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**DOE SITE
PERFORMANCE ASSESSMENT
ACTIVITIES**

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Prepared For

**EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, Idaho 83405**

By

**Rogers & Associates Engineering Corporation
P.O. Box 330
Salt Lake City, Utah 84110-0330**

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ABSTRACT

Information on performance assessment capabilities and activities was collected from eight DOE sites. All eight sites either currently dispose of low-level radioactive waste (LLW) or plan to dispose of LLW in the near future. A survey questionnaire was developed and sent to key individuals involved in DOE Order 5820.2A performance assessment activities at each site. The sites surveyed included: Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), Paducah Gaseous Diffusion Plant (Paducah), Portsmouth Gaseous Diffusion Plant (Portsmouth), and Savannah River Site (SRS). The questionnaire addressed all aspects of the performance assessment process; from waste source term to dose conversion factors. This report presents the information developed from the site questionnaire and provides a comparison of site-specific performance assessment approaches, data needs, and ongoing and planned activities. All sites are engaged in completing the radioactive waste disposal facility performance assessment required by DOE Order 5820.2A. Each site has achieved various degrees of progress and have identified a set of critical needs. Within several areas, however, the sites identified common needs and questions.

SUMMARY

The Department of Energy (DOE) Order 5820.2A establishes policies, guidelines, and minimum requirements by which DOE manages its radioactive and mixed waste. The Order mandates that all radioactive and mixed wastes be managed in a manner that ensures protection of the health and safety of the public, DOE and contractor employees, and the environment.

Consistent with these objectives, DOE sites with low-level waste (LLW) disposal facilities are required to prepare and maintain a site-specific radiological performance assessment for the disposal of LLW. To comply with these requirements, affected sites must develop the capabilities for conducting performance assessments.

The EG&G Idaho Radioactive Waste Technical Support Program (TSP) requested Rogers and Associates Engineering Corporation (RAE) to conduct a survey of current and planned performance assessment activities and capabilities at various DOE sites. The survey determined the current capabilities of each site to prepare and maintain the Order 5820.2A performance assessment. The survey also identified the approaches used by each site to comply with the Order.

Information on performance assessment capabilities and activities was collected from eight DOE sites. All eight sites either currently dispose of LLW or plan to dispose of LLW in the near future. A survey questionnaire was developed and sent to key individuals involved in performance assessment activities at each site. The sites surveyed included: Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), Paducah Gaseous Diffusion Plant (Paducah), Portsmouth Gaseous Diffusion Plant (Portsmouth), and Savannah River Site (SRS). The questionnaire addressed all aspects of the performance assessment process; from waste source term to dose conversion factors.

RAE personnel discussed all aspects of performance assessment in face-to-face meetings with representatives of all eight sites. Site personnel provided information to address all questions on the questionnaire. Written responses developed during the site interviews were compiled and submitted to the sites for comments. Following comment resolution, the interview responses were used to form the basis for this report.

Waste Source Term

All DOE sites have nuclide inventory data for the waste to be included in the 5820.2A performance assessment. Radionuclide concentrations are measured or estimated on a per-package basis.

The quality of available source term data range from poor to good. Source term data varies between sites and in some cases between disposal facilities at the same site. Significant changes in the waste source term are expected to occur throughout the DOE system as a result of changes in site facilities and operations. Improvements in the quality of waste source term data are being pursued at the majority of the sites. Typically, the approach taken is the institution of more stringent waste acceptance criteria.

Physical and chemical characteristic data collected for as-generated waste are generally sparse. Most sites do not plan to collect additional information on these aspects of the waste, believing enough information exists for the performance assessment.

Development of effective waste stream characterization at the sites is likely to be hampered by a lack of resources. The extent to which characterization efforts have progressed in the past has been limited by the availability of funds. This situation is expected to prevail in the future as well.

Waste Form and Waste Packaging

The predominant forms of waste requiring disposal vary across the sites. Waste disposed of in the Grout Facility at Hanford, in the tumulus at ORNL and in the Z-Area Saltstone, Y-Area and Mixed/Hazardous Waste Disposal Facilities at SRS will be stabilized with grout. The majority of the waste disposed at the remaining sites will be unstabilized.

The leaching behavior of the as-disposed waste is understood on an inconsistent basis. Little emphasis has been placed on this aspect of the assessment at some sites. This leads to the sites using conservatively high release rates that assume all contaminants are immediately available for transport. The need for a better understanding of contaminant release rates is recognized by a majority of sites. Several sites expressed a need for support in the development of leach rate information. Site-specific lysimeter studies were perceived as one method to develop this information.

Disposal Technology

In general, DOE sites situated in arid regions of the U.S. continue to rely on shallow-land burial for the disposal of LLW. The majority of LLW disposed at INEL, LANL, and NTS is buried in earthen trenches and covered with an engineered cover system at the time of final closure. Shallow-land burial is used for solid waste at Hanford, liquid waste is treated and disposed of in the Grout Disposal Facility. This latter facility employs grout, concrete, and asphalt barriers, as well as an elaborate engineered cover system.

Most of the facility designs adopted by the humid eastern sites incorporate multiple engineered barriers. The tumulus at ORNL and all proposed facilities at SRS employ concrete casks or vaults, over which an engineered cover system is placed at closure. Facility designs have not been finalized at Paducah and Portsmouth.

Personnel at Hanford and INEL anticipate that they will be required to alter their current shallow-land burial practices. These changes are expected to be necessary, primarily, to address the public's perception of what constitutes adequate safety in the disposal of LLW.

The critical features of the disposal technologies will be a function of the design of the facility and the site characteristics. At the arid sites, site characteristics are heavily relied on.

Critical features of the Grout Disposal Facility at Hanford, the tumulus at ORNL and the proposed facilities at SRS include the grout, concrete and asphalt barriers and the engineered cover systems. Little or no reliance is placed on site characteristics to ensure the health and safety of the public.

While the behavior of the critical features of shallow-land burial is generally understood, less knowledge of the behavior of the facilities employing multiple engineered barriers is available at this time. Understanding the behavior of these barriers requires understanding the performance of the newly constructed facility as well as changes in performance as the structures age.

The long-term performance of engineered facilities is not understood by either ORNL or SRS personnel. Concrete performance data are needed by these sites, as are computer codes useful in projecting facility performance. Limited work has been completed on the long-term performance of the engineered barriers incorporated into the Hanford Grout Facility.

Transport Pathways and Exposure Scenarios

Groundwater pathways were identified as being the most significant for contaminant migration from disposal facilities situated in the eastern U.S. These pathways also play an important role at the western sites of Hanford and INEL. However it is a low-level chronic one compared to the eastern sites. Surface water pathways are potentially significant at ORNL, Paducah and Portsmouth; surface water transport plays a minor role at SRS. Atmospheric transport of contaminants at Hanford, ORNL, and SRS is relatively unimportant, but plays an important role at the remainder of the sites. Transport pathways resulting in exposures to the hypothetical intruder are important at all DOE sites.

The exposure scenarios planned for inclusion in the 5820.2A performance assessment consider exposures to the inadvertent intruder and general public at all sites. Certain exposure pathways may be excluded from a given site's assessment if the exposure risk posed by the pathway is negligible.

Participants in the survey believe the exposure scenarios used in the performance assessment should be consistent with features specific to each site. While scenarios may vary in specifics, they should share the same underlying philosophy across the DOE system.

Guidance from DOE-Headquarters or the Performance Assessment Peer Review Panel was requested about the amount of detail required before dismissing a given transport or exposure pathway from consideration in the final assessment. Suitable approaches to consideration of the probability of scenarios, especially infrequent events, should also be addressed.

Performance Assessment Computer Codes

Past assessments of the performance of disposal facilities at DOE sites other than Paducah and Portsmouth range from preliminary screening calculations to final assessments. No assessments have been conducted for Paducah or Portsmouth; neither of these sites have operational disposal facilities.

The assessments and screening calculations completed to date vary in their completeness and the degree to which they address all important pathways at the respective sites. As a result, the extent to which projected exposures are expected to bound actual exposures varies among the sites.

Six of the sites have not reached final decisions on the use of one or more of the codes for the 5820.2A assessment. Some of the codes slated for use have, or will, require modification to meet site needs. Validation of the selected codes is planned at all sites, although little progress has been made on

this aspect of the assessment to date. Suitable approaches to model validation, recommended by DOE Headquarters or the Peer Review Panel, would be of assistance to the sites.

Some sites are faced with the task of projecting the long-term performance of disposal facilities employing multiple engineered barriers. Few codes exist which are suitable for this application, those that do exist will require modification to fully meet site requirements. Funding for these efforts is needed.

Site Characteristics

With the exception of NTS, groundwater parameters were identified as being among the most important site parameters. Among the more widely mentioned parameters were soil characteristic curves, saturated and unsaturated soil hydraulic conductivities, and nuclide distribution coefficients. Parameters pertinent to modeling shallow sub-surface flow and surface runoff were cited as important by LANL and ORNL. Other parameters important to sites' efforts include atmospheric pathway parameters, lateral erosion rates, and resuspension factors.

The majority of the data to be used in the 5820.2A performance assessments are specific to the sites. Site-specific hydrologic data are available for all but the Paducah site. Atmospheric data for sites where airborne transport plays an important role are also site-specific. Parameters for which literature-based data are generally relied upon include distribution coefficients and food chain parameters.

The availability of data for the important parameters varies dramatically across the DOE system. Plans generally exist at the sites to remedy these data needs, although available resources often hinder data collection.

Compliance Strategies and Compliance Points

Except for ORNL, all sites are currently using, or will use, the performance objectives stated in Order 5820.2A. Personnel at ORNL have chosen to adopt more stringent performance objectives, 10 mrem/year to the intruder or general public and 4 mrem/year as a limiting groundwater dose, due to uncertainties associated with disposal facility performance. These limits will apply to the disposal facilities currently under development.

Apportionment of DOE performance objectives among site facilities has been considered by most sites. The Hanford site has adopted an apportionment plan for the Grout Disposal Facility. Personnel at

other sites either do not believe apportionment is necessary to ensure compliance or have not considered the issue.

All sites will consider the inadvertent intruder in demonstrating compliance with Order 5820.2A. They will also consider exposures to members of the general public, generally at a point within 100 m of the disposal units. Additional compliance points include the nearest stream or river, the site boundary during operations and institutional control, and offsite atmospheric receptor locations. Sites believe that DOE-Headquarters should formally recognize performance objectives and compliance points. All limits and points should be explicitly stated in the Order, including groundwater protection standards and locations of members of the general public.

The period of simulation to be used in the performance assessments ranges between 1,000 and 10,000 years. In addition to these times, sites anticipate the need to identify peak exposures which occur beyond these times. Guidance from DOE-Headquarters or the Performance Assessment Peer Review Panel on the length of simulation necessary for the assessments would eliminate the inconsistencies that currently exist.

Dose Conversion Factors

All sites use dose conversion factors approved by DOE. Internal dose conversion factors are based on International Commission on Radiation Protection (ICRP) 26/30/48.

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1. INTRODUCTION

The Department of Energy (DOE) Order 5820.2A¹ establishes policies, guidelines, and minimum requirements by which DOE manages its radioactive and mixed waste. The Order mandates that all radioactive and mixed wastes be managed in a manner that ensures protection of the health and safety of the public, DOE and contractor employees, and the environment.

Consistent with these objectives, DOE sites with low-level waste (LLW) disposal facilities are required to prepare and maintain a site-specific radiological performance assessment for the disposal of waste. These assessments must demonstrate compliance with the performance objectives stated in Chapter III of the Order. In order to comply with 5820.2A requirements, affected sites must develop capabilities for conducting performance assessments. These capabilities may be achieved through developing technical expertise at the site or through hiring private contractors. Compliance with the Order will require that each site model its disposal system(s) and calculate realistic dose projections resulting from waste disposed of at that site.

1.1 Purpose

The EG&G Idaho, Inc. Radioactive Waste Technical Support Program (TSP) requested Rogers and Associates Engineering Corporation (RAE) to conduct a survey of current and planned LLW performance assessment activities and capabilities at each DOE site. The intent of this survey is to determine the current capabilities of each site to prepare and maintain the performance assessment required by Order 5820.2A. The survey will also provide an understanding of the approaches taken by each site in complying with Order 5820.2A and the status of these efforts. The information gained from this effort will be used by the TSP to develop a strategy and activities to support site performance assessments. The information will aid in identifying aspects of performance assessment where DOE sites are making technical improvements, issues confronting the sites, and areas where additional work may be required.

1.2 Report Organization

This report discusses the results of the TSP performance assessment survey. The methodology used in collecting site information is described in Chapter 2. An overview of DOE site performance assessment activities is found in Chapter 3. Chapter 4 consists of detailed discussions on the major topics covered in the interview process. Activities, capabilities, and status in each of these areas are compared and contrasted among the sites. Current performance assessment capabilities are summarized by site in

Chapter 5. A copy of the performance assessment survey is provided in Appendix A. Each site's response to the survey is provided in Appendix B.

2. METHODOLOGY

Information on performance assessment capabilities and activities was collected from eight DOE sites. These sites and their acronyms are listed in Table 2-1. The sites were selected for consideration because all of them currently accept or generate LLW which is, or is intended to be, disposed of on site.

RAE used a three-step process to survey performance assessment activities at each of the eight sites. The three steps were:

Develop survey questionnaire

Data collection and review

Report preparation

Each step is briefly described in the following paragraphs.

2.1 Develop Survey Questionnaire

The survey questionnaire was developed through several iterations between RAE and the EG&G Idaho TSP. The intent was to gain an understanding of the approach taken in each site's performance assessment and to address each major topic of the performance assessment process in detail. The resulting questionnaire (see Appendix A) has the following nine sections:

General

As-Generated Waste Source Term

As-Disposed Waste Package/Form

Disposal Technology

Exposure Scenarios and Pathways

Computer Codes

Site Characteristics

Table 2-1. DOE sites included in the performance assessment survey

<u>Site</u>	<u>Site Acronym</u>
Hanford Site	Hanford
Idaho National Engineering Laboratory	INEL
Los Alamos National Laboratory	LANL
Nevada Test Site	NTS
Oak Ridge National Laboratory	ORNL
Paducah Gaseous Diffusion Plant	Paducah
Portsmouth Gaseous Diffusion Plant	Portsmouth
Savannah River Site	SRS

Compliance Strategies and Compliance Points

Dose Conversion Factors

2.2 Data Collection and Review

Information on each site's 5820.2A performance assessment activities was collected using the questionnaire. Site personnel associated with, or responsible for, performance assessment efforts were mailed a copy of the questionnaire. Subsequently, appointments were made to visit each site and discuss the questionnaire with personnel involved in the assessment effort.

RAE visited six of the eight DOE sites listed in Table 2-1. Information for the Paducah and Portsmouth Gaseous Diffusion Plants was collected during discussions at ORNL, as personnel at ORNL are responsible for performance assessment activities at both Paducah and Portsmouth. Participants at each site were asked all questions in the survey and responses were recorded.

Responses recorded during the site interviews were compiled and prepared for distribution to the lead individual taking part in the site interviews, as well as to the EG&G Idaho TSP. Comments on the content of these notes were solicited and received from personnel at all sites. The comments were incorporated into the notes from the interviews, the notes being used as the basis for the text of this report. The reviewed and approved site responses are contained in Appendix B.

2.3 Report Preparation

Early in the survey process RAE provided the TSP a proposed outline of the report "DOE Site Performance Assessment Activities." Upon completion of the review of survey responses by site participants a draft report was compiled. The TSP reviewed and commented on the draft. This report addresses those comments.

3. OVERVIEW OF SITE PERFORMANCE ASSESSMENT ACTIVITIES

This Chapter provides an overview of each site's performance assessment activities. Included is a brief description of the general conditions at each site, the disposal technology or technologies developed for LLW disposal, and the current status of the 5820.2A assessment. As the majority of the site assessments have not been completed, the approaches that will be taken in completing them is discussed.

3.1 General Site Conditions and Disposal Facilities

The performance of LLW disposal facilities at the DOE sites will rely upon the interaction of site characteristics and the features of the disposal technology or technologies employed. This section provides a brief description of these characteristics and features. This general information provides the background necessary to understand the responses to the questionnaire.

3.1.1 Site Characteristics

The eight DOE sites can be roughly divided into two groups by general site characteristics. Sites situated east of the Mississippi River, which include ORNL, the Paducah and Portsmouth sites, and SRS, are characterized by humid conditions and dense vegetation. Annual rainfall ranges between 100 to 150 cm, most of which finds its way to surface streams and underlying groundwater aquifers. The landscape is dotted with rivers, streams, ponds, and lakes, and the depth to groundwater is generally shallow.

In contrast, arid or semi-arid conditions predominate at sites located in the western U.S., including the Hanford site, INEL, LANL, and NTS. Precipitation is on the order of 7 to 40 cm annually, and evapotranspiration rates are high. Vegetation is typically sparse and the depth to groundwater is great.

3.1.2 Disposal Facilities

As will be discussed in greater detail in the following sections, most of the sites have currently operating disposal facilities. Officials at some of the sites anticipate that these facilities will meet disposal needs, and no plans for additional facilities exist at this time. In contrast, disposal facilities are in the developmental stages at the remainder of the DOE sites. These facilities are being developed to replace facilities that have been filled to capacity and/or to provide greater safety in the disposal of waste.

The facilities currently in use or under development are listed in Table 3-1 by site, along with the primary disposal technology employed. This summary provides a quick overview of the directions currently

under consideration at the various sites and introduces the nomenclature to be used in discussing these disposal facilities throughout the report. As this is a summary only, it is important that details provided for each site in Chapter 4 be consulted for a complete understanding of this material.

As seen in Table 3-1, the majority of the DOE sites located in the western U.S. rely on shallow-land burial for waste disposal. In contrast, sites east of the Mississippi River are in the process of developing technologies that employ multiple engineered barriers.

3.2 Status of 5820.2A Performance Assessments

The eight DOE sites exhibit varying degrees of progress on completion of the 5820.2A performance assessments. Estimated completion dates for each disposal facility assessment are listed in Table 3-2.

3.3 Performance Assessment Approach

The performance of a given disposal facility will rely on the interaction between disposal site characteristics and features of the disposal technology. Evidence of this fact is the general reliance of the eastern DOE sites on enhanced technologies, where site characteristics do not favor simple burial of the waste (Table 3-1). Sites located in arid or semi-arid climates tend to rely on favorable site characteristics more than on the features of the disposal technology to ensure safety.

Emphasizing these generalities, personnel at eastern sites place a great deal of importance on accurately representing contaminant release rates from engineered facilities and the long-term performance of these structures. These aspects of the performance assessment are generally seen as crucial to the success of the effort, i.e. crucial to the ability to show compliance with the Order.

Table 3-1. Disposal facilities in use or under development at the DOE sites

<u>DOE Site</u>	<u>Disposal Facility</u>	<u>Disposal Technology^a</u>
Hanford	W-5 Solid Waste Facility ^b	SLB
	Grout Disposal Facility ^c	BGV
INEL	Radioactive Waste Management Complex ^b	SLB,GCD
LANL	Area-G Disposal Facility ^b	SLB,GCD
NTS	Area-5 Disposal Facility ^b	SLB,GCD
	Area-3 Disposal Facility ^b	SLB
ORNL	Solid Waste Storage Area #6 ^b	Tumulus,GCD
	West Chestnut Ridge Disposal Facility (Class 1) ^c	Landfill
	West Bear Creek Valley Disposal Facility (Class 2) ^c	Tumulus
	Class 3 Waste Disposal Facility ^c	Landfill
	Bear Creek Burial Ground ^b	SLB
Paducah	To Be Determined ^d	---
Portsmouth	To Be Determined ^d	---
SRS	Burial Ground ^b	SLB
	Z-Area Saltstone Disposal Facility ^c	BGV
	Radioactive Waste Disposal Facility ^c	BGV
	Y-Area Disposal Facility ^c	BGV
	Mixed/Hazardous Waste Disposal Facility ^c	BGV

- a. SLB - Shallow-Land Burial
GCD - Greater-Confinement Disposal
BGV - Belowground Vault
- b. Indicates disposal facility currently in use.
- c. Indicates disposal facility under development.
- d. Waste is currently stored for disposal.

Table 3-2. Scheduled completion dates for the 5820.2A performance assessments

<u>DOE Site</u>	<u>Disposal Facility</u>	<u>Scheduled Completion Date</u>
Hanford	W-5 Solid Waste Facility	1993
	Grout Disposal Facility	1990
INEL	Radioactive Waste Management Complex	1990 ^a
LANL	Area-G Disposal Facility	1991
NTS	Area-5 Disposal Facility	1990
	Area-3 Disposal Facility	--- ^b
ORNL	Solid Waste Storage Area #6	1991
	West Chestnut Ridge Disposal Facility (Class 1)	1992
	West Bear Creek Valley Disposal Facility (Class 2)	1994
	Class 3 Waste Disposal Facility	--- ^b
	Bear Creek Burial Ground	--- ^c
Paducah	To Be Determined	1993
Portsmouth	To Be Determined	1995
SRS	Burial Ground	--- ^c
	Z-Area Saltstone Disposal Facility	1991
	Radioactive Waste Disposal Facility	1992
	Y-Area Disposal Facility	1993
	Mixed/Hazardous Waste Disposal Facility	1993

a. Indicates date of draft assessment; no date has been scheduled for the final assessment.

b. Indicates no currently scheduled date for completion.

c. Indicates that no performance assessment is scheduled because the disposal facility is being closed.

Performance assessments for DOE sites located in the western U.S. consider rates of contaminant release from the disposal facility, but do not tend to place as much reliance on this aspect of the system to ensure compliance. Here, the rate of contaminant releases from the disposal facility are expected to diminish in significance as a result of the favorable climatic conditions and depth to groundwater. Under these conditions, accurate representation of site characteristics plays a major role in performance assessment.

Performance assessment personnel at the sites were asked to rank the importance of various aspects of the performance assessment. The rankings are found on Table 3-3. A ranking of 1 means most important; 4 is least important. As shown on the Table, most sites rated source term and site characteristics more important than waste package/form or disposal technology.

4. RESULTS AND DISCUSSION

This chapter discusses the information collected during the site interviews. The information is divided among several different aspects of the performance assessment process. The nine aspects of performance assessment listed in Table 4-1 are used to organize the presentation of site activities. Within each aspect, the activities of all eight sites are discussed. This approach is taken to facilitate comparison of activities between sites.

The following discussions assimilate information provided by the sites, highlighting similarities and differences among the participants. Following the discussion of each aspect, a section is devoted to site concerns. These sections address the concerns the sites have within each aspect of the performance assessment and the performance assessment process as a whole.

4.1 Waste Source Term

This section addresses the radiological and nonradiological characteristics of the waste to be disposed of under Order 5820.2A. It is concerned with waste in its as-generated condition, prior to treatment, processing, and packaging.

4.1.1 Radiological Characteristics

The discussion on radiological characteristics of the waste addresses three important aspects. These include the status of current knowledge, the quality of this information, and anticipated changes in the waste source term.

Status of Current Knowledge. All eight DOE sites have nuclide inventory data for waste to be included in the 5820.2A performance assessment. Inventory data for waste disposed of in the past are generally less well known. As the Order regulates the disposal of waste from the date of issuance forward, the relative lack of data for past disposal is technically not an issue in the assessment process. Functionally, however, this lack of data is important. The disposal facilities presently used at the sites (and to be covered in the performance assessment) were also used for past disposal. Therefore, the total waste source term must be considered.

Table 4-1. Aspects of the performance assessment process

Waste Source Term
Waste Form and Waste Packaging
Disposal Technology
Transport Pathways and Exposure Scenarios
Computer Codes
Site Characteristics
Compliance Strategies and Compliance Points
Dose Conversion Factors
General Aspects

Radionuclide concentrations are measured or estimated on a per package basis. Activity measurements generally consist of gamma scans of waste packages, the results being used in conjunction with scaling factors to arrive at estimates of other radionuclide inventories. These scaling factors are based on specific knowledge of the process(es) generating the waste.

Often, waste held in storage during the construction of facilities designed to handle it has undergone a more thorough characterization. Waste slated for disposal in the Grout Disposal Facility at Hanford and in the Z-Area, Y-Area and Mixed/Hazardous Waste Facilities at the SRS has been in storage for long periods of time at each facility. This has provided the opportunity to perform laboratory analyses on these materials.

The implementation of new waste acceptance criteria at some of the sites, discussed below, will require detailed analyses of waste, followed by periodic sampling to ensure consistency over time. This approach will have the effect of re-establishing and strengthening the indirect approaches often used in waste source term characterization.

Data Quality. The quality of the source term data ranges from poor to good at the various DOE sites. LANL personnel believe the source term data collected since approximately 1971 are of good quality. This year marks the time at which new waste acceptance and characterization procedures were implemented. Source term data are considered to be of good quality for both past and present disposal at the NTS as well.

Source term data for the Hanford Grout Disposal Facility are based on analysis of three million gallons of stored waste. The data from these analyses are used to compute average nuclide concentrations, standard deviations, and projected upper bound inventories. A program is in place to characterize the remaining tank waste. As additional samples of the waste are analyzed, existing source term data will be revised.

Radionuclide inventories of the waste awaiting disposal in the Z-Area Saltstone Facility at SRS are well characterized. Much of this waste is currently in storage, some of it for thirty years. During this time, the waste has undergone comprehensive laboratory characterization. The waste will be sampled further before the grouting process and when it emerges as a grout.

Quality of the source term data for the low-level and mixed waste to be disposed of in the Y-Area and Mixed/Hazardous Waste Facilities at SRS is also good. Similar to the Saltstone Facility waste, much

of this waste is currently in storage and has been characterized. The level of confidence in these data may diminish if the waste generated in the future varies significantly from the material in storage. This will

most likely be true for the Mixed/Hazardous Waste Facility because significant quantities of mixed waste will be generated during future site remediation efforts.

The quality of past source term data for the LLW disposed of in the SRS Burial Ground is more suspect. Improved data for future disposal, however, are expected as a result of more thorough characterization procedures.

Historical source term data for the INEL are of variable quality, primarily due to an inconsistent level of effort on the part of the generators in characterizing their waste. Data from research-based facilities are generally of good quality, though the same cannot be said for data from the majority of the production facilities. Source term data currently collected at the INEL are of considerably better quality than past data, and are expected to improve in the future as new waste acceptance criteria are instituted.

Confidence in source term data at the remaining DOE sites is generally quite low. Inadequate or simplistic process knowledge has hindered the collection of high-quality source term data for the Hanford Solid Waste Disposal Facility, and for the ORNL, Paducah, and Portsmouth sites. These problems are expected to continue until greater demand is put upon the generators to improve their performance in this area.

Improvements in the quality of waste source term data are being pursued at the majority of the sites. Typically, the approach taken is the institution of more stringent waste acceptance criteria. While the specifics of these criteria vary between sites, their general effect will be to encourage or demand more effort on the part of generators for characterizing their waste.

These characterization efforts will vary by site and by the nature of the waste. While some sites will demand a more analytically based characterization of the waste source term, other sites will more readily accept data based on process knowledge. Waste generated by processes that are well understood and that are consistent over time, is more appropriate for characterization through process knowledge than waste with wide temporal inconsistencies. Analytical measurements of waste capable of producing high exposures are also impractical.

As part of these more stringent waste certification programs, some sites are providing the generators with help in characterizing waste nuclide inventories. Hanford will issue guidance documents that educate generators about the available characterization procedures and how to implement them. The program at the INEL will also lend educational assistance to the generators.

Limits on acceptable nuclide concentrations will be developed for each of the ORNL disposal facilities. Using these limits as a basis, generators at the site will be forced to prove that their waste qualifies for disposal at a given facility before it will be accepted. Waste that cannot be accommodated at the site's facilities will require offsite disposal.

A majority of the certification programs includes an audit process through which the methods used by generators to characterize their waste will be examined and judged as to their adequacy. If the waste generated by a given facility changes, additional audits of the characterization procedures would be performed.

The improved quality of data generated through the certification programs will not be realized until the programs have been fully implemented. The time for complete implementation of these programs varies widely between sites, ranging from a few months at the INEL to up to five years at ORNL.

Implementation at ORNL has been slowed because waste classification limits must be developed for each of that site's disposal facilities. Since several of these facilities are still in the developmental stage, implementation is delayed.

Future Waste Source Term Characteristics. Significant changes in the source term configuration may occur throughout the DOE system. The Hanford site is in the process of terminating operations. While certain facilities are still operating and generating waste, these plants will complete their missions within a few years and close down. This will have an obvious effect on the amount and nature of waste generated at the site.

As part of the shutdown of the Hanford site, waste treatment facilities have been built and have begun operations. While these facilities are designed largely for the treatment of high-level and transuranic (TRU) waste, by-product LLW will be generated during operations. Finally, as the shutdown of the site proceeds, waste generated from decontamination and decommissioning of site facilities will increase significantly.

Changes in the source term are expected on a more or less continuous basis at the INEL. These changes will be the direct result of closing facilities that have fulfilled their usefulness and developing new ones.

Waste minimization efforts at the Los Alamos site may have a significant impact on the laboratory's future waste source term. Changes that may impact the Area-G Disposal Facility include the implementation of a below-regulatory-concern rule for suspect waste and the start-up of two incinerators at the site. Either of these events will result in reductions in the volume of waste disposed of, thereby increasing average nuclide concentrations.

In addition to these impacts, a large amount of decontamination and decommissioning work is expected to occur at LANL in the next four years. The waste generated from these activities is expected to be primarily mixed waste, requiring disposal in a RCRA-approved disposal site.

At NTS, projections of changes in the waste source term are made difficult because the majority of the waste disposed of at the site is generated offsite. Two factors, however, may affect the inventory of waste requiring greater-confinement disposal. The first of these has to do with problem waste, including greater-than-class-C and noncertifiable TRU waste. Efforts are currently in progress to identify the quantities and nature of these types of waste belonging to the DOE. In the event that the NTS was selected for disposal of some or all of these wastes, nuclide inventories at the site would be changed.

The Nevada site is also interested in developing the capability to accept special situation or problem waste from DOE generators on a regular basis. This waste may be similar to the problem waste described above or may include a unique array of contaminants. If these capabilities are developed the amount of waste requiring greater-confinement disposal would likely increase.

