionuclide inventories of waste terms; 2) radionuclide distribution within waste form; 3) interactions of radionuclides with EBS materials; 4) radiolytic effects; 5) temperature; 6) multiphase fluid flow effects; 7) key site parameters (e.g., initial pore water composition). In addition, sensitivity of EBS performance to potentially adverse conditions and features at the site will be evaluated.

Organization (Principal Investigator):

PNL/PASS (M. Apted)
UCB (T. Pigford)
LLNL (L. Jardine)

Level of Effort (FTE's): 4.9

PNL/PASS	2.0	LLNL	2.0	UCB	0.9

Milestones and Schedule:

LLNL report on EBS release rates	4/90
LLNL report on EBS sens. studies	9/90
PNL report on EBS release rates	4/90
PNL report on EBS sens. studies	9/90
UCB report on EBS release rates	4/90
UCB report on EBS sens. studies	9/90

Linkages with Other Activities:

Output from: 90-2-1, 90-2-2, and 90-2-5.
Input to: 90-2-8 and 90-2-9.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-8

Activity Area: Waste Package Performance Assessment

Activity Title: PACE TSPA source term support

Objective & Technical Approach:

Provide containment and release rate distributions for the expected performance. Provide review of source terms used for expected and disturbed performance scenarios. The information for the PACE containment and release rate analyses will be used as the basis for the review of the source terms for the TSPA analyses.

Organization and Principal Investigator:

PNL/PASS (M. Apted)
LLNL (L. Jardine)

Level of Effort (FTE's): 1.0

PNL/PASS	0.5
LLNL	0.5

Milestones and Schedule:

LLNL report on review of TSPA exp. perf srce. terms	3/90
LLNL report on review of TSPA dist. perf srce. terms	6/90
LLNL report on review of TSPA sens. study srce. terms	8/90
PNL report on review of TSPA exp. perf srce. terms	3/90
PNL report on review of TSPA dist. perf srce. terms	6/90
PNL report on review of TSPA sens. study srce. terms	8/90

Linkages with Other Activities:

Results will be used in the activities 90-1-3 and 90-1-4.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-9

Activity Area: Model Development and Validation

Activity Title: Develop container failure correlations

Objective & Technical Approach:

The simplest approach to modeling lifetime of nuclear waste vessels is to start with a well-known distribution function for the failure of materials. The most widely used and most flexible function is the Weibull function. This function has a principal advantage of having three adjustable parameters namely the slope, the initiation time, and the intercept.

Subtask 1. Definition of the container emplacement environment
Subtask 2. Define engineering reference case
Subtask 3. Develop statistical correlation equations
Subtask 4. Sensitivity of alloys to failure modes
Subtask 5. Prediction projection

Organization (Principal Investigator):

ANL/University of Minnesota (R. Staehle)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

U. Minn report on container failure freq. corr. 9/90

Linkages with Other Activities:

Provides model to support activity 90-2-6.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-10

Activity Area: Code Development and Verification

Activity Title: Develop cladding nonuniform corrosion model for AREST

Objective & Technical Approach:

The objective of this activity is to develop a computational model that addresses the long-term nonuniform corrosion behavior of zircalloy cladding in a tuff repository environment (e.g., pitting, crevice corrosion, stress-corrosion cracking). This model will be incorporated into the AREST code.

The nonuniform corrosion model will be enhance to include the capability to specify non-rectangular geometries for the corrosion cavity.

A submodel will be developed to describe the growth of zircalloy corrosion product films and the passage of electric current and ions through these films.

A submodel will be developed to describe the effects of stress/strain at the tip of a stress corrosion crack.

Organization (Principal Investigator):

Level of Effort (FTE's):

Not funded for FY 90

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-11

Activity Area: Code Development and Verification

Activity Title: Develop container nonuniform corrosion model for AREST

Objective & Technical Approach:

The objective of this activity is to develop a computational model that addresses the long-term nonuniform corrosion behavior of waste package container materials in a tuff repository environment (e.g., pitting, crevice corrosion, stress corrosion cracking). This model will be incorporated into the AREST code.

The nonuniform corrosion model will be enhanced to include the capability to specify non-rectangular geometries for the corrosion cavity.

A submodel will be developed to describe the growth of zircalloy corrosion product films and the passage of electric current and ions through these films.

A submodel will be developed to describe the effects of stress/strain at the tip of a stress corrosion crack.

Organization (Principal Investigator):

Level of Effort (FTE's):

Not funded for FY 90

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-12

Activity Area: Code Development and Verification

Activity Title: Develop AREST

Objective and Technical Approach:

The objective of this task is to enhance the performance assessment capabilities of the AREST code for source-term analysis of the engineered barrier system. Specific activities are:

1) Code Implementation: add the most recent mass-transfer models from the UC Berkeley (UCB) group. Incorporate new corrosion models.

2) Code Distribution: support the distribution and installation of QA-versions of the AREST code for other OCRWM contractors through the National Energy Software Center (NESC).

3) Benchmarking: compare the analytical solutions in AREST against numerical codes like PORFLO and MAGNUM-CHAINT.

4) The spatial variability of repository source term will be accounted for.

Organizational Participants and Principal Investigators:

PNL/PASS (M. Apted)

Level of Effort (FTE's): 1.0

Schedule and Milestones:

PNL documentation of AREST 9/90

Linkage with Other Activities:

Input from: 90-2-10 and 90-2-11.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-13

Activity Area: Model Development and Validation

Activity Title: Develop model of mass transfer through rubble

Objective & Technical Approach:

In FY 89, conservative, mass transfer analyses were carried out to evaluate release rates both from a waste solid directly in contact with unsaturated tuff ("bathtub release model") as well as separated by a fine backfill.

During FY 90, we will analyze and illustrate the possible benefits of a reduction in diffusion pathways if, realistically, the annular material remains as unconsolidated rubble. This will be done by applying analytical techniques developed for estimating heat conduction through rubble and packing.

Organization (Principal Investigator):

UCB (T. Pigford)

Level of Effort (FTE's): 0.5

Milestones and Schedule:

UCB report on model of mass transfer through rubble 9/90

Linkages with Other Activities:

Provides model development for 90-2-7.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-14

Activity Area: Model Development and Validation

Activity Title: Develop model of waste form release due to solid-phase alteration

Objective & Technical Approach:

A basic assumption made in the AREST code is that the contained radionuclide species, if not limited by their own solubility, will be release congruently with the dissolution of the waste matrix. Laboratory experiments now indicate that this dissolution may be congruent with the solid-solid phase alteration oft he matrix rather than the matrix itself.

This activity involves the formulation of new equations for alteration controlled release, and the results will be illustrated using rate constants derived from laboratory experiments.

Organization (Principal Investigator):

UCB (T. Pigford)

Level of Effort (FTE's): 0.5

Milestones and Schedule:

UCB report on model of release due to solid-phase alt. 9/90

Linkages with Other Activities:

Provides model development for 90-2-7.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-15

Activity Area: Model Development and Validation

Activity Title: Develop model for colloid transport

Objective & Technical Approach:

To further refine conceptual models previously developed for the coupled transport of colloids and solute. Analytical solutions will be developed for those species that exhibit a solubility equilibrium between solute and colloids or pseudocolloids (solutes sorb on natural colloids).

The average translational speed of ground water in a pore or fracture is the average of a parabolic distribution of velocities between solid surfaces. Unlike the fluid in contact with a solid surface, a non-sorbing colloid cannot exist at zero velocity at that surface. As a result, the colloids will move at a faster average velocity than the fluid itself. The difference in speed varies directly with the particle size of the colloid. This phenomenon is called "hydrodynamic chromatography".

Testing of these models against field data on Pu and Am colloids from Los Alamos National Laboratory is contemplated.

Organization and Principal Investigator:

UCB (T. Pigford)

Level of Effort (FTE's): 0.5

Milestones and Schedule:

UCB report on model of colloid transport 9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-16

Activity Area: Model Development and Validation

Activity Title: Develop model for gas release from EBS

Objective & Technical Approach:

To continue the effort initiated in FY 89 to predict the time-dependent inflow of air through penetrations in failed waste containers and to predict the release rates of carbon-14 as carbon dioxide as well as that of other gaseous radionuclides.

Organization and Principal Investigator:

UCB (T. Pigford)

Level of Effort (FTE's):

Not funded in FY 90

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-17

Activity Area: Code Development and Verification

Activity Title: Develop PANDORA

Objective & Technical Approach:

To extend PANDORA-1 to PANDORA-1.1 and add process interactions and details as identified in recent PA and specialized scientific investigations.

PANDORA-2.0 development, a deterministic single waste package system model will also start during FY 90.

Organization (Principal Investigator):

LLNL (L. Jardine)

Level of Effort (FTE's): 2.0

LLNL 2.0

Milestones and Schedule:

LLNL documentation of PANDORA-1.1	9/90

Linkages with Other Activities:

Contingent upon completion of 90-2-18.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-18

Activity Area: Code Development and Verification

Activity Title: Develop uncertainty methods for PANDORA

Objective & Technical Approach:

To develop sampling techniques for use in describing the uncertainty in the predictions of (LLNL) source term models; also applicable to numerical integration over a large number of variables within the source term model. Controlled sampling method will be applied to a single-waste-package evaluation and to the source term model.

Organization (Principal Investigator):

LLNL (L. Jardine)

Level of Effort (FTE's): 0.5

LLNL	0.5

Milestones and Schedule:

LLNL report on uncertainty methods for PANDORA	9/90

Linkages with Other Activities:

Provides input to 90-2-17

PERFORMANCE ASSESSMENT ACTIVITY 90-2-19

Activity Area: Code Development and Verification

Activity Title: Develop EQ3/EQ6

Objective & Technical Approach:

To expand the ability of the EQ3/6 codes to model geochemical reactions involving the waste package and repository geochemical environment. Various new submodels will be added. Document the software and perform verification of EQ3/6 codes and database packages and conduct limited validation of the model.