The inconsistent nature of much of the waste generated at the Oak Ridge, Paducah, and Portsmouth sites makes it likely that changes in the waste source term will occur. Approximately 50 percent of the waste generated at the Y-12 Plant at Oak Ridge, Paducah, and Portsmouth is consistent over time, the remainder of the waste is quite variable. Waste from the X-10 and K-25 facilities at Oak Ridge is inconsistent over time, with waste from the X-10 facility being especially so.

In addition to these factors, waste minimization efforts at Oak Ridge may impact the amount and nature of the waste generated. Current plans call for incinerating some portion of the combustible waste produced at the site.

Eventual closure of the five reactors at the SRS, two of which have already been shut down, and the construction of a single large reactor will influence the amount of waste generated at the site. However, because the same basic plant design has been used, the radiological characteristics of this waste are not expected to be significantly different.

Changes in plutonium production as a result of changes in current thinking about defense production would eliminate some of the waste currently generated at the SRS. Finally, waste generated from decontamination and decommissioning activities, expected to be heavy within 5 to 10 years, would impact current source term estimates.

4.1.2 Physical and Chemical Characteristics

Physical and chemical characteristic data collected for as-generated waste are generally meager. Radioactive waste disposal/shipment forms submitted by the generators are consistent among the sites and require a generic description of the waste (e.g. wood, metal, trash) and the assurance that there are no free liquids, gases, RCRA- or EPA-listed constituents. The quality of this level of data is generally good among the sites.

Additional data are being pursued by three of the sites to better characterize the chemical properties of the as-generated waste. These data are important to site personnel in determining radionuclide release rates and transport in the vicinity of the disposed waste.

Los Alamos intends to investigate both the chemical form of its waste in greater detail and the related analytical needs for the site's mixed waste. Data from these studies was expected to be available near the end of 1989. The chemistry of uranium in waste at the SRS is expected to receive additional attention, although no formal study plans have been made. Finally, additional chemical characterization data are expected to be necessary to address waste release rates at the Hanford site. The nature of the data needed for this effort has not yet been determined.

INEL, NTS, ORNL, Paducah, and Portsmouth do not currently plan to collect additional information on the physical and chemical characteristics of the as-generated waste. Personnel at these sites believe they have enough data for the performance assessments.

4.1.3 Site Concerns

Funding is needed by a number of the sites in support of waste characterization efforts. This assistance is important at the disposal system level and for the generators themselves.

There is concern that the development of effective waste stream characterization at the sites will be hampered by a lack of resources. The extent to which characterization efforts have been undertaken in the past has been limited by the availability of funds. A similar situation is expected to prevail in the future.

4.2 Waste Form and Waste Packaging

This portion of the report is concerned with the as-disposed waste form and waste packaging characteristics. The impact of form and packaging on the leaching behavior of the waste is also considered.

4.2.1 Waste Form

The predominant forms of waste requiring disposal vary across the sites. All waste disposed in the Hanford Grout Facility, the ORNL tumulus, and the Saltstone, Y-Area, and Mixed/Hazardous Waste Facilities at the Savannah River Site will be stabilized with grout. Limited grouting of waste is used at the Hanford Solid Waste Facility for stabilizing liquid waste streams and sludge. The majority of the waste disposed of at the other sites is unstabilized.

Other forms of waste commonly encountered at the DOE sites include compactible trash, non-compactible waste such as metals, and soil and rubble. Compaction of the compactible trash is used inconsistently among the sites as a means of volume reduction. While LANL routinely compacts this waste, other sites have no requirements for compaction. Two of the sites are looking into, or have instituted, pricing schedules or other programs which provide generators with an incentive to compact their waste.

Incineration of combustible waste is being pursued at four of the sites. It has been pursued reluctantly at the Hanford facility because the state of Washington has a history of opposing in-state waste incineration. Two incinerators are being developed at LANL, while a commercial incinerator is being built at Oak Ridge. An experimental incinerator is in place at INEL. Use of these facilities will reduce the waste volumes requiring disposal and produce an ash waste form.

4.2.2 Waste Package Characteristics

A variety of waste packages are accepted for disposal at the DOE sites. Container types accepted include 210-L drums, B-25 boxes, and a variety of other steel and wooden boxes, depending upon the class

of the disposed waste. Bulk waste is accepted for disposal at the LANL Area-G Disposal Facility, at the NTS Area-3 Disposal Facility, and at the SRS Burial Ground. Waste disposed of at the Area-3 facility at the NTS may be left in transport containers and placed in the crater.

Additional package types are used for the disposal of higher activity tritium or other special wastes at some of the sites. Steel liners are used at ORNL for waste disposed of in the greater-confinement disposal silos. At LANL, higher activity tritium waste is packaged in drums lined and sealed with asphalt. The INEL uses carbon steel cask liners for disposing of activated metals at the Radioactive Waste Management Complex (RWMC).

4.2.3 Waste Leaching Behavior

The leaching behavior of as-disposed waste is understood on an inconsistent basis at the DOE sites. Relatively little emphasis has been placed on this aspect of performance assessment at LANL and NTS. Current modeling efforts at these sites have either assumed that all contaminants are available for transport from the waste or they have used leach rates that are conservatively high.

While work is planned to begin quantifying waste leach rates at the LANL, results of current groundwater modeling efforts are expected to have a bearing on the resources expended in acquiring this information. Should groundwater modeling indicate that it is unlikely that contaminants will reach the aquifer within the simulation period adopted for the performance assessment, large expenditures on leach rate determinations would be impractical. Collection of additional data on release rates is not planned at NTS.

The need for additional information on release rates is recognized at the remaining sites. Hanford personnel plan to collect empirical data on leach rates for the Solid Waste Facility. Diffusion data have been collected for use in the Grout Disposal Facility performance assessment. These data, collected for several years, consider grouts which incorporate both actual and simulated double-shelled tank waste. A database of grout diffusivities is being established at the site for a number of contaminants in other types of grout, in support of data used in the performance assessment.

In addition to diffusion data, other aspects of the grout are being studied as a part of the Grout Disposal Facility effort at Hanford. These include the nature of the chemical reactions that occur between the grout and waste constituents, and the impact of the highly alkaline nature of the grout on vault performance. These aspects are expected to play an important role in determining contaminant release rates from the facility.

Modeling of contaminant releases at the INEL is based on empirical data for retrieved transuranic waste. It is recognized that improved data and leaching models are required for the disposal facility, although no formal plans to collect the necessary data are in place. Attention to the performance of long-lived waste containers, such as high-integrity containers, is also important to modeling efforts at the site.

Data on the leaching behavior of waste disposed of at the Y-12 plant at Oak Ridge are being collected through the withdrawal of leachate from disposal trenches. A lysimeter study is also in place, in which leachate is collected from saturated waste and analyzed. Additional leaching data are anticipated through the analysis of leachate collected from the proposed West Chestnut Ridge Disposal Facility. Data on leach rates for the grouted Class 2 waste are generally unavailable.

Leaching behavior of the grouted waste destined for disposal in the SRS Saltstone Facility is well understood. Considerable laboratory work has been performed to characterize the diffusion characteristics of this material while it has been in storage. Changes in leach rates accompanying degradation of the waste form are not well understood.

Differences in the chemical characteristics of the contaminants leached from the saltstone vaults and the surrounding soils may play a potentially significant role in the performance assessment. The leachate emerging from the vaults will be highly alkaline and saturated with nitrates and sodium. As it contacts the more acidic clays surrounding the vaults, the leach solution is expected to flocculate. Precipitation of the leachate is expected as the pH of the material moderates in the native site soils. These interactions are expected to result in significant slowing of the contaminant plume. Additional work is planned to investigate these geochemical aspects.

Leaching of contaminants from the Radioactive Waste Disposal Facility at the SRS is not understood. It is unclear to site personnel how waste contaminants will migrate from the unstabilized waste within the vaults to the inner vault surface. Additional work is planned to identify these processes and collect the data needed in future modeling efforts.

4.2.4 Site Concerns

Several sites expressed a need for assistance in defining contaminant release rates. More often than not, additional funding was considered to be most helpful. Data on concrete and grout performance would also be of use to ORNL and SRS. Site-specific data on nuclide distribution coefficients would be beneficial to many of the sites.

Lysimeter studies were perceived as being useful in developing contaminant release rate data. They were considered to be of limited use in defining contaminant transport velocities below the disposal units because soils placed in the lysimeters would be disturbed and not necessarily representative of natural conditions.

A national lysimeter study was viewed with mixed emotions by site personnel. Personnel at many sites did not expect that waste forms and soils used in such a study would address their situations any better than lysimeter studies currently in place. Other sites expressed the opinion that they would want to perform any lysimeter work taking place at their sites.

4.3 Disposal Technology

This section addresses the technologies used in the disposal of LLW. The technologies used, or planned for use, by each site are discussed, including the critical features of each. A summary of the disposal technologies and critical features of the anticipated technologies are summarized in Table 4-2.

4.3.1 Current and Future Technologies

In general, DOE sites situated in arid regions of the U.S. continue to rely on shallow-land burial for the disposal of their LLW. In contrast, multiple engineered barriers, with an earthen cover system, are incorporated into most of the facility designs adopted by the humid eastern sites.

The majority of LLW disposed of at INEL, LANL, and NTS is buried in earthen trenches, over which an engineered cover system will be placed at the time of final closure. Shallow-land burial is used for the disposal of solid LLW at Hanford, liquid waste will be treated and disposed of in the Grout Disposal Facility.

While similar in concept, shallow-land burial of waste at INEL, LANL, NTS, and Hanford varies in its implementation. Trench dimensions vary across the sites, ranging in depth from approximately 5 to 14 m, in width from 8 to 30 m, and in length from 85 to 200 m. The interim cover, applied to prevent the dispersal of waste contaminants until application of the final cover, ranges in depth from about 1 to 2.5 m.

The NTS disposes of bulk waste, including contaminated soil and debris from atmospheric test shots, at the Area 3 Disposal Facility. Waste 'trenches' are constructed through the removal of the soil barrier between two adjacent craters remaining from past atmospheric test shots. The single trench created is filled with waste. The soil and debris may be left in transport containers.

Table 4-2. Disposal technologies and critical features

	Hanford	INEL	LANL	NTS	ORNL	Paducah	Portsmouth	SRS
Current Disposal Technology ¹	1. SLB	1. SLB 2. GCD	1. SLB 2. GCD	1. SLB 2. GCD	1. Tumulus 2. SLB 3. GCD	Waste is stored	Waste is stored	1. SLB
Anticipated Disposal Technology ¹	1. SLB 2. BGV	1. SLB 2. GCD	1. SLB 2. GCD	1. SLB 2. GCD	1. Tumulus 2. Landfill	To Be Determined	To Be Determined	1. BGV
4-12 Critical Features of Anticipated Disposal Technology ²	1. Site characteristics Engineered cover system 2. Asphalt cocoon Grouted waste form Engineered cover system Clay cap	1. Engineered cover system 2. Engineered cover system	1. Engineered cover system Site hydrology 2. Engineered cover system Site hydrology	1. Site climate/geology 2. Site climate/geology	1. Concrete casks Grouted waste form 2. Low nuclide concentrations	To Be Determined	To Be Determined	1. Grouted waste form Concrete vaults

1. SLB = Shallow Land Burial
GCD = Greater-Confinement Disposal
BGV = Below-Ground Vault

2. Numbers refer to the technologies listed in the Anticipated Disposal Technology section of the table.

Decisions on the configuration of the final cover system for the shallow-land burial facilities have not been reached. These systems, however, are expected to consist of a multi-layer system designed to limit infiltration and resist plant and animal bio-intrusion. Both Hanford and the NTS plan to use a RCRA-approved cover system. Personnel at INEL and LANL indicated that performance assessment results would play a role in the selection of a final cover design.

The INEL, LANL, and NTS have additional facilities for the disposal of higher-activity waste. At INEL, this waste is disposed of in soil vaults. These vaults are 0.4 m to 2 m in diameter and are drilled to within 0.6 m of the underlying basalt. Following placement of the waste, an interim cover of clean fill, typically 1 to 2 m thick, is placed over the vaults. A final cover system will be placed over the vaults at the time when the disposal facility is closed.

Greater-confinement disposal at the NTS is performed for high specific activity waste and waste with high tritium content. Earthen shafts, approximately 3 m in diameter, are drilled to a depth of approximately 37 m. Waste is placed to within 20 m of the ground surface, and overburden is added to fill the remainder of the shaft. A final cover will be added at the time of closure.

Waste shafts are used at LANL to dispose of higher activity waste, including tritium waste. Vertical shafts are drilled to depths of 8 to 20 m and range between 0.6 and 2.5 m in diameter. While some of the shafts have been lined with concrete or steel culverts, the majority are unlined. The shafts are filled to within 1 m of the ground surface, at which point a thin layer of tuff is added. Concrete is poured and mounded to seal the shaft.

The Grout Disposal Facility at Hanford will be used for the disposal of liquid waste currently in storage in double-shelled tanks at the site. Following stabilization with grout, this waste will be pumped into a series of concrete vaults. A total of 44 vaults is anticipated. The internal dimensions of the vaults are approximately 38 m long, 15 m wide, and 10 m deep. Each vault is surrounded by a continuous layer of asphalt pavement and has a RCRA-approved concrete catch basin underneath it. A leachate collection system is also placed beneath each vault. A RCRA-approved cover system will be applied over the disposal units.

Grout and/or concrete barriers enjoy widespread use in disposal facilities at ORNL and SRS. A tumulus disposal design is being demonstrated at ORNL's SWSA-6. All waste is grouted and placed in concrete casks measuring 1.7 by 1.7 by 2 m. The casks are placed on a concrete pad and a final cover, 1.2 to 1.5 m thick, is applied. This technology is being proposed for use at the proposed West Bear Creek Disposal Facility for Class 2 waste disposal.

The proposed ORNL West Chestnut Ridge Facility, for Class 1 waste, is a landfill designed to meet state industrial landfill requirements. The facility will be equipped with a synthetic liner and leachate collection system, designed to last 30 years.

Greater-confinement disposal silos are also being demonstrated at SWSA-6. These silos are constructed of concrete and range in diameter from 2.4 to 3 m. Resin vessels or corrugated iron pipes are placed within the silos, depending upon the type of waste that is to be placed in them. Following placement of the solid waste, an interim concrete cap is placed over the silo. An engineered cover system will be applied over the silos at the time of closure.

ORNL personnel are also interested in developing a Class 3 waste facility at the site. The proposed facility will be designed to handle relatively large volumes of waste contaminated with depleted uranium. It is a landfill design, and has a leachate collection and treatment system to ensure that liquid effluent concentrations are below appropriate groundwater limits. It is expected that the soluble fraction of the contamination can be removed from the waste within the period of institutional control. Exposures resulting from the waste remaining in the trench will be minimized by emplacing a permanent intruder barrier.

The Savannah River Site currently disposes of LLW in earthen trenches at the Burial Ground. This facility, portions of which are undergoing final closure at this time, will not be used for future disposal of waste. Construction of the new Radioactive Waste Disposal Facility is scheduled to begin in 1990.

The Radioactive Waste Disposal Facility will deal with LLW in five different ways, depending upon the nature of the waste. Waste containing readily separable, mobile, long-lived radionuclides (C-14 and I-129) will be stored. This waste, generated at a rate of about 200 ft³/year, is expected to require disposal at a more suitable site.

Waste with measurable tritium, or waste which is generated at a tritium facility, will be placed in an abovegrade concrete vault and stored for ten half-lives, approximately 120 years. Following this period, the vaults will be covered with an earthen cover. Separate vaults will be constructed for high- and low-activity tritium waste. Vaults will be sized such that a vault will be filled about every two years.

Other LLW will be disposed of in belowgrade vaults. Separate vaults will be constructed for low- and higher-activity waste, and will be sized in such a way that a vault will be filled about every two years.

A 1.2-m interim cover will be applied over all disposal vaults, a final cover system will be applied at the time of closure. The cover depth from final grade to the top of the waste will be approximately 2.4 m for the low-activity waste vaults. It will be twice that for vaults with higher-activity waste.

The Area-Z Saltstone Facility at the SRS will be used for the disposal of salts and liquids separated from sludge waste. Concrete vaults, approximately 180 m long, 30 m wide, and 7.6 m high, are built in groups of 3 to 6 with common walls between them. All waste is stabilized using slag-substituted grout, which is pumped directly into the vaults. As the vault groups are filled with waste, a 1.2-m interim cover is applied. A final cover system will be applied at the time of closure. The cover depth from final grade to the top of the waste will be approximately 5 m.

Disposal technologies for the Y-Area and Mixed/Hazardous Waste Facilities at the SRS are expected to incorporate concrete vaults. Both facilities will employ a double liner and leachate collection system because both will be designed to accept mixed waste. All waste will be stabilized with grout prior to disposal.

Disposal technologies for the Paducah and Portsmouth sites have not yet been finalized. Feasibility studies are investigating numerous disposal options, ranging from trench disposal to technologies employing multiple engineered barriers.

As a number of the disposal facilities discussed above are under development, these technologies are intended for future use at the various sites. Modifications in materials and/or construction practices may be made in the ORNL tumulus facility as site personnel gain more information from the tumulus demonstration project and experimental studies on concrete performance. It is not anticipated that additional greater-confinement disposal silos will be constructed at the proposed West Bear Creek Valley Disposal Facility. The fate of the Class 3 disposal facility is unknown because of the uncertainty associated with the technical feasibility of the concept.

Personnel at the Hanford site and the INEL anticipate that they will be required to alter their current shallow-land burial practices. Hanford personnel expect they will be required to incorporate engineered barriers into the Solid Waste Disposal Facility design. Changes in the technologies at the sites may or may not be performance based.

Personnel at the INEL think public perception may force changes in disposal containers, and may require the use of interim storage and possibly engineered barriers. These changes are not expected to be necessary on a performance basis.

Changes in the disposal technology at LANL, if required, are expected to be performance based. If the technology is altered, it is likely to involve changes in the design of the cover system. The incorporation of additional engineered barriers is not anticipated. There are currently no expectations that the disposal technologies employed at NTS will change in the future.

4.3.2 Technology Performance Modeling

The critical features of the disposal technologies will be a function of the design of the facility itself and the site characteristics. Primary importance is placed on site characteristics at the arid sites, including the INEL, LANL, NTS, and the Solid Waste Facility at Hanford. These characteristics include the extensive unsaturated zones underlying the disposal facilities and the site climatic conditions, characterized by relatively low annual rainfall and high evapotranspiration rates.

The cover system was identified as an important feature of the disposal trenches at three of the sites. Designed properly, the cover minimizes the rate of water infiltration and provides intruder protection. Features of the cover system responsible for intruder protection include its depth and the use of intruder resistant materials in construction.

Several features of the Hanford Grout Disposal Facility are considered crucial to the design. The asphalt pavement surrounding each of the vaults serves as a hydraulic barrier to infiltration, essentially eliminating advective flow to the vaults. The low moisture content and hydrophobic nature of the pavement provides a diffusion barrier to waste within the vaults. The grouted waste form slows contaminant releases due to its diffusion characteristics and through chemical interaction with the waste constituents. The engineered cover system minimizes infiltration into the disposal site and discourages intrusion into the waste. Water that is able to percolate through the cover is shunted around the vaults by the clay cap located above the asphalt pavement.

Critical features of the tumulus facility at ORNL and the Saltstone Disposal Facility at SRS are the grouted waste form and concrete casks or vaults. These features slow the rate at which contaminants are released into the groundwater, thereby maximizing radioactive decay prior to contaminant release. Intruder protection provided by the concrete vaults and grouted waste form is enhanced by the earthen cover system.

Benefits of concrete vaults, in terms of slower contaminant release rates and intruder protection, are extended to the waste disposed of at the Radioactive Waste Disposal Facility at the SRS. The cover system over these vaults deters intrusion into the waste by deep-rooted plants and by humans. Intruder protection is enhanced for the higher activity vaults through the application of a thicker cover system.

Critical features of the greater-confinement disposal silos at ORNL include the concrete components used in construction and the grout seal applied after waste placement. These features slow the release of waste contaminants into the groundwater and deter intrusion into the waste.

The most important feature of the proposed West Chestnut Ridge Disposal Facility at the ORNL is the very low radionuclide concentrations in the waste. Although the facility design includes a synthetic liner and leachate collection system, these systems are expected to last no longer than 30 years. Consequently, the protection supplied by these features is temporary.

Critical features of the proposed ORNL Class 3 facility are the leachate collection and treatment systems, and the ability to design the system with the required percolation characteristics. A permanent barrier is important in minimizing intruder exposures from the insoluble waste.

The behavior of the critical features of the shallow-land burial technologies in use at the arid sites is generally considered to be well understood. Considerable effort has been expended at these sites to model the expected groundwater flow paths and project water travel times in the vadose zone.

Less attention has been paid to the long-term performance of earthen cover systems. The majority of the sites simply model erosion of the cover system, no other failure is assumed to occur. Hanford may assume that a portion of the cover system of the Solid Waste Facility fails, leading to higher infiltration over that portion of the disposal unit.

The behavior of the technologies employing grout and/or concrete will change as the facility deteriorates. Consequently, understanding the behavior of these features requires understanding the performance of the newly constructed facility, as well as changes in performance as the structure loses its integrity.

Data defining contaminant release rates for the newly constructed vault are available for two of the three sites employing them. Data on diffusion of contaminants through grout and concrete have been collected for the Hanford Grout Disposal Facility and the Saltstone Facility at SRS. While additional data will continue to be collected at these sites, no problems are anticipated in defining the corresponding contaminant release rates. To date, less attention has been paid to defining diffusion coefficients at ORNL.

In contrast to the Saltstone Facility, the release of contaminants from the Radioactive Waste Disposal Facility vaults at the SRS is not understood. Additional work will be required to define the processes involved in the movement of nuclides from the unstabilized waste to the walls of the concrete vaults and out into the surrounding area.

A bigger concern of site personnel, in terms of understanding the behavior of vault and tumulus technologies, lies with the long-term performance of these structures. The performance assessments conducted in preparing environmental impact documents for the SRS Radioactive Waste Disposal, Y-Area, and Mixed/Hazardous Waste Facilities assumed that the vaults will remain intact for the duration of the simulation. The assessment for the Hanford Grout Disposal Facility assumes that the effectiveness of the concrete grout, and asphalt barriers will endure for the 10,000-year simulation period.

Hanford personnel are in the process of developing more information on the long-term performance of asphalt pavement. This work includes the examination of radiation effects and the impact of bio-degradation on this layer.

Personnel at ORNL and SRS are also pursuing solutions to better address the long-term performance of their concrete facilities. Both sites are interested in adapting the BARRIER code for use with their disposal technologies.

Personnel at Oak Ridge plan to collect experimental data on tumulus performance through accelerated testing. This work will address structural questions about the technology and provide information on diffusion and leaching characteristics. Materials testing data for the Saltstone Facility at the SRS may prove applicable to the SRS Radioactive Waste Disposal Facility.

4.3.3 Site Concerns

A number of areas relating to disposal technology were identified in which the TSP could play a role. Chief among these was the need for financial support. In some cases, this support is required in order to meet scheduled completion dates of disposal facility performance assessments. As an example, completion of the Z-Area Saltstone Facility assessment at SRS by 1991 (Table 3-2) depends on adequate funding for 1990 and 1991.

Financial support is important in developing the necessary capabilities for modeling long-term performance of disposal technologies employing grout and concrete barriers. These efforts will help sites already employing concrete and grout in their facility designs, as well as sites anticipating the need to incorporate these features into present disposal technologies. Funding would also allow sites to further current work on cover system design for final site closure.

Empirical data on the long-term performance of concrete performance is of vital importance to the sites employing engineered barriers. Establishing a national database on concrete performance was seen as being a very useful step in addressing this lack of information.

Technical analyses of a variety of currently feasible disposal technologies would be useful. An analysis of this type would address the radiological performance and cost-benefit aspects of several disposal technologies, each situated within various disposal environments. For example, the analysis may consider disposal of waste using abovegrade vault, belowgrade vault, shallow land burial, and tumulus technologies at disposal sites in humid and arid environments.

A comparative analysis of disposal technologies would provide baseline information needed in identifying suitable technologies for the disposal of radioactive waste. If site expectations are correct, this information may be needed in the future when sites find themselves in the position of having to develop new technologies for waste disposal.

4.4 Transport Pathways and Exposure Scenarios

This section discusses the transport and exposure pathways which are significant at each of the eight sites. The suite of pathways expected to be included in DOE Order 5820.2A assessments are also discussed.

4.4.1 Transport Pathways

Hydrologic pathways were identified as being the most significant in terms of contaminant migration from disposal facilities situated in the eastern U.S.. Contaminant migration may be significant via the groundwater and surface water pathways at ORNL, Paducah, and Portsmouth. At Oak Ridge, approximately 90 percent of the water percolating into the soil in that region is diverted to surface streams, the remaining 10 percent becoming deep infiltration. Surface water pathways play a relatively minor role at the SRS because these waters are rather far removed from the disposal facility.

Atmospheric transport of contaminants at ORNL and SRS is relatively unimportant. All waste disposed of at SRS and the vast majority disposed of at ORNL will be containerized or stabilized and will prevent airborne releases.

Groundwater pathways also play an important role at the Hanford site and at the INEL, albeit a low-level chronic one compared to the eastern sites. Suspension and atmospheric transport of contaminants brought to the surface through bio-intrusion and flooding play an important role at the INEL, but are insignificant at Hanford. Transport pathways resulting in exposures to the hypothetical intruder, including excavation of waste material, resuspension of contaminants, and biotic transport, play a significant role at both sites.

Resuspension and biotic pathways, and excavation of waste material are expected to be the most significant transport pathways at the LANL. Groundwater is not expected to result in exposures to either the intruder or general public. Similar patterns are noted for the NTS.

NTS personnel indicated that gaseous diffusion of tritium and radon may result in exposures to intruders, should either contaminant exist in sufficient quantities in the waste. Doses from this pathway, however, are expected to be negligible. Gaseous transport was cited by INEL personnel as meriting investigation to assess the potential for health risks.

4.4.2 Exposure Pathways and Scenarios

The exposure scenarios planned for inclusion in DOE Order 5820.2A assessments address the points of compliance listed in the Order's performance objectives. Intruder scenarios and scenarios that model exposures to the general public are considered at all DOE sites. The exact nature of the exposure pathways included in these scenarios, however, varies as a function of which transport pathways dominate at the respective sites.

The final assessments for Hanford, INEL, ORNL, and SRS will address exposures to the intruder and general public due to the ingestion of contaminated foodstuffs and water, direct radiation from buried and/or excavated waste, and inhalation of suspended contaminants. Performance assessments for Paducah and Portsmouth are expected to address similar exposure pathways.

Exposures resulting from the use and consumption of groundwater are not expected to be included in the intruder scenarios for either LANL or NTS. In the absence of these groundwater scenarios, the technical basis for excluding them from the assessment will be provided.

Personnel at the LANL have extended the idea of exposure scenarios and investigated the impact of groundwater migration of waste contaminants under several different conditions or scenarios. These scenarios investigate the impact of saturation conditions in the tuff underlying the disposal facility on groundwater flow and transport. This work is important in terms of bounding the uncertainties with respect to what saturation conditions may exist in this stratum in the future.

4.4.3 Site Concerns

Hanford personnel believe decisions leading to standardized exposure scenarios should be made. Scenarios should vary in specifics, consistent with site characteristics, across the DOE system. However, they should have the same underlying philosophy at all sites.

Other sites support the notion that site-specific aspects of the exposure scenarios should be considered in the performance assessment. As an example, it is considered unreasonable to assume that the agricultural intruder irrigates crops using contaminated well water at the eastern sites. While irrigation is essential to crop survival in the arid western U.S., farmers in the east typically rely on precipitation.

Discussed earlier, the importance of transport pathways in contaminant migration varies due to the climatic conditions and/or features of the disposal technologies in use at the sites. Personnel for all but one of the sites plan to dismiss unimportant pathways from formal consideration in the 5820.2A performance assessment. However, the level of effort and the amount of supporting documentation required in demonstrating the insignificance of a given pathway is not clear. Suitable approaches to this aspect of the performance assessment should be specified by DOE-Headquarters or the Performance Assessment Peer Review Panel.

Some of the sites plan to include infrequent or catastrophic events in the exposure scenarios they model for the 5820.2A assessments. Examples of these may include flooding and subsidence of disposal trenches. Given their very nature, modeling of these exposure scenarios should realistically consider the probability of these events occurring. It is not clear if probabilistic modeling is considered acceptable in demonstrating compliance with Order 5820.2A performance objectives.

4.5 Performance Assessment Computer Codes

The computer codes used in modeling site disposal facilities are the subject of this section. Past assessment activities, and the codes used, are discussed and the codes intended for future analyses are identified for all aspects of the assessments. Finally, validation of the codes targeted for use is addressed.

4.5.1 Past Performance Assessments

Past assessments of the performance of disposal facilities at DOE sites other than Paducah and Portsmouth range from preliminary screening calculations to final assessments. No prior assessments have been conducted for the Paducah and Portsmouth sites as design plans for the disposal facilities at these sites have not been finalized. Screening calculations have been conducted for the Solid Waste Facility at Hanford, the Area-G Disposal Facility at LANL, and the demonstration tumulus at SWSA-6 at ORNL.

Screening calculations conducted at Hanford examined groundwater migration of four radionuclides from the disposal facility and subsequent exposures to downgradient receptors. Groundwater

flow in the unsaturated zone was modeled using a one-dimensional, unit gradient solution, while transport of contaminants through the unconfined aquifer was simulated using the CHAINT computer code. Doses to the downgradient individual were projected using the GENII code for the 1,000 year simulation period.

The intent of these screening calculations was to identify potential problems with respect to groundwater transport of commonly occurring nuclides at the site. As such, they did not address all important transport and exposure pathways at the site. Most notably, the calculations did not include dose projections for the intruder.

Limited sensitivity analyses were performed in conjunction with the screening calculations. These analyses examined the impact order of magnitude changes in groundwater infiltration rates had on model projections. As infiltration was increased, groundwater travel times decreased, consistent with understanding of the site.

The approach taken in modeling the unsaturated zone is expected to underestimate water and contaminant travel times as it does not account for the effects of lateral flow. Consequently, the doses projected for the downgradient individual will likely exceed potential exposures from this pathway. Additional exposures would result from the pathways omitted from consideration in these calculations.

Screening calculations for LANL have focused on modeling unsaturated groundwater flow and transport. These calculations, performed to help identify potential problems at the facility, tracked the extent of migration of contaminants downward into the tuff layer. Doses to human receptors were not calculated. If warranted by the results, this work may form the basis for dismissing formal consideration of the groundwater pathway in the final assessment.

In addition to the groundwater modeling efforts, some modeling of intruder doses and doses to members of surrounding communities from atmospheric pathways has been performed at LANL. Atmospheric pathways modeling was based on data collected from the meteorological tower at the Area-G Disposal Facility. Modeling of surface water/runoff and erosion pathways has also been conducted.

Analytical solutions were used to model groundwater flow and transport, while a modified version of the SPUR code was used for surface water and runoff calculations. Erosion was simulated using the Universal Soil Loss Equation (USLE) approach. EPA-AIRDOS was used in the atmospheric modeling work, while the NRC 10 CFR 61 codes were used in modeling exposures to the intruder.

The modeling efforts at LANL address most of the important transport and exposure pathways. Exposures resulting from erosion and cliff retreat, potentially significant at the site, have not been considered.

Sensitivity analyses were not performed as part of any LANL screening calculations. Uncertainties associated with groundwater modeling were considered through the design of the modeling study. Monte Carlo sampling of hydraulic conductivities was performed for this work, yielding a distribution of depths to which the groundwater penetrates the vadose zone. The intent is that the stochastic nature of these groundwater analyses be maintained throughout the rest of the final performance assessment.

The results from the groundwater screening calculations are considered to be conservative. Groundwater transport calculations did not account for rates of release of contaminants from the disposal trenches. Rather, contaminant inventories were assumed to be available for immediate transport from the trench. The simulations also did not account for an engineered cover system, assuming only that the interim cover was present.

Atmospheric pathways modeling is expected to be reasonably accurate. EPA-AIRDOS calculations for the Los Alamos Meson Physics Facility (LAMPF) project doses from short-lived activation products 30 to 50 percent higher than exposures calculated using monitoring results.

Screening calculations conducted at ORNL considered the performance of several facilities at SWSA-6, including the two tumuli, the Interim Waste Management Facility, and continuing operations. The continuing operations include a variety of silos and wells used for greater confinement disposal, biological trenches, and staging buildings used in tumulus disposal operations.

Exposures to inadvertent intruders and members of the general public, located 100 m from the disposal unit, were modeled for each ORNL facility. This scoping analysis did not use formalized computer codes. The calculations considered all transport and exposure pathways that are expected to play an important role at the site. Limited sensitivity studies addressed the impact of changes in head and hydraulic conductivity on groundwater flow patterns. Uncertainty analyses were not performed.

The screening calculations were conservative and did not model the facilities in a manner expected to be realistic. The integrity of the tumuli was not assumed to extend beyond the 100-year institutional period, in contrast to expectations of a 300- to 500-year lifetime for the facility. Modeling of groundwater contaminant transport was simplistic, ignoring the hydrologic heterogeneity of the site.

The exposures calculated for the intruder scenarios are expected to bound human exposures at the site. It is not clear if the approach taken in modeling groundwater doses to the general public yielded doses that would bound expected exposures.

In addition to the screening calculations performed by Martin Marietta at ORNL, NUS Corp. is performing assessments for the proposed West Chestnut Ridge and West Bear Creek Valley Disposal Facilities. These assessments are being done for the ORNL Environmental Impact Statement.

More formal performance assessments have been conducted at a number of DOE sites. In addition to the screening calculations discussed above for the Hanford Solid Waste Disposal Facility, an assessment of the Grout Disposal Facility has been completed. Since that time, revisions have been made to the final facility design. The assessment is being updated to reflect these modifications.

The prior assessment for the Grout Facility addressed exposures to the inadvertent intruder and exposures to members of the general public as a result of using contaminated groundwater. Codes used in the assessment include TRACR3D and S-301 for unsaturated flow and transport, respectively. SLAEM was used to model saturated transport and flow and GENII for exposure pathways modeling. Sensitivity and uncertainty analyses were not performed as part of the assessment.

Performance assessments of the proposed Radioactive Waste Disposal, Y-Area, and Mixed/Hazardous Waste Disposal Facilities at SRS have been completed as part of site environmental impact documents. Additional screening calculations for the intruder scenarios have been performed based on Kennedy and Peloquin.² An assessment of the Z-Area Saltstone Facility was also performed as part of the Environmental Impact Statement for the SRS vitrification plant.

The various SRS assessments addressed all important pathways, including exposures resulting from groundwater contamination and exposures to the inadvertent intruder. Exposures were modeled for the environmental impact documents using the PATHRAE computer code. No formal computer codes were used for the assessment of the Z-Area facility. Sensitivity and uncertainty analyses were not performed as part of these analyses.

Results from the assessments are expected to underestimate the actual exposures received from waste disposal, since it was assumed that the concrete vaults used for each of these facilities would remain intact forever. As this will not be the case, elevated releases from the facilities are expected, resulting in higher potential human exposures. The longevity of the concrete vaults will be modeled in future assessments, at which point model projections will be expected to bound actual exposures.

The INEL has completed a draft performance assessment for the RWMC. This assessment is considered a baseline study for use in identifying potential problems at the disposal facility. The computer codes used in the analysis and the areas of application are listed in Table 4-3.

The assessment addressed exposures to the intruder following institutional control, and groundwater and atmospheric exposures to members of the general public. It is assumed that these latter exposures will occur at the INEL boundary prior to site closure and at the boundary of the RWMC following the institutional control period.

The draft assessment did not address infrequent or catastrophic events such as flooding or subsidence of the waste trenches. The establishment of a residence over the waste and cultivation of foodcrops was considered for the waste pits only. The intruder scenario for the soil vaults assumed that a person drilled through the vault, with doses resulting from acute exposures from the well cuttings.

Sensitivity analyses were performed as part of the draft assessment, focusing on groundwater and leaching-related input parameters. Insight gained in previous sensitivity studies for the RWMC was considered applicable to the present effort. Results of past and present sensitivity analyses were generally considered consistent with the current understanding of site processes.

The INEL draft assessment is considered to be reasonably conservative and to bound exposures to humans. A difference of opinion arose about the projections for the groundwater pathway. Low groundwater fluxes through clay interbeds beneath the site are expected to slow contaminant transport relative to modeling results. However, the presence of perched water under the facility may have the opposite effect, accelerating groundwater flow and resulting in higher exposures from this pathway.

The Nevada Test Site has completed a draft performance assessment for the Area-5 Disposal Facility and is conducting an internal review of this analysis. No prior assessments have been performed for Area-3 disposal.

The Area-5 assessment considered exposures to offsite individuals resulting from airborne transport of contaminants, as well as exposures to the inadvertent intruder. Contaminant transport and exposures from groundwater were omitted from the analysis. Doses from this pathway are expected to be negligible due to the extremely arid nature of the site and the depth to groundwater. Infrequent events such as flooding were not included in the analysis.

Table 4-3. Computer codes used in the INEL baseline assessment

<u>Computer Code</u>	<u>Application</u>
DOSTOMAN	Near-Field Pathways
FLASH/FLAME PATHRAE	Groundwater Flow and Transport Groundwater and Intruder Exposure Pathways
MICROSHIELD	Direct Radiation Exposures
EPA-AIRDOS	Atmospheric Transport and Exposure Pathways

The DOSTOMAN computer code was used to model all transport and exposure pathways, except atmospheric pathways. The EPA-AIRDOS code was used for this pathway. Neither sensitivity nor uncertainty analyses were performed as part of the analysis. The results of the assessment are expected to bound the exposures to humans resulting from the disposal of waste at Area-5.

4.5.2 Order 5820.2A Performance Assessments

Consistent with the wide variety of approaches taken in the screening calculations and assessments above, the codes tentatively identified for use in the 5820.2A assessment vary widely among the sites. These computer codes are listed in Table 4-4. It should be recognized that the codes identified are subject to revision for a variety of reasons. Six of the sites have not reached final decisions on one or more codes for the assessment. Codes selected for certain aspects of the assessment may be found to be unnecessary if screening calculations permit dismissal of some transport or exposure pathways. Changes in code selection may also occur as a result of the review of preliminary or draft performance assessments. If the DOE Peer Review Panel deemed a code used by a given site to be inappropriate, different codes would need to be adopted.

In some instances, more than one code is identified for a component of the assessment for a given site. With the exception of those listed for groundwater pathways, for which both flow and transport codes are given, multiple code listings indicate the codes being considered. Final code selections will be made in time to meet scheduled completion dates for the assessment.

Computer codes for two sites, Paducah and Portsmouth, remain to be determined. Decisions on the design of the disposal facilities for these sites have not been made. Consequently, identification of the codes to be used in the performance assessments is not considered to be necessary at this time.

Codes for certain aspects of the performance assessment have not been selected for many sites because these aspects do not apply to the site and/or disposal technology. As an example, surface water transport is insignificant at the extremely arid NTS. Similarly, sites employing shallow-land burial need not be concerned with codes that model the degradation of engineered barriers.

The majority of the codes identified are currently available to the respective sites. However, some modeling capabilities, such as the diffusion codes indicated for the SRS remain to be developed.

In some cases, the code or codes intended for use required modification to fully meet site modeling needs. An example is the U.S. Geologic Survey (USGS) method of characteristics code, being used at ORNL for saturated flow modeling. This code required extensive modification by ORNL

Table 4-4. Computer codes identified for use in the 5820.2A assessment

Component	Hanford ^a	INEL	LANL	NTS	ORNL	Paducah	Portsmouth	SRS
Waste Form Releases	1. Empirically 2. S-301	BLT DOSTOMAN EQ3EQ6 PHREEQE	N/A	DOSTOMAN	BARRIER	TBD	TBD	PHREEQE Diffusion Code
Cover Infiltration	1. VAM-2D 2. TRACR3D	DOSTOMAN	SPUR	DOSTOMAN	UTM BARRIER	TBD	TBD	HELP
Disposal Unit Percolation	1. VAM-2D 2. TRACR3D	DOSTOMAN	SPUR	DOSTOMAN	BARRIER	TBD	TBD	HELP
Disposal Unit Degradation	1. N/A 2. N/A	N/A	N/A	N/A	BARRIER	TBD	TBD	BARRIER
Disposal Unit Releases	1. N/A 2. S-301	DOSTOMAN	N/A	N/A	BARRIER	TBD	TBD	Diffusion Code
Surface Water Transport	1. N/A 2. N/A	N/A	SPUR	DOSTOMAN	UTM	TBD	TBD	Undecided
Vadose Zone Flow/Transport	1. VAM-2D 2. TRCR3D S-301	FLASH FLAME	Analytical Solutions	DOSTOMAN	UTM	TBD	TBD	FEMWATER FEMWASTE

Table 4-4 (Continued)

Component	Hanford ^a	INEL	LANL	NTS	ORNL	Paducah	Portsmouth	SRS
Saturated Zone Flow/Transport	1. VAM-2D PORFLO 2. SLAEM	MAGNUM CHAI NT	AQUAFEM	DOSTOMAN	USGS MOC	TBD	TBD	FEMWATER FEMWASTE
Atmospheric Transport	1. GENII 2. GENII	EPA-AIRDOS	EPA-AIRDOS GENII	EPA-AIRDOS	EPA-AIRDOS	TBD	TBD	EPA-AIRDOS
Radionuclide Uptake	1. GENII 2. GENII	PATHRAE	BIOTRAN GENII PATHRAE	DOSTOMAN	Empirically	TBD	TBD	Hand Calculations
Dose	1. ICRP 2. ICRP	ICRP	ICRP	ICRP	ICRP	TBD	TBD	ICRP

- a. 1. Solid Waste Facility codes.
2. Grout Disposal Facility codes.

personnel to allow the use of site-specific surface head data. Another example of the need for code modification involves the BARRIER code, intended for use in modeling facility degradation at some of the sites. While this code models a number of engineered disposal technologies, code modifications will be necessary to address the design peculiarities of various sites' facilities.

4.5.3 Computer Code Validation

Little has been completed in terms of model validation and/or calibration. However, in recognition of the importance of this work, all sites are making plans to perform these analyses.

Validation work involving the VAM-2D and PORFLO groundwater codes used at Hanford is expected to take place using historical plume data for a leaking tank. Additional validation studies may include some tracer studies and collecting data from boreholes drilled in and around an existing waste trench. However, nothing definite has been scheduled.

Validation of the TRACR3D code to be used in the next assessment of the Grout Disposal Facility at Hanford is in progress at LANL. Validation of the groundwater transport code S-301 is also planned.

INEL personnel have submitted a proposal for work intended to validate the groundwater codes FLASH and FLAME in a laboratory setting. Data collected from a test plot at the West Test Trench at the INEL are expected to provide information needed to validate modeling of near-surface groundwater flow.

Some validation of groundwater codes has been performed at LANL. This work, however, is not considered pertinent to the present 5820.2A performance assessment effort. The past validation effort involved codes not targeted for use in the 5820.2A assessment or addressed only disturbed conditions. The potential for validation exists using information from an old plutonium disposal site (TA-21). Simulations of surface runoff using the SPUR code have compared favorably with field data from areas surrounding the disposal site. Similar data are needed for Area-G to extend this comparison.

While not directly relevant to the Area-G Disposal Facility, some validation work has been performed for the BIOTRAN code. Data from the old, Area-B disposal site and from the Pantex facility have been used in these efforts. Some validation of the EPA-AIRDOS code has also been performed for releases from the LAMPF.

Tracer work has been conducted at ORNL for use in validation of groundwater models. This study, performed at Bear Creek Valley, will be implemented at SWSA-6 as well. Additional data collection efforts are planned for the Knox Ridge area to support validation exercises.

The UTM code has been demonstrated to be consistent with field data for forested areas. Since the climax condition of the Oak Ridge region is forest, it remains to be learned how to 'walk' the code through the successional stages from the present field condition of SWSA-6.

ORNL personnel intend to pursue validation of site codes to the extent allowed by available time and money. If they are unable to fully validate the codes, they will increase the level of conservatism used in the modeling to try to account for this deficiency.

Code validation has not been initiated at either the NTS or SRS. Personnel at both sites believe that sufficient data exist to illustrate proper code functioning. Additional data, expected to aid validation efforts, will be collected at NTS in the course of modeling the proposed RCRA-approved mixed waste facility.

Site data collected from the existing Burial Ground at SRS should provide the information necessary to validate groundwater models at the adjacent Radioactive Waste Disposal Facility. Data collected from saltstone lysimeter experiments should permit validation of geochemical modeling for the Area-Z Saltstone Disposal Facility.

4.5.4 Site Concerns

Concern was expressed about the level of consistency between codes used for 5820.2A assessments and those mandated for other applications. For example, the RESRAD code is mandated for use in site cleanup activities at LANL. It is important that the modeling approaches taken in the codes for these applications, and any others, be consistent with approaches adopted for demonstrating compliance with Order 5820.2A.

Simulation of the performance of engineered barriers is a source of concern at a number of sites. Personnel at several of the sites, including Hanford, ORNL, and SRS, have elected to incorporate engineered barriers into the design of one or more of their disposal facilities. The performance of these barriers, including asphalt, grout, and concrete, is largely unknown and demands attention if the performance assessment is to be credible.

In the face of this lack of knowledge, preliminary calculations and draft assessments have either assumed that these barriers remain intact for the length of simulation or do not assume they will be in existence beyond the institutional control period. Neither of these alternatives is desirable as the success of many of these facilities depends on some minimum period of performance, generally much greater than 100 years.

Relatively few computer codes that address the performance of grout and concrete barriers are available. The most notable existing codes are BARRIER and COSMOS. While the BARRIER code addresses a range of disposal technologies, successful use of this code for these DOE disposal facilities would require additional capabilities. ORNL and SRS personnel are interested in assessing this code's strengths and weaknesses, and adapting it for use at their sites if feasible. The COSMOS code is proprietary, and is not currently available for use at DOE sites.

Personnel at a number of the sites were unsure about the extent to which validation of assessment codes must be pursued. Guidance from DOE-Headquarters or the Peer Review Panel on how to approach the problem and the degree of complexity required in performing model validation would be useful.

4.6 Site Characteristics

The physical characteristics of which influence the important transport and exposure pathways at each site are discussed in this section. These characteristics include information on site geologic, hydrologic, and meteorologic conditions.

4.6.1 Important Site Parameters

With the exception of NTS, groundwater parameters were mentioned as being among the most important site parameters. This is consistent with the identification of the groundwater pathway as being among the most significant transport pathways at the majority of the sites. While the groundwater pathway was not identified as being particularly significant at LANL, it is important that the data upon which this conclusion is based are representative of site conditions.

Among the more widely mentioned groundwater flow and transport parameters were soil characteristic curves, saturated and unsaturated soil hydraulic conductivities, and radionuclide distribution coefficients. Other parameters mentioned were lateral and longitudinal dispersivities, structural geology of the site, and hydraulic head distributions. The geochemical interactions between waste contaminants and native soils in the vadose zone were also considered important.

The importance of parameters pertinent to modeling shallow sub-surface flow and surface runoff was mentioned by LANL and ORNL personnel. Parameters included here were rainfall distribution data, radionuclide distribution coefficients, and geochemical parameters for the site.

Other parameters important to the sites' modeling efforts include atmospheric pathway parameters (INEL, NTS), lateral erosion rates (LANL), and resuspension factors (LANL). Parameters which influence the exposures received by the intruder were also identified as being significant. Here, for instance, the climate of the site will play a significant role insofar as it influences land use patterns.

4.6.2 Data Availability

The majority of the data to be used in 5820.2A performance assessments are specific to the site, and often to the disposal facility itself. Site-specific hydrologic data are available for all but the Paducah site. Atmospheric data for sites where airborne transport plays an important role are also site-specific. Parameters for which literature-based data are most generally relied upon include distribution coefficients and food chain parameters.

The availability of data for the important parameters varies dramatically across the sites. A lack of data exists for important groundwater parameters at Hanford. These shortcomings are being addressed through the development of stratigraphic cross-sections for the Solid Waste Facility and through collection of data necessary for input into soil characteristic curve fitting routines. Site personnel are also looking into the collection of distribution coefficient data for unsaturated conditions.

Site data collection efforts associated with the Hanford Grout Disposal Facility are focusing on hydrologic characteristics as well. Parameters for which data are being collected include hydraulic conductivities, particle size distributions and densities, in-situ water content, and soil water retention properties.

Except for resuspension data, personnel at INEL believe atmospheric parameters are adequately characterized. Sufficient data are also believed to exist for modeling the unsaturated and saturated groundwater pathways. In contrast, site personnel have little confidence in data describing the near-field properties, i.e. those conditions influencing the rates of contaminant release from the waste form.

The quality of some of the data used in LANL groundwater modeling efforts is such that additional data would be helpful. Site personnel are interested in acquiring better data for use in defining

soil characteristic curves and data on saturated hydraulic conductivities. Additional data on the flow characteristics of the sand/cobble conglomerate below the tuff at the disposal site are also needed. No efforts are scheduled to collect these data.

NTS personnel believe they have adequate data for the 5820.2A assessment. Therefore, no additional data are being collected for this effort. However, data collected for the site's 40 CFR 191 assessment are expected to be applicable to the 5820.2A assessment.

Personnel at ORNL are confronted with large volumes of data for their disposal facilities. The extremely heterogeneous nature of the site's geohydrology, however, makes interpretation of these data difficult. Site personnel are left with the perplexing task of deciding when they have enough data, or the 'right' data, to accurately characterize their disposal systems. Additional data for the Oak Ridge site will be generated as a by-product of monitoring activities and model validation work.

While fewer data generally exist for Paducah than for ORNL, personnel are confronted with problems similar to those encountered at the latter site. That is, the heterogeneous nature of this site causes difficulty in data interpretation. The shortcomings in the amount of data available will be partially relieved as a result of data gathering efforts in connection with the site remediation program. For the Portsmouth site, only minor additions to the database characterizing the surface water regime will be required for an initial assessment of the site.

Site characteristic data currently available at SRS are adequate for completion of the performance assessment with the exception of site-specific distribution coefficients for selected nuclides. These data are scheduled for collection in time for the performance assessment.

Site-specific data from one site are generally of little use to the other sites. DOE sites located near commercial LLW disposal facilities could potentially benefit from data collection efforts of those operations. Personnel at Hanford and SRS, however, believe their commercial counterparts have little to offer.

Data collection efforts at one site may prove useful to other sites in an indirect manner. Insight into the experimental design used to collect certain types of data at one site may help another site needing similar information. As an example, personnel at two sites discussed the need for innovative approaches to collecting data on in-situ hydraulic conductivities under unsaturated conditions.

4.6.3 Site Concerns

The sites are aware of the kinds of data they need and how to collect them. To the extent that funds allow, programs are underway to collect much of this information. Efforts to collect site-specific data are hindered by the unrealistic expectations that approaches and data from a given DOE site can be modified for use at the other sites. While this expectation may be appropriate for other aspects of the assessments, it would be appropriate here only to the extent that the two sites are similar.

The level of detail required by the Performance Assessment Peer Review Panel in addressing site characteristics is vague to personnel at Hanford and Oak Ridge. It is not clear to what degree the sites must develop site-specific data and how much literature-based information can be relied upon for parameters for which data are difficult and/or expensive to collect.

4.7 Compliance Strategies and Compliance Points

The approaches taken in demonstrating compliance with the performance objectives of 5820.2A are addressed here. Aspects of these approaches include selecting compliance points, the length of simulation, and the strategies used in the apportionment of performance objectives among site facilities. Site compliance points and approaches are summarized in Table 4-5.

4.7.1 Performance Objectives and Apportionment

With the exception of ORNL, all sites are using, or will use, the performance objectives stated in Order 5820.2A. Personnel at the ORNL have chosen to adopt more stringent performance objectives, 10 mrem/year to the intruder or general public and 4 mrem/year as a limiting groundwater dose. These more stringent limits, adopted due to the uncertainties associated with disposal facility performance on the site, apply to the proposed facilities at West Chestnut Ridge and West Bear Creek Valley, and to the Interim Waste Management Facility. The performance objectives stated in Order 5820.2A will be used for continuing operations at SWSA-6. Order 5820.2A performance objectives apply to all effluent and exposure pathways from all LLW facilities at a given DOE site. DOE field offices may elect to apportion fractions of these overall site limits to each facility to ensure that the sum of all facility doses does not exceed the performance objectives.

Apportionment of the overall DOE site performance objectives among facilities has been considered by a number of sites. The Hanford site adopted an apportionment plan for the Grout Disposal Facility to set original design goals. This plan apportions 20 percent of the groundwater protection and

Table 4-5. Compliance points and approaches

	Hanford	INEL	LANL	NTS	ORNL	Paducah	Portsmouth	SRS
Compliance Points	Intruder Site boundary during operations Facility boundary during institutional control General public at 100 m	Intruder Site boundary during operations Facility boundary during institutional control	Intruder General public at 100 m Surrounding communities Rio Grande river	Intruder General public at 100 m Downwind receptor	Intruder Facility boundary during institutional control General public at 100 m	Intruder Facility boundary during institutional control General public at 100 m	Intruder Facility boundary during institutional control General public at 100 m	Intruder General public at 100 m Nearest stream
Dose Apportionment	Grout facility apportioned 20% of dose criteria	Not considered	Not expected to be necessary	Not expected to be necessary	No technical basis for apportionment (report submitted)	Not expected to be necessary	Not expected to be necessary	Not expected to be necessary
Period of Simulation	1,000 yr Peak search	10,000 yr Peak search	1,000 yr Peak search	1,000 yr Peak search	10,000 yr Peak search	10,000 yr Peak search	10,000 yr Peak search	1,000 yr Peak search

general public performance objectives, 4 and 25 mrem/year, respectively, to this facility. This plan has been used in past assessments and is to be used in the next analysis as well. Whether or not the apportionment factor will be modified in the future depends on the availability of modeling information on the potential spatial and temporal overlap of projected releases from the other disposal facilities at the site.

ORNL personnel have submitted a report to DOE stating that they believe apportionment of doses to be unnecessary for the disposal facilities currently in place or planned for the site. This conclusion relies on the high degree of geohydrologic separation of the disposal facilities and the more restrictive dose criteria to be used at the proposed disposal facilities.

Allocation of allowable dose performance objectives is considered unnecessary for the Paducah or Portsmouth sites. Current plans call for a single disposal facility at each site; thus cumulative dose events are not anticipated.

Apportionment at LANL, NTS, and SRS is considered unnecessary. Only one disposal facility is currently in use at the LANL, thus negating any cumulative impacts after closure of the site. In order to receive doses from more than one disposal facility at SRS, the receptor would need to be located considerably farther away than the point of maximum exposure for individual disposal facilities. Doses at these downstream or downgradient points are expected to be negligible. Personnel for NTS do not anticipate cumulative exposures from the Area-3 and Area-5 disposal facilities. Dose apportionment has not been considered at the INEL; guidance on the approach which should be taken in addressing this aspect of the assessment is requested by site personnel.

4.7.2 Spatial and Temporal Compliance Strategies

Points at which compliance with Order 5820.2A will be judged include a number of consistent locations among the DOE sites. All sites will consider the onsite intruder. The compliance point for most sites will be a point 100 m from the disposal units following the end of the institutional control period. The Grout Facility assessment will not consider a receptor 100 m from the disposal units but will consider locations at the disposal facility boundary. Additional compliance points include the nearest stream or river (Hanford Grout Disposal Facility, LANL, SRS), the site boundary during operations and institutional control (Hanford Solid Waste Facility, INEL, ORNL), and offsite atmospheric receptor locations (INEL, LANL, NTS). Additional compliance points, as required by the Order, will be added as necessary.

The period of simulation to be used in the performance assessments ranges from 1,000 to 10,000 years among the DOE sites. In addition to these times, sites anticipate the need to identify peak exposures which occur beyond these times.

4.7.3 Site Concerns

The sites believe that DOE-Headquarters needs to formally recognize performance objectives and compliance points. The 4-mrem/year groundwater limit and the 100-m compliance point for members of the general public are not explicitly included in Order 5820.2A. If the DOE sites are expected to abide by these restrictions, they should be precisely stated in the Order.

Questions about the approaches appropriate for apportionment of facility doses were voiced at the INEL. Site personnel have not yet considered apportionment in the performance assessment for the RWMC and would find guidance helpful.

Guidance on the length of the simulation necessary for the assessments would be beneficial to personnel at a number of sites. Opinion was divided about the appropriateness of a uniform simulation period for all eight sites. Tailoring the period of simulation to the temporal performance of the disposal facility was seen by some as appropriate. Here, then, sites for which peak scenario exposures occur shortly after facility closure would be appropriately modeled using short simulation periods. Others saw the need to establish a consistent methodology to be used at all DOE sites.

The validity of extremely long simulation periods was questioned by personnel at several of the sites. Concern exists that the use of limited data to project doses for extremely long periods of time is unreliable, and perhaps even negligent.

The use of extended periods of simulation raises the question of how to account for climatic changes over that time span. If DOE-Headquarters or the Peer Review Panel expect consideration of climatic changes in the performance assessments, the sites will be faced with significant difficulties in trying to comply.

Some participants fear sites will be required to consider the worst-case approaches in assessing the performance of their facilities. Worst-case approaches may be useful in comparing impacts of design options, but participants believe they should not be used in demonstrating compliance. Hearing DOE-Headquarters or the Peer Review Panel's opinion on this matter would be welcome by the sites.

4.8 Dose Conversion Factors

Methodology and dose conversion factors used in the 5820.2A performance assessment are addressed here. These include internal dose conversion factors, ingestion and inhalation, and factors used for projecting external doses.

4.8.1 Source of Dose Conversion Factors

Internal dose conversion factors used for performance assessment at all of the DOE sites are based on ICRP 26, ICRP 30, and ICRP 48.³ External dose conversion factors are based on DOE-approved methodology.⁴ The EPA-AIRDOS computer code, used by a number of the sites for atmospheric pathways modeling, uses EPA RADRISK dose conversion factors at the present time.

4.9 General Aspects

This portion of the report summarizes information on the current site concerns in terms of completing their 5820.2A performance assessments. The role of the Performance Assessment Peer Review Panel is also discussed.

4.9.1 Site Concerns

Specific problems and concerns of the sites have been discussed for each aspect of the 5820.2A performance assessment. A number of issues communicated by site personnel apply to several aspects of the assessment process or are not directly linked to specific performance assessment areas. These problems and concerns are addressed here.

The quality of communication among sites on performance assessment issues was generally considered inadequate; relying, for the most part, on contacts made on an individual basis. In those cases where formal gatherings provided a potential for significant site interactions, the people often selected to attend were inappropriate for the exchange of technical information or lacked the expertise to recognize the utility of information being disseminated.

Tremendous value was perceived to exist in establishing channels through which the sites could learn of the approaches taken by other sites, as well as the problems and issues facing them, in conducting their assessments. People at several of the sites were interested in establishing a series of workshops to help bridge present communication gaps. These workshops, held on an informal basis for the technical

contributors to the 5820.2A assessment from each site, would provide an opportunity to discuss issues and problems facing the sites. Some suggested these workshops could also serve the function of an informal review committee for completed assessments.

Concern was voiced over the inconsistent use of enhanced disposal technologies across the DOE system. It is expected that the use of different technologies will create problems in the public's perception of DOE's approach in disposing of radioactive waste. For example, the use of concrete barriers at one site and the use of shallow-land burial at another will both be assessed as being safe, potentially confusing the public.

4.9.2 The Role of the Performance Assessment Peer Review Panel

The majority of the sites believe the Performance Assessment Peer Review Panel should assume a larger role in the 5820.2A performance assessment process. To date the Panel has been a passive organization. Site personnel generally agree that membership on the Panel will need to be recognized as a full-time commitment by DOE-Headquarters, and supported as such, if the Panel is to become a valuable resource to the sites.