Organization (Principal Investigator):

LLNL (R. Aines)

Level of Effort (FTE's): 2.0

LLNL 2.0

Milestones and Schedule:

LLNL documentation for EQ3/6 code	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-20

Activity Area: Code Development and Verification

Activity Title: Develop EQ3/EQ6 data base capability

Objective & Technical Approach:

This activity incorporates thermodynamic values into a EQ3/6 database module. The task includes development of data entry and retrieval procedures (including manuals), maintenance of the database, and qualification and documentation of data (new or existing) using internationally recognized standards and procedures.

Organization (Principal Investigator):

LLNL (R. Aines)

Level of Effort (FTE's): 2.0

LLNL 2.0

Milestones and Schedule:

LLNL documentation of new DATAO 9/90

Linkages with Other Activities:

Needed for EQ3/EQ6 development in 90-2-19.

PERFORMANCE ASSESSMENT ACTIVITY 90-2-21

Activity Area: Code Development and Verification

Activity Title: Develop TOUGH

Objective & Technical Approach:

Develop and document TOUGH code.

Organization and Principal Investigator:

PNL/PASS (M. Altenhofen)
LBL (K. Preuss)

Level of Effort (FTE's): 0.6

PNL/PASS	0.1
LBL	0.5

Milestones and Schedule:

LBL documentation of TOUGH	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-2-22

Activity Area: Model Development and Validation

Activity Title: Develop non-isothermal model of flow in fractured, heated media

Objective & Technical Approach:

To develop mathematical model describing air/water vapor and water movement (2-phase flow) in non-isothermal, fractured porous media, including the effects of post-emplacement temperature fields.

Organization (Principal Investigator):

LBL (K. Preuss)

Level of Effort (FTE's): 2.0

LBL 2.0

Milestones and Schedule:

LBL report on models of nonisothermal flow 9/90

Linkages with Other Activities:

This model development is input to: 90-2-2 and 90-2-3.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-1

Activity Area: Site Performance Assessment

Activity Title: PACE data base review for NBPA

Objective & Technical Approach:

Review and evaluate existing information to ensure that the conceptual models and data used for the PACE NBPA activities are adequate and consistent with activities addressing other PA areas.

Create a working group to review existing data and to define the conceptual models and data bases to be used in FY 1990 work.

This review will be conducted on an ongoing basis but specific data packages will be provided for each of the hydrology and disturbed zone analyses.

Organization (Principal Investigator):

PNL/PASS (M. Freshley)
SNL (P. Kaplan)
LBL (C. Tsang)

Level of Effort (FTE's): 0.9

PNL/PASS	0.3	SNL	0.3	LBL	0.3

Milestones and Schedule:

PNL initial data package for sensitivity studies	2/90
PNL updated data package for sensitivity studies	6/90
SNL initial data package for sensitivity studies	2/90
SNL updated data package for sensitivity studies	6/90
LBL initial data package for sensitivity studies	2/90
LBL updated data package for sensitivity studies	6/90

Linkages with Other Activities:

This activity defines the data set that will be used in activities 90-3-2 through 90-3-8.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-2

Activity Area: Site Performance Assessment

Activity Title: PACE sensitivity study of fracture/matrix interactions

Objective & Technical Approach:

Investigate interaction between fractures and surrounding matrix as well as the transition from fracture-dominated to matrix-dominated flow.

A tuff medium transected by discrete variable-aperture fractures will be considered. Unsaturated flow within the fractures, fracture-matrix flow, and matrix-matrix flow across fractures will be simulated.

Organization and Principal Investigator:

PNL/PASS (M. Freshley)
LBL (C. Tsang)
SNL (P. Kaplan)

Level of Effort (FTE's): 1.2

PNL/PASS	0.2
LBL	0.5
SNL	0.5

Milestones and Schedule:

PNL report of sens. study of frac./mx. interactions	9/90
SNL report of sens. study of frac./mx. interactions	9/90
LBL report of sens. study of frac./mx. interactions	9/90

Linkages with Other Activities:

Analyses depend on data from activity 90-3-1. Analyses will be conducted in concert with 90-3-3. Results will be used in the sensitivity studies of activity 90-3-8.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-3

Activity Area: Site Performance Assessment

Activity Title: PACE sensitivity study of intra-layer heterogeneity

Objectives and Technical Approach:

Investigate the dependence of convergent-divergent flow-field on spatial heterogeneity and correlation structures of fractured or lensed media. Assess whether the heterogeneous features help to spatially smooth out the extreme precipitation events or tend to concentrate the flow channelling through the system.

A tuff unit several tens of m thick and much larger lateral extent will be modeled. The lenses/cavities/fractures will cause distortion of the flow field. The output will consist of saturation, potential, convergent-divergent flow tubes and travel time distributions.

Organization and Principal Investigator:

PNL/PASS (M. Freshley)
LBL (C. Tsang)
SNL (P. Kaplan)

Level of Effort (FTE's): 1.2

PNL/PASS	0.2
LBL	0.5
SNL	0.5

Milestones and Schedule:

PNL report of sens. study of inhomogeneities	9/90
SNL report of sens. study of inhomogeneities	9/90
LBL report of sens. study of inhomogeneities	9/90

Linkages with Other Activities:

Analyses depend on data from activity 90-3-1. Analyses will be conducted in concert with 90-3-2. Results will be used in the sensitivity studies of activity 90-3-8.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-4

Activity Area: Site Performance Assessment

Activity Title: PACE sensitivity study of pre-emplacement hydrology

Objective & Technical Approach:

Investigate the flow field relevant to the calculation of groundwater travel times. Investigate the importance of lateral flow in tilted layer units, flow through faults, and the influence of stratigraphic variations and water table variations on the flow field.

The regime to be modeled is a thick zone (several hundred m) which would represent the strata between the ground surface and a boundary below the water table. The simulation will take into account both liquid and vapor flow. 2-D cross-sections 2 - 10 km wide, oriented either E-W or N-S will also be modeled. They can include an internal fault such as the Ghost Dance Fault. Output will consist of preferred flow paths and velocity distributions.

Organization and Principal Investigator:

PNL/PASS (M. Freshley)
LBL (C. Tsang)
SNL (P. Kaplan)

Level of Effort (FTE's): 1.2

PNL/PASS 0.2 LBL 0.5 SNL 0.5

Milestones and Schedule:

PNL report of sens. study of pre-empl. hydrol.	9/90
SNL report of sens. study of pre-empl. hydrol.	9/90
LBL report of sens. study of pre-empl. hydrol.	9/90

Linkages with Other Activities:

Analyses depend on data from activity 90-3-1. Results will provide basis for activity 90-3-5 and for the sensitivity study of activity 90-3-8.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-5

Activity Area: Site Performance Assessment

Activity Title: PACE analyses of perching

Objective & Technical Approach:

Investigate the creation and subsequent evolution of a perched water body at the contact between the TSw and each of the underlying CHnv and CHnz units respectively.

A 2-D E-W cross-section will be modeled with the Solitario Canyon Fault forming its western boundary. The model will contain the Ghost Dance Fault which will be assumed to produce a 25 m vertical displacement. Infiltration enters through the top of the system and some of the water is instantaneously transmitted down the fault to its contact with the CH units where it will be impounded. The simulation will predict the maximum extent of the perched water body that develops as well as the time required for it to dissipate.

Organization and Principal Investigator:

PNL/PASS (M. Freshley)
LBL (C. Tsang)

Level of Effort (FTE's): 0.7

PNL/PASS	0.2
LBL	0.5

Milestones and Schedule:

PNL report on perched water analysis	9/90
LBL report on perched water analysis	9/90

Linkages with Other Activities:

Some of the analyses depend upon the results of activity 90-3-4.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-6

Activity Area: Site Performance Assessment

Activity Title: PACE analyses of postclosure hydrology

Objective & Technical Approach:

Calculate the impacts of heat produced by the waste, the effects of excavation, and the effects of ventilation on the hydrology.

The effects of excavation for this repository will be estimated considering impacts on both hydrologic properties and the diversion of the infiltration flux. The effects of air movement through the repository openings, including that due to ventilation during construction and waste emplacement, on the hydrology will be evaluated. Finally, the effect of the heat due to the emplaced waste will be evaluated. In particular, the convective flow of air through the unsaturated rock and its effect on the movement of the water will be evaluated.

Organization and Principal Investigator:

PNL/PASS (M. Freshley)
LBL (C. Tsang)

Level of Effort (FTE's): 0.7

PNL/PASS	0.2
LBL	0.5

Milestones and Schedule:

PNL report on postclosure hydrology	9/90
LBL report on postclosure hydrology	9/90

Linkages with Other Activities:

Analyses depend upon the results of 90-3-1 and 90-3-4. Temperature distributions needed for these analyses will be provided in activity 90-2-3. Results will be used for the analysis of activity 90-3-7.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-7

Activity Area: Site Performance Assessment

Activity Title: PACE TSPA ground-water velocity support

Objective & Technical Approach:

Provide the ground-water flow models to support evaluation of flow velocities and fluxes for TSPA analyses. Review moisture fields to be used in TSPA analyses.

The TSPA scenarios and the results of the studies of pre-emplacement hydrology and post-emplacement effects will be considered in the evaluation of the velocity fields to be used in the TSPA analyses.