Guidance on a number of topics by the Peer Review Panel would be helpful to many of the sites. This guidance should include perspective on how site performance assessments will be judged by the Panel, including the amount of detail expected in modeling site transport and exposure pathways, the nature of the exposure scenarios requiring attention, and the length of the simulation period necessary. It is believed that answers to these questions will permit each site to judge how to best allocate resources among the various aspects of the performance assessment.

It is also considered important that the Peer Review Panel play a role in ensuring a consistent performance assessment approach across the DOE system. The adoption of different exposure scenarios and simulation periods by each site, for instance, is seen by some as troublesome. It is believed that the public perception of the Order 5820.2A assessment process and, perhaps of the DOE system, will be eroded by this inconsistent approach.

5. DOE SITE SUMMARIES

Chapter 5 provides a summary of the information presented in Chapter 4 by site to present a complete site-specific picture of performance assessment activities. For convenience, the sites are discussed in alphabetical order.

5.1 Hanford Site

5.1.1 General

The performance assessment for the W-5 Solid Waste Disposal Facility is scheduled for completion in 1993. A draft performance assessment has been completed for the Grout Disposal Facility. This assessment is being revised to address changes in facility design and is expected to be finalized in October 1990.

Site personnel consider waste source term and site characteristics to be the most important aspects of the Solid Waste Facility performance assessment. Disposal technology is important for intruder protection, less so in terms of groundwater transport of contaminants. Waste form and package are relatively unimportant.

Source term and disposal technology are the most important components of the assessment for the Grout Disposal Facility. Site characteristics are considered slightly less important, followed by waste form and package.

Data quality for the Solid Waste Facility is not good; more detailed data are needed for an adequate assessment. The quality of data collected for the Grout Facility is good.

Problems facing personnel performing the Solid Waste Facility assessment include the relative lack of detailed data, for both the waste source term and the vadose zone. Data on contaminant release rates are also needed. Grout Facility personnel identified the long-term stability of barriers used in the disposal technology and long-term changes in climate and groundwater flow patterns as sources of uncertainty.

It is believed that the Peer Review Panel should sanction the approaches to be taken in conducting the 5820.2A performance assessment. Enough general guidance on aspects of the assessment process already exists.

5.1.2 As-Generated Waste Source Term

Waste source term data are provided by the generators on a per-package basis for the Solid Waste Facility. The quality of these data is considered poor. Waste to be disposed of in the Grout Facility is sampled and characterized analytically. The quality of these data is good.

The quality of the source term data for the Solid Waste Facility will be improved through the implementation of a stricter waste certification program. Development of better analytical techniques is being investigated as part of this effort. Sampling of waste to be disposed of in the Grout Facility is performed on an ongoing basis.

Changes in the source term for the Solid Waste Facility are expected as the site is in a shutdown mode. Waste from current processes will cease, and waste from decontamination and decommissioning activities will be generated in larger quantities.

The majority of the waste to be disposed of in the Grout Facility is in storage. The consistency of this waste across the storage tanks is unknown.

Physical characterization data collected for the solid waste is limited to a generic description of the material. The physical characteristics of the waste for the Grout Disposal Facility will be those of the grout used to stabilize the material. Chemical data collected for the disposal facilities are consistent with RCRA data requirements.

5.1.3 As-Disposed Waste Package/Form

Predominant forms of solid waste include compactible/combustible waste, metals, and soil. Compaction is used to reduce waste volume, grouting of waste is used on a limited basis.

Waste disposed of at the Solid Waste Facility is packaged in 55-gallon drums and in a variety of different-sized boxes, depending upon the level of activity present. All waste will be grouted prior to disposal in the Grout Facility.

Leaching behavior of the waste forms and packages used in the Solid Waste Facility is not well understood. Additional data will be acquired to alleviate this shortcoming. Release from the Grout Disposal Facility is diffusion limited for species soluble in grout pore solution. Additional data on the diffusion characteristics of the facility, as well as other properties of the grout, are being collected to refine current understanding of contaminant release rates.

5.1.4 Disposal Technology

Solid waste is disposed of using shallow-land burial at the Hanford site. The Grout Facility will use belowground vaults for the disposal of double-shelled tank waste.

Features critical to the success of the Solid Waste Facility include the engineered cover system, site climatic conditions, and the extensive unsaturated zone below the facility. Components critical to the success of the Grout Facility include the asphalt diffusion barrier, the grouted waste form, the engineered cover system, and the clay cap.

Cover performance is well understood. The asphalt, grout, and concrete components of the Grout Facility are currently modeled to remain intact for the entire simulation period. Long-term performance of the facility components is being investigated.

5.1.5 Exposure Scenarios and Pathways

The most significant transport pathways at the site are those leading to intruder exposures, including atmospheric and biotic pathways, and the excavation of waste. Groundwater pathways are a chronic, low-level problem at the site. Atmospheric pathways have been modeled but were found to be insignificant.

Exposure scenarios for the Solid Waste Facility assessment will include the hypothetical onsite intruder and members of the general public within 100 m of the disposal units. The Grout Disposal Facility assessment will address exposures to the hypothetical intruder, members of the general public at the disposal facility boundary, and persons located outside the boundaries of the Hanford site.

Site personnel question what constitutes suitable exposure scenarios for use in the assessment. Hanford personnel believe standard scenarios should be used across the DOE system as part of a consistent approach to 5820.2A performance assessments.

5.1.6 Computer Codes

Preliminary groundwater calculations have been performed for the Solid Waste Facility. These analyses were conducted to identify potential problems at the site. Hanford personnel have completed a draft performance assessment for the Grout Disposal Facility. This assessment is undergoing revision to address changes in facility design.

Screening calculations for the Solid Waste Facility did not address all important transport and exposure pathways. Most notably, the calculations did not consider intruder exposures. The Grout Disposal Facility assessment addressed all important pathways. Sensitivity analyses were performed for both facilities, uncertainty analyses were not conducted.

Groundwater calculations for the Solid Waste Facility are expected to bound potential exposures. It is not clear whether the Grout Disposal Facility assessment results bounded human exposures.

Computer codes have been identified for the assessments for both facilities. Validation of groundwater codes for the Grout Facility assessment is underway. Work is planned for validating groundwater codes for the Solid Waste Facility.

5.1.7 Site Characteristics

Groundwater flow and transport parameters are among the most important for the Solid Waste Disposal Facility. Other significant parameters include diffusion coefficients and stratigraphic characteristics. Important parameters for the Grout Disposal Facility include diffusion coefficients for the grout, concrete vault, and asphalt, and groundwater parameters.

Hydrologic data for the Solid Waste and Grout Disposal Facilities are generally site specific. Additional data are being acquired to characterize the hydrology of both facilities.

5.1.8 Compliance Strategies and Compliance Points

Compliance points for the Solid Waste Disposal Facility include the hypothetical onsite intruder, a member of the general public within 100 m of the disposal units, and the site boundary during operations and the institutional control period. Compliance points for the Grout Disposal Facility include the intruder, a member of the general public within 100 m of the boundary of the disposal facility, and offsite exposures.

The simulation period for the Solid Waste Facility is tentatively set at 1,000 years. The Grout Disposal Facility assessment will run for 10,000 years. Both analyses will identify peak exposures.

An apportionment factor of 20 percent of the performance objectives required by Order 5820.2A was used to set the original design goals and is used currently in assessments of the Grout Facility. No apportionment is considered necessary for the Solid Waste Disposal Facility.

Personnel believe compliance points and performance objectives should be stated outright in Order 5820.2A. The period of compliance should be specified as part of the performance objectives.

5.1.9 Dose Conversion Factors

Dose conversion factors are based on ICRP 26/30/48.³ External factors are based on DOE approved methodology.⁴

5.2 Idaho National Engineering Laboratory

5.2.1 General

INEL personnel are in the process of completing a baseline assessment for Order 5820.2A. The analysis is viewed as a baseline calculation to see what potential problems exist with respect to demonstrating compliance with the Order. The completion date for the final assessment has not been scheduled.

Site personnel view the waste source term as being the most important aspect of the performance assessment. This aspect is followed, in order of importance, by site characteristics, disposal technology, and waste form and package.

The quality of the data collected at the site is considered good. More critical concerns lie with the quality of data taken from the literature and the quality of work from other labs.

Personnel at the site did not think performance assessment requirements were clear. These issues could be clarified with guidance from the Performance Assessment Peer Review Panel, explaining how the site should arrive at solutions to these concerns.

An important technical problem facing the site is the modeling of near-field phenomena, including nuclide release rates and geochemical aspects of radionuclide migration. Time and funding will be required to address these issues.

INEL personnel believe the Peer Review Panel should take a more active role in providing guidance to the sites. The site needs guidance from the Panel on the approaches necessary to demonstrate compliance with the Order.

5.2.2 As-Generated Waste Source Term

Waste source term data are supplied by the generators on a per-package basis. Quality of historic data is generally poor. The quality of current data is much better and is expected to improve through the implementation of new waste acceptance criteria. These new criteria will become effective in April 1990.

Physical and chemical data supplied by the generators are limited. This information includes a generic description of the waste and a list of any EPA-listed hazardous constituents.

Changes in the source term are expected on a more or less continuous basis at the site. These changes will accompany the closure of old facilities and the start of operations at new ones.

A need exists for better communications between sites on a technical level. Currently, opportunities for informational exchanges are not taken advantage of.

5.2.3 As-Disposed Waste Package/Form

Specific waste packages are accepted on a routine basis, non-standard packages must go through an acceptance procedure. There are currently no stabilization criteria for INEL waste, these will be included in the new waste acceptance criteria. There are no requirements for waste minimization. Solidification agents are not used at the site on a regular basis.

Modeling of waste leaching is based on empirical data from a waste retrieval study. Site personnel recognize the need for additional data and models for this aspect of the assessment.

5.2.4 Disposal Technology

Waste is disposed of using shallow-land burial disposal technology. Higher activity waste is disposed of in soil vaults, while the majority of the waste is placed in pits. The configuration of the final cover for the site has not been determined.

No performance-driven changes in this technology are expected. Public perception may force changes in the mode of disposal, however, including changes in disposal containers, the use of interim storage and, possibly, the use of engineered barriers.

5.2.5 Exposure Scenarios and Pathways

Important transport pathways at the site include groundwater and atmospheric transport. Surface water transport is not considered important short of site flooding. Gaseous transport of contaminants may play a role in contaminant transport at the site.

Exposure pathways addressed in the baseline assessment include onsite intruders, offsite atmospheric receptors, and the 80-km population. Exposures resulting from flooding or subsidence of the site were not examined. Site personnel need to know what standard exposure scenarios should be addressed in the assessment, how to address infrequent events such as flooding and subsidence, and how to factor the probability of exposure scenario occurrence into the analyses.

5.2.6 Computer Codes

A baseline performance assessment was conducted to identify potential problems facing the site in demonstrating compliance with Order 5820.2A. Exposures to intruders and offsite individuals were modeled. All important transport and exposure pathways were considered to have been addressed in the assessment. Site personnel believe the assessment is reasonably conservative.

Sensitivity analyses examined the impact of variations in groundwater and leaching-related parameters. Results from past sensitivity studies conducted for the site are considered applicable in certain cases. No uncertainty analyses were performed.

The codes used for the baseline assessment are expected to be used in future assessments with the possible exception of the code used in modeling the near-field. Personnel plan to examine more suitable codes for this aspect of the assessment.

Validation of groundwater codes used in the assessment is planned, pending approval of the necessary data collection efforts. The level of detail required in code validation should be specified by DOE-Headquarters or the Peer Review Panel.

5.2.7 Site Characteristics

Important parameters include those pertaining to groundwater and atmospheric transport. Additional parameters of importance include contaminant release rates and distribution coefficients.

Little confidence exists in data describing the near-field site phenomena. Available data for the unsaturated and saturated zone groundwater parameters are adequate. Atmospheric data are also adequate, with the exception of resuspension data.

Hydrologic and atmospheric data used in the assessment are generally site-specific. Literature-based data include food chain transport parameters and contaminant release rates. Data from other sites are not considered useful, although knowledge of the experimental approaches used in collecting the information may be valuable.

5.2.8 Compliance Strategies and Compliance Points

Compliance points addressed in the draft assessment include the site intruder, wells at the disposal facility and site boundaries, and the 80-km population. The simulation period was 10,000 years. Times of peak exposures were also identified.

Apportionment of dose criteria has not been considered at the site. Suitable approaches to this issue need to be suggested by the Peer Review Panel. Guidelines on the length of the simulation period and the significance of exposures occurring at distant times, would also be helpful.

5.2.9 Dose-Conversion Factors

The EPA-AIRDOS code uses EPA RADRISK dose factors at the present time. All other codes used in the baseline assessment use DOE-approved factors.^{3,4}

5.3 Los Alamos National Laboratory

5.3.1 General

The 5820.2A performance assessment for the Area-G Disposal Facility is scheduled for completion in October 1991. Important aspects of the performance assessment include the waste source term and the site characteristics. The disposal technology is important only for the intruder protection it provides. Waste form and package are relatively unimportant.

Quality of the data to be used in the site assessment is good. Data collection efforts at the site are subject to a LANL quality assurance program. There is concern about the accuracy of waste source term projections, as it is difficult to predict what activities the site will be involved with in the future.

Site personnel are unsure what level of detail is required in the performance assessment. Modeling of climatic changes, whether and how it should be done, is also problematic.

LANL personnel believe technical workshops would enhance effective communication among personnel at the DOE sites about the 5820.2A assessments. Information from the Peer Review Panel as to how completed assessments will be judged for adequacy would be beneficial.

5.3.2 As-Generated Waste Source Term

Generators supply waste source term data on a per package basis. These data, as well as historical data, are considered to be of good quality.

Waste minimization efforts at the site may result in changes in the source term. Volumes and types of waste will also be impacted by decontamination and decommissioning work at the site.

Physical information on the waste is generally limited to a generic description of the material. Chemical characteristics are not well known, nor are they considered to be very important to the performance assessment effort.

5.3.3 As-Disposed Waste Package/Form

Five waste streams comprise the bulk of LANL LLW: compactible trash, non-compactible waste, sludges from liquid waste treatment, waste from decontamination and decommissioning activities, and contaminated equipment. Treatment of waste before disposal consists of compaction and some sizing, no solidification of waste is performed. Waste forms disposed of at the site may change in the future as additional treatment options are developed. Waste may or may not be containerized prior to disposal.

Rates of contaminant releases from the waste have not been studied. While work in this area is planned, the level of effort will be dictated by the potential for significant groundwater transport of contaminants.

5.3.4 Disposal Technology

Shallow land burial is used for disposal of LLW at LANL; higher activity waste is placed in shafts. Changes in the disposal technologies used will be determined by the results of the performance assessment. Site personnel expect any changes to be limited to modifications in cover system design.

The most critical feature of these technologies is the extensive unsaturated zone and the slow rates of groundwater flow through it. The cover system may play an important role in minimizing infiltration and bio-intrusion. These features are reasonably well understood.

5.3.5 Exposure Scenarios and Pathways

Atmospheric and biotic transport pathways, and excavation of waste are the most significant modes of contaminant movement. Plant and animal intrusion, and erosion may also play significant roles in contaminant transport. Site personnel do not expect groundwater pathways to cause significant exposures.

The performance assessment will include exposures to onsite intruders, as well as exposures to members of the general public located adjacent to the disposal units and others located downwind of the site. Additional exposure scenarios will be addressed if they are considered feasible.

Advice on the approach to be taken in modeling intruder exposure scenarios is needed. This advice should address the combination of activities and pathways that require consideration in the analysis.

5.3.6 Computer Codes

A preliminary groundwater assessment has been performed for the disposal facility. These calculations were conducted to identify the potential for problems in demonstrating compliance with groundwater performance objectives. Sensitivity analyses were not performed as part of the analyses. Uncertainties in some groundwater parameters were addressed.

These analyses addressed all reasonable groundwater pathways. Results of the assessment are expected to be reasonably conservative.

Final selection of computer codes for modeling atmospheric and surface pathways has not been made. The codes used for the preliminary groundwater assessment will most likely be used in future assessments.

Validation of the codes used in groundwater modeling has not been conducted. Site personnel believe there are sufficient data to permit at least partial validation. Validation is planned for the remaining codes used in the assessment. Advice is needed from DOE-Headquarters or the Peer Review Panel about the approaches and detail expected in conducting code validation.

5.3.7 Site Characteristics

Important site parameters include a host of groundwater and surface water pathway characteristics. Rates of erosion could also be important. Additional data are needed for a number of these parameters to allow more accurate representation of the disposal facility environment.

Atmospheric and hydrologic data used in facility assessments are either specific to the LANL site or to the disposal facility. Retardation factors are calculated from literature-based distributional coefficients.

5.3.8 Compliance Strategies and Compliance Points

Compliance points include a member of the general public within 100 m of the disposal units, the onsite intruder, surrounding communities, and the Rio Grande River. Apportionment of doses is not expected to be necessary at the site because facility releases do not overlap in either time or space.

The preferred period of simulation for the performance assessment is 1,000 years. Peak exposures occurring beyond this time will also be investigated. DOE-Headquarters or Peer Review Panel guidance on the length of simulation would be helpful.

5.3.9 Dose Conversion Factors

DOE-approved dose conversion factors are used in site assessments.^{3,4} Internal factors are based on ICRP 26/30/48.

5.4 Nevada Test Site

5.4.1 General

A draft performance assessment for the Area-5 Disposal Facility has been prepared for the NTS by EG&G Idaho. The assessment is being reviewed and should be completed by June 1990. The completion date of the performance assessment for the Area-3 Disposal Facility has not yet been determined.

Site personnel rank the waste source term, waste form/package, and the disposal technology as being the most important aspects of the performance assessment. Site characteristics are considered slightly less important.

Quality of site data collected in the past is often not very good. Site personnel are in the process of updating much of this information. Present-day quality standards are much higher. An EPA-approved quality assurance plan is being implemented at this time.

A number of miscellaneous disposal sites with small associated activities exist at NTS. It is not clear if formal performance assessments must be conducted for each of these sites or if these areas can be dealt with in a more cursory manner. NTS personnel believe that the Peer Review Panel should inform the sites what of criteria will be used in judging the adequacy of the assessments.

5.4.2 As-Generated Waste Source Term

Waste source term data are supplied by the generators on a per-package basis. Confidence in these data is high. Source term data will improve as the site implements a more stringent waste certification program.

Changes in the waste source term are difficult to anticipate as the majority of the waste disposed of at NTS is generated offsite. Increases in the amount of waste requiring greater-confinement disposal may occur if problem or special situation waste is disposed of at the site.

5.4.3 As-Disposed Waste Package/Form

No waste treatment or processing is performed at NTS. Generators are requested to use NTS-preferred waste packages. The site will accept non-standard packaging, providing it meets all NTS requirements.

Generators are not required to compact waste. However, the disposal pricing schedule favors minimizing waste volume. No solidification agents are currently used at the site.

5.4.4 Disposal Technology

Waste is disposed of at Area-3 and Area-5 Disposal Facilities using shallow-land burial. High-specific-activity waste is disposed of using greater-confinement disposal. No changes in these disposal technologies are expected.

The most critical features of these technologies are the geology and climate of the site. The total depth of cover material over the waste will provide intruder protection.

The performance of the critical features is believed to be adequately known. The conservative approach taken in modeling site performance is expected to compensate for aspects of the disposal technology that site personnel may not understand.

5.4.5 Exposure Scenarios and Pathways

The most significant transport pathways at the site are those leading to intruder exposures, including atmospheric and biotic pathways and the excavation of waste. Groundwater transport is negligible because of the low site infiltration rates.

The draft performance assessment considered acute and chronic exposures to the intruder and airborne transport of waste offsite. Exposures due to groundwater pathways and site flooding were omitted from consideration.

5.4.6 Computer Codes

The draft 5820.2A performance assessment for the Area-5 Disposal Facility considered exposures to onsite intruders and offsite residents. Neither uncertainty nor sensitivity analyses were performed as part of the analysis.

Site personnel believe the assessment addressed all important transport and exposure pathways. Projected doses are expected to bound human exposures.

Decisions on the code(s) to be used in the final assessment have not been made. Final decisions will be reached after completing of the review of the draft assessment.

Validation of computer codes used in the draft assessment was not conducted. Site personnel believe enough data exist to permit validation on a limited basis.

5.4.7 Site Characteristics

Parameters pertinent to atmospheric pathways and intruder exposures are most important. Site personnel believe enough data exist for these parameters.

Site-specific atmospheric data are available for the Area-5 Disposal Facility. Hydrologic data from site characterizations also exist. The majority of the biotic pathway data are taken from the literature.

5.4.8 Compliance Strategies and Compliance Points

Compliance points for the final assessment will include an offsite receptor of airborne contaminants, an onsite intruder, and a member of the general public located within 100 m of the disposal units. The draft assessment considered a simulation period of 1,000 years. Times of peak exposures will be identified in the final assessment. Apportionment of dose criteria is considered unnecessary.

Personnel need to know what the period of compliance should be. Peak exposures are expected to occur well after this compliance period; guidance on how to interpret these exposures is needed.

5.4.9 Dose Conversion Factors

Internal dose conversion factors used in the performance assessment are taken from ICRP 26/30/48.³ External factors are based on DOE-approved methodology.⁴

5.5 Oak Ridge National Laboratory, Paducah, Portsmouth

5.5.1 General

Oak Ridge staff expect to complete the initial draft of the performance assessment for SWSA-6 by September 1990, and the final assessment in 1991. Scoping studies for the Paducah and Portsmouth sites will be conducted in 1990. Performance assessments for the proposed West Chestnut Ridge and West Bear Creek Valley Disposal Facilities are scheduled to be completed in 1992 and 1994, respectively.

Disposal technology, waste form, and waste packaging are viewed as the most important aspects of the performance assessment for the ORNL tumulus facility, followed by source term and site characteristics. For Class 1 waste disposal at Oak Ridge, source term is considered the most important. Disposal technology, waste form and package, and site characteristics are of equal and moderate importance. Both the Paducah and Portsmouth sites share the rankings given the Class 1 disposal facility at Oak Ridge.

Data quality issues are the most significant problems facing these sites. The quality of waste source term data is generally poor for the three sites. Waste form data are poor for the Oak Ridge and Portsmouth sites, but better for Paducah. The quality of site characteristic data for Oak Ridge is suspect. Fewer site data exist for the remaining two sites.

Site personnel believe the Peer Review Panel needs to outline its expectations for the 5820.2A performance assessment. Sites should be aware of the level of detail necessary in characterizing the site and modeling the disposal facility. Feedback from DOE-Headquarters on the acceptability of the sites' performance assessment schedules would also be helpful.

5.5.2 As-Generated Waste Source Term

Generators at each of the three sites provide information on the waste source term on a per-package basis. Little confidence exists in the radiological source term data because so little effort has been expended in characterizing the waste. A new waste certification plan will be implemented at all three sites to help rectify this situation.

Potentially large changes in the source term are expected in the future because a large portion of the waste generated at Oak Ridge, Paducah, and Portsmouth is of a very inconsistent nature. Additional changes may result from waste minimization efforts at the ORNL.

No formal database of chemical or physical characteristics of the waste exists at any of the sites. Physical data required on waste shipment forms include the physical state, weight, and volume. Chemical data include PCB, asbestos, and hazardous substance contents. Quality of these data ranges from poor to good.

5.5.3 As-Disposed Waste Package/Form

The proposed West Chestnut Ridge Disposal Facility at ORNL will accept bulk waste (soils, metals) and waste packaged in 55-gallon drums and B-25 boxes. The tumulus disposal facilities at this site will accept B-25 boxes, with or without drums inside, and special large-volume vaults. All waste will be grouted within the boxes.

Experimental work is being conducted at ORNL to quantify leach rates from Class 1 waste. Similar leaching data are not available for the Class 2 waste disposed in the tumulus. Less emphasis is placed on leaching from this waste.

5.5.4 Disposal Technology

The ORNL is currently demonstrating tumulus and greater-confinement disposal technologies at SWSA-6. The West Chestnut Ridge Disposal Facility, a landfill design, is proposed for Class 1 waste disposal. The proposed West Bear Creek Valley Disposal Facility will employ the tumulus technology for disposal of Class 2 waste. The basic design of these facilities is not expected to change.

The critical feature of the Class 1 landfill is the low nuclide concentrations in the waste. Synthetic liner and leachate collection systems play a short-lived role in facility performance.

The Class 2 facility relies upon the grouted waste form to slow the release of contaminants from the facility. The engineered cover system is designed to minimize the intrusion of plants into the waste.

Performance of the landfill is reasonably well understood. On the other hand, the long-term performance of the tumulus facility is not known. Data on the long-term performance of grout and concrete are needed to help alleviate this shortcoming.

Disposal facility designs have not been finalized for the Paducah and Portsmouth facilities. Technologies ranging from landfill designs to above- or belowground vaults are under consideration.

5.5.5 Exposure Scenarios and Pathways

Groundwater and surface water transport are the most significant pathways at the Oak Ridge, Paducah, and Portsmouth sites. Atmospheric pathways are relatively unimportant, as the majority of the waste disposed of at the site will be containerized or stabilized.

The primary exposure pathways/scenarios planned for consideration in the performance assessments are the onsite intruder and the downstream individual. It is considered important to be able to use exposure scenarios that are consistent with resource use patterns in the area of the disposal site. Insignificant exposure pathways will be dismissed from formal consideration in the assessment.

5.5.6 Computer Codes

Site assessments have been performed for the Oak Ridge site. No assessments have been conducted for the Paducah or Portsmouth sites.

The Oak Ridge analyses were screening calculations designed to identify potential problems at SWSA-6. These calculations considered all the transport and exposure pathways considered important at the site. Exposures calculated for the onsite intruder are expected to bound human exposures. It is not clear if calculated exposures to downgradient receptors were bounded.

Personnel will reach final decisions on the computer codes to be used in the 5820.2A assessment of the Oak Ridge site by April 1990. Little thought has been given to the codes to be used at the Paducah and Portsmouth sites.

Validation of groundwater codes is expected to be possible at the Oak Ridge site. Collection of data for these efforts is planned. If a model cannot be fully validated, more conservative approaches to modeling will be adopted.

Oak Ridge personnel require waste form and disposal technology codes for accurate modeling of the tumulus facility. Codes addressing waste form degradation and nuclide release codes would also be helpful.

5.5.7 Site Characteristics

Groundwater and surface water parameters are the most important in modeling site transport processes. While large quantities of data exist for the ORNL, interpretation of this information is difficult due to the extreme heterogeneity of the site. Confidence in the data is uncertain for the same reason.

Site data are not abundant for the Paducah site. Similar to the situation at Oak Ridge, the heterogeneous nature of the site makes data interpretation difficult. Considerably more data exist for Portsmouth. Personnel believe that a performance assessment could be conducted for this site, given minor additions to the site database.

Site-specific data for Oak Ridge and Portsmouth include hydrologic data; waste form data are generally site-specific for Paducah. Site-specific waste form data are lacking for the ORNL and Portsmouth, while hydrologic data for Paducah are taken from the literature. All sites lack food chain parameter values specific to their disposal facilities.

5.5.8 Compliance Strategies and Compliance Points

ORNL compliance points include a 100-m well for the general public, the site boundary during the institutional control period, and a 1-m well for the intruder. No population locations are considered. Similar points of compliance will be used for the other sites.

The ORNL is limiting the acceptable exposures to the intruder to 10 mrem/year (4 mrem/year for groundwater protection) as opposed to the 100-and 500-mrem/year intruder limits stated in the 5820.2A performance objectives. Dose criteria for members of the general public are the same.

The simulation period for the performance assessment is expected to be 10,000 years at all three sites. Peak exposures will be identified for each disposal facility.

Apportionment of doses is not expected to be necessary at Paducah and Portsmouth. Oak Ridge personnel have submitted a report to DOE stating that they do not believe apportionment is necessary at ORNL.

5.5.9 Dose Conversion Factors

Internal dose conversion factors are taken from ICRP 26/30/48.³ External factors are those approved by DOE.⁴

5.6 Savannah River Site

5.6.1 General

SRS personnel are developing four disposal facilities. The performance assessment for the Z-A Saltstone Facility is scheduled to be complete by the end of 1991. The performance assessment for the Radioactive Waste Disposal Facility will be conducted in parallel with, or directly after, the assessment for the Z-Area facility. The date of completion may follow the Saltstone Facility assessment by as much as three to six months.

Performance assessments for the Mixed/Hazardous and Y-Area Disposal Facilities have not been scheduled. Personnel expect to complete them within two years after the Area-Z Saltstone Facility assessment.

The waste source term is considered the most important in the performance assessment, followed by site characteristics. Waste form, waste package, and disposal technology are less important, with actual ranking of these aspects differing between the Saltstone Facility and the Radioactive Waste Disposal Facility.

Quality assurance programs were not in existence when much of the existing field data were collected. A full quality assurance program has been instituted. Laboratory data to be used in the assessment have been collected under a formal quality assurance program.

Progress on the 5820.2A performance assessment is hampered by a lack of funding. In terms of technical issues, it remains for site personnel to determine contaminant release mechanisms for the Radioactive Waste Disposal Facility.

It would be helpful if the Peer Review Panel would outline how the sites' assessments are to be judged. Such a document would allow the site to allocate limited resources more effectively.

SRS personnel believe that periodic informal workshops among the performance assessment personnel at the DOE sites would be helpful. These forums would provide an opportunity for personnel to learn of the approaches taken by other sites and of solutions to problems.

5.6.2 As-Generated Waste Source Term

The waste to be disposed of in the Saltstone Facility is in storage and has been characterized analytically in the laboratory. Source term data for the Radioactive Waste Disposal Facility are those collected for the existing Burial Ground. Waste for the Y-Area and Mixed/Hazardous Waste Facilities is in storage and has been characterized.

The quality of source-term data for the Saltstone, Y-Area, and Mixed/Hazardous Waste Facilities is good. Data for the Radioactive Waste Disposal Facility are more suspect. Better quality data are expected through implementation of more rigorous waste acceptance criteria.

The source term at SRS could change significantly in the future. These changes may result from reactor closures at the site, changes in plutonium production, and decontamination and decommissioning work.

Few physical data, save for volume, are requested on the disposal/shipment form. Chemical data requested include the generator's assurance that the waste contains no free liquid, cadmium, lead, oil, mercury, or listed RCRA materials. Additional information on uranium waste chemistry and its impact on contaminant transport may be necessary for the performance assessment.

5.6.3 As-Disposed Waste Package/Form

The predominant waste form to be disposed of in the Saltstone Facility is slag-substituted grout. Most waste disposed of in the Radioactive Waste Disposal Facility will be containerized. Bulk waste disposal will be reviewed on a case-by-case basis. Standard containers will be used to the extent possible. All waste to be disposed of in the Y-Area and Mixed/Hazardous Waste Disposal Facilities will be stabilized with grout.

The waste form for the Saltstone Facility is well characterized. Considerably less is known about the nature of containerized waste currently disposed of at the Burial Ground.

Leaching of the Area-Z waste is diffusion limited, until degradation of the waste form. The release of contaminants from the Radioactive Waste Disposal Facility is less well understood. It remains for site personnel to identify the mechanisms involved in contaminant releases from this facility.

5.6.4 Disposal Technology

Shallow land burial is used at the Burial Ground. All proposed facilities will employ belowground concrete vaults. The Saltstone, Y-Area and Mixed/Hazardous Waste Facilities will use a grouted waste form. Waste will be disposed of without stabilization in the Radioactive Waste Disposal Facility.

The critical features of the Radioactive Waste Disposal Facility are the concrete vaults and the engineered cover system. In addition to these features, the grouted waste form plays an important role in the remaining facilities.

While the behavior of the critical features of the Saltstone Facility is largely known, work remains with respect to understanding chemical interactions of the grout and waste, and the long-term performance of the grout waste form and concrete vaults. The long-term performance of the Radioactive Waste Disposal Facility vaults is also not understood.

5.6.5 Exposure Scenarios and Pathways

The significant transport pathway at the site is groundwater transport. Surface water transport is considered insignificant due to the distance to surface streams and rivers. Atmospheric and bio-intrusion pathways play a minor role at the site.

The 5820.2A assessment will consider exposures to the onsite intruder and to a member of the general public located within 100 m of the disposal units. Scenarios unique to the site will be identified and assessed with respect to their significance.

5.6.6 Computer Codes

Assessments have been performed in the past for all of the proposed disposal facilities. These assessments considered all important transport and exposure pathways. Projected doses from these analyses are expected to underestimate human exposures. Sensitivity and uncertainty analyses were not performed as part of these prior assessments.

Final decisions on the computer codes to be used in the final assessments have not been reached. These decisions will be made in time to meet scheduled deadlines.

Validation and verification of the computer codes used in the assessments are planned. Personnel believe that sufficient data exist for validation of groundwater codes and geochemical modeling approaches.

5.6.7 Site Characteristics

Unsaturated zone groundwater parameters are among the most important site parameters. Parameters affecting leach rates are also significant. Hydrologic parameters for aquifer transport are considered relatively unimportant because aquifer travel times to receptor locations are short.

Current understanding of site characteristics affecting contaminant release rates is insufficient for the Radioactive Waste Disposal Facility. Additional experimental data may be needed as well.

Data for hydrologic parameters are generally site-specific. Distribution coefficients are site-specific for the most important nuclides. Biotic and food chain pathways data are usually taken from the literature.

5.6.8 Compliance Strategies and Compliance Points

Compliance points include the intruder, the 1 m well, the 100 m well, and the nearest stream. The simulation period is expected to be 1,000 years for the various disposal facilities; peak exposures will also be identified. Apportionment of doses is not expected to be necessary to meet performance objectives. Guidance on what constitutes acceptable periods of compliance and whether additional compliance points require consideration would be beneficial.

5.6.9 Dose Conversion Factors

Dose conversion factors to be used in the assessment are approved by DOE.^{3,4} Internal factors are based on ICRP 26/30/48.

6. REFERENCES

1. U.S. Department of Energy, "Radioactive Waste Management," DOE Order 5820.2A, September 26, 1988.
2. Kennedy, W.E. and R.A. Peloquin, Intruder Scenarios for Site-Specific Low-Level Radioactive Waste Classification, DOE/LLW-71T, September 1988.
3. U.S. Department of Energy, Internal Dose Conversion Factors for Calculation of Dose to the Public, DOE/EH-0071, July 1988.
4. U.S. Department of Energy, External Dose-Rate Conversion Factors for Calculation of Dose to the Public, DOE/EH-0070, July 1988.

APPENDIX A

QUESTIONNAIRE

**PROFILE OF DOE ORDER 5820.2A
LOW-LEVEL WASTE
PERFORMANCE ASSESSMENT
ACTIVITIES AND PLANS**

**— SITE DATA, CAPABILITIES, AND
ACTIVITIES QUESTIONNAIRE —**

The following questionnaire is intended for your review prior to participation in a meeting with Defense Low-Level Waste Management Program representatives on DOE Order 5820.2A low-level waste performance assessment activities. The questionnaire is intended to familiarize you with the topics to be discussed and the level of detail of the discussions. You do not need to provide a written response to the questionnaire. Program representatives will be responsible for taking minutes during the upcoming meeting.

The questionnaire is divided into nine parts:

- A. General
- B. As-Generated Waste Source Term
- C. As-Disposed Waste Package/Form
- D. Disposal Technology
- E. Exposure Scenarios and Pathways
- F. Computer Codes
- G. Site Characteristics
- H. Compliance Strategies and Compliance Points
- I. Dose Conversion Factors

The General section focuses on an overview of your performance assessment activities and is intended to provide Program personnel with a perspective for use in the more detailed discussions that will follow. The remaining eight sections are intended to stand alone and elicit detailed information on each subject area.

Your cooperation in review of this questionnaire and participation in the upcoming site visit is much appreciated.

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
AND PLANS**

— Site Data, Capabilities, and Activities Questionnaire —

A. General (This sections deals with the overall approach for your 5820.2A site radiological performance assessment)

1. When will the site performance assessment required by DOE Order 5820.2A be completed?
2. For your site's 5820.2A site performance assessment, rank (1 to 5) the current status of the following components of the assessment based on amount of data available, your degree of confidence in the data and the relative importance of each component to the overall site performance assessment. (1 = greatest amount of data available / highest level of confidence / most important to performance assessment; 5 = least amount of data available / lowest level of confidence / least important to performance assessment.)

<u>Component</u>	<u>Amount of Data Available</u>	<u>Level of Confidence</u>	<u>Relative Degree of Importance</u>
a. Source Term (Radiological and Non-Radiological)			
b. Waste Package/Form (includes waste matrix and package/ container)			
c. Disposal Technology (disposal unit, barriers, cover, etc.)			
d. Computer Codes	N/A		N/A
e. Site Characteristics			

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
AND PLANS**

— Site Data, Capabilities, and Activities Questionnaire —

A. General (Continued)

3. Do you have any concerns regarding the quality of the data to be used in performance assessments? Would a set of data quality standards assist in eliminating these concerns? If so, what should these standards consist of?
4. What are the biggest problems facing you in terms of being able to comply with DOE Order 5820.2A radiological assessments requirements?
5. Are these problems unique to your site? Why or why not?
6. What is needed to rectify these problems in a timely manner?
7. Could the EG&G Idaho Performance Assessment Center be of use in resolving these problems?
8. Could the EG&G Idaho Performance Assessment Center be of use in the conduct of your site performance assessments?
9. Would a Performance Assessment Review Guidance Document be of assistance in meeting compliance objectives of 5820.2A? This document would discuss the criteria used by the Peer Review Panel in the review of each site's performance assessment.

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
AND PLANS**

— Site Data, Capabilities, and Activities Questionnaire —

B. As-Generated Waste Source Term (This section is concerned with the radiological and non-radiological characteristics of the material that will be disposed of in the facility(ies) to be addressed by your 5820.2A performance assessment. Information is requested on the characteristics of the material in its as-generated condition.)

1. What data on radiological source term are currently available?
2. What level of confidence exists for these data? Why?
3. What additional data are required? Why?
4. What efforts are underway or planned to collect these data?
5. When will these data be available?
6. Are any changes in source term configuration anticipated due to changes in operations or other factors?
7. Are radionuclide concentrations in the waste known? How (direct analysis, process knowledge, back calculation, etc.)? On what basis (per package, per shipment, monthly averages, etc.)?
8. What are the physical form and characteristics of each type of waste material when it is generated?
9. For each type of waste described in Question 8, what data exist on waste's chemical characteristics? How were these data obtained?
10. What is your confidence in these data? Why?
11. Are additional data required? If so, what activities are underway or planned to collect these data? When will these data be available?
12. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
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— Site Data, Capabilities, and Activities Questionnaire —

C. As-Disposed Waste Package/Form (This section is concerned with the characteristics of the waste as it is placed in the disposal unit. Information is requested on the composite characteristics of the various components that make up the waste form (e.g., waste matrix, liner, container/package, etc.)

1. What are the predominant forms of waste to be disposed of at the facility considered in your 5820.2A performance assessment? Which waste materials (the subject of Questions 8 and 9 in the As-Generated Source Term section) make up each type of as-disposed waste package/form? (Explain how as-generated waste becomes as-disposed of waste packages/forms, e.g., solidify resins.)
2. Is waste-form characterization for each of your as-disposed waste packages/forms complete? How was this characterization conducted? What are each as-disposed packages/form's characteristics?
3. If waste solidification agents are used, what are they?
4. Is the leaching behavior of each as-disposed waste package/form understood? If yes, what is the predicted performance? What is the basis for your prediction (e.g., accelerated tests, monitoring disposal of waste)? If no, what activities are underway or planned to collect these data?
5. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
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— Site Data, Capabilities, and Activities Questionnaire —

D. Disposal Technology

(This section is concerned with the technology to be used to dispose of your low-level wastes. Information on each component of your disposal units is to be addressed --for example, leachate collection system, liners, pads, trench, vaults, intruder barrier, multi-layer cover system, etc.)

1. What are the technologies currently used for waste disposal?
2. Will the disposal technologies currently in use be used "as is" in the facility being assessed by your 5820.2A performance assessment? If not, why not? What changes will be made or technologies will be used? If the disposal technology is yet to be decided upon, when will this decision be made? What will this decision be based on?
3. What is the configuration of the disposal technology to be used, including cover design, engineered barriers and other features? Which features are critical to the anticipated performance of the technology?
4. Is the behavior of the technology and each critical component of the technology known? What is the predicted behavior? What is the basis for this prediction? What is your confidence in these data?
5. If the behavior of the technology or its critical components are not known, what efforts are underway or planned to collect this information? When will such data be available?
6. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
AND PLANS**

— Site Data, Capabilities, and Activities Questionnaire —

E. Exposure Scenarios and Pathways (This section concerns the exposure scenario and transport pathways that will be included in your 5820.2A performance assessment.)

1. What are the significant radionuclide transport pathways at your disposal site? Why are others not significant?
2. What exposure pathways and scenarios do you currently plan to consider in your 5820.2A site assessment?
3. What exposure pathways/scenarios are not planned to be considered in site assessment activities? Why are they excluded from consideration?
4. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
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— Site Data, Capabilities, and Activities Questionnaire —

F. Computer Codes (This section is concerned with the computer codes which are planned to be used in predicting the performance of your disposal facility and site. Your responses should address plans for modeling the entire disposal system, from release of radionuclides from the waste to health effects.)

1. Have site assessments been carried out for your disposal facility? If so, what were the assessments for? What did they involve?
2. What computer codes were used in past site assessments?
3. Did past site assessments address all important transport and exposure pathways?
4. Were uncertainty and/or sensitivity analyses performed as part of these past site assessments? Were the results consistent with current understanding of site processes? If not, how did they differ?
5. Did computer codes for past assessments appear to model the disposal facility in a realistic and consistent manner? If not, why? Are the results of the assessments expected to bound exposures to humans? If not, why?
6. What specific code is to be used to model each component of the exposure pathways in your 5820.2A performance assessment? Is each code available to you now? If not, when will it be available?

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y / N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form			
Water infiltration to the disposal unit			
Penetration of water into the disposal units and around/through the waste			
Degradation of the disposal unit

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**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
AND PLANS**

— Site Data, Capabilities, and Activities Questionnaire —

F. Computer Codes (Continued)

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y / N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide releases from the disposal unit			
Surface water transport			
Transport through the unsaturated zone			
Transport through saturated zone			
Atmospheric transport			
Radionuclide uptake			
Health effects			
7.	If a specific code has not been decided upon, when will a code be selected?		
8.	If you were required to do your 5820.2A performance assessment today, what codes would you use? What level of confidence would you have in this assessment? Why?		
9.	Can codes in use or being developed at other sites be adopted and modified for use at your site? If not, why not? If so, which codes from which sites?		
10.	Are site codes planned for use in your 5820.2A performance assessment (Question 5) validated and/or calibrated? If so, how was this accomplished? If not, what activities are under way or planned to validate and/or calibrate your codes? Is validation/calibration necessary? Is it possible?		
11.	Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?		

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
AND PLANS**

— Site Data, Capabilities, and Activities Questionnaire —

G. Site Characteristics (This section is concerned with your site's physical characteristics which impact transport pathways and exposure scenarios. Included is information on geologic, hydrologic, demographic, and meteorological characteristics.)

1. What are the important parameters necessary to model the significant transport pathways for your site?
2. Are there enough data currently available for these parameters? What is your confidence in these data?
3. Which parameters require more data to be collected and analyzed? Which transport pathways are affected? What efforts are underway or planned to collect these data? When will these data be available?
4. What site characteristic data are based on information from site-specific studies and what data rely on more general literature values? Are data taken from the literature calibrated to better address site conditions or are they used unmodified? Are assumed values used for some variables in the absence of site-specific information? What efforts are being made to replace assumed or general literature data with site-specific information?
5. Would data collected from other DOE or commercial sites be of benefit to your efforts? If so, which data?
6. Does your site need help in gathering the necessary data?
7. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
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— Site Data, Capabilities, and Activities Questionnaire —

H. Compliance Strategies and Compliance Points

(This section is concerned with the physical location of the points to be used for judging compliance with the low-level waste performance objectives of 5820.2A.)

1. What compliance points are to be used in modeling exposures to humans? Where are the compliance points in relation to the disposal trenches; important geographic features; site, facility, and reservation boundaries; local populations; etc.
2. Field offices may elect to apportion fractions of the overall DOE site dose limits to each facility. Has this approach been used in devising site compliance strategies? If so, how have the site dose limits been apportioned among the facilities? What is the basis of this apportionment?
3. What is the period of simulation to be used in modeling exposures to humans? Why is this period of time considered appropriate?
4. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

**PROFILE OF DOE ORDER 5820.2A LLW
PERFORMANCE ASSESSMENT ACTIVITIES
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— Site Data, Capabilities, and Activities Questionnaire —

I. Dose Conversion Factors (This section is concerned with the methodology and values to be used to determine predicted doses.)

1. What is the source of dose conversion factors that will be used in site assessments?
2. Would additional guidance or system-wide support be helpful or necessary in completing your efforts in this area? If so, what would be most helpful?

APPENDIX B

SITE RESPONSES

<u>Site</u>	<u>Appendix Page No.</u>
Hanford	B-2
INEL	B-19
LANL	B-33
NTS	B-47
ORNL, Paducah, Portsmouth	B-58
SRS	B-71

HANFORD SITE

The interview of Hanford personnel was conducted on January 23 and 24, 1990. Additional telephone conversations were conducted to more fully learn about aspects of the Grout Disposal Facility. Comments on the notes from the interview were received on February 19, 1990, and March 6, 1990.

A. GENERAL

Technical Participants: Andy Anderson, Jerry Scott, Don Wood, Joe Westsik, Marc Wood

1. Site personnel expect to start the performance assessment for the W-5 Solid Waste Disposal Facility in earnest this year. The scheduled completion date for the final assessment is 1993.

This year, site personnel will perform a characterization of the site geology, identify exposure scenarios for consideration, develop the conceptual model(s) and model groundwater flow and transport at the site. Some waste characterization will also be done. Once these tasks are complete, they will assess what they have and, from there, where to proceed.

A draft performance assessment has been completed for the Grout Disposal Facility. This assessment is undergoing revision to address changes in the facility design. The draft of this assessment is expected to be done by May/June 1990, with the final report expected about October 1990.

2. The following information was supplied for the Solid Waste Facility.

<u>Component</u>	<u>Amount of Data Available</u>	<u>Level of Confidence</u>	<u>Relative Degree of Importance</u>
Source Term	4	4	1
Waste Package/Form	2	3	2-3
Disposal Technology	3	3	1,3
Computer Codes	N/A	3	N/A
Site Characteristics	3	3	1-2

Some information on source term exists. As little analytical data forms the basis of this information, confidence in this information is poor.

Site personnel have a fairly good idea of waste packages used in disposal, the types of solid waste materials, and would know grouting specifications if solidification was extensively used. As all treatment options have not been finalized, confidence in the data is not as high as it could/will be.

The importance of the disposal technology is given two scores. The first relates to intruder protection, the second to migration of contaminants with groundwater. The lower importance with regards to migration has to do with the fact that they consider the disposal site to be more important than the technology used.

The level of confidence in the codes is relatively low because the codes have not been applied to the disposal site. It is expected, however, that the codes will be suitable.

Site characteristics are considered important in terms of groundwater transport of radionuclides. Importance of the site in terms of intruder protection may be as low as a 5. For the intruder, the technology (primarily the cover) is more important.

The following was one participant's opinion on the Grout Disposal Facility.

<u>Component</u>	<u>Amount of Data Available</u>	<u>Level of Confidence</u>	<u>Relative Degree of Importance</u>
Source Term	2	2	1
Waste Package/Form	2-3	2	4
Disposal Technology	3	3	1
Computer Codes	N/A	Not Sure	N/A
Site Characteristics	3	3	2

The amount and quality of data for the waste source term is quite high for the tank waste that has been analyzed. Additional data are being collected on the waste not yet characterized.

The low relative importance of the grouted waste form reflects upon the greater importance placed on the multiple barriers comprising the disposal technology. The relatively low rankings of the availability of data for the technology, and the confidence in those data, are being remedied through ongoing work. Additional site data are also being collected for the assessment.

3. Definite concerns exist with respect to the quality of the data for the Solid Waste Facility assessment. The performance assessment must be technically based in the conclusions it draws, it can't be based on intuition or the expectation that there will be no problems.

In general, personnel need much more detailed data to permit more accurate modeling of the disposal site. Currently the data available are sufficiently general that the assessment can't consider the site in what is judged to be sufficient detail.

A quality assurance program is in place for the Grout Facility. Quality of existing data is considered good.

4. With regards to the Solid Waste Disposal Facility, problems facing the site include a lack of radionuclide source term data and a lack of data for modeling vadose zone transport. Data are needed which permit characterization of the variability of the hydrogeology of the site. These data will allow personnel to conduct sensitivity and uncertainty analyses and will help them decide when they have enough data on this aspect of the site.

Few nuclide release data exist which are relevant to the arid conditions found at the site. These leach rates would be most useful if they could be obtained for various waste forms.

There is a question as to what constitutes suitable exposure scenarios for use in the assessment. Site personnel believe decisions leading to standardized scenarios need to be made. These scenarios may vary in specifics, consistent with site-specific characteristics, but should have the same underlying philosophy among the various DOE sites.

Difficulty is anticipated in interpreting monitoring results and using these results in the confirmation of performance assessment results. At least a portion of the contamination detected through monitoring will be that from past trench releases, not the contamination addressed by performance assessments for 5820.2A.

The question of whether the probability of occurrence of exposure scenarios could, or should, be included in the assessment was raised.

There is concern with the regard paid the performance assessment process on a management and site operations basis. They tend to see the performance assessment as something to get done so they can move on to more important things. They do not see the performance assessment as a part of an overall waste management plan for the site. They do not realize that the performance assessment aids in designing monitoring programs, and deciding on suitable treatment and disposal technologies.

Some of the relative disregard paid the performance assessment may result from the fact that the site is in a shutdown mode. Many people overlook the fact that LLW is still being generated at the site, and will be for the foreseeable future, despite the impending closure.

There was a question as to how to combine the impact of all facilities at Hanford and arrive at a site-wide release rate. This release rate must be such that the total site remains in compliance.

Grout Facility personnel noted the long-term stability of barriers used in the disposal technology and long-term changes in climate and groundwater flow patterns as sources of

uncertainty. It isn't clear how climatic and groundwater changes should be addressed, or if they need to be considered.

Site personnel are modeling the facility using an infiltration rate (5 cm/year) 50 times that expected through the disposal system. This approach is being taken to help with the uncertainties about barrier stability and climatic changes.

There is also some question with respect to the criteria which must be complied with. The period of time for which compliance must be demonstrated is not clear.

5. While the problem cited regarding shutdown of the site is unique to Hanford, most of the problems cited above are not viewed as being unique to the site.
6. Time and money are required for rectifying the technical difficulties facing the site for the Solid Waste Disposal Facility. A document outlining decisions reached on standardized exposure scenarios is also needed.
7. In general, site personnel see themselves as having as much in the way of technical resources as the Performance Assessment Center. The Center could play an important role in terms of dispersing information relevant to the 5820.2A performance assessment process to the sites.

The idea of periodic workshops (about every 6 months) for pertinent technical personnel from the DOE sites was thought to be an effective way to find out what the sites were doing, and how they were dealing with various performance assessment issues. These meetings could also serve as an informal technical review committee for site performance assessments. The Center was viewed as being potentially useful in terms of establishing these workshops.

Currently, communications between sites is done on an individual basis. Hanford personnel working on the solid waste facility have some communications channels established with the SRS and INEL. Less in the way of communications occurs with ORNL, little or none with NTS and LANL.

Westinghouse has a sub-contract with ORNL to help with grout technology questions. Here, then, there are direct communications between Grout Facility personnel and ORNL.

8. Technical resources for performing the assessment exist at the site; personnel can, and wish, to do the work themselves. Their experience with the site makes it preferable that they do the work.
9. The prevailing view is that the Peer Review Panel hasn't done much to help the performance assessment process, to date it has been a very passive organization. More support of the panel needs to be shown by DOE-Headquarters if the Panel is to be a significant resource.

Enough general guidance on various aspects of the assessment process exist. What would be more helpful is a sanctioning of approaches to be taken, not just a round-table discussion of the concerns. Needs identified in the guidance also require funding by DOE-Headquarters.

While not a responsibility of the Panel, there is a question as to the impact of the performance assessment requirements on mixed waste disposal. RCRA includes no requirements for performance assessments for mixed waste. Are the sites expected to do assessments along the

lines of the radiological waste assessments just the same? If not, what will be done to address the public's mistrust of this inconsistent treatment of these wastes? DOE-Headquarters needs to let the sites know what is expected in this area.

B. AS-GENERATED WASTE SOURCE TERM

Technical Participants: Andy Anderson, Jerry Scott, Jack Sonnichsen, Marc Wood

1. Activities by radionuclide are currently provided by generators of waste for disposal at the W-5 Solid Waste Disposal Facility.

Sampling of the waste slated for disposal in the Grout Facility is conducted to determine nuclide concentrations.

2. The level of confidence in existing data for the Solid Waste Disposal Facility is generally not high. Problems with data tend to result from a lack of effort on the generators' part in applying process knowledge to their waste. Past practice included very general approaches to applying process knowledge and scaling nuclide activities from measurements of package activities. The result was often no separation of a given facility's total waste into separate waste streams.

People involved with the Grout Disposal Facility are generally comfortable with the source term data. These data, however, are based on relatively limited sampling, approximately 3 million gal of waste in storage has been analyzed.

3. In general, additional or new types of data are not required for the Solid Waste Facility, just better quality data. Additional information may be pursued for nuclides shown to be important in terms of demonstrating compliance. If a few nuclides can be shown to be important, e.g. via the performance assessment, it is expected that site personnel could get more cooperation from the generators in terms of getting quality waste source term data.

There needs to be some thought given to balancing the expense of getting good quality data on the source term and the cost of acquisition of those data. Hanford personnel find themselves in a position where they have to get generators to try harder to characterize their waste after several years of getting by without this effort. Many generators are less willing to exert more effort as they are in a shutdown mode.

As waste from different tanks is being readied for disposal in the Grout Facility, representative samples need to be analyzed for radioactive and chemical content.

4. An improved certification program is in the process of being implemented for the Solid Waste Disposal Facility. Guidance documents are being issued to help the generators in adopting better techniques for waste characterization. Generators are being required to prepare a documented rationale for how they determine the radionuclides and hazardous constituents. The waste acceptance criteria are updated annually and regular meetings are held between the certification committee and the generators to identify and rectify problems the generators are having.

There is little commitment to a strict audit procedure to ensure that generators comply with the certification plan. Consequently, there is some concern that data quality could suffer.

Better analytical techniques are expected to be needed to help in improving waste characterization procedures. These techniques are under investigation at this time.

An ongoing program exists to sample and analyze double-shelled tank waste for chemical and radiologic contents for the Grout Disposal Facility.

5. Final implementation of the waste certification plan, which will provide better quality data for the Solid Waste Facility, is expected in the next 1 to 2 years.
6. The site is in a shutdown mode. While some facilities are still operating, they will complete their missions in the next few years and close. Some waste treatment facilities, primarily for high-level waste and TRU waste, are starting up and will generate some by-product LLW. As the site shutdown progresses, waste from decontamination and decommissioning activities will increase significantly.

Much of the waste to be disposed in the Grout Facility is already in storage, some of the waste is still being generated. The consistency of the waste in the tanks isn't well known, but will be characterized to ensure any variations are accounted for.

7. Concentrations of nuclides in the waste are known on a per package basis for the Solid Waste Facility. Prior to about two years ago, the source term data were known on a per-shipment basis.

Concentrations for the waste slated for the Grout Disposal Facility are determined by analytical measurements of samples of waste taken from the double-shelled tanks.

8. Physical characterization data collected for the solid waste is limited to a general description of the waste, e.g., wood, metal, plastic, etc. and the percentages of each.

The physical characteristics of the waste for the Grout Facility will be those of the grout used to stabilize the material.

9. Data collected for the Solid Waste and Grout Disposal Facilities are consistent with RCRA data requirements. Analysis for organics in the Grout Facility waste is also conducted.
10. Quality of the physical and chemical waste data is good.
11. Additional data are required for the Solid Waste Facility to allow development of better information on nuclide release rates from the waste. A leaching study is being planned to help in defining these needs. The study will look at a limited number of waste-forms (on the order of 3). Leachate will be collected from saturated waste and analyzed to quantify the contaminants released. Results from the study are expected within one to two years.

As the need for additional data for these studies arises, data will be collected as part of the research effort. Site personnel do not see the need to ask generators for these additional physical/chemical characteristic data. Data currently supplied by the generators are considered adequate.

Diffusion rate data for the Grout Facility are being collected for the performance assessment for the final facility design.

12. No.

C. AS-DISPOSED WASTE PACKAGE/FORM

Technical Participants: Andy Anderson, Jack Sonnichsen, Joe Westsik, Marc Wood

1. The predominant form of the waste, with respect to the Solid Waste Disposal Facility, varies with the type of waste, e.g. remote-handled versus contact-handled versus mixed waste. Overall, predominant forms will be compactible/combustible waste, metals and soil material. Remote-handled is predominantly metals, contact-handled waste will be primarily metal, compacted combustibles and soil.

The site is trying to provide incentives for generators to compact waste. A compactor has been installed at the Solid Waste Disposal Facility. Incineration is being pursued, but very reluctantly as the State of Washington has a history of opposing incineration in the state. It is expected that mixed and hazardous waste will be sent for incineration at other sites, e.g. INEL or LANL. Solidification is performed on pond waste, liquid waste streams and sludges, generally using grout. The amount of waste solidified is a relatively small portion of the entire waste volume.

Low-activity LLW (similar to class 1 waste) is disposed in 55 gal drums and in a variety of different-sized boxes. Intermediate- and high-activity LLW (similar to class 2 and 3 waste) will be packaged in a standard steel TRU box for the most part. These boxes are roughly 4 ft by 5 ft by 8 ft for intermediate- and high-activity LLW and 3 ft by 4 ft by 6 ft for low-activity LLW.

All waste will be grouted prior to disposal in the Grout Disposal Facility.

2. Waste form characterization is not complete for the Solid Waste Facility, final treatment strategies for numerous waste streams need to be determined. Characteristics of waste are given above.

Waste slated for disposal in the first set of Grout Facility vaults has been characterized. Additional waste will be characterized for later disposal.

3. Grout is the predominant solidification agent in use when solidification of waste is employed for the Solid Waste Facility. Grout is the solidification agent used in the Grout Disposal Facility.
4. Leaching behavior of the waste-forms and packages used in the Solid Waste Disposal Facility isn't well understood. Leaching studies are to be performed to better understand this aspect of the assessment. Drilling in and around some existing trenches may provide some historical data on contaminant release, some of the trenches are up to 40 years old.

Sampling at existing sites may also provide information on what components of the waste migrate from the waste and the rate of said migration. This information can probably be

collected by measuring differences in soil nuclide concentrations as a function of distance from the trenches.

Release from the Grout Facility is diffusion limited for species soluble in grout pore solution, with the asphalt pavement being the primary diffusion barrier. These species include I, pertechnetates, Na and Cs. Additional diffusion data are being collected to be used in the final design performance assessment.

Other aspects of the grout are expected to affect release rates from the Grout Facility. These include the highly alkaline nature of the grout and the chemical reactions which occur between the grout and the waste constituents. Work is under way to characterize these aspects of contaminant release as well.

5. In terms of the Solid Waste Facility, having access to leach data from other sites would allow them to make inter-site comparisons. This is of limited use, however, as waste-forms are expected to be site-specific.

The idea of a lysimeter study to quantify release rates was considered potentially useful. The importance of using site-specific soils and waste-forms in any lysimeter studies was recognized.

A lysimeter study was seen as being of limited use in terms of understanding nuclide transport beneath the trench, i.e. following leaching. This is because the soils used in the lysimeters would be disturbed and, as a result, not representative of in-situ conditions. Also, unless instrumented properly, lysimeters would not allow examination of the horizontal movement of contaminants.

Lysimeter studies may provide help in the design of monitoring programs as results could yield insight into when and where to look for contaminants.