Organization and Principal Investigator: Several

PNL/PASS (M. Freshley)
SNL (P. Kaplan)

Level of Effort (FTE's): 0.7

PNL/PASS	0.2
SNL	0.5

Milestones and Schedule:

SNL report on moisture fields used for input to TSPA anal. 7/90

Linkages with Other Activities:

Analyses depend upon results of activities 90-1-2 and 90-3-6. The results will be used for the TSPA activities in 90-1-3 through 90-1-5.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-8

Activity Area: Site Performance Assessment

Activity Title: PACE sensitivity study of GWTT

Objective & Technical Approach:

Calculate the GWTT and understand its dependence on key site parameters. Identify under what circumstances the site would fail to meet the criteria specified by 10 CFR 60.113 (a) (2) for pre-waste-emplacement hydrologic conditions and assess compliance of the site with that regulation. Evaluate the probabilities of a failure using natural analog and site characterization data by performing analyses. Evaluate sensitivity of GWTT to potentially adverse conditions and features at the site. Calculate cumulative distribution functions for the GWTT. Evaluate sensitivity of the GWTT to site parameters. Identify and analyze analog and site data to identify the circumstances under which the site would fail to meet the criteria specified by regulation. Estimate the probabilities associated with a failure given model and parameter uncertainties.

Organization (Principal Investigator):

PNL/PASS (M. Freshley)
SNL (P. Kaplan)

Level of Effort (FTE's): 3.0

PNL/PASS 1.0 SNL 2.0

Milestones and Schedule:

SNL report on GWTT sens. study	9/90
PNL report on GWTT sens. study	9/90

Linkages with Other Activities:

Analyses depend upon results of 90-2-4 and 90-3-4.

PERFORMANCE ASSESSMENT ACTIVITY 90-3-9

Activity Area: Code Development and Verification

Activity Title: Develop flow and transport codes

Objective & Technical Approach:

Develop and verify NORIA, LLUVIA, and FEMWATER computer codes that will be used in assessments of performance for the resolution of issues 1.1, 1.2, 1.3, 1.6, 1.8, and 1.9. This includes developing the capability for modeling fluid (liquid or vapor) flow and the transport of energy and/or contaminants.

Organization (Principal Investigator):

SNL (R. Barnard)

Level of Effort (FTE's): 2.0

Milestones and Schedule:

SNL report on the verif. of NORIA, FEMWATER, and LLUVIA	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-3-10

Activity Area: Model Development and Validation

Activity Title: Develop flow and transport conceptual models

Objective & Technical Approach:

Validate the following calculational models: (1)those used primarily in assessment of performance for the resolution of Issues 1.1, 1.2, 1.3, 1.6, 1.8, and 1.9; (2) models that describe fluid flow or the transport of energy/or radionuclides; and (3) models that are not used exclusively in the resolution of a single issue.

Conduct experiments and perform corresponding analyses to ensure that the conceptual models and their mathematical and numerical representations correctly account for the physical processes embodied in the models; coordinate model.

Organization (Principal Investigator):

SNL (R. Glass)

Level of Effort (FTE's): 2.0

Milestones and Schedule:

SNL report on prel. validation of unsat. flow model 9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-3-11

Activity Area: Code Development and Verification

Activity Title: Develop PORFLO

Objective & Technical Approach:

Implement multi-phase flow modeling capability in the PORFLO-3 code.

The current version of PORFLO, acknowledges the presence of air only through the traditional functional dependence of the fluid hydraulic conductivity on the relative saturation. However, a separate equation to determine the pressure in the vapor phase is not explicitly solved.

In FY 90, equations for the gas phase will be incorporated in the model. The gas phase would consist of air and other gases generated by the waste. Pressure and radionuclide concentrations in the gas phase will be computed separately. The model can then be used to estimate the cumulative release of carbon-14 as CO_2 gas. In addition, PORFLO will be documented for general use in the program.

Organization (Principal Investigator):

PNL/PASS (M. Freshley)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

PNL document PORFLO 9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-3-12

Activity Area: Model Development and Validation

Activity Title: Develop model for isothermal fluid flow in the unsaturated zone

Objective & Technical Approach:

To develop mathematical models of isothermal fluid flow in the unsaturated zone. Interactions between the matrix and the fractures, and the relationships among the flux, saturation, matric potential, and hydraulic conductivity will be examined.

Organization (Principal Investigator):

LBL (T. Narisimhan)

Level of Effort (FTE's): 2.8

LBL 2.8

Milestones and Schedule:

LBL report on concepts of flow in part. sat. tuff 9/90

Linkages with Other Activities:

This model development will provide input to: 90-3-2 through 90-3-5 and 90-3-9.

PERFORMANCE ASSESSMENT ACTIVITY 90-4-1

Activity Area: Repository Performance Assessment

Activity Title: Peer review of radiological safety studies

Objective & Technical Approach:

The objective of this activity is to ensure that the studies and investigations conducted as part of preclosure safety analysis are consistent with the established PA strategies, as well as the objectives of the repository program and the other elements of CRWM, in particular, the Source Term Containment Evaluation Program of the DOE Transportation Branch.

Reviews of the results of work performed by other groups (e.g., transportation source term) will be conducted to determine whether they can be extended for use in the repository safety analysis or to determine any additional information needs (e.g., analytical models, data, computer codes) that should be provided.

Organization and Principal Investigator:

Level of Effort (FTE's):

Activity not funded in FY 90

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-2

Activity Area: Repository Performance Assessment

Activity Title: Develop methodology for identification of accident initiating events

Objective & Technical Approach:

Provide a recommendation on a systematic approach for identifying and screening initiating events for accident scenarios to be analyzed for repository preclosure safety analysis. The approach will be to review the structured analyses of potential failures/consequences (e.g. fault tree analysis) that have been conducted in the past. For example, the Level 1 PRA study performed by SNL for FY 1989 would be reviewed to evaluate the approach and the set of events identified. In addition, working backwards from significant failures/consequences that have been identified, initiating events that could have led to such failures would be systematically deduced. The systematics of such approaches will be evaluated and a recommended approach for initiating event identification will be provided.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-3

Activity Area: Repository Performance Assessment

Activity Title: Equipment failure data for sequences

Objective & Technical Approach:

The objective for this activity is to provide database support to activity 90-4-4 (Accident Model Development). The PRA accident analysis performed by SNL in FY 89 will be reviewed; and the risk-dominant sequences will be identified. For these sequences, the equipment failure data used to estimate the accident frequencies against equipment failure databases developed for nuclear fuel cycle facilities similar to the repository (e.g., the MRS facility) and chemical process facilities will be reviewed. Recommendations will be provided regarding the need for updating the FY 89 SNL accident analysis to reflect the results of PNL review.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-4

Activity Area: Repository Performance Assessment

Activity Title: Accident model development

Objective & Technical Approach:

The objective of this activity is to develop a parametric source term model using the risk-significant initiating events, accident scenarios, and event trees identified during the FY 89 work.

First, the accident event trees developed during FY 89 will be updated, if necessary, to reflect review comments from PNL and failure data for equipment in facilities similar to the repository (e.g., the MRS facility) provided by PNL. Then, using the EVNTRE computer code, the source term model will be integrated into the event tree model such that the source term will be calculated as the accident sequence develops. Thus, a source term and a frequency may be defined for each accident sequence. Because of the number of accident sequences that must be analyzed, the source term model will consist of correlations that are capable of being exercised a large number of times. Correlations will be developed that will relate the release fractions to various parameters associated with the accident environment (e.g., drop height and orientation). These correlations will be developed from information existing in the literature, bounding structural and thermal calculations, information obtained from FY 89 activities, and source term estimates for impact and impacting scenarios provided by PNL.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-5

Activity Area: Repository Performance Assessment

Activity Title: Impact accident source term

Objective & Technical Approach:

This activity will characterize the source term from impact accidents, considering two "bounding" scenarios: 1) bare fuel assembly or canistered HLW dropped during handling 25 ft onto other assemblies or canistered HLW in a storage cart (in-cell event) and 2) packaged consolidated spent fuel or canistered HLW in transport cask impacts walls due to transporter runaway on a ramp into below-grade repository (repository event).

A finite element code will be used to determine if and how the various barriers (cask, package/canister, clad) fail due to the levels of impact. For scenarios involving spent fuel, a crud source term from impact will also be considered. The impact of "leakers" (pin-hole leaks), failed clad (visible breaks in the clad), and internal pressure generated by oxidized fuel on clad failure must be evaluated.

A fragmentation code based upon the work performed at ANL will be developed in parallel to determine the potential fragmentation of the waste form. The compressive forces (and therefore the pressure) imposed upon the waste form will be used to estimate the motive force that expels the fragmented materials plus pre-existing fines. The potential increase in gap inventory at-risk from the subdivision of the fuel. The loss of oxidized fuel pellets from any failed fuel elements in any assembly will be considered.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-6

Activity Area: Repository Performance Assessment

Activity Title: Impact/fire source term

Objective & Technical Approach:

This activity will characterize the source term from an impact-fire during transport of the packaged spent fuel or vitrified HLW to the below-grade repository.

The major emphasis in this task will be to assess the response of the barriers (cask, package, clad) to the impact and thermal forces imposed by the event. If the barriers fail and expose the radioactive materials, the mechanism to be evaluated for spent fuel is the rapid oxidation of the zircalloy clad. If such an event occurs, the potential consequences could be much more severe than for the release of materials (crud, gap inventory, fines, oxidized fuel) by temperature alone. The effect of the potential subdivision of the spent fuel by impact (a large increase in the surface area exposed to the atmosphere) on the radionuclides released by heat will be assessed as will the potential oxidation of fuel by the fire conditions. For vitrified HLW, the potential increased release of radionuclides from thermal effects appears to be small even if the barrier between the vitrified HLW and the atmosphere are lost. A potential concern may be the effect of the rapid cooling of the canister and glass by fire extinguishment methods (e.g., extinguishment by water).