The site currently has some lysimeter work in place. Some lysimeters are designed to look primarily at cover designs and the amount of infiltration through various cover systems. Some tracer work has also been done with Co and EDTA to look at the influence of the EDTA on Co transport.

D. DISPOSAL TECHNOLOGY

Technical Participants: Andy Anderson, Jack Sonnichsen, Joe Westsik, Don Wood, Marc Wood

1. The disposal technology at the Solid Waste Disposal Facility is shallow-land burial. The Grout Facility will employ belowground vaults for the disposal of double-shelled tank waste at the site.
2. The initial assessment will address the Solid Waste Facility at W-5. Site personnel are looking into alternative technologies for the replacement for this disposal facility, expected to be needed within 3 to 5 years. Performance assessment results are expected to play a major role in the direction taken with respect to future disposal technologies.

One participant expects that the existing trench technology will be used in the future for the low-activity LLW (class 1). He expects that enhanced technologies will be used for higher-activity LLW, regardless of the performance assessment results. This will be done primarily to satisfy the public's perception of what is safe. The added technology will probably employ concrete barriers, e.g. grouted waste. He thinks the decision on this improved technology will be made within 1.5 to 2 years.

The results of the performance assessment will be used to provide a basis for where the facility design needs to be improved (an iterative design approach). Currently, the role of the closure cover with respect to the intrusion scenarios is not well developed.

The Grout Facility is undergoing final design revisions.

3. Current disposal practice at the Solid Waste Facility is standard shallow-land burial. The V-trenches are excavated to a depth of about 26 ft and currently have about 8 ft of clean fill over them. A RCRA-approved cover is expected to be applied over the disposal site (required as mixed waste can be found throughout the facility trenches).

All hazardous waste is shipped offsite for disposal. Mixed waste is being stored, a RCRA-approved disposal facility is in the design stage. A performance assessment of this facility has not been completed.

The cover is considered a critical component at the Solid Waste Disposal Facility as it minimizes infiltration and provides intruder protection. If a grouted waste form is used at this facility in the future, benefit would be gained through delayed contaminant releases and a more stable waste form. Hanford personnel involved with the Solid Waste Facility are also relying on the site characteristics to minimize groundwater problems, including low rainfall, high ET, and a deep aquifer.

The Grout Facility employs concrete vaults, filled with grouted waste. The vaults are surrounded in an asphalt pavement or cocoon. A RCRA cap is applied over the vaults, followed by a multi-layer earthen cover system designed to minimize infiltration. The facility is RCRA-approved, as it employs a double liner and leachate collection system below the vaults. A total of about 44 vaults is planned for construction.

Several components are critical to the success of the Grout Facility. The asphalt barrier serves as a diffusion barrier. The grouted waste helps in minimizing releases due to the diffusion characteristics of the grout and chemical interactions between the grout and waste constituents. These chemical reactions tend to bind the waste. The engineered cover system minimizes infiltration and discourages intrusion. Water which does penetrate the site is diverted around the asphalt cocoon by the RCRA clay cap.

4. Cover performance is pretty well understood. The 5820.2A assessment for the Solid Waste Facility may assume some portion of the cover fails, thereby increasing infiltration.

The cover system and the asphalt, grout, and concrete components of the Grout Facility are currently modeled to remain intact for the entire simulation period. No subsidence, waste volume changes, or changes in barrier diffusivities is assumed. Work has looked into grout performance, including compressive strength, thermal analysis and aspects of leaching behavior.

5. No additional information is considered necessary for modeling the Solid Waste Facility disposal technology.

Long-term performance of the asphalt layer is being studied, including radiation effects and bio-degradation of the material, for the Grout Disposal Facility.

6. Long-term performance data on concrete would be helpful if technologies employing concrete and/or grout were adopted for the Solid Waste Facility.

There needs to be coordination across all DOE with respect to how to improve disposal technology to meet the public's perception of what is safe. It is expected that the use of different technology enhancements at each site will create problems in the public's perception of DOE's handling of waste disposal. Simply, if one technology is good in one place, why isn't it in another? While variations on a theme may be acceptable across sites, a need for a general philosophical approach to disposal technology was seen as important.

In addition to these considerations, future disposal site designs need to be consistent with CERCLA site remediation requirements. If design is not handled properly, the sites could build a case for having to retrieve all old waste.

E. EXPOSURE SCENARIOS

Technical Participants: Bruce Napier, Jerry Scott, Jack Sonnichsen, Joe Westsik, Marc Wood

1. Significant exposure scenarios at the Hanford site include intruder and groundwater pathways. The groundwater pathways is a chronic, low-level problem.

Atmospheric pathways have been modeled in the past but were not found to be significant.

2. Exposure scenarios to be considered in the 5820.2A assessment for the Solid Waste Facility include:
 - Intruder who lives on the site, grows food and eats it, no physical disruption of the site.
 - Intruder who drills a well, builds a house, plants food crops adjacent to the facility. Doses include those to the driller and the resident.
 - Intruder-Agriculture Scenario.
 - General public receptor within 100 m of the trenches.

Exposure scenarios to be considered in the Grout Facility assessment include:

- Drinking water scenario.
- Full garden scenario.
- Exposures resulting from releases to the Columbia River.
- Intruder who drills a well and resides over the site.

The first two scenarios will be assumed to occur on the Hanford site but off the disposal site. Intruder scenarios will consider the decreased probability of intrusion into the grouted vaults due to the presence of the various barriers in the disposal facility.

3. Exposures to downwind and/or down-gradient populations will not be considered in the Solid Waste Facility assessment. These were considered in the past, for the site Environmental Impact Statement, but are not required by 5820.2A.
4. No.

F. COMPUTER CODES

Technical Participants: Raz Khaleel, Jack Sonnichsen, Joe Westsik, Marc Wood

1. No prior assessments have been performed for the Solid Waste Disposal Facility. Some screening calculations for the groundwater were performed last year. These assessments were run for four nuclides (C, Co, Cs, Sr) to see if there were any problems. These were examined as they were among the most abundant radionuclides.

A draft performance assessment has been completed for the Grout Facility. This assessment is undergoing revision to address changes in the facility design.

2. The screening calculations for the Solid Waste Facility modeled groundwater using a one-dimensional, steady-state, unit gradient code for the unsaturated zone. Transport through an unconfined aquifer was addressed using CHAINT. Pathway doses were modeled using GENII for the 1,000 year simulation period.

Codes used in modeling unsaturated flow and transport for the Grout Facility were TRACER3D and S-301, respectively. SLAEM was used to model saturated flow and transport. GENII was used for exposure pathways modeling. MEPAS was used to examine health effects.

3. Solid Waste Facility screening calculations did not address all important transport and exposure pathways. Most notably, the calculations did not look at the intruder exposures.

The Grout Facility assessment looked at all important pathways.

4. Sensitivity analyses for the Solid Waste Facility screening calculations examined the affect of various uniform infiltration rates (.05, .5, 5. cm/year) for the site. Travel times decreased as these infiltration rates rose, ranging from about 100 to 10,000 years, and were consistent with one-dimensional modeling done for the Grout Facility. C-14 showed up in the aquifer at the highest infiltration rate.

Some sensitivity analyses were performed for the Grout Facility, examining changes in diffusivities, well location, and infiltration. No uncertainty analyses were performed.

5. The one-dimensional nature of the modeling used for the Solid Waste Facility screening calculations probably under-estimated vertical travel times as it did not account for lateral flow. Consequently, doses to humans from the groundwater pathway were probably too high. To this extent, the results are expected to bound the expected exposures.

The past assessment for the Grout Facility identified areas needing more attention in future efforts. Consequently, it is not clear if that work modeled the site in a realistic fashion. The general approach taken in that assessment, however, will be used in future assessments.

6. For the Solid Waste Facility:

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	Empirically	N	In 1-2 year
Water infiltration to the disposal unit	VAM-2D	Y	
Penetration of water into the disposal units and around/through the waste	VAM-2D	Y	
Degradation of the disposal unit	N/A		
Radionuclide releases from the disposal unit	N/A		
Surface water transport	N/A		
Transport through the unsaturated zone	VAM-2D PORFLO	Y Y	
Transport through the saturated zone	VAM-2D PORFLO	Y Y	

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Atmospheric transport	GENII	Y	
Radionuclide uptake	GENII	Y	
Health effects	GENII	Y	

Waste form nuclide release data will be collected from site-specific studies. As engineered barriers are not currently employed, degradation of the facility and releases from the disposal unit are not applicable. Little surface water exists, making this aspect unimportant.

The codes to be used in the next assessment for the Grout Facility are given below.

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	S-301	Y	
Water infiltration to the disposal unit	TRACR3D	Y	
Penetration of water into the disposal units and around/through the waste	TRACR3D	Y	
Degradation of the disposal unit	N/A	-	
Radionuclide releases from the disposal unit	S-301	Y	
Surface water transport	N/A	-	
Transport through the unsaturated zone	S-301	Y	
Transport through the saturated zone	SLAEM	Y	
Atmospheric transport	GENII	Y	
Radionuclide uptake	GENII	Y	
Health effects	GENII	Y	
	MEPAS	Y	

Codes will not be used for modeling degradation of disposal units as the vaults are assumed to remain intact for the simulation period. However, conservative properties are assigned to components of the disposal units.

7. Codes have been selected.
8. The codes listed for question 6 would be used for the Solid Waste Facility. Confidence in the assessment would not be high as more detailed data are needed.

The assessment for the Grout Facility has been completed, save for some final design revisions.

9. Yes, VAM-2D, TRACR3D, S-301 and SLAEM were all developed elsewhere.
10. Some validation of VAM-2D and PORFLO is expected to be done using historical plume data from a leaking tank. The tank started leaking in early 1973, site personnel have plume data through 1978.

No other validation activities for the Solid Waste Disposal Facility are currently planned. There has been some discussion with regards to boring holes in and around an existing waste trench at the site to collect data on contaminant movement. Such data could be used in validation exercises. Tracer work has also been discussed for help in code validation. Nothing definite is scheduled for either of these, however.

Verification analyses have been performed for TRACER3D and S-301; a little benchmarking of TRACR3D with PORFLO has been done. Validation of the TRACR3D code is in progress at the LANL.

11. No guidance is needed with respect to the Solid Waste Disposal Facility, it is just a matter of site personnel collecting the necessary data.

The assessment for the Grout Disposal Facility is essentially complete.

G. SITE CHARACTERISTICS

Technical Participants: Raz Khaleel, Jerry Scott, Jack Sonnichsen, Joe Westsik, Marc Wood

1. Important parameters with respect to the groundwater flow parameters for the Solid Waste Facility assessment include:
 - moisture characteristic curves
 - effective porosity
 - specific storage of the aquifer
 - saturated hydraulic conductivity

Important groundwater transport parameters include:

- longitudinal dispersivity
- lateral dispersivity

- distribution coefficients

Other important parameters include diffusion coefficients and stratigraphic characteristics.

In terms of intruder exposures, few individual parameters really stand out as being very important. The climate of the site, as it influences land-use, plays a significant role.

Important parameters for the Grout Facility will include diffusion coefficients for the grout, concrete vault and asphalt, and groundwater parameters similar to those listed above for the unsaturated zone. Aquifer parameters are considered relatively unimportant as the total water travel time in this region is very short, on the order of 30 to 50 years for a 1 km well. Lateral dispersion in the aquifer is not considered, the entire contaminant plume is assumed to be drawn into downstream wells.

2. There generally are not sufficient data for the groundwater parameters listed above for the Solid Waste Facility assessment. However, the amount of data that is 'enough' depends, in part, on the sensitivity of the performance assessment to these parameters. That is, if assessment results are relatively insensitive to a given parameter, fewer data would be required compared to a more important parameter.

The confidence in the data is generally not good. Confidence in the data is clouded given the very heterogeneous nature of the hydrogeology at the solid waste Disposal Facility.

Additional hydrologic data are being pursued for the Grout Facility.

3. Stratigraphic cross-sections have recently been developed for the Solid Waste Facility. Data have also been collected which will allow the development of better soil characteristic curves using routines in the groundwater codes. These curves are generated by entering necessary soil data for use in Brooks-Corey and Van Genuchten formulations.

Data are being collected on essentially all physical and chemical characteristics of the vadose zone. These data are being collected on a small scale, and are expected to be available within 1 to 2 years.

The collection of better distribution coefficient data, especially for use in modeling unsaturated conditions, is being considered. Currently, distribution coefficients for saturated media are adapted for use under partially saturated conditions. This is not considered satisfactory.

Collection of additional data on site hydrology is planned as part of the Grout Facility effort. At least one more well is planned for the disposal site to help in these efforts.

4. Most hydrologic data for the Solid Waste Facility are site-specific in nature. Distribution coefficient data rely on literature values in many cases. Improvements in these data are being considered, as described above.

Hydrologic data for the Grout Facility are site-specific.

5. Distribution coefficient data from other sites may help personnel modeling the Solid Waste Facility in either of two ways. The actual values of distribution coefficients under unsaturated conditions may be useful. Even if the data are not applicable to the Hanford site, the data may

provide insight into the relationship between distribution coefficients under saturated and unsaturated conditions.

U.S. Ecology is not considered to have any data to offer from their commercial site in Washington.

6. Help in identifying suitable approaches to collecting unsaturated zone distribution coefficients would be useful to personnel involved in the Solid Waste Facility assessment. Otherwise, continued funding will allow site personnel to get what they need.
7. The level of detail required in addressing site characteristics for the Solid Waste Facility would be helpful. For instance, are site-specific distribution coefficients necessary? Are site-specific waste form data required? Can sites be adequately modeled with one-dimensional groundwater models?

H. COMPLIANCE STRATEGIES AND COMPLIANCE POINTS

Technical Participants: Bruce Napier, Vince Panesko, Jerry Scott, Don Wood, Joe Westsik, Marc Wood

1. Compliance points for the Solid Waste Facility include the site boundary during operations and the institutional control period. Following this period, the general public receptor is placed within 100 m of the trenches. The site intruder will also be included to exhibit compliance.

It is not expected that the Solid Waste Facility assessment will consider an offsite population following operations and institutional control, at least for this year's calculations. This point of compliance may be addressed in the future. Additional points of compliance will be examined, if necessary.

Compliance points for the Grout Facility will include the intruder, disposal facility boundary locations and offsite exposures to the public.

2. Apportionment of doses from disposal facilities has been considered with respect to the Grout Facility. An apportionment factor of 20 percent of the objectives was used to set the original design goals and is used currently in facility assessments. Whether this factor will be modified in the future for the grout facility depends on the availability of modeling information on the potential spatial and temporal overlap of projected releases from the other disposal facilities.

With the exception of the Grout Facility, apportionment is not expected to be considered in the future. While releases from the disposal facilities may overlap in a spatial sense, they are not expected to overlap temporally, thereby negating the need for apportionment.

The system assessment is planned to be addressed by Westinghouse personnel. It is seen as a systems engineering type analysis which will identify the options open for waste management, including treatment and processing, and disposal technologies. These topics need to be considered with respect to ALARA, technological needs at the facility, and costs versus benefits. Once feasible options are identified, they will be considered with respect to the effect they have on the performance assessment.

3. The simulation period for the Solid Waste Facility assessment is tentatively set at 1,000 years, although the time of peak exposures are expected to be identified as well. This period of simulation is considered sufficient in light of the uncertainties associated with modeling the site.

The simulation period used in the Grout Facility assessment was 10,000 years. Peak exposures will also be identified.

4. The time for compliance needs to be specified as part of the performance objectives. This is currently a major area of uncertainty, and a consistent approach is needed across the DOE system.

Questions exist with respect to what the compliance point(s) should be in the assessment. Some participants weren't aware of the 100 m compliance point stated in supplementary guidance to the Order.

DOE-Headquarters needs to stand behind guidance, either making it mandatory or dropping it from consideration. An example is the guidance regarding the 100 m distance for the general public compliance point. Technically, as this is not in the Order, it does not need to be complied with. If DOE backs this guidance, they should put it in the Order and make it mandatory.

Another example of this is the groundwater standard of 4 mrem/year. Currently, regulations for this standard are still in the works and, as such, do not exist. If DOE wants this included as a performance objective they should sanction it and put it in the Order.

Compliance demonstrations should include a reasonable range of future conditions. Worst-case approaches may be useful in comparing impacts of design options, but should not be used in demonstrating compliance. Guidance in this area would be useful.

I. DOSE CONVERSION FACTORS

Technical Participants: Bruce Napier, Jerry Scott, Don Wood, Marc Wood

1. Dose conversion factors are based on ICRP 26/30/48. External factors are based on DOE approved methodology, although they are calculated independently by site personnel.
2. No.

IDAHO NATIONAL ENGINEERING LABORATORY SITE

The interview of Idaho National Engineering Laboratory personnel was conducted on November 21 and 22, 1989. Comments on the notes from the interview were received via telephone on February 21, 1990.

A. GENERAL

Technical Participants: Marilyn Case, Steve Maheras

1. INEL personnel are in the process of completing an assessment of the RWMC for Order 5820.2A. The assessment is viewed as a baseline calculation to see what potential problems exist with respect to demonstrating compliance with the Order. The final assessment is not currently scheduled for any specific completion date; it will be done by the time it is expected from DOE.
2. Participants answers are separated by a slash (/).

<u>Component</u>	<u>Amount of Data Available</u>	<u>Level of Confidence</u>	<u>Relative Degree of Importance</u>
Source Term	1(rad) / 3 4(nonrad)	+300% / 4 +- 30%	1 / 1
Waste Package/Form	1 / 2	2 / 2	4 / 4
Disposal Technology	1 / 1	1 / 1	3 / 3
Computer Codes	N/A 2(unsat'd zone)	1(aquifer) / 3 3(near-field)	N/A
Site Characteristics	4-5 / 4	3 / 5	2 / 2

The disposal technology is expected to cause few problems with respect to modeling as data availability is a matter of engineering control. Given this, confidence in these data is high.

Present and new waste package/form data are considered relatively easy to access as disposal must meet requirements. To the extent that the requirements are met, the data for modeling also exist and the confidence is good.

Waste form and package are considered relatively unimportant as packages fail quickly relative to the half-lives of the important nuclides (e.g. Pu and U). Solidified waste, which may involve longer waste 'lifetimes' comprises a small portion of the total waste disposed, thereby minimizing the intruder protection gained from this disposal strategy. The small fraction of

the waste that is solidified and the long half-lives of important nuclides minimizes the benefit of the solidification process. However, liquids are to be solidified thereby dramatically reducing the leaching of this waste.

Quality of data for waste currently disposed and to be disposed in the future are quite good and should improve; data for old waste is generally poor. Modeling of release rates from the inventory is largely uncharted territory. Few ideas exist with respect to an approach to the problem.

Near-field site characteristics are poorly known and quite important to the modeling effort. Unsaturated zone data are being collected on an ongoing basis. Once again, leaching of contaminants from the waste is not well understood.

Model development was considered to address the site adequately. Computer codes for the aquifer and atmosphere were considered good; near-field models (waste package performance, leaching, transport in the waste) were considered lacking to poor.

3. The quality of the data collected at the site is considered good. The site has numerous data standards which must be met to ensure proper procedure. Bigger concerns lie with those data taken from the literature and the quality of work from other labs. There also is concern with respect to the uncertainty associated with experimental data.

It was suggested during the interview that a need existed for the adoption of standard values by the DOE system for certain model parameters, an example of food bioaccumulation factors was used. Others disagreed with this approach. It was agreed that a literature review of computer codes and data for performance assessments would be helpful in making site personnel aware of all appropriate sources of data and computer codes. Given this information, which would need to be updated periodically, site personnel could use their best judgement in final code and data selection.

Updating of Regulatory Guide 1.109 was seen as a potentially helpful source of information for standard parameters.

4. Performance assessment requirements were not viewed as being clear. For instance, questions as to 1) whether the assessment should take into account treatment facilities e.g. WERF and PREP, 2) where compliance points should be situated in terms of meeting EPA standards, 3) how long the assessment should be run, 4) how or whether climatic changes during long simulations should be accounted for, 5) whether accident analyses should be included, 6) how often the performance assessment should be updated, and 7) how cumulative effects should be handled came up.

On a more specific level, help is needed with regards to modeling H-3 and C-14. Site personnel wondered if the specific activity approach was best or if other alternatives should be considered. There were also questions as to whether monitoring programs would need to be augmented as new facilities or processes come on line at the site. Technical problems exist at the INEL with respect to near-field modeling, including geochemistry of radionuclides and release rates.

5. These problems are perceived as existing at most sites.

6. It was felt that the issuance of a guidance document by the Peer Review Panel could help with the more general issues listed above. The idea of a document with specific guidance, e.g. a simulation period for all sites, is not wanted. A technical guidance document explaining how each site should arrive at decisions of this type was considered more appropriate. INEL personnel wanted to be left with the freedom to use their judgement as to the final path taken, given that they are most knowledgeable regarding site peculiarities.

In terms of the technical problems facing the site, time and money would help most in rectifying these problems.

7. Note that the participants are part of the Performance Assessment Center. They felt the Center could assume a role in a number of technical issues, including waste-form degradation model development, release rate modeling and performing the literature review discussed earlier. It may also be appropriate for the Center to write the guidance document being looked for from the Peer Review Panel. Here, then the Center could write the document and get it reviewed by the Panel prior to issuance.
8. The Performance Assessment Center is not seen as being appropriate for conducting site performance assessments. This is due to the fact that it is envisioned that the Center may play a role in, or even conduct, the review of the site performance assessment reviews. If this came to pass, doing site assessments as well would probably be construed as a conflict of interest.
9. Yes, this type of document would be of assistance. This would differ from the document discussed earlier (question 6) in that it would provide the basis for judging completed assessments.

In general, it is felt that the Peer Review Panel should take a larger role in terms of providing more guidance. They should overcome any political or funding problems to provide this help.

B. AS-GENERATED WASTE SOURCE TERM

Technical Participant: Dale Wells

1. Old, disposed waste is difficult to characterize. New waste data exist by generator. Data currently collected include the nuclides present, curies of non-fissiles and grams of fissiles. Categories such as MFP, MAP, unidentified beta and unidentified gamma were recently omitted from disposal forms to force generators to try harder in characterizing their waste.
2. Quality of old waste data is considered unknown, but isn't expected to be very good. Quality of the data varies with the generator. In general, research and scientific facilities provide good quality data. Production facilities don't put much effort into characterizing their waste; data quality for these facilities is poor.

The quality of more recent data is better, and will improve as new waste acceptance criteria are implemented. Data entry is now done via remote data entry at computer terminals. The program kicks out inappropriate data entries which forces generators to expend more effort in characterizing their waste.

Each generator must participate in a waste certification program which assesses how the lab analyses are performed, and how waste is sampled for assay. Generators which do not comply with data requirements may be shut down.

3. Currently, some nuclides are excluded from reporting requirements due to extremely short half-lives (in the range of hours to days). Criteria are being developed which specify what nuclides need to be included, taking into account things such as nuclides and activities included in below-regulatory concern rulings.
4. Current activities include the development of a more comprehensive waste acceptance criteria and classification system for TRU, mixed, hazardous and sanitary waste. This program will include the waste certification program.
5. The new criteria will be in effect April 1990 and will include a limited grace period for demonstration of compliance.
6. Changes in the source term are expected on a more or less continuous basis as new facilities and processes come on line. More detailed data are expected as time goes on, even apart from these changes.
7. Waste data are collected on a per-package basis. Currently, generators take gamma scans and scale the other nuclides. Some extremely high-activity waste is quantified by process analysis as it is simply too radioactive to measure safely.

The waste acceptance criteria will help the generators in measuring their nuclide inventories, something the generators are struggling with at this time. Characterization of waste streams which can be measured without undue exposures will begin with a detailed analysis. To the extent that the waste stream does not change, i.e. the process responsible for the waste is consistent over time, periodic sampling will be performed to check the waste. If the process is changed, the detailed analysis must be repeated for the new waste stream.

8. Physical characterization data for the waste are limited. The generator must indicate if the waste is a solid or solidified, and must state that it is capable of maintaining its solid state. No gases or liquids are permitted.
9. Chemical characteristics required for shipment of LLW must include indication of the lack of EPA-listed hazardous contaminants. Generic names of the constituents must also be included, e.g. wood, plastic, copper, concrete. If the waste is mixed, the components making it such must be identified, quantified and included in the waste characterization.
10. Confidence in the data is quite good. Data quality will be ensured through the use of waste audits. These audits start at procurement and follow the entire analytical procedure. Annual audits are being discussed but may have to be limited to the high risk waste streams due to the number of site waste streams.

While confidence is good, it is recognized that generators may misrepresent the waste at times if they don't know how to quantify waste contaminants.

11. The waste acceptance criteria being formulated at this time will provide the appropriate source term data. While the criteria will be continually refined, no specific activities aimed at collecting additional data are planned.
12. Effective waste stream characterization will be maximized through experience, including studying regulations and looking for new and better ways of doing things. This experience will be gained to the extent that DOE demonstrates a commitment to gathering this information. In the past, money has dictated how much waste stream characterization is pursued; this is expected to continue in the future.

Site personnel feel that the INEL is the only site moving towards a waste classification system that is the equal of the Nuclear Regulatory Commission's system. The site has a lot of experience that other sites might be able to learn from, especially on a generic basis. Specific facility details of the waste tracking system may not be readily applied to other sites.

There is a need for increased communications between sites as little currently exists. Personnel at the various sites do not generally know what is being done at the other sites.

It is often the case that the wrong people from INEL attend forums where technical information could be exchanged. For instance, middle or upper managers may attend and not recognize the value of the technical information being disseminated. Also, people who attend meetings often do not have the authorization to commit to inter-site projects. In each case, valuable opportunities are lost and often aren't communicated to the appropriate technical people back at the site.

C. AS-DISPOSED WASTE PACKAGE/FORM

Technical Participants: Marilyn Case, Steve Maheras, Dale Wells

1. Packaging of waste for disposal is a controlled process. Only specific packages are routinely accepted for disposal; non-standard packages must go through an acceptance procedure. This procedure consists of extensive documentation which includes design-equivalency studies, and justification for use of the non-standard packaging. As an example, to dispose of a complete reactor vessel the generator would need to provide things such as weight limits, transportation criteria, and nuclide inventories. Once the package is approved, it is approved on a site-wide basis for standard use.

Contact handled containers currently on the accepted list include:

- 5 to 55 gal round drums w/ maximum of 20 lbs/gal
- 71 gal square drum
- DOT M-3 and M-4 bins
- INEL waste wooden boxes which are either 4 by 4 by 4, 4 by 4 by 8 or 2 by 4 by 8 ft w/ a maximum of 6000 lbs/box
- steel box (4 by 4 by 6 ft) for WERF compacted waste

Other packages include concrete resin vaults, 'SHADE' containers (drum in concrete in steel), 55 ton carbon steel cask inserts for activated materials (4 ft diameter, 8 ft high), and 5 ton cask inserts (6 by 1 ft).

Treatment of waste may include sizing, compaction, solidification and absorption of liquids at the generator. This is simply done for efficiency. All treatment done to eliminate a problem with waste or to achieve EPA-approved waste is done at WERF.

There currently are no stabilization criteria for INEL waste; these will be included in the new waste acceptance criteria.

If a generator does not have a compactor, of any type or quality, no compaction of trash is required. There is currently no regulatory impetus behind waste volume reduction; DOE places no constraints on this aspect of disposal, although they are starting to look into the matter. This is indicative of a lack of long-term perspective in this area.

2. Waste forms or streams generally correspond to waste from a facility or from processes within a facility. INEL content codes are essentially waste stream designations and include streams such as asbestos, absorbed liquids, mixtures (e.g. wood, plastics, cloth), hazardous, ion exchange media, biological waste, and metals. One-time content codes may be developed to allow shipment of waste from a facility, e.g. waste from decontamination of a hot cell.

Content codes are kept to a minimum for simplicity by specifying a range of waste constituents in many cases. Some content codes are combined when a single constituent may represent the dominant hazard in all affected waste streams. For example, if asbestos is found in three diverse streams, and is the sole hazard in all three, the content codes for the three streams may be combined.

Wooden boxes disposed in the RWMC were, on average, 85 percent void space in 1984 (based on the weight of soil). A similar amount of void space is expected to be present in packages currently disposed at the facility and suggests a potential for subsidence problems.

3. Solidification agents are not used at the INEL on a regular basis.
4. Contaminant leach modeling is currently based on empirical data from a waste retrieval study. This study involved retrieval of drums of Rocky Flats waste and estimated leach rates therefrom. The nuclides involved were TRUs, the data however are used in determining leach rates for all nuclides. It is recognized by site personnel that current leaching models are inadequate.

Outside of using general corrosion data for estimating drum longevity, little is done to model container lifetimes. The assumption is that these lifetimes are sufficiently short compared to half-lives of the important nuclides that they are relatively unimportant. It is recognized that longer-lived containers, e.g. high-integrity containers, may deserve more attention than this.

5. As discussed with respect to section B, people at the appropriate level in the organization should be sent to conferences and workshops for information transfer. Currently, the wrong people are being sent, people who are not in touch with the technical information being presented or who lack the authority to commit to pertinent projects or tasks.

Technical needs include help in defining release rates, distribution coefficients, leaching of activated metal from INEL soil vaults and aspects of chemical waste dumping. A lysimeter study was identified as being useful in developing better information on contaminant release rates.

Financial support would permit collection of additional data on leaching.

D. DISPOSAL TECHNOLOGY

Technical Participants: Marilyn Case, Steve Maheras, Dale Wells

1. Currently, disposal of waste utilizes shallow land burial. All waste is packaged and stacked, and has been for at least the past 15 years. In the distant past, liquids were dumped directly into the pits. Two disposal configurations are used: soil vaults and pits.

Soil vaults are 16 to 72 inches in diameter and penetrate to within 2 ft of the basalt. These vaults are used for high activity waste and, once full, are covered with 3 to 6 ft of operational soil cover, whatever depth is required to get exposures down to a safe limit (< 1 mrem/hr). Additional cover will be added at the end of operations, approximately 5 m.

Pits are large, along the lines of 100 by 100 m or more, and are used for the majority of disposed waste. These will be covered at the same time as the soil vaults for closure.

2. While the use of shallow land burial may remain in effect in the future and little or no regulatory impetus exists to consider alternatives, the disposal technology used at the site is expected to be shaped by public perception. This perception may force changes in disposal containers, the use of interim storage and possibly engineered barriers.