Organization and Principal Investigator:

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-7

Activity Area: Repository Performance Assessment

Activity Title: Characterization of aerosol particle transport phenomena

Objective & Technical Approach:

The objective of this activity is to develop estimates of aerosol particle sources and facility contamination factors for particulate radionuclides generated during routine operations and potential accidents at the repository. The aerosol particle sources will be estimated for normal operating and accident conditions identified in FY 89 activities, supplemented by source term estimates for accidents involving impact and fire provided by PNL.

For these sources, aerosol transport calculations will be made using MAEROS and/or CONTAIN computer codes depending on condition to be modeled. The results of the calculations will be a table of best estimates and uncertainties of decontamination factors for each conditio.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-8

Activity Area: Repository Performance Assessment

Activity Title: Uncertainty in radionuclide inventories from ORIGEN2

Objective & Technical Approach:

The overall purpose of this task is to provide estimates of the uncertainties in radionuclide inventories calculated with ORIGEN2. Diskettes of ORIGEN2 inventory data have been distributed as reference values. The uncertainties will be developed in the following sequence of subtasks.

1) Radionuclides pertinent to radiological safety will be identified.

2) PWR and BWR burnup analyses will be performed with ORIGEN2 for a wide range of parameter values: burnup to 60 GWD/MTU, enrichment to 5% by weight U-235, decay time to 100 years. For some cases, reactor histories for which experimental radionuclide data are available will be evaluated. Also, cases will be calculated with a burnup code which applies a more case-dependent reactor physics model.

3) The radionuclide inventories calculated in subtask 2 for those radionuclides identified in subtask 1 will be evaluated with regard to uncertainty, sensitivity, and importance.

Organization (Principal Investigator):

ORNL (Ralph Best)

Level of Effort (FTE's): 0.5

Milestones and Schedule:

ORNL report on unc.in bounding inventories in ORIGEN 9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-4-9

Activity Area: Model Development and Validation

Activity Title: Validate ORIGEN2

Objective & Technical Approach:

The major objective of this task is to generate the necessary experimental data by analyzing well-characterized commercial spent fuel. Both compositional and radiological data of the uranium dioxide as well as selected parts of the fuel assembly (cladding, springs, other structural pieces) will be analyzed. Thermal emission and spark source mass spectrometry will be used extensively.

Radiation source strengths (neutron and gamma ray emission) are very important to preclosure performance assessments and the literature data is woefully inadequate for use in validating code output. These analyses will be performed and comparisons will be made with the output from selected computer codes. Fuels from both BWRs and PWRs have been obtained from the Materials Characterization Center (PNL) for analyses.

Organization (Principal Investigator):

ORNL (J.W. Roddy)

Level of Effort (FTE's): 2.0

Milestones and Schedule:

ORNL report on validation of ORIGEN2	9/90

Linkages with Other Activities:

Sensitivity studies from 90-1-3, 90-2-7, and 90-4-8 will identify key radionuclides.

PERFORMANCE ASSESSMENT ACTIVITY 90-5-1

Activity Area: Performance Assessment Support to Design Programs

Activity Title: ESF design requirements support

Objective & Technical Approach:

Perform analyses to develop design requirements for surface facilities and ESF title II design to ensure that requirements related to repository performance are met. The activity requires analyses in eleven areas:

(1) Water use for roads and pads;
(2) Water use for shaft construction;
(3) Leakage from ponds and sewers;
(4) Effect of disturbed zone on radionuclide transport;
(5) Construction fracture effects;
(6) Shaft creep;
(7) Thermal stresses;
(8) Waste temperature fields;
(9) Radiological safety;
(10) Effects of tracer tests; and
(11) Effects on chemical transport.

In addition, the activity involves qualification of relevant PA codes (TOSPAC, STRESS-3D, and NORIA) to satisfy design control quality assurance requirements.

Organization (Principal Investigator):

SNL (A. Stevens)
PNL/PASS (P. Doctor)

Level of Effort (FTE's): 2.2

SNL	2.0
PNL/PASS	0.2

Milestone and Schedule:

Linkages with Other Activities:

Input from: 90-1-8, 90-1-9, 90-3-10, and 90-3-11

PERFORMANCE ASSESSMENT ACTIVITY 90-5-2

Activity Area: Performance Assessment Support to Design Programs

Activity Title: ESF design analysis support

Objective & Technical Approach:

Perform analyses of surface facilities and ESF title II design to ensure that requirements related to repository performance are met. The activity requires analyses in eleven areas:

(1) Water use for roads and pads;
(2) Water use for shaft construction;
(3) Leakage from ponds and sewers;
(4) Effect of disturbed zone on radionuclide transport;
(5) Construction fracture effects;
(6) Shaft creep;
(7) Thermal stresses;
(8) Waste temperature fields;
(9) Radiological safety;
(10) Effects of tracer tests; and
(11) Effects on chemical transport.

In addition, the activity involves qualification of relevant PA codes (TOSPAC, STRESS-3D, and NORIA) to satisfy design control quality assurance requirements.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90

Milestone and Schedule:

Linkages with Other Activities:

Input from: 90-1-8, 90-1-9, 90-3-10, and 90-3-11

PERFORMANCE ASSESSMENT ACTIVITY 90-5-3

Activity Area: Performance Assessment Support to Design Programs

Activity Title: ESF alternative design features analysis support

Objective & Technical Approach:

Provide documentation and results of calculations used in analyses of postclosure performance that support design efforts, contribute to the resolution of Issue 1.3, and indirectly support activities carried out under other performance assessment WBS elements.

Perform all efforts required to calculate the elements of postclosure performance that are needed to support the design of the repository, seals and waste package and construction of the surface based investigations of the repository. Perform analyses of postclosure performance that are needed to support activities carried out under other performance assessment WBS elements. Synthesize and evaluate (1) hydrologic and environmental information needed to determine whether aquifers at the site meet the special source criteria (SCP Activity 1.3.1.1.1) and (2) demographic and economic data needed to determine whether Class I or special sources of ground water exist at the site (SCP Activity 1.3.1.1.2).

Organization (Principal Investigator):

SNL	(A. Stevens)	Assessments
PNL/PASS	(P. Doctor)	Oversight

Level of Effort (FTE's): 3.5

SNL	3.0
PNL/PASS	0.5

Milestones and Schedule:

Linkages with Other Activities:

Input from: 90-1-8, 90-1-9, 90-3-10, and 90-3-11

PERFORMANCE ASSESSMENT ACTIVITY 90-5-4

Activity Area: Performance Assessment Support to Design Programs

Activity Title: ACD design requirements support

Objective & Technical Approach:

Review preclosure and postclosure PA conceptual designs to identify specific PA concerns that may lead to changes in the designs that should be reflected in the ACD requirements. The scope includes surface facilities, shafts, underground facilities, and seals.

Through a coordination with the ACD design efforts, identify design considerations by others that might affect performance. Identify and scope problems to be analyzed by WG's 1 through 4 in support of the development of ACD design requirements.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-5-5

Activity Area: Performance Assessment Support to Design Programs

Activity Title: Repository ACD design analysis support

Objective & Technical Approach:

Assess the postclosure characteristics and configurations of the underground facilities at the Yucca Mountain MGDS and ensure that they show compliance with design criteria. Provide information for the resolution of the performance issues.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-5-6

Activity Area: Repository Performance Assessment

Activity Title: Waste retrieval requirements analyses

Objective & Technical Approach:

Assess the effect of waste retrieval requirements on the performance of the postclosure repository system.

- Compile retrieval-related design requirements and estimate retrieval conditions.
- Perform a compliance analysis to ensure that the requirements for retrievability are met.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-5-7

Activity Area: Repository Performance Assessment

Activity Title: Seal performance requirements analyses

Objective & Technical Approach:

Assess the performance of sealing components sealing designs and the sealing system.

The technical approach will utilize input from the seal design effort, the seal materials testing effort, and the scenario development efforts to create a seal system model. The performance of the seal system model will be evaluated against established performance goals.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-6-1

Activity Area: Performance Assessment Support to Licensing Programs

Activity Title: EIS scoping support

Objective & Technical Approach:

Define performance measures and general methodology for the PA for the EIS as a part of the scoping process.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded for FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-6-2

Activity Area: Performance Assessment Support to Licensing Programs

Activity Title: Alternative licensing strategies analyses support

Objective & Technical Approach:

Provide performance assessment support to effort to identify alternative approaches to licensing. Provide support in the specification of performance assessment methodologies, top level strategies, and performance allocation.

Organization (Principal Investigator):

ANL/Golder (D.Caldwell)

Level of Effort (FTE's): 2.0

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-6-3

Activity Area: Performance Assessment Support to Licensing Programs

Activity Title: Review of PA to support EPA standards

Objective & Technical Approach:

Conduct review of scenarios, consequences, and probabilities used by EPA in its evaluations for the new HLW environmental standards.

Organization (Principal Investigator):

RE/SPEC (P.Gnirk)

Level of Effort (FTE's): 3.9

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-7-1

Activity Area: Performance Assessment Support to Testing Programs

Activity Title: Prioritization of surface-based testing analysis support

Objective & Technical Approach:

Support efforts to evaluate and prioritize surface-based testing program with respect to potentially disqualifying features of the site.

Performance assessments will be conducted to evaluate the significance of potentially adverse conditions (PACs) at the site and tests will be evaluated in terms of their ability to evaluate these PACs. Significance will be evaluated in terms of a ranking measure such as potential risk. Scenarios will be developed for the PACs and probabilities and consequences will be estimated for each scenario to determine values of the ranking measure. Tests will be evaluated in terms of their utility with regard to each scenario. Priorities will be estimated from the ranking measures and the utilities.