The Abovegrade Earth Mounded Concrete Vault Facility is eliciting some interest in DOE. Regulations, however, are not forcing the consideration of the technology. Site personnel will be exploring enhanced covers, barriers and other features by the time the final assessment is completed.

3. The configuration of the disposal technology to be used is the same as that described above for current practice. This may change due to pressures exerted by the public, otherwise no changes are expected.

The cover system is important to the disposal technology as it must provide adequate protection against erosion for extended periods of time.

4. The technology currently consists of a trench, or soil vault, in the ground. Site personnel feel comfortable with their modeling of this technology. As no engineered enhancements other than a final cover system are included, behavior of components is not an issue. In terms of long-term cover performance, erosion is modeled for the period of simulation.

Depth of cover over old trenches is largely unknown, estimated to range from 4 to 17 ft. This lack of knowledge creates some concern with respect to exposure of waste due to erosion.

The flood diversion system at the site is designed to divert the Big Lost River away from the RWMC in the event of a flood. Concern exists as to how this system will work in the future if no one is around to operate the flood gates.

5. Stated above, site personnel appear to be comfortable with their modeling of the behavior of the disposal technology. As such, no data are being collected. (The behavior of the waste form/package is not understood but is not considered here.)
6. Support in analyzing the performance of engineered barriers may be important if they are incorporated into the disposal technology. Nothing is perceived as being helpful in terms of understanding the current technology.

It would be helpful to have the benefit of assessments of a variety of disposal technologies at a variety of geographic locales. This would provide insight for sites finding themselves faced with the need to select a suitable disposal technology. This analysis should consider cost/benefit aspects of waste disposal.

Another helpful guidance document would be one in which issues pertinent to the siting of a disposal facility are discussed.

E. EXPOSURE SCENARIOS AND PATHWAYS

Technical Participants: Marilyn Case, Steve Maheras

1. The two important pathways at the site are considered to be groundwater and atmospheric transport. Atmospheric transport results in the suspension of contaminants brought to the surface via flooding and/or biointrusion.

Surface water transport is not considered important in the absence of floods and as long as someone is available to operate the flood diversion system.

Infrequent events, such as flooding or subsidence of waste trenches are not addressed in the current assessment. These have occurred in the past but it is not considered likely that they will occur again.

Gaseous transport of contaminants may merit investigation to assess the potential for health risks.

2. For the baseline assessment, an individual was assumed to drill into a soil vault and bring the waste up to the surface. Exposures include inhalation and direct radiation. People are not expected to live and farm over the vaults given the small diameters of the vaults. The depth of the cover over the vaults is also considered to be sufficiently deep to make farming unimportant.

Explorer, construction and agriculture scenarios are considered for the much larger pits. The use of contaminated water from a boundary well was also considered. During INEL operations this individual is considered to be at the INEL boundary. After operations, the individual is moved to the edge of the RWMC boundary.

Potential doses resulting from the construction of a potato cellar. However, this exposure scenario was dismissed before calculating actual effects because excavation during construction was not expected to encounter the buried waste.

The atmospheric scenario assumes the uptake of contaminants by plants and their subsequent death, bio-intrusion by animals, and contamination through flooding. The material brought to the surface is suspended and blown offsite. The scenario is most likely to occur during operations; intrusion will not penetrate the interim plus final cover system. For this scenario, the individual is located at the INEL boundary.

The simulation was carried sufficiently far to look at that time when erosion has removed enough cover to permit intrusion by plants and animals once again. At this time, the receptor location is at the RWMC boundary.

3. No exposures resulting from flooding and subsidence were examined.
4. Help would be useful in terms of what standard scenarios should be considered in the performance assessment, how to address infrequent events such as flooding and subsidence, and how the probability of scenarios should be factored into analyses, especially for infrequent events.

F. COMPUTER CODES

Technical Participants: Bob Baca, Marilyn Case, Steve Maheras

1. A baseline assessment has been completed. The assessment is considered to be a screening calculation to alert site personnel to the problems they face in complying with 5820.2A.

Exposures to intruders and offsite individuals were modeled.

2. The computer codes used in the baseline assessment include the following:
 - DOSTOMAN for near-field modeling
 - FLASH/FLAME for unsaturated flow and transport calculations
 - PATHRAE for groundwater and intruder pathways
 - MICROSIELD for direct gamma exposures
 - EPA-AIRDOS for atmospheric transport and exposure pathways
3. Site personnel appear to feel that all important transport and exposure pathways were addressed in the baseline assessment.
4. Sensitivity analyses were performed as a part of the baseline assessment. Site personnel looked at nominal values of selected parameters as well as values which resulted in higher doses; they explored some parameter combinations as well. The analyses focused on groundwater and leaching-related parameters.

Aquifer and atmospheric parameters were not included in the sensitivity studies. Results from past sensitivity studies conducted for the site are still considered applicable in certain cases.

INEL personnel did not appear to be surprised by the results of these analyses, i.e. things seem to be working the way they expected. If there were any surprises, they had to do with near-field phenomena. Pu-238/9/40 showed strong dependence on distribution coefficients;

suggesting that colloid transport, possibly combined with fracture flow in unsaturated zone, could be an important factor in modeling.

No uncertainty analyses were performed. These analyses will be pursued in the future. Site personnel feel they should be developing the use of stochastic simulators in unsaturated groundwater flow and transport modeling to allow the propagation of modeling uncertainties.

5. The preliminary assessment is expected to be reasonably conservative. Better near-field modeling may show contaminants will be held up more than modeling currently projects because of the presence of clay interbeds beneath the facility. In contrast to this outlook, the presence of perched water under the site may result in more rapid transport of contaminants through the unsaturated zone.

The baseline assessment did not account for the final engineered cover system, modeling only the interim cover.

6.

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	DOSTOMAN	Y	
Water infiltration to the disposal unit	DOSTOMAN	Y	
Penetration of water into the disposal units and around/through the waste	DOSTOMAN	Y	
Degradation of the disposal unit	N/A	-	
Radionuclide releases from the disposal unit	DOSTOMAN	Y	
Surface water transport	N/A	-	
Transport through the unsaturated zone	FLASH FLAME	Y	
Transport through the saturated zone	MAGNUM CHAINT	Y	
Atmospheric transport	EPA-AIRDOS	Y	
Radionuclide uptake	PATHRAE EPA-AIRDOS	Y	
Health effects	N/A	-	

7. Additional capability in terms of modeling site geochemistry may be adopted through the use of two geochemistry codes, EQ3EQ6 and PHREEQE. These codes could be used to derive release rates and distribution coefficients.

8. Except for the code used in modeling the near-field, codes used for the baseline assessment will most likely be used in future assessments. For near-field site personnel are considering using BLT (Breach, Leach and Transport) for container degradation and leaching, and something like BARRIER for barrier degradation if necessary. BLT adapts FEMWATER and FEMWASTE to trenches, and accounts for degradation of steel drums and boxes.

Depending upon the continued acceptance of EPA-AIRDOS for atmospheric transport, GENII may be adopted for this aspect of the assessment

Given improvement in modeling the near-field aspects, site personnel would be confident in the performance assessment. Outside of the near-field, they feel they have an adequate understanding of the facility to demonstrate compliance with 5820.2A.

9. The GENII code from Hanford is being considered for use in the final assessment. The BLT code was developed at another site as well.
10. INEL personnel currently benchmark codes with personnel from Pacific Northwest Laboratories (i.e. see if two codes agree in their projections). EPA-AIRDOS was verified by site personnel a few years ago.

A validation study has been proposed with respect to the FLASH/FLAME computer codes. Plans call for instrumenting a 1 ft diameter basalt core (5-6 ft tall) with thermocouples and tensiometers in the laboratory and modeling the core with the codes.

A study plot has been set up at the West Test Trench at the RWMC in which the surficial sediments (up to 7-8 ft deep) are equipped with neutron probes and a meteorological station. Currently, three years of temperature cycling, moisture profile and matric potential data exist for the study plot. These data will be used in calibration efforts for FLASH and FLAME.

11. Work on concrete barrier degradation may be important to future site efforts. Guidance was requested on suitable approaches to model validation.

Communications between sites could be improved through modeling workshops and, to a lesser degree, written progress reports. Some contacts are made at annual LLWTSP meetings; the LLWTSP also conducts annual visits to sites to see progress made on projects they are funding. Relatively little technical interchange occurs at these progress meetings, however.

G. SITE CHARACTERISTICS

Technical Participants: Bob Baca, Marilyn Case, Steve Maheras

1. Important parameters data for the site will be those pertaining to groundwater movement and atmospheric transport. Other important parameters include inventory and release rates, and distribution coefficients.
2. There is little confidence in data describing the near-field phenomena; data describing nuclide leaching nuclides are needed. Data for the unsaturated and saturated zone groundwater parameters are considered good. Nevertheless, public pressure may force collection of more groundwater data for both the vadose and saturated zones.

Atmospheric data is generally considered to be adequate. Resuspension data could be improved, as it applies to Hanford site conditions.

3. Data needed include distribution coefficients and resuspension rates. These parameters affect waste release and the groundwater and atmospheric pathways. The effort being expended in these areas, and when these data will be available, is unclear.

4. Many parameters used in the baseline performance assessment are based on literature values, including data for food chain transport and contaminant release rates. No particular efforts are made to adapt these data for application at the INEL. Atmospheric data and data for groundwater modeling are generally site-specific.

The study plot at the West Test Trench will provide more data on soil water balance aspects. Distribution coefficient and leaching data could be collected with lysimeter studies, but these studies will require time and money. Many parameters would not be pursued as they are considered relatively unimportant, e.g. food chain parameters. Distribution coefficient and hydraulic conductivity data will be pursued.

5. Knowledge about experimental design from other sites would be helpful. The actual data would not be of much use because of site-specificities.
6. A national lysimeter study may be useful. Other than that, site personnel need time and money to get the information themselves.
7. Areas in which help would be useful include:
 - insight into experimental design from other sites
 - methods of gathering data
 - modeling aspects site personnel might be overlooking, e.g. geochemical interactions
 - insight into what site processes might be important in terms of contaminant transport, i.e., what other sites are pursuing

There needs to be some coordination of effort at INEL, in the form of channels of communication through which people can learn of experiments and developmental efforts in progress. Different groups at the INEL are pursuing the development of performance assessment capabilities on their own, a coordination of efforts would be more productive.

H. COMPLIANCE STRATEGIES AND COMPLIANCE POINTS

Technical Participants: Marilyn Case, Steve Maheras

1. Current compliance points include:
 - Intruders
 - RWMC boundary well
 - INEL boundary well
 - 80-km population (atmospheric)
2. Apportionment has not been considered for the INEL. There is confusion with respect to how this should be approached, guidance in this area is needed.
3. The baseline assessment considered a simulation period of 10,000 years. Peak doses occurring beyond this period were also identified. The attitude of site personnel is that they will run the simulation for as long as required by the Order; and maybe longer to locate the peaks doses.

4. Guidance on the length of the simulation would be helpful. There is some uncertainty with respect to what should be concluded from peak doses that occur at extremely great times.

I. DOSE CONVERSION FACTORS

Technical Participants: Marilyn Case, Steve Maheras

1. The EPA-AIRDOS code uses EPA RADRISK dose factors at the present time. All other codes used in the baseline assessment use DOE-approved factors, based on ICRP 26/30/48.
2. No.

LOS ALAMOS NATIONAL LABORATORY SITE

Los Alamos National Laboratory personnel were interviewed on December 18 and 19, 1989. Comments on the notes from the interview were received by telephone on January 26, 1990.

A. GENERAL

Technical Participants: Tom Buhl, Mac Ennis

1. The site's implementation plan states that the Area-G Disposal Facility performance assessment for 5820.2A will be complete in October 1991. There is considered to be enough data to show the gross integrity of site, enough to complete the assessment by the fall of 1990, if necessary. However, the 1991 completion date allows site personnel the time to give the assessment the level of attention they feel it deserves.
2. The responses of the participants are separated by slash (/) marks.

<u>Component</u>	<u>Amount of Data Available</u>	<u>Level of Confidence</u>	<u>Relative Degree of Importance</u>
Source Term	2 / 1-2	1 / 1-2	1 / 1-2
Waste Package/Form	2 / 2-3	1 / 2-3	4 / 3-4
Disposal Technology	2 / 1-2	1 / 1-2	1 / 3-4
Computer Codes	N/A	2 / 3-4	N/A
Site Characteristics	2 / 1-2	1 / 1-2	1 / 1-2

The radiological source term data are considered good, the nonradiological source term data are not as readily available. Area-G disposal will not include RCRA mixed waste, but will include disposal of PCB's, asbestos, waste oil, bio-waste and beryllium.

Waste package and form are not considered to be important because of the long half-lives of the dominant nuclides. Exposures to intruders are not expected to be influenced by changes in release rates due to consideration of waste form degradation.

The disposal technology is considered important only insofar as the earthen cover system goes. There really aren't any other features of the technology above and beyond features of shallow-land burial. Engineered barriers are not important as the site provides adequate protection in and of itself.

The relative lack of confidence in computer codes by one respondent is indicative of a lack of confidence in how well codes accurately model disposal facilities in general. It is not in reference to the specific codes the site has identified for use in the assessment.

3. Data quality is not a major concern at the site. Data are collected as per site Quality Assurance documents (e.g. LA-UR-1076; Feb., 1987). These documents are updated regularly to reflect improved protocol, and account for newly issued DOE regulations. The report is tailored after the EPA CERCLA format for quality assurance.

Concern was expressed with regards to the waste projections used in modeling. As site personnel can't possibly foresee what facilities, or type of facilities, will come on line over the future of the site the estimates may bear little resemblance to reality.

4. Dealing with climatic and land use changes in performance assessments is viewed as being problematic. It isn't clear if these issues have to be considered. If they do require attention, site personnel do not know how to approach this aspect of the assessment. Modeling of lateral erosion, or cliff retreat, and subsequent surface water transport of contaminants also poses problems for the assessment.

It is unclear to site personnel what level of detail is expected in the 5820.2A performance assessments. They are not sure DOE knows either, such that iterations of the assessments will be necessary. These iterations will provide the opportunity for DOE to shape their expectations and for the sites to adapt to them.

5. With the exception of the erosion/surface water and cliff retreat questions, these problems are not considered unique to LANL. Many are probably shared among the sites.
6. Site personnel are not sure how to rectify the problems pertaining to climatic/land use changes with time and the level of detail expected in the performance assessment. Cliff retreat is being examined through dating of stains on sides of mesas.
7. The Performance Assessment Center could be useful in establishing better communications between sites. Workshops may provide the best opportunities for the exchange of information between the sites. They could provide general information, deal with specific problems, and provide insight into suitable approaches for these problems. Workshop topics could include such things as Monte Carlo and Latin Hypercube sampling techniques and approaches to sensitivity and uncertainty analyses, including the statistical techniques.

Annual performance assessment progress reports for the DOE sites were considered less useful. However, a listing of people and their areas of modeling expertise for each site could be useful.

The Performance Assessment Center was also seen as being helpful in terms of supplying guidance documents.

8. It was believed that the site should develop their own assessment capabilities. Little or no help from the Performance Assessment Center in this area is needed or desired. The Center may be able to play a role in the assessment by providing informal reviews of the assessment to the sites. This would allow the sites to see if they were on the right track

with their analysis before subjecting their work to formal review by the Peer Review Panel.

9. Issuance of a guidance document by the Peer Review Panel was viewed as helpful by some site personnel. This guidance should include insight into how the completed assessments will be judged for adequacy, what groundwater scenarios should be addressed for the site and the length of the simulation period.

Other respondents felt there was enough general guidance out there for the sites to get started. It was considered useful, however, to allow the sites the opportunity to receive a preliminary review once they have begun their assessment.

B. AS-GENERATED WASTE SOURCE TERM

Technical Participants: Tom Buhl, Mac Ennis

1. Weston put together a document for LANL which summarizes all known information for each trench and waste shaft at the disposal site ('Site Database, Task 46, TA-54', Sept. 1989). The report provides a history of the trench/vault, the nuclide inventories, and the time of closure. Similar information on future waste will be maintained.
2. Confidence for post-1971 data is greater than before this period. This marks a time when new record-keeping procedures were put into effect. Overall, the quality of the source term data is good.
3. No additional data on the waste source term are required.
4. Not applicable.
5. Not applicable.
6. Waste volumes may change in the future as the site pursues waste minimization. Possible changes impacting the Area-G Disposal Facility include implementation of a below-regulatory-concern rule for suspect waste and the startup of two incinerators. The incinerators, expected to be on-line within about 2 years, will be used to get rid of combustible waste streams.

Both of these efforts will reduce the volume of waste requiring disposal, thereby increasing activity concentrations. These increases are not expected to be significant, however, given the low initial activity of the majority of this waste.

The source term will also be impacted due to the large amount of decontamination and decommissioning work expected in the next four years. The waste generated by these activities is expected to be primarily mixed waste. This waste would be disposed of in a RCRA-approved, mixed waste facility currently being sited by Kaiser and Dames & Moore personnel.

7. Source term characterization is conducted on a per-package basis and relies primarily on process knowledge. No sampling of waste is performed by the Health, Safety and

Environment Division or disposal staff. There has been consideration given to acquiring the necessary instrumentation to perform spot checks on waste concentrations, nothing definite has been planned.

8. Five waste streams comprise the majority of LANL LLW: compactible trash, non-compactible waste, sludges from liquid waste treatment, decontamination and decommissioning waste, and contaminated equipment. Liquid scintillation vials are also generated. The compactible trash comprises 3 to 5 percent of the total waste and includes things such as paper, plastic gloves, and small amounts of glass. Non-compactible trash is miscellaneous materials, including pieces of metal and pipe, small pieces of equipment, and wire. Decontamination and decommissioning waste is primarily dirt, rubble, and structural steel. Contaminated equipment includes all items too large to be boxed, e.g. process equipment, large pipes, office and lab furniture, and glove boxes.

9. Chemical characteristics are not well known, nor are these properties considered important for most waste. This outlook is consistent with the outlook of site personnel on release rates (discussed below).

The site is proceeding with the replacement of organic solvents with aqueous substitutes to minimize mixed waste.

10. Site personnel consider the waste to be characterized sufficiently well to allow modeling of it.
11. Information on the chemical form of the waste is being investigated further. The information generated is expected to be important for any work they choose to do on nuclide release rates, and transport. Issues that may be addressed by this work include the vapor-phase transport of H-3 and the affect of organics on nuclide transport rates.

Other work being conducted with respect to the chemistry of the waste includes a study of alternatives to current radionuclide characterization procedures and a study of chemical analysis needs for mixed waste disposal. Data from these studies are expected by about the end of 1989.

12. No.

C. AS DISPOSED WASTE PACKAGE/FORM

Technical Participants: Tom Buhl, Mac Ennis

1. Compactible trash is compacted, wrapped in plastic and baled for disposal. Non-compactible trash is placed in cardboard boxes (2 ft³), dumped in the trench and compacted with the bulldozer. Site personnel are looking into sizing this waste and are discussing the suitability of using cardboard boxes with DOE.

Sludge, from the Liquid Waste Treatment Plant, is placed in 55-gal drums and dumped in the trenches; it is not dried or solidified. This practice is also being examined, discussed in the site's implementation plan. Neither decontamination and decommissioning waste nor contaminated equipment is treated prior to disposal.

Tritium waste with concentrations less than 20 mCi/m³ is disposed as normal waste. Waste with tritium concentrations above this threshold yet less than 100 Ci/m³ is placed in asphalt-lined and sealed 30- or 55-gal drums. If the tritium concentration is greater than 100 Ci/m³, the waste is placed in 30 gal drums. Asphalt is used to fill voids in super drums, which are then placed inside a 55-gal overpack. The space between the two drums is filled with asphalt.

TRU waste may be sized for disposal.

2. Waste form characterization is essentially complete. However, these waste forms may change in the future. The use of incineration at the site will produce ash, a waste form not currently disposed of at LANL. This ash may or may not be mixed waste.
3. No solidification agents are currently used.
4. The rates of contaminant release from the waste have not been quantified. It was assumed that the entire inventory is available for transport in groundwater screening calculations conducted at the site.

Site personnel recognize the need to quantify release rates and plan on doing it. They will probably use an equilibrium approach to estimate the rates. If release rates of nuclides become important in the groundwater modeling, more effort will be required in this area. Until rates of releases become a problem, however, it is not expected that model development will be aggressively pursued for this aspect of the assessment.

Instrumenting a new trench with neutron moisture probes and a leachate collection system has been discussed as a means of developing insight into contaminant leaching. If this project is pursued, the instrumented trench isn't expected to be ready for at least a year.

5. Generally, no additional guidance is considered necessary. If funds for a national lysimeter study become available site personnel would participate but would want to do the experimental work themselves.

Lysimeter studies are to be installed at the Area-G Disposal Facility to check for seepage in and around the pits. These lysimeters will also provide the opportunity to collect and analyze leachate from the trenches.

D. DISPOSAL TECHNOLOGY

Technical Participants: Tom Buhl, Mac Ennis

1. Standard shallow-land burial is used for disposal of most of the waste. Higher- activity LLW is placed in shafts.
2. The performance assessment will indicate, to a large extent, what changes in disposal technology may be necessary. Given this information, LANL personnel may choose to optimize the design of the disposal facility to remain well within performance objectives. There is a lot of support at the site with respect to being conservative in the assessment.

If the technology is altered, it is likely to involve changes in the cover system design. It is expected that use of cover designs developed at the site will, at the very least, be evaluated for use at the disposal site. How thorough this evaluation is will depend on the results of the performance assessment. If the need for enhanced covers isn't supported by groundwater calculations or intruder modeling, the expense of the cover systems will likely argue against their use.

No expectations exist for incorporation of concrete barriers.

3. Earthen trenches are used for the disposal of the majority of the LLW, engineered barriers are not employed. The trenches are filled with waste and a minimum of 1 m of crushed tuff is placed over the waste. A topsoil layer is applied and seeded.

This cover may or may not serve as the final cover. If intruder doses are too high, a more robust cover system may be necessary. Cover design will have to be considered with respect to bio-intrusion as well.

The waste shafts for higher activity waste are up to 65 ft deep and are generally 6 ft or less in diameter; some shafts are oversized for LAMPF shielding waste. The shafts may be lined with steel or concrete culverts, the majority are unlined.

The most critical feature of both the trench and shaft technology is the extensive unsaturated zone and the relatively slow rates of groundwater flow through it. The cover system may play an important role if nominal groundwater flow and transport velocities are too high.

4. The behavior of the unsaturated zone is considered to be reasonably well understood. Under normal conditions, groundwater and contaminant travel times are expected to be very slow. It is not expected that contaminants will reach the aquifer in less than 10,000 years.

The performance of the earthen cover system over extended periods of time may require consideration in the performance assessment.

5. In the event that the performance assessment supports additional development of the disposal technology, programs are already under way to provide support. Cover system designs have been studied at Area-B for a number of years.
6. The biggest help would be money for work on cover system development.

E. EXPOSURE SCENARIOS AND PATHWAYS

Technical Participants: Tom Buhl, Mac Ennis, Everett Springer

1. Atmospheric and biotic transport pathways, and excavation of the waste by humans are the most significant modes of contaminant movement at the site. Site personnel do not envision that groundwater pathways will result in significant exposures, if any.

Short-term, mechanical resuspension during facility operations could lead to some doses, although they are likely to be negligible. Some modeling of an extended source has been performed using EPA-AIRDOS, where the source term is contaminated soil. Projected doses were small under windy conditions.

Bio-intrusion into the waste is seen as another transport pathway that will have to be examined. While cover systems have been developed at the site which effectively limit bio-intrusion, the need for these covers must be assessed carefully as they are expensive to install.

A number of pathways are being, or will be, examined to determine their significance. Exposure of waste through erosion and subsequent transport via surface water/runoff will be examined. Atmospheric transport of the exposed waste will also be assessed.

Exposure of the waste due to erosion must consider cliff retreat, where the sides of the mesas are eroded away. Rates of cliff retreat have been calculated, more work will be done to further this knowledge and assess the potential importance of the pathway.

Tectonic and volcanic pathways are not expected to be considered in the assessment.

2. Intruder scenarios are considered to be the most important exposure scenarios. Exposure pathways would include eating contaminated foodstuffs, receiving direct radiation and inhalation of dust. The drilling of a well into the aquifer will be considered. This drilling activity is likely to be most important in terms of potential exposures due to direct radiation from unearthed waste.

Doses resulting from the atmospheric transport of contaminants exposed through erosion or cliff retreat will be examined. Exposures resulting from the transport of the exposed waste via surface water/runoff pathways will also be considered, as will exposures due to the transport of waste material to the Rio Grande.

A number of groundwater scenarios, characterized by different levels of saturation in the vadose zone, will be examined to ensure that groundwater pathways do not result in unacceptable exposure. The levels of saturation considered will be those considered feasible in the event of climatic change. Saturated conditions will not be considered in this work.

3. No feasible exposure scenarios will be ruled out from consideration in the assessment. Complete assessments of a given pathway or scenario may not be performed, however, if intermediate calculations show them to be insignificant. For instance, if it is shown that contaminants in the groundwater will not arrive at the aquifer during the simulation period, there would be no reason to consider groundwater pathway exposures.
4. There is some concern with respect to how intruder scenarios should be performed. For instance, what should the intruder be assumed to do at the site. There is an infinite combination of pathways and scenarios that could be considered, help is needed in coming up with viable subsets of these for using the assessment.

Insight into the ground rules to be used in judging the assessments would be helpful. What approaches are considered acceptable?

F. COMPUTER CODES

Technical Participants: Tom Buhl, Mac Ennis, Everett Springer

1. A number of performance assessments have been performed at LANL. Atmospheric exposures have been projected for receptors in surrounding communities, including White Rock and Los Alamos, using data from the Area-G meteorological tower. Doses were negligible, less than 1 mrem/year.

Additional atmospheric modeling will be performed for Area-G, calibration of the model will be attempted using data from Area-G air samplers. These efforts will consider natural and mechanical resuspension.

Preliminary groundwater flow and transport modeling work for Area-G is being completed. These calculations are screening calculations for the 5820.2A assessment, to get an idea of the potential for groundwater problems.

Modeling of the saturated zone has not been performed. Some head measurements for the aquifer are available, but flow directions in the aquifer are still open to question. Site personnel feel that if it can be demonstrated that water does not reach the aquifer in a reasonable amount of time, saturated flow will not need to be considered.

The Nuclear Regulatory Commission's 10 CFR 61 codes have been used to screen the disposal facility. Doses to the intruder and groundwater doses were calculated. While projected doses were negligible, little confidence is placed in these calculations by site personnel.

Summaries of additional past site assessments are discussed in Wenzel et al. (LA-10768-MS) and a paper by Hansen and Rodgers ('Risk Analyses for Shallow Land Burial and Greater Confinement of Alpha-Contaminated Wastes').

2. BIOTRAN has been used for surface pathways in past assessments, EPA-AIRDOS was used in the atmospheric modeling described above. As discussed, the 10 CFR 61 codes were used for intruder and groundwater dose screening work.

Unsaturated groundwater flow and transport calculations were calculated using analytical solutions. The SPUR code was modified for use in modeling runoff and surface water transport, while the universal soil loss equation approach was used in erosion calculations. In the event that modeling of saturated flow and transport is necessary, AQUAFEM, a M.I.T., 3-dimensional finite element code, would probably be used.

3. Past assessments appear to address all reasonable groundwater pathways.
4. Sensitivity analyses have not been performed for the most recent groundwater modeling work. The use of sensitivity studies is seen as being limited under changing conditions, e.g. climatic changes.

Uncertainty analyses for the recent groundwater modeling are addressed by the stochastic approach taken in the assessment. Monte Carlo sampling of conductivities was done,

yielding a distribution of flow predictions, e.g. depth of penetration of contaminants into the vadose zone.

No uncertainty or sensitivity analyses have been done for the other pathways modeling. The need for these analyses is apparent to site personnel. The stochastic approach taken in groundwater modeling is expected to be maintained in the rest of the performance assessment. Sensitivity studies will be used to narrow the list of parameters considered in this approach.

5. Groundwater modeling work is considered reasonable to date. Horizontal bores, which indicate that no contaminants have arrived at selected locations below the trenches, support this conclusion on a limited basis.

The groundwater work is quite conservative in approach. Flow is modeled as being one-dimensional, with no account being made for fractures in the tuff. These fractures are considered relatively unimportant at the levels of saturation encountered in the vadose zone. The calculations assume no engineered barriers exist, e.g. cover systems, and assume that all waste nuclides are available for transport, i.e., there is no consideration of leach rates.

The EPA-AIRDOS calculations described above are consistent with site expectations. Doses projected for the LAMPF using this code are about 30 to 50 percent higher than those calculated using monitoring data for short-lived activation products.

Site personnel believe that current results are reasonably conservative.

- 6.

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	N/A		
Water infiltration to the disposal unit	SPUR	Y	
Penetration of water into the disposal units and around/through the waste	SPUR	Y	
Degradation of the disposal unit	N/A		
Radionuclide releases from the disposal unit	N/A		
Surface water transport	SPUR	Y	

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Transport through the unsaturated zone	Analytical Soln's	Y	
Transport through the saturated zone	Not Considered		
Atmospheric transport	EPA-AIRDOS	Y	
	GENII	Y	
Radionuclide uptake	BIOTRAN	Y	
	GENII	Y	
	PRESTO	Y	
Health effects	ICRP 26/30/48	Y	

Radionuclide releases from the waste have not been modeled, yet work on this aspect is planned. While the rates of release are not considered to be important for groundwater exposure calculations, the need for quantification of these rates is recognized. Preliminary groundwater modeling work has considered all of the source to be immediately available for transport to this point. The direction to be taken in defining release rates is not known, hence no codes have been adopted.

Degradation of the disposal technology involves only the cover system as no other engineered features are employed. No codes are known which address deterioration in cover performance over time.

The BIOTRAN code is perceived as being more research grade and too complex for the 5820.2A assessments. This complexity is not seen as benefiting the assessment. It is viewed as making sensitivity analyses more difficult, given the large number of parameters needed for code operation. Also the code uses a number of 'hardwired' parameter values, making sensitivity analyses more difficult than necessary.

7. Codes for the final assessment will be selected within the next three months or so, although site personnel will keep an eye out for better ones. A number of codes may be used for portions of the assessment and the level of consistency between codes examined. This approach is seen as a way of checking the applicability of the codes to the site. If two codes show significant differences, the basis of this disparity can be determined and the approaches taken by the codes assessed to decide which approach is more appropriate for use at the LANL.

There is concern about the level of consistency between codes used for 5820.2A assessments and codes mandated for other uses. For example, RESRAD is mandated for use in site

cleanup activities. It is important that this code be consistent with LLW assessment codes; checks on consistency may need to be considered in the code selection process.

8. The current approach to groundwater is seen as appropriate for the final assessment. The current effort is considered to adequately address the groundwater pathway without overdoing it.

These groundwater screening calculations can be finalized given the total source mass and decisions on which groundwater scenarios should be considered. These scenarios concern, primarily, the level of saturation of the vadose zone. Site personnel are currently using a saturation level of 6 percent moisture content by volume, 20 percent moisture content (half-saturated) will probably be examined. Higher water contents than these are unlikely to occur and will probably not be considered.

It is expected that the site will use GENII for surface water, intruders, worker doses and short-term atmospheric doses. As 40 CFR 61 requires that EPA-AIRDOS be used to show compliance with that regulation, (unless other codes are specifically approved) this code will probably be used for offsite atmospheric transport modeling.

There is a possibility that BIOTRAN will be used to model surface pathways for more distant deadlines, e.g. October 1991. Site personnel don't think they have time to use it if the assessment has to be ready prior to that time.

9. Yes, EPA-AIRDOS, GENII and PRESTO codes are all from other sites. EPA-AIRDOS and PRESTO are both EPA codes, GENII was developed by Battelle.
10. Validation of the groundwater modeling hasn't been considered yet, although some validation has been done with codes similar to the ones currently being used. The potential for doing some validation exists using information from TA-21, a plutonium disposal site. Data for this area are difficult to use because the actual source term is largely unknown and the site was saturated for awhile. There are added complexities geochemical characteristics of the site.

Some validation has been performed using caisson studies, representing disturbed tuff/pits. The applicability of this effort to undisturbed conditions is unclear.

Model validation provides assurance about model performance under the conditions tested, conditions that may exist in the future are not supported. If consideration of climatic changes becomes necessary, this fact needs to be recognized. As the conditions which will exist in the future due to changes in climate are unknown, code validation for these conditions will not be possible.

Results from SPUR simulations appear to fit surface runoff data for areas surrounding Area-G quite well. Similar data are needed for Area-G to extend this comparison to the disposal facility.

Some validation of EPA-AIRDOS has been done using release data from LAMPF. Site personnel suspect they could do some validation work with GENII using Area-B data. Data from Area-B has been used for some validation work with BIOTRAN. This site is an old disposal site and contains Pu, U and activation products. It has been closed since 1948.

Data from the site include concentrations for leaf litter, pulp, bark and needles. BIOTRAN validation work has also been performed for the Pantex facility.

Site personnel are interested in what other sites have done with respect to validation of GENII and PRESTO.

11. Guidelines on what is expected in terms of model validation would be helpful. What is it that the Peer Review committee and DOE are looking for?

G. SITE CHARACTERISTICS

Technical Participants: Tom Buhl, Mac Ennis, Everett Springer

1. Important groundwater data include:

- water content vs. pressure head curve, including spatial aspects
- water content vs. relative hydraulic conductivity, including spatial aspects
- saturated conductivity in space
- retardation coefficients for pertinent nuclides
- source term
- geochemistry as it relates to transport in unsaturated zone
- chemistry of source term, e.g. organics, and how it affects releases

Important surface water data include:

- rainfall distribution information for modeling runoff
- retardation factors
- geochemical aspects

Site personnel believed that dust loading data used in calculating exposures to workers during site operations are generally too small. Data from an Environmental Restoration Program study suggests a value of about 30 mg/l on the back of a tractor. This change isn't expected to result in significant exposures.

Lateral erosion rates and resuspension data may be important parameters, screening calculations using the NRC 10 CFR 61 codes appear to implicate airborne pathways for the intruder scenarios as being important.

2. Data exist for soil characteristic curves, and site personnel have moderate confidence in them, but additional data would always be helpful. Some information exists for retardation factors from Yucca Mountain, their applicability to Area-G is unknown. Quality of saturated conductivity data is very good.

A compilation of site data was performed prior to the groundwater modeling effort. Characteristic curves are based on core samples. Hydraulic conductivities have shown a wide divergence with the source and method of collection of information. Depending upon the source of data, saturated conductivities have been found to range from 1 to over 800 m/year.

3. A method which would allow the measurement of saturated conductivities in-situ and without having to soak down the soils is desired.

Retardation data needs could probably be met with a literature search. The complexity of nuclide speciation of TRUs makes lab work in this area of questionable value. Even if the behavior of the different states of a nuclide is known, the species present at the facility will be largely unknown. To complicate the issues further, these species may change over time, making current knowledge of nuclide speciation of the waste of limited use.

Little is known about the zone beneath the tuff. This area is primarily a sand/cobble conglomerate. While it is thought that vertical one-dimensional flow modeling is adequate for this zone, information on the amount of cobble present would be of use. There is a possibility that the cobble will act as an impermeable flow barrier.

There is currently no scheduled effort to collect these data. Discussions are held which acknowledge the needs but no action has yet been taken.

Site personnel are collecting data from rainfall simulator plots to determine erosion rates other parameters needed for cover system design. They are also using the universal soil loss equation approach to estimate runoff and, hence, erosion rates.

Data from surface water pathways work may be used to define water percolation rates at a given soil depth. This percolation rate could then be input into unsaturated zone modeling efforts as a water source term.

4. All groundwater modeling is based on Area-G-specific data or LANL-specific data. The former comprise 35-40 percent of total, LANL-specific data comprise the rest.
5. Geologic data from other sites which indicate different and unusual things would be helpful in terms of stimulating thought of all important aspects of groundwater flow and transport at LANL. An example would be information from INEL about the interactions of Pu and organics.
6. Funds are needed, the site has the people it needs.
7. Information about anything other sites are doing in terms of measuring saturated conductivities in unsaturated media would be helpful. Work using cores is not considered useful as the measurements will not be representative of in-situ conditions.

A national lysimeter study would be useful if alternative waste forms become an issue at the site. If current waste forms are used, the study wouldn't offer much. The site has lysimeters and could support the study.

H. COMPLIANCE STRATEGIES AND COMPLIANCE POINTS

Technical Participants: Tom Buhl, Mac Ennis

1. Compliance points include the 100 m member of the general public (confused by the fact that this point is over the edge of the mesa), the onsite intruder, surrounding communities of White

Rock and Los Alamos, Bandelier National Monument, East Gate, supply wells at 100 m or more, and the Rio Grande.

2. No other facilities are likely to be operating or releasing contaminants after closure of Area-G. If some facilities are stabilized in place, this may not be true. The location of the various facilities makes it unlikely that their exposures would add to one another. Does apportionment under these conditions matter?
3. The assessment will be run for whatever length of time required by DOE-Headquarters. Personnel involved with groundwater modeling prefer 1,000 years. The uncertainty of modeling results for even this period of time is great. Climatic data used in modeling at the site dates back to about 1910. These data don't even support a few hundred year simulation period.

While the stochastic approach taken in groundwater modeling helps with this relative lack of data, confidence in simulations extending hundreds or thousands of years is not great. Site personnel are looking at wetter conditions or scenarios to help bound doses from groundwater transport in the event they are required to model the site for more than 1,000 years.

4. Guidance on the length of simulation would be helpful.

I. DOSE CONVERSION FACTORS

Technical Participants: Tom Buh; Mac Ennis

1. DOE EH reports.
2. Send more copies of the reports.

NEVADA TEST SITE

The interview of Nevada Test Site personnel was conducted on December 20 and 21, 1989. Comments on the notes from the interview were received by telephone on February 5, 1990.

A. GENERAL

Technical Participants: Art Vollmer, Max Dolenc

1. The NTS had a draft performance assessment for the Area-5 Disposal Facility conducted by EG&G Idaho about a year ago. Site personnel have reviewed it and will resolve comments with the participants. It is expected to be finalized by June 1990.

The performance assessment for Area-3 has not been started, no completion date has been scheduled.

Currently, site personnel are interested in starting the 40 CFR 191 assessment and ensuring that this assessment is consistent with the 5820.2A assessment.

2.

<u>Component</u>	<u>Amount of Data Available</u>	<u>Level of Confidence</u>	<u>Relative Degree of Importance</u>
Source Term	1	1	1
Waste Package/Form	1	1	1
Disposal Technology	1	1	1
Computer Codes	N/A	3	N/A
Site Characteristics	2	2	2

Most of the waste disposed at the site has come in the last 10 years, and accounts for about 99 percent of the activity. As a result, the data for the majority of the source term is quite good, confidence in these data is high. Waste shipment forms sent with waste, the source of information about the waste, are SWIMS-type forms. While the form has categories such as MFP, these general categories are considered to be quite well characterized.

Existing site data are considered to be suitable for the 5820.2A assessment. Site data are still being collected, primarily for the 40 CFR 191 assessment. These data may aid in the performance assessment for 5820.2A as well.

Computer codes used in the assessment are considered conservative and simplistic. The degree to which they are representative of the site was questioned.

3. The quality of site data collected in the past has not always been very good; data for some parameters are lacking or of poor quality. Site personnel are in the process of updating much of this information. Nevertheless, poorer quality data are sometimes used for lack of anything else.

The poor quality of some of the site data isn't considered to be especially important in light of how well the site performs. Even with these deficiencies, the site can still demonstrate compliance with the Order.

Present-day quality standards are much higher. An EPA-approved quality assurance plan is being implemented. EPA approval of this program is important as application for a RCRA Part B permit for mixed waste disposal is being pursued at this time.

Data quality standards, in addition to what is being instituted at the site, aren't considered necessary.

4. Site personnel are not sure what needs to be considered with respect to the systems assessment. A number of small, miscellaneous disposal sites with small associated activities exist at the site, e.g. tunnel ponds. It is not clear if these sites can be dealt with in a cursory manner or if a formal assessment of each is necessary.
5. This problem is not considered unique to the NTS. Each site is expected to have its own set of miscellaneous waste sites.
6. The concern with respect to the systems assessment could probably be remedied if the ground rules for conducting it were defined.
7. Yes.
8. Yes, EG&G Idaho conducted the draft assessment for the NTS.
9. It would be beneficial to the site to know the criteria which will be used in judging the adequacy of the sites' assessments.

Three functions are seen for the Peer Review Panel:

- review the assumptions used in site assessments
- review the doses calculated for the site assessments
- inform sites when they have problems with meeting requirements.

The Panel has a responsibility to inform sites that groundwater doses greater than 4 mrem/year are troublesome, they should not perpetuate the general guidelines set forth in the 5820.2A performance objectives.

The outline for the performance assessment report put out by the Peer Review Panel was considered helpful.

B. AS-GENERATED WASTE SOURCE TERM

Technical Participants: Art Vollmer, Max Dolenc

1. Waste volumes and nuclide activities are collected from the generators. Data on the source term are collected using SWIMS-type forms. These forms lump some waste forms together, resulting in a loss of data resolution. This lumping is considered to be unnecessary, it would be better to collect all the data.

Activities for primary and secondary nuclides are specified using SWIMS waste categories. Information on nuclide distributions in waste may be missing for some early site waste.

The draft assessment uses 10-year average waste volume and nuclide concentration data.

2. Confidence in source term data is high. Records are reasonably complete for the past 10 years, the period over which the majority of the waste was disposed.
3. No additional data are to be collected for the 5820.2A effort. However, some changes affecting the waste source term data are to be instituted.

Source term data are known on a per package basis but have been entered in the database on a per-shipment basis in the past. Data will begin to be entered on a per-package basis. This will allow them to answer queries people may have, especially important in the case of special waste situations, e.g. waste requiring greater- confinement disposal. It is not expected that per-package data will be entered retroactively.

Source term data will improve as the site prepares for the acceptance of RCRA mixed waste. Changes in acceptance criteria made in this process will be carried over to LLW operations. Generators will be required to provide waste characterizations. The site will inspect the characterization and audit the generator before acceptance of the waste. This audit will verify the generator's method of characterization, whether it is by process knowledge or direct analysis, and will ensure that the information is adequate.

Annual updates of the audits may or may not be performed. The site will, on a semi-annual basis, demand that the generator reassert that the waste streams from a given facility haven't changed and demand the basis for the assertion.

Chemical analyses designed to check generators' characterizations are not routinely performed as site personnel would rather not breach containers unless it is absolutely necessary. A real time radiography unit will be acquired and used to check on the physical nature of the waste arriving at the site. Approximately 10 percent of the waste, at a minimum, will be checked using this unit. If this procedure, or others, turns up suspect waste, containers may be breached for further checks.

4. Not applicable.
5. Not applicable.
6. Problem waste is currently being identified across the DOE system, including greater-than-class-C and non-certifiable TRU waste. If the NTS is asked to dispose of some of this waste,

providing greater-confinement disposal was adequate, it is expected that the waste would be accepted, thereby influencing nuclide inventories.

NTS does not generate much in the way of process wastes, the majority of the waste disposed at the site includes process waste streams from Mound, Fernald, Rocky Flats and others. Things that might show up in significant amounts include depleted uranium and thorium waste (from Fernald). Changes in waste from these operations cannot be anticipated, whether or not the changes will be significant can only be speculated about. Significant changes are not expected.

The site is interested in being able to take special situation waste. Waste class disposal limits (classes 1,2,3) would be developed and used in deciding if a given type of waste could be accepted for disposal. If it could be safely disposed at the site, they would accept it. If these capabilities are developed and employed, waste inventories at the site would be affected.

7. Waste concentrations are known on a per-package basis, as per SWIMS-type forms supplied by the generators of the waste. The basis of this information was not known by the interviewees.
8. Waste disposed in Area-3 is primarily NTS waste, contaminated debris and soil from old atmospheric test shots. Area-5 waste is the more typical LLW. Of this, the vast majority is from offsite generators. There are currently 18 approved offsite generators whose waste is disposed at site. Given the fact that the Area-5 waste is generated offsite, physical characteristics are not known any better than the data provided on the shipment form.

In addition to volume and weight, physical information provided is limited to the type of waste, including biological waste, contaminated equipment, decontamination debris, dry solids, solidified sludge and not classified.

9. Chemical characteristics of the waste shipped to NTS for disposal are not known beyond what is listed on the shipment form.
10. Confidence in the information on waste form is good. If site personnel are not confident of what the waste is, they will not accept it.
11. No additional data are considered to be required.
12. Site personnel are of the opinion that they have effective waste acceptance criteria and know what they have at the site. Consequently, additional support is not considered necessary. They are, however, always interested in hearing of other sites' approaches in this area.

Site personnel feel they know what the other sites are doing in the region. In addition to contacts made on an individual basis, the Ad Hoc Committee meetings provide a good forum for informational exchange. In general, adequate channels exist to access the necessary information.

There was some question as to how to accommodate classified waste in the waste source term. Little or nothing is known about this waste and, while it is considered to be a small amount of the total waste disposed, interest was expressed in knowing how other sites deal with classified waste.

After further discussion, it was considered likely that site personnel would know what the classified waste had in it. This information may have to be disguised to hide process details, and may be omitted if the quantity of waste involved was very small.

C. AS DISPOSED WASTE PACKAGE/FORM

Technical Participants: Art Vollmer, Max Dolenc

1. No waste treatment or processing is done at the NTS. Generators are asked to use NTS-preferred waste packages (2 by 4 by 7 ft wood or metal boxes, 55-gal drums); the generators generally comply as these packages are most convenient for them as well. The site will accept non-standard packaging, providing it meets all requirements and site personnel are consulted first.

No criteria exist with respect to compacting. The pricing schedule, however, favors minimizing waste volume. Otherwise, the waste form must meet Department of Transportation requirements, contain no free liquids or chelating agents, and comply with weight limits.

2. Waste form and packaging characterization is considered complete; the source of data is the disposal and storage shipment form. Package information includes container type, whether the container is shielded or not, container volume and weight, and surface radiation level.
3. No solidification agents are currently used at NTS.
4. Site personnel would prefer not to take credit for the waste package or waste form in the assessment. With the exception of the disposal of short-lived nuclides like H-3 in long-lived containers, e.g. high-integrity containers, the reliance on container lifetimes to ensure safety is considered troublesome.

In modeling disposal at the NTS, personnel would prefer to assume that all waste is immediately available for transport, that no solubility limits exist and that contaminants move with the water, i.e., no contaminant retardation. The draft assessment, however, did not make these assumptions.

Inspection of the draft assessment report reveals that leach rates used in the analysis are based on empirical data for Pu-239 and Pu-240 from waste retrieval work at the INEL. Current plans do not call for additional data to be collected for use in the performance assessment.

5. Additional guidance is not required.

D. DISPOSAL TECHNOLOGY

Technical Participants: Art Vollmer, Max Dolenc

1. Waste is disposed at Area-3 and Area-5 using shallow-land burial. High specific-activity waste is disposed using greater-confinement disposal methods.

2. The existing disposal technologies will be used 'as is' in the future. Final cover configurations have not been decided upon.
3. Trenches at the Area-5 Disposal Facility are excavated to a depth of approximately 25 ft, waste is placed to within 4 ft of the ground surface. An 8 ft interim cover of clean soil is placed over the waste. A final cover will be applied at the time of closure. The configuration of the final cover has not been decided upon, although it is expected to be the same as that used over RCRA mixed waste sites. The total thickness of the interim plus final cover system is expected to be on the order of 12 ft.

A diagram of the proposed RCRA-approved cover for Area-5 was supplied by site personnel.

Bulk waste is buried at Area-3, in craters formed during test shots. The soil between adjacent craters is removed and waste is disposed in the single crater so formed. Waste is disposed in 8 ft lifts, separated by 3 ft lifts of clean soil. The waste may be loose or in sea-vans, which are left in place in the crater. Loose waste is covered as soon as it is placed, containers may be left uncovered for a time.

A diagram of the proposed final cover configuration for Area-3 was supplied by site personnel.

The waste disposed in Area-3 is mostly from atmospheric test cleanup. The waste is generated intermittently, atmospheric sites are cleaned up only when no other work exists for the people involved. Nuclides are mostly Cs and Sr, with some Pu.

Greater-confinement disposal shafts are 10 ft in diameter and 120 ft deep; the walls of the shafts are soil. The shafts are filled with waste to within 70 ft of the ground surface, and overburden is added to bring the level of material to the ground surface. The shafts will be capped with a final cover at closure.

Greater-confinement disposal is used for high specific-activity waste. Tritium waste is also disposed in the shafts if the package activity is greater than 1000 Ci. The predominant package used in disposal is the 55 gal drum. The drums are lowered into the shaft and released.

The most critical features of these technologies are the basic geology and the climate of the site. The aquifer at the site is on the order of 800 ft deep at the Area-5 site. Annual precipitation at the site is very low, evapotranspiration rates are very high. The total depth of cover material over the waste will provide intruder protection.

4. The conservative approach taken in modeling site performance is expected to compensate for any aspects of the disposal technology site personnel may not understand. As the critical features of the disposal system are the site characteristics, it is the site that must be understood. Site personnel have run a number of unsaturated groundwater models to estimate travel times. These calculations suggest travel times are on the order of 10,000 to 100,000 years. This modeling was done assuming high hydraulic conductivities and a constant head.
5. The critical features are known adequately, no additional efforts are underway.
6. No.

E. EXPOSURE SCENARIOS AND PATHWAYS

Technical Participants: Art Vollmer, Max Dolenc

1. The most significant transport pathways at the site are those resulting in intruder exposures, including atmospheric and biotic pathways, and the excavation of waste. Flooding could also play an important role at the site by exposing the waste for subsequent airborne transport.

A dike engineering analysis is being conducted to ensure that the dikes that have been constructed around the disposal areas are adequate. These dikes are expected to effectively rule out flooding.

Some concern exists at the site with respect to the gaseous migration of Rn and H-3, if either contaminant should ever exist in sufficient quantities. While exposures are expected to be negligible, this transport pathway could affect the site intruder.

Groundwater pathways have been dismissed based on calculations of groundwater travel times using a number of simple groundwater codes and hand calculations. Water from 500 year infiltration events has been found to percolate to a depth of only 17 ft.

2. The draft performance assessment considered acute and chronic exposures to the intruder and airborne transport of waste offsite. Additional pathways are generally not considered necessary for the final assessment.

An oil or gas drilling scenario was suggested as being feasible as the site is situated on a thrust belt. A mining scenario may also be appropriate. Exposures to intruders due the gaseous transport of Rn or H-3 may require examination.

3. The draft assessment dismisses groundwater, and does not consider flooding. For the final assessment, these latter pathways may still be ruled out, but in a more technically defensible manner. That is, calculations will be conducted which provide a technical basis for omitting the pathways.
4. No.

F. COMPUTER CODES

Technical Participants: Art Vollmer, Max Dolenc

1. A draft assessment has been performed for Order 5820.2A. The assessment projected exposures to onsite intruders and offsite residents.
2. The EPA-AIRDOS code was used for atmospheric pathways modeling. DOSTOMAN was used for all other aspects of the assessment.
3. The draft assessment considered intruder and offsite atmospheric exposures, most likely the only important transport and exposure pathways. It did not consider flooding of the site, groundwater transport or gaseous transport of waste contaminants. The risk posed by these pathways, however, is not expected to be significant.

4. Neither uncertainty nor sensitivity analyses were performed for the draft assessment. The need for these analyses is recognized by site personnel. Due to the large number of assumptions used in the assessment, the uncertainties and importance of certain parameters must be addressed.
5. Site personnel do not feel the complexity of the modeling approach used in the draft assessment is warranted given the available data. Simpler representations of many of the transport pathways, e.g. the biotic and food chain pathways, would be preferable.

Site personnel are not comfortable with the rate constant approach taken in the DOSTOMAN code, preferring instead the use of more direct analytical solutions. These solutions can be seen and manipulated directly, tending to simplify the conduct of sensitivity and uncertainty analyses.

The EPA-AIRDOS code is acceptable as long as it receives approval from the Environmental Protection Agency.

The draft assessment is expected to bound exposures to humans.

6.

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	DOSTOMAN	Y	
Water infiltration to the disposal unit	DOSTOMAN	Y	
Penetration of water into the disposal units and around/through the waste	DOSTOMAN	Y	
Degradation of the disposal unit	N/A	-	
Radionuclide releases from the disposal unit	N/A	-	
Surface water transport	DOSTOMAN	Y	
Transport through the unsaturated zone	DOSTOMAN	Y	
Transport through the saturated zone	DOSTOMAN	Y	

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Atmospheric transport	EPA-AIRDOS	Y	
Radionuclide uptake	DOSTOMAN	Y	
Health effects			

Codes listed above are what were used for the draft assessment, DOSTOMAN may not be used for final assessment. Decisions on the code(s) to be used in the final assessment have not been made.

Radionuclide leaching mechanisms aren't planned to be included in the assessment. Rather, the nuclides will assumed to be available for transport. Containers, short of long-lived ones that may be used for H-3, would probably not be considered in terms of the benefit they provide.

7. It hasn't been decided yet if the codes are going to be changed for the final assessment. Final decisions will be reached when the comments on the draft are resolved with EG&G Idaho.
8. The EPA-AIRDOS code would be used for atmospheric exposures, other codes remain to be identified. The assessment would be performed in such a way as to be considered conservative, i.e. to bound exposures to humans.
9. Yes, codes developed by the Environmental Protection Agency and personnel at the Savannah River Site were used in the draft assessment.
10. Codes used in the final assessment will need to be verified. Validation is considered possible on a limited basis. The site will have to model and validate for the RCRA-approved mixed waste site. The data required for this effort would probably aid 5820.2A validation exercises.
11. As the site is hiring modelers to do their assessment, guidance in this area for NTS personnel is considered unnecessary. Mention was made of the fact that a modeling workshop put on by the Performance Assessment Center for the states was a good source of information. Something similar should be done for the DOE sites.

G. SITE CHARACTERISTICS

Technical Participants: Art Vollmer, Max Dolenc

1. Parameters used to model airborne transport and intruder exposures are expected to be most important. Groundwater parameters are not important at the site.
2. Site personnel feel there are enough data for the 5820.2A assessment at the site.
3. No data are being pursued for the LLW assessment.

Data collection for the 40 CFR 191 assessment will continue for the next four years or so. This work will include collection of distribution coefficient and hydraulic conductivity data. Data on sub-surface characteristics will be used to help assess the potential for gas movement of Rn and H-3. These data could be used for the 5820.2A assessment where appropriate.

4. Site-specific atmospheric data are available for Area-5. Most of the biological data are literature values. Site hydrologic data from site characterizations exist. No efforts are being made to improve data for the 5820.2A assessment.
5. No.
6. No.
7. Little value was seen for a lysimeter study to determine nuclide release rates. Site personnel felt distribution coefficient and diffusion data are generally more useful as greater potential benefit resides in changes in transport rates than in release rates. Data for each of these parameters would help most of the sites. Given the lack of a groundwater pathway at the site, data on release rates and transport parameters for this route are not required at NTS.

H. COMPLIANCE STRATEGIES AND COMPLIANCE POINTS

Technical Participants: Art Vollmer, Max Dolenc

1. Compliance points have/will include(d) an offsite receptor of airborne emissions, an intruder, and a member of the general public 100 m from the disposal units.
2. No apportionment is being done at the site.
3. The draft assessment was done for 1,000 years. Site personnel feel they have a responsibility to find the peaks, especially if these doses approach the performance objectives, and, otherwise, simulate for a reasonable period of time. If the peak dose nears the limit(s), they need to be concerned, regardless of the timing of the peak.
4. There is quite a lot of concern as to how the system assessment should be approached. They have a number of small areas of contamination, tunnel ponds are an example. Is a formal assessment of each of these sites necessary for the systems analysis, or can they be dealt with on a more cursory basis?

The system should support meaningful points of compliance, points where exposures may be expected to occur, and should give guidance on whether there are others to consider. Should compliance points be influenced by the geographic location of the disposal site?

Guidance in terms of the length of time the simulation is run and how the time of occurrence of peak exposures should be addressed would be helpful.

Should any apportionment of doses be modified over time to account for facilities which close and/or stop emitting nuclides?

I. DOSE CONVERSION FACTORS

Technical Participants: Art Vollmer, Max Dolenc

1. DOE EH reports.
2. No.

OAK RIDGE NATIONAL LABORATORY SITE

The interview at Oak Ridge National Laboratory was conducted on January 9, 1990. This interview included performance assessment activities at the Oak Ridge site, and the Paducah and Portsmouth Gaseous Diffusion Plants. Comments on notes of the interview were transmitted over the telephone on February 5, 1990.

A. GENERAL

Technical Participant: Tim Myrick

1. The schedule currently planned for performance assessment activities is given in "Action Plan for Completing MMES Radiological Performance Assessment". The initial draft of the performance assessment for SWSA-6 is the primary concern and is expected to be completed by September, 1990, with the final assessment completed in 1991.

Scoping studies for Paducah and Portsmouth are to be conducted in 1990. The performance assessments for the West Chestnut Ridge and West Bear Creek Valley Facilities are scheduled for completion in 1992 and 1994, respectively.

Paducah and Portsmouth are currently storing waste, neither site has a disposal facility at this time. Each is in the process of performing design and siting studies, along with scoping assessments to determine the directions personnel should be pursuing.

2.

<u>Component</u>	<u>Amount of Data Available</u>			<u>Level of Confidence</u>			<u>Relative Degree of Importance</u>		
	<u>OR</u>	<u>PORT</u>	<u>PAD</u>	<u>OR</u>	<u>PORT</u>	<u>PAD</u>	<u>OR</u>	<u>PORT</u>	<u>PAD</u>
Source Term	4	3	3	4	3	3	2	2	2
Waste Package/Form	3,2	3	3	3	3	3	3,1	3	3
Disposal Technology	3,2	3	3	3	3	3	3,1	3	3
Computer Codes	N/A	N/A	N/A	2	3	3	N/A	N/A	N/A
Site Characteristics	2,2	4	4	3	3	3	3,2	3	3

Responses are given for the Oak Ridge, Portsmouth and Paducah sites, multiple entries for Oak Ridge correspond to Class 1 and 2 waste, respectively.

Most components are relatively less important for the Paducah and Portsmouth sites, compared to Oak Ridge, due to the low waste volumes and activities involved. Oak Ridge's Class 2 waste data are considered most important as that waste represents the greatest potential threat to receptors.

The risk represented by Class 2 waste is reflected in the greater care that will be expended in disposal of it. It is recognized that the disposal technology and waste form are very important in terms of safely disposing this waste at Oak Ridge. As considerable care will be taken in its disposal, confidence in disposal technology data for this waste is high.

Confidence in computer codes for the Paducah and Portsmouth sites, for which code identification has not been completed, is stated as being a 3 as no problems are anticipated in coming up with suitable codes.

3. Several areas of concern exist with respect to the quality of the data to be used in the performance assessment. Important areas of concern include:
 - a. Source term - the source term database for Oak Ridge, Portsmouth and Paducah is not of good quality. The data, supplied by the generators, are often based on surface scans, no rigorous analytical basis for the waste numbers is generally available. There is a need to get better numbers, especially for long-lived nuclides, e.g. Am and Cm.
 - b. Waste form and package - there are many waste forms at the three sites (5 plants). No database exists for even the major waste forms or types. Personnel are looking more carefully into what is going into the SWSA-6 tumulus demonstration and the Interim Waste Management Facility to help alleviate these needs.
 - c. Site characteristics - a reasonably large database exists for SWSA-6 site characteristics, although quality of the data is suspect. Less data generally exist for Portsmouth and Paducah, especially for the latter site.

Time and money are needed to remedy these concerns, although site personnel don't think these resources will be supplied by DOE. The performance assessment for 5820.2A is perceived by site personnel as being well down the list of DOE priorities.

Data quality standards are not high on the site's list of needs. Even if there were standards, there would be problems meeting them, given