Organization (Principal Investigator):

SNL (S. Sinnock)

Level of Effort (FTE's): 1.8

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-7-2

Activity Area: Performance Assessment Support to Testing Programs

Activity Title: Calico Hills characterization analysis support

Objective & Technical Approach:

Evaluate and prioritize alternatives to characterization of the Calico Hills unit. Various methods of characterization of the Calico Hills unit will be specified (e.g. remote sensing, surface based drilling, examination of outcrops, excavation). These methods will be evaluated in terms of cost, information that can be acquired, impacts on waste isolation, and other factors. PA will be conducted to estimate impacts on waste isolation. Sensitivities of performance measures to the methods of characterization and to the parameters obtained by the method will be evaluated. Design analysis will be conducted to rank the methods.

Organization (Principal Investigator):

SNL (F. Bingham)

Level of Effort (FTE's): 1.0

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-7-3

Activity Area: Performance Assessment Support to Testing Programs

Activity Title: HLW waste forms study support

Objective & Technical Approach:

The purpose of this task is to conduct PA (supported by the necessary testing) to ensure that the glass produced by the DWPF will be acceptable for disposal in the repository. To accomplish this objective, sensitivity studies will be conducted at the systems level to identify the key chemical and physical parameters affecting radionuclide release from the EBS. In turn, these parameters will be related to fundamental properties of the glass waste form that need to be controlled by the waste form producer to ensure the acceptability of the product. Appropriate tests (e.g. MCC-1) will be identified to measure these fundamental properties and the relationship (if any) between these tests and waste acceptance.

Organization and Principal Investigator:

PNL/PASS (P. Doctor)

Level of Effort (FTE's): 1.2

Milestones and Schedule:

PNL report on FY 90 glass waste form study	9/90

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-7-4

Activity Area: Performance Assessment Support to Testing Programs

Activity Title: Study plan reviews for PA

Objective & Technical Approach:

Review study plans to ensure that data to be obtained are appropriate for the PA being supported.

Develop criteria for the performance assessment discussions in the study plans. Review study plans against these criteria.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-7-5

Activity Area: Performance Assessment Support to Testing Programs

Activity Title: Performance confirmation program support

Objective & Technical Approach:

Assess and ensure the compliance of the Yucca Mountain MGDS. Performance Confirmation Program with the requirements of 10 CFR 60.137 (SCP Issue Resolution Strategy 8.3.5.16).

Develop overall plans for the performance confirmation program and document them in the form of a strategy and guidelines document with separate plans for activities to be conducted during each functional phase of the repository life cycle. Produce a facilities design requirements document. During FY 1990, the strategy and guidelines document will be completed. Planning for early performance confirmation testing and facilities design requirements will proceed.

Organization (Principal Investigator):

Level of Effort (FTE's):

Activity not funded in FY 90.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-8-1

Activity Area: Performance Assessment Support

Activity Title: Sensitivity analysis of reactive transport using ggeochemical Transport Model

Objective & Technical Approach:

To study the effects of geochemical processes on transport of radionuclides (reactive transport) and to construct a computational model of geochemical transport system that represents the conceptual model of the effects of site geochemistry on radionuclide transport. Integrated transport calculations will be made.

Geochemical processes will be studied using TRANQL for their effects on transport and site geochemical/physical data will be integrated with a 3-D porous media transport codes TRACR3D and HDOC.

Sensitivity Analysis for the purpose of guiding geochemical characterization will be performed by constructing an adjoint version of TRACR3D, TRACRIN. (Ref. LANL Study plan 8.3.1.3.7.1 page 6, 8, and 13.)

Analyses of PACE 90-1 problems will be conducted.

Organization (Principal Investigator):

LANL (K. Eggert)

Level of Effort (FTE's):

Activity not funded by performance assessment.

Milestones and Schedule:

Linkages with Other Activities:

Input to: PACE 90-1-3

PERFORMANCE ASSESSMENT ACTIVITY 90-8-2

Activity Area: Performance Assessment Support

Activity Title: Sensitivity analysis of colloid transport

Objective & Technical Approach:

To partially guide the geochemical characterization activities by investigating processes that significantly affect colloidal transport. The activity will determine the most appropriate computational representation for these processes.

Alternative processes will be modeled either individually or as part of a larger computational model (like TRACRN). Two levels of sensitivity analysis will be performed using Code CTCN: 1) identification of important contributing processes, and 2) parametric sensitivity analysis.

Analyses of PACE 90-2 problems will be conducted.

Organization (Principal Investigator):

LANL (K. Eggert)

Level of Effort (FTE's):

Activity not funded by performance assessment.

Milestones and Schedule:

Linkages with Other Activities:

Input to PACE 90-2-2 and 90-2-7. Also, complements colloid transport model development 90-2-15.

PERFORMANCE ASSESSMENT ACTIVITY 90-8-3

Activity Area: Performance Assessment Support

Activity Title: Sensitivity analysis of thermal and thermochemical coupled processes

Objective & Technical Approach:

To partially guide the geochemical characterization activities by investigating thermal/thermochemical processes and their effect on geochemistry of natural barrier, which may significantly affect the radionuclide transport. The activity will determine the most appropriate computational representation for these processes.

Regional stress and heat effects will be modeled using FEHMSN, and sensitivity analyses will be performed on parameters.

Analyses of PACE 90-2 problems will be conducted.

Organization (Principal Investigator):

LANL (K. Eggert)

Level of Effort (FTE's):

Activity not funded by performance assessment.

Milestones and Schedule:

Linkages with Other Activities:

Input to PACE 90-2-2 and 90-2-7.

PERFORMANCE ASSESSMENT ACTIVITY 90-8-4

Activity Area: Performance Assessment Support

Activity Title: Develop transport model

Objective & Technical Approach:

Provide documentation, verification, validation, and software support for codes to be applied to Retardation Sensitivity Analysis following NUREG-0856. The codes are TRACRN, TRACRIN, TRANQLN, FEHMSN, CTCN, and HDOC (see study plan for details).

1. Produce baseline documentation

2. Code maintenance and configuration management

Organization (Principal Investigator):

LANL (K. Eggert)

Level of Effort (FTE's):

Activity not funded by performance assessment.

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-8-5

Activity Area: Performance Assessment Support

Activity Title: Development of near-field flow and transport model

Objective & Technical Approach:

Develop numerical simulations of heat and fluid flow in partially saturated, fractured rock.

Construct a three-dimensional, finite-difference solution the partial differential equations governing multiphase fluid flow. Incorporate it into the LLNL version of the original (LBL) TOUGH code, and apply to near field at Yucca Mountain.

Analyses of PACE 90-2 problems will be conducted.

Organization (Principal Investigator):

LLNL (J. Nitao)

Level of Effort (FTE's):

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-8-6

Activity Area: Performance Assessment Support

Activity Title: Develop model thermomechanical response of waste package environment

Objective & Technical Approach:

Develop models for prediction of the mechanical behavior of borehole walls and fractures.

Numerical simulations will use existing KEYBLOCK code and yet-to-be-developed fracture propagation codes as well as existing geomechanics codes that may be further developed, e.g. ADINA, ADINA-T.

Analyses of PACE 90-2 problems will be conducted.

Organization (Principal Investigator):

LLNL (S. Blair)

Level of Effort (FTE's):

Milestones and Schedule:

Linkages with Other Activities:

PERFORMANCE ASSESSMENT ACTIVITY 90-8-7

Activity Area: Performance Assessment Support

Activity Title: Development of isothermal conceptual model of the unsaturated zone

Objective & Technical Approach:

Continue development, testing, and refinement of conceptual models for the unsaturated-zone geohydrologic system at Yucca Mountain with special emphasis on identifying and testing potentially viable alternative hypotheses within the overall site-scale conceptual model.

Perform scoping calculations and develop selected PACE 90-3 test-case problems for solution using the TOUGH hydrologic simulator.

Organization (Principal Investigator):

USGS (D. Hoxie)
LBL (G. Bodvarsson)

Level of Effort (FTE's):

Activity not funded by performance assessment.

Milestones and Schedule:

Linkages with Other Activities:

APPENDIX A

PERFORMANCE ASSESSMENT ACTIVITIES

This appendix lists all of the activities given on the activity sheets of Chapter 4 along with the participants in those activities. This list is given in Table A-1.

Table A-1
LIST OF PERFORMANCE ASSESSMENT ACTIVITIES

Activity	Title	Participants
90-0-1	PA Technical Integration Group (TIG)	R/S, SAIC, WESTN
90-0-2	PA Working Group (WG) Support	PNL,UCB,SNL,LLL ,LBL,LANL,USGS
90-0-3	Management Support	WESTON,PNL,ANL
90-0-4	Management Support	SAIC
90-0-5	Technical Management of PNL/PASS PA activities	PNL
90-0-6	International performance assessment activities and Validation Oversight Group	PNL
90-1-1	PACE data base review for TSPA	SNL,PNL
90-1-2	PACE scenario and probability development	PNL,SNL
90-1-3	PACE expected performance analyses	PNL,SNL,UCB
90-1-4	PACE disturbed performance analyses	PNL,SNL
90-1-5	PACE CCDF sensitivity analyses	PNL,SNL
90-1-6	Develop SUMO	PNL
90-1-7	Develop model for gaseous radionuclide transport	SNL
90-1-8	Develop site suitability methodology	SNL
90-1-9	Develop TOSPAC	SNL
90-1-10	Develop STRESS-3D	SNL
90-1-11	Develop global climate model	PNL
90-1-12	Develop Total System Simulator	SNL
90-2-1	PACE data base review for EBSPA	LLNL,PNL,UCB
90-2-2	PACE near-field environments	LBL,LLNL
90-2-3	PACE thermal and thermomechanical anal.	Unfunded
90-2-4	PACE disturbed zone	Unfunded
90-2-5	PACE EBS release modes	PNL,LLNL
90-2-6	PACE containment failure analyses	UMinn,PNL,LLNL
90-2-7	PACE EBS release rate analyses	PNL,UCB,LLNL
90-2-8	PACE TSPA source term support	PNL,LLNL
90-2-9	Develop container failure correlations	UMinn
90-2-10	Develop cladding nonuniform corrosion model for AREST	Unfunded
90-2-11	Develop container nonuniform corrosion model for AREST	Unfunded
90-2-12	Develop AREST	PNL
90-2-13	Develop model of mass transfer through rubble	UCB
90-2-14	Develop model of waste-form release due to solid-phase alteration	UCB

Table A-1 (Continued)
LIST OF PERFORMANCE ASSESSMENT ACTIVITIES

90-2-15	Develop model of colloid transport	UCB
90-2-16	Develop model of gas release from EBS	Unfunded
90-2-17	Develop PANDORA	LLNL
90-2-18	Develop uncertainty methods for PANDORA	LLNL
90-2-19	Develop EQ3/EQ6	LLNL
90-2-20	Develop EQ3/EQ6 data base capability	LNL
90-2-21	Develop TOUGH	PNL,LBL
90-2-22	Develop non-isothermal model of flow in fractured, heated media	LBL
90-3-1	PACE data base review for NBPA	PNL,SNL,LBL
90-3-2	PACE sensitivity study of fracture/matrix interactions	PNL,SNL,LBL
90-3-3	PACE sensitivity study of intra-layer heterogeneity	PNL,SNL,LBL
90-3-4	PACE sensitivity study of pre-emplacement hydrology	PNL,SNL,LBL
90-3-5	PACE analyses of perching	PNL,LBL
90-3-6	PACE analyses of postclosure hydrology	PNL,LBL
90-3-7	PACE TSPA ground-water velocity support	PNL,SNL
90-3-8	PACE sensitivity study of GWTT	PNL,SNL
90-3-9	Develop flow and transport codes	SNL
90-3-10	Develop flow and transport conceptual models	SNL
90-3-11	Develop PORFLO	PNL
90-3-12	Develop model for isothermal flow in the unsaturated zone	LBL
90-4-1	Peer review of radiological safety studies	Unfunded
90-4-2	Develop methodology for identification of accident initiating events	Unfunded
90-4-3	Equipment failure data for accidents	Unfunded
90-4-4	Accident model development	Unfunded
90-4-5	Impact accident source term	Unfunded
90-4-6	Impact/fire source term	Unfunded
90-4-7	Characterization of aerosol particle transport phenomena	Unfunded
90-4-8	Uncertainty in radionuclide inventories from ORIGEN2	ORNL
90-4-9	Validate ORIGEN2	ORNL
90-5-1	ESF design requirements support	SNL,PNL
90-5-2	ESF design analysis support	SNL,PNL
90-5-3	ESF alternative design features analysis support	SNL,PNL
90-5-4	ACD design requirements support	Unfunded
90-5-5	ACD design analysis support	Unfunded
90-5-6	Waste retrieval requirements analyses	Unfunded
90-5-7	Seal performance requirements analyses	Unfunded
90-6-1	EIS scoping support	Unfunded

Table A-1 (Continued)
LIST OF PERFORMANCE ASSESSMENT ACTIVITIES

90-6-2	Alternative licensing strategies analyses support	ANL
90-6-3	Review of PA to support EPA standard	R/S
90-7-1	Prioritization of surface-based testing analysis support	SNL
90-7-2	Calico Hills characterization analysis support	SNL
90-7-3	HLW waste forms study	PNL
90-7-4	Study plan reviews for PA	Unfunded
90-7-5	Performance confirmation program support	Unfunded
90-8-1	Sensitivity analysis of reactive transport	LANL
90-8-2	Sensitivity analysis of colloid transport	LANL
90-8-3	Sensitivity analysis of thermal and thermochemical process	LANL
90-8-4	Develop transport model	LANL
90-8-5	Develop near-field flow and transport model	LLNL
90-8-6	Develop model of thermomechanical response of waste package	LLNL
90-8-7	Develop isothermal model of unsaturated zone.	USGS

APPENDIX B

SPREAD SHEETS FOR PA ACTIVITY LEVELS OF EFFORT

The tables in this appendix summarize the level of effort (LOE) expected for each performance assessment (PA) area and for the entire program. Tables B-0 through B-7 summarize the LOE for each organization in each PA area for the activities to be conducted under Work Breakdown Structure (WBS) Element 1.2.1.4 (performance assessment). These areas are described in Section 3. Area 0 (Table B-0) refers to general implementation and oversight support. Areas 1 through 4 (Tables B-1 through B-4) refer to (1) total system performance assessments, (2) engineered-barrier system performance assessments, (3) natural barriers performance assessments, and (4) preclosure safety assessments; these activities include both PACE (Performance Assessment Calculational Exercises) activities and methodology and conceptual and computational model development for the EIS, SAR, and other specific, future performance assessments.

Areas 5 through 7 (Tables B-5 through B-7) refer to direct support for current Geologic Repository Program efforts. Table B-5 refers to support to repository and ESF design, Table B-6 refers to support to licensing considerations, and Table B-7 refers to support to the testing programs.

Table B-8 summarizes all of the WBS 1.2.1.4 activities in the program according to the categories of (1) PACE, (2) development future milestones such as the SAR, and (3) direct support to current program efforts in the areas of design, licensing, and testing.

TABLE B-0: GENERAL IMPLEMENTATION AND OVERSIGHT

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-0-N	OSIR Contractors					OSIR	ACTIVITY NUMBER 90-0-N	YMPO Contractors						YMPO	YMPO+
	PNL	PNL/PASS	RE/SPEC	UCB	ANL	Total		SNL	LLNL	LANL	USGS	LBL	ORNL	Total	+OSIR
1	0	0	1.5	0	0	1.5	1	0	0	0	0	0	0	0.0	1.5
2	0	0.8	0	0.2	0	1.0	2	0.8	0.2	0	0	0.2	0	1.2	2.2
3	3.7	0	0	0	0.6	4.3	3	0	0	0	0	0	0	0.0	4.3
4	0	0	0	0	0	0.0	4	0	0	0	0	0	0	0.0	0.0
5	0	3.0	0	0	0	3.0	5	0	0	0	0	0	0	0.0	3.0
6	0	1.0	0	0	0	1.0	6	0	0	0	0	0	0	0.0	1.0
Totals	3.7	4.8	1.5	0.2	0.6	10.8	Totals	0.8	0.2	0.0	0.0	0.2	0.0	1.2	12.0

TABLE B-1: TOTAL SYSTEM PERFORMANCE ASSESSMENT (TSPA)

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-1-N	OSIR Contractors PNL	PNL/PASS	RE/SPEC	UCB	ANL	OSIR Total	ACTIVITY NUMBER 90-1-N	YMPO Contractors SNL	LLNL	LANL	USGS	LBL	ORNL	YMPO Total	YMPO+ +OSIR
1	0	0.3	0	0	0	0.3	1	0.3	0	0	0	0	0	0.3	0.6
2	0	1.0	0	0	0	1.0	2	2.0	0	0	0	0	0	2.0	3.0
3	0	2.0	0	0.4	0	2.4	3	3.0	0	0	0	0	0	3.0	5.4
4	0	2.0	0	0	0	2.0	4	1.0	0	0	0	0	0	1.0	3.0
5	0	2.0	0	0	0	2.0	5	1.0	0	0	0	0	0	1.0	3.0
PACE-90	0.0	7.3	0.0	0.4	0.0	7.7	Totals	7.3	0.0	0.0	0.0	0.0	0.0	7.3	15.0
6	0	1.0	0	0	0	1.0	6	0	0	0	0	0	0	0.0	1.0
7	0	0	0	0	0	0.0	7	1.5	0	0	0	0	0	1.5	1.5
8	0	0	0	0	0	0.0	8	0.6	0	0	0	0	0	0.6	0.6
9	0	0	0	0	0	0.0	9	1.0	0	0	0	0	0	1.0	1.0
10	0	0	0	0	0	0.0	10	1.0	0	0	0	0	0	1.0	1.0
11	0	5.3	0	0	0	5.3	11	0.0	0	0	0	0	0	0.0	5.3
12	0	0	0	0	0	0.0	12	1.0	0	0	0	0	0	1.0	1.0
Development	0.0	6.3	0.0	0.0	0.0	6.3	Totals	5.1	0.0	0.0	0.0	0.0	0.0	5.1	11.4
Totals	0.0	13.6	0.0	0.4	0.0	14.0	Totals	12.4	0.0	0.0	0.0	0.0	0.0	12.4	26.4

Note (*): Work in Activity 11 will be transferred to YMPO during FY 1990

TABLE B-2: ENGINEERED BARRIER SYSTEM PERFORMANCE ASSESSMENT (EBSPA)

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-2-N	OSIR Contractors PNL	PNL/PASS	RE/SPEC	UCB	ANL	OSIR Total	ACTIVITY NUMBER 90-2-N	YMPO Contractors SNL	LLNL	LANL	USGS	LBL	ORNL	YMPO Total	YMPO+ +OSIR
1	0	0.3	0	0.3	0	0.6	1	0	0.3	0	0	0	0	0.3	0.9
2	0	0	0	0	0	0.0	2	0	0.5	0	0	0.5	0	1.0	1.0
3	0	0	0	0	0	0.0	3	0	0	0	0	0	0	0.0	0.0
4	0	0	0	0	0	0.0	4	0	0	0	0	0	0	0.0	0.0
5	0	0.3	0	0	0	0.3	5	0	0.3	0	0	0	0	0.3	0.6
6	0	0.5	0	0	0.7	1.2	6	0	0.5	0	0	0	0	0.5	1.7
7	0	2.0	0	0.9	0	2.9	7	0	2.0	0	0	0	0	2.0	4.9
8	0	0.5	0	0	0	0.5	8	0	0.5	0	0	0	0	0.5	1.0
PACE-90	0.0	3.6	0.0	1.2	0.7	5.5	Totals	0.0	4.1	0.0	0.0	0.5	0.0	4.6	10.1
9	0	0	0	0	1.0	1.0	9	0	0	0	0	0	0	0.0	1.0
10	0	0	0	0	0	0.0	10	0	0	0	0	0	0	0.0	0.0
11	0	0	0	0	0	0.0	11	0	0	0	0	0	0	0.0	0.0
12	0	1.0	0	0	0	1.0	12	0	0	0	0	0	0	0.0	1.0
13	0	0	0	0.5	0	0.5	13	0	0	0	0	0	0	0.0	0.5
14	0	0	0	0.5	0	0.5	14	0	0	0	0	0	0	0.0	0.5
15	0	0	0	0.5	0	0.5	15	0	0	0	0	0	0	0.0	0.5
16	0	0	0	0	0	0.0	16	0	0	0	0	0	0	0.0	0.0
17	0	0	0	0	0	0.0	17	0	2.0	0	0	0	0	2.0	2.0
18	0	0	0	0	0	0.0	18	0	0.5	0	0	0	0	0.5	0.5
19	0	0	0	0	0	0.0	19	0	2.0	0	0	0	0	2.0	2.0
20	0	0	0	0	0	0.0	20	0	2.0	0	0	0	0	2.0	2.0
21	0	0.1	0	0	0	0.1	21	0	0	0	0	0.5	0	0.5	0.6
22	0	0	0	0	0	0.0	22	0	0	0	0	2.0	0	2.0	2.0
Development	0.0	1.1	0.0	1.5	1.0	3.6	Totals	0.0	6.5	0.0	0.0	2.5	0.0	9.0	12.6
Totals	0.0	4.7	0.0	2.7	1.7	9.1	Totals	0.0	10.6	0.0	0.0	3.0	0.0	13.6	22.7

TABLE B-3: NATURAL BARRIERS PERFROMANCE ASSESSMENT (NBPA)

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-3-N	OSIR Contractors PNL	PNL/PASS	RE/SPEC	UCB	ANL	OSIR Total	ACTIVITY NUMBER 90-3-N	YMPO Contractors SNL	LLNL	LANL	USGS	LBL	ORNL	YMPO Total	YMPO+ +OSIR
1	0	0.3	0	0	0	0.3	1	0.3	0	0	0	0.3	0	0.6	0.9
2	0	0.2	0	0	0	0.2	2	0.5	0	0	0	0.5	0	1.0	1.2
3	0	0.2	0	0	0	0.2	3	0.5	0	0	0	0.5	0	1.0	1.2
4	0	0.2	0	0	0	0.2	4	0.5	0	0	0	0.5	0	1.0	1.2
5	0	0.2	0	0	0	0.2	5	0	0	0	0	0.5	0	0.5	0.7
6	0	0.2	0	0	0	0.2	6	0	0	0	0	0.5	0	0.5	0.7
7	0	0.2	0	0	0	0.2	7	0.5	0	0	0	0	0	0.5	0.7
8	0	1.0	0	0	0	1.0	8	2.0	0	0	0	0	0	2.0	3.0
PACE-90	0.0	2.5	0.0	0.0	0.0	2.5	Totals	4.3	0.0	0.0	0.0	2.8	0.0	7.1	9.6
9	0	0	0	0	0	0.0	9	2.0	0	0	0	0	0	2.0	2.0
10	0	0	0	0	0	0.0	10	2.0	0	0	0	0	0	2.0	2.0
11	0	1.0	0	0	0	1.0	11	0	0	0	0	0	0	0.0	1.0
12	0	0	0	0	0	0.0	12	0	0	0	0	2.8	0	2.8	2.8
Development	0.0	1.0	0.0	0.0	0.0	1.0	Totals	4.0	0.0	0.0	0.0	2.8	0.0	6.8	7.8
Totals	0.0	3.5	0.0	0.0	0.0	3.5	Totals	8.3	0.0	0.0	0.0	5.6	0.0	13.9	17.4

TABLE B-4: PRECLOSURE SAFETY ASSESSMENT

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-4-N	OSIR Contractors PNL	PNL/PASS	RE/SPEC	UCB	ANL	OSIR Total	ACTIVITY NUMBER 90-4-N	YMPO Contractors SNL	LLNL	LANL	USGS	LBL	ORNL	YMPO Total	YMPO+ +OSIR
1	0	0.0	0	0	0	0.0	1	0	0	0	0	0	0	0.0	0.0
2	0	0.0	0	0	0	0.0	2	0	0	0	0	0	0	0.0	0.0
3	0	0.0	0	0	0	0.0	3	0	0	0	0	0	0	0.0	0.0
4	0	0	0	0	0	0.0	4	0	0	0	0	0	0	0.0	0.0
5	0	0.0	0	0	0	0.0	5	0	0	0	0	0	0	0.0	0.0
6	0	0.0	0	0	0	0.0	6	0	0	0	0	0	0	0.0	0.0
7	0	0	0	0	0	0.0	7	0	0	0	0	0	0	0.0	0.0
8	0	0	0	0	0	0.0	8	0	0	0	0	0	0.5	0.5	0.5
9	0	0	0	0	0	0.0	9	0	0	0	0	0	2.0	2.0	2.0
Development	0.0	0.0	0.0	0.0	0.0	0.0	Totals	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.5

TABLE B-5: PERFORMANCE ASSESSMENT DESIGN SUPPORT

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-5-N	OSIR Contractors					OSIR	ACTIVITY NUMBER 90-5-N	YMPO Contractors						YMPO	YMPO+
	PNL	PNL/PASS	RE/SPEC	UCB	ANL	Total		SNL	LLNL	LANL	USGS	LBL	ORNL	Total	+OSIR
1	0	0.2	0	0	0	0.2	1	2.0	0	0	0	0	0	2.0	2.2
2	0	0.0	0	0	0	0.0	2	0.0	0	0	0	0	0	0.0	0.0
3	0	0.5	0	0	0	0.5	3	3.0	0	0	0	0	0	3.0	3.5
4	0	0.0	0	0	0	0.0	4	0	0	0	0	0	0	0.0	0.0
5	0	0.0	0	0	0	0.0	5	0	0	0	0	0	0	0.0	0.0
6	0	0.0	0	0	0	0.0	6	0	0	0	0	0	0	0.0	0.0
7	0	0.0	0	0	0	0.0	7	0	0	0	0	0	0	0.0	0.0
Totals	0.0	0.7	0.0	0.0	0.0	0.7	Totals	5.0	0.0	0.0	0.0	0.0	0.0	5.0	5.7

TABLE B-6: PERFORMANCE ASSESSMENT LICENSING SUPPORT

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-6-N	OSIR Contractors PNL	PNL/PASS	RE/SPEC	UCB	ANL	OSIR Total	ACTIVITY NUMBER 90-6-N	YMPO Contractors SNL	LLNL	LANL	USGS	LBL	ORNL	YMPO Total	YMPO+ +OSIR
1	0	0.0	0	0	0	0.0	1	0	0	0	0	0	0	0.0	0.0
2	0	0	0	0	2.0	2.0	2	1.9	0	0	0	0	0	1.9	3.9
3	0	0	1.8	0	0	1.8	3	0	0	0	0	0	0	0.0	1.8
Totals	0.0	0.0	1.8	0.0	2.0	3.8	Totals	1.9	0.0	0.0	0.0	0.0	0.0	1.9	5.7

TABLE B-7: PERFORMANCE ASSESSMENT TESTING SUPPORT

Detailed FY 1990 FTE's for each contractor activity; effective 31 Dec 1989

ACTIVITY NUMBER 90-7-N	OSIR Contractors PNL	PNL/PASS	RE/SPEC	UCB	ANL	OSIR Total	ACTIVITY NUMBER 90-7-N	YMPO Contractors SNL	LLNL	LANL	USGS	LBL	ORNL	YMPO Total	YMPO+ +OSIR
1	0	0	0	0	0	0.0	1	1.8	0	0	0	0	0	1.8	1.8
2	0	0	0.0	0	0	0.0	2	1.0	0	0	0	0	0	1.0	1.0
3	0	1.2	0	0	0	1.2	3	0	0	0	0	0	0	0.0	1.2
4	0	0.0	0	0	0	0.0	4	0	0	0	0	0	0	0.0	0.0
5	0	0	0	0	0	0.0	5	0.0	0	0	0	0	0	0.0	0.0
Totals	0.0	1.2	0.0	0.0	0.0	1.2	Totals	2.8	0.0	0.0	0.0	0.0	0.0	2.8	4.0

TABLE B-8: OVERALL FY 1990 FTE's BY ACTIVITY CATEGORY FOR EACH CONTRACTOR; Effective 31 Dec 1989

ACTIVITY CATEGORY	OSIR Contractors					OSIR		YMPO Contractors						YMPO	YMPO+
	PNL	PNL/PASS	RE/SPEC	UCB	ANL	Total		SNL	LLNL	LANL	USGS	LBL	ORNL	Total	+OSIR
GEN IMPL & OVRSITE	3.7	4.8	1.5	0.2	0.6	10.8		0.8	0.2	0	0	0.2	0	1.2	12.0
PACE-90															
WG-1	0	7.3	0	0.4	0	7.7		7.3	0	0	0	0	0	7.3	15.0
WG-2	0	3.6	0	1.2	0.7	5.5		0.0	4.1	0	0	0.5	0	4.6	10.1
WG-3	0	2.5	0	0	0	2.5		4.3	0	0	0	2.8	0	7.1	9.6
WG-4	0	0	0	0	0	0.0		0	0	0	0	0	0	0.0	0.0
Subtotal	0.0	13.4	0.0	1.6	0.7	15.7	Totals	11.6	4.1	0.0	0.0	3.3	0.0	19.0	34.7
DEVELOPMENT															
WG-1	0	6.3	0	0.0	0	6.3		5.1	0	0	0	0	0	5.1	11.4
WG-2	0	1.1	0	1.5	1.0	3.6		0	6.5	0	0	2.5	0	9.0	12.6
WG-3	0	1.0	0	0	0	1.0		4.0	0	0	0	2.8	0	6.8	7.8
WG-4	0	0.0	0	0	0	0.0		0.0	0	0	0	0	2.5	2.5	2.5
Subtotal	0.0	8.4	0.0	1.5	1.0	10.9	Totals	9.1	6.5	0.0	0.0	5.3	2.5	23.4	34.3
TECHNICAL SUPPORT															
WG-5	0	0.7	0	0	0	0.7		5.0	0	0	0	0	0	5.0	5.7
WG-6	0	0.0	1.8	0	2.0	3.8		1.9	0	0	0	0	0	1.9	5.7
WG-7	0	1.2	0.0	0	0	1.2		2.8	0	0	0	0	0	2.8	4.0
Subtotal	0.0	1.9	1.8	0.0	2.0	5.7	Totals	9.7	0.0	0.0	0.0	0.0	0.0	9.7	15.4
CONTRACTOR TOTAL	3.7	28.5	3.3	3.3	4.3	43.1	Totals	31.2	10.8	0.0	0.0	8.8	2.5	53.3	96.4

APPENDIX C

MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES

This appendix summarizes the milestone specified for the fiscal year 1990 performance assessment activities listed in Appendix A. Table C-1 gives the milestones of all the activities coordinated by Working Group 1 categorized according to activity number, the organization responsible for the milestone completion, and the date for milestone completion. The remaining tables give the milestones for the activities coordinated by the other Working Groups in the same format.

Table C-1
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 1 - Total System Performance

Activity 90-1-1	Date
PNL data package for TSPA exp. perf analyses	2/90
PNL data package for TSPA dist perf analyses	4/90
PNL data package for TSPA sensitivity studies	6/90
SNL data package for TSPA exp. perf analyses	2/90
SNL data package for TSPA dist perf analyses	4/90
SNL data package for TSPA sensitivity studies	6/90
SNL report on issues and data needs for PA	9/90
Activity 90-1-2	
PNL rept. on scenario set for TSPA exp. perf. analyses	1/90
PNL rept. on scenario set for TSPA dist. perf. analyses	2/90
PNL rept. on methodology for scenario selection	8/90
SNL rept. on scenario set for TSPA exp. perf. analyses	1/90
SNL rept. on scenario set for TSPA dist. perf. analyses	2/90
SNL rept on volcanism & human intrusion	9/90
SNL report on screening of scenarios vs consequences	9/90
Activity 90-1-3	
PNL report on expected performance	4/90
UCB report on expected performance	4/90
SNL report on expected performance	4/90
SNL report on water pathways	9/90
SNL report on gas pathways	9/90
Activity 90-1-4	
SNL report on analysis for disturbed performance	7/90
PNL report on analysis for disturbed performance	7/90
Activity 90-1-5	
PNL report on sens. anal. of system performance	9/90
SNL report on sens. anal. of system performance	9/90

Table C-1 (Continued)
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 1 - Total System Performance

Activity 90-1-6	Date
PNL documentation of SUMO	9/90
Activity 90-1-7	
SNL report on model of gas-phase releases	9/90
Activity 90-1-8	
SNL report on site suitability methodology	9/90
Activity 90-1-9	
SNL documentation of TOSPAC, volume 2	9/90
Activity 90-1-10	
SNL documentation of STRESS-3D	9/90
Activity 90-1-11	
PNL documentation for global climate modeling study plan	1/90
PNL report on FY 90 global climate modeling	9/90
Activity 90-1-12	
SNL report on total system simulator	9/90

Table C-2
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 2 - Engineered-Barrier System Performance

Activity 90-2-1	Date
PNL data package for TSPA source term for exp. perf.	2/90
PNL data package for TSPA source term for dist. perf.	4/90
PNL data package for TSPA source term for sens. anal.	6/90
PNL data package for EBSPA containment failure anal.	2/90
PNL data package for EBSPA sens. anal.	4/90
LLNL data package for TSPA source term for exp. perf.	2/90
LLNL data package for TSPA source term for dist. perf.	4/90
LLNL data package for TSPA source term for sens. anal.	6/90
LLNL data package for EBSPA containment failure anal.	2/90
LLNL data package for EBSPA sens. anal.	4/90
UCB data package for EBSPA sens. anal	6/90
Activity 90-2-2	
LLNL report on near-field environments for EBSPA	3/90
LLNL report on near-field env. for EBSPA sens. anal.	5/90
LBL report on near-field environments for EBSPA	3/90
LBL report on near-field env. for EBSPA sens. anal.	5/90
Activity 90-2-5	
PNL report on release modes for EBSPA analyses	2/90
LLNL report on release modes for EBSPA analyses	2/90
Activity 90-2-6	
LLNL report on WP failure rates for TSPA src. terms	2/90
LLNL report on WP failure rates for EBSPA anal.	3/90
LLNL report on WP failure rates for EBSPA sens. study	6/90
PNL report on WP failure rates for TSPA src. terms	2/90
PNL report on WP failure rates for EBSPA anal.	3/90
PNL report on WP failure rates for EBSPA sens. study	6/90
UMinn report on WP failure rates for TSPA src. terms	2/90
UMinn report on WP failure rates for EBSPA anal.	3/90
UMinn report on WP failure rates for EBSPA sens. study	6/90

Table C-2 (Continued)
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 2 - Engineered-Barrier System Performance

Activity 90-2-7	
LLNL report on EBS release rates	4/90
LLNL report on EBS sens. studies	9/90
PNL report on EBS release rates	4/90
PNL report on EBS sens. studies	9/90
UCB report on EBS release rates	4/90
UCB report on EBS sens. studies	9/90
Activity 90-2-8	
LLNL report on review of TSPA exp. perf srce. terms	3/90
LLNL report on review of TSPA dist. perf srce. terms	6/90
LLNL report on review of TSPA sens. study srce. terms	8/90
PNL report on review of TSPA exp. perf srce. terms	3/90
PNL report on review of TSPA dist. perf srce. terms	6/90
PNL report on review of TSPA sens. study srce. terms	8/90
Activity 90-2-9	
U. Minn report on container failure freq. corr.	9/90
Activity 90-2-12	
PNL documentation of AREST	9/90
Activity 90-2-13	
UCB report on model of mass transfer through rubble	9/90
Activity 90-2-14	
UCB report on model of release due to solid-phase alt.	9/90
Activity 90-2-15	
UCB report on model of colloid transport	9/90

Table C-2 (Continued)
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 2 - Engineered-Barrier System Performance

Activity 90-2-17	
LLNL documentation of PANDORA-1.1	9/90
Activity 90-2-18	Date
LLNL report on uncertainty methods for PANDORA	9/90
Activity 90-2-19	
LLNL documentation for EQ3/6 code	9/90
Activity 90-2-20	
LLNL documentation of new DATAO	9/90
Activity 90-2-21	
LBL documentation of TOUGH	9/90
Activity 90-2-22	
LBL report on models of nonisothermal flow	9/90

Table C-3
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 3 - Natural Barriers Performance

Activity 90-3-1	Date
PNL initial data package for sensitivity studies	2/90
PNL updated data package for sensitivity studies	6/90
SNL initial data package for sensitivity studies	2/90
SNL updated data package for sensitivity studies	6/90
LBL initial data package for sensitivity studies	2/90
LBL updated data package for sensitivity studies	6/90
Activity 90-3-2	
PNL report of sens. study of frac./mx. interactions	9/90
SNL report of sens. study of frac./mx. interactions	9/90
LBL report of sens. study of frac./mx. interactions	9/90
Activity 90-3-3	
PNL report of sens. study of inhomogeneities	9/90
SNL report of sens. study of inhomogeneities	9/90
LBL report of sens. study of inhomogeneities	9/90
Activity 90-3-4	
PNL report of sens. study of pre-empl. hydrol.	9/90
SNL report of sens. study of pre-empl. hydrol.	9/90
LBL report of sens. study of pre-empl. hydrol.	9/90
Activity 90-3-5	
PNL report on perched water analysis	9/90
LBL report on perched water analysis	9/90
Activity 90-3-6	
PNL report on postclosure hydrology	9/90
LBL report on postclosure hydrology	9/90
Activity 90-3-7	
SNL report on moisture fields used for input to TSPA anal.	7/90

Table C-3 (Continued)
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 3 - Natural Barriers Performance

Activity 90-3-8	Date
SNL report on GWTT sens. study	9/90
PNL report on GWTT sens. study	9/90
Activity 90-3-9	
SNL report on the verif. of NORIA, FEMWATER, and LLUVIA	9/90
Activity 90-3-10	
SNL report on prel. validation of unsat. flow model	9/90
Activity 90-3-11	
PNL document PORFLO	9/90
Activity 90-3-12	
LBL report on concepts of flow in part. sat. tuff	9/90

Table C-4
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 4 - Preclosure Radiological Safety

Activity 90-4-8	Date
ORNL report on unc.in bounding inventories in ORIGEN	9/90
Activity 90-4-9	
ORNL report on validation of ORIGEN2	9/90

Table C-5
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 5 - Support to Design

No milestones specified

Table C-6
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 6 - Support to Licensing

No milestones specified

Table C-7
MILESTONES FOR PERFORMANCE ASSESSMENT ACTIVITIES
Working Group 7 - Support to Testing

Activity 90-7-3	Date
PNL report on FY 90 glass waste form study	9/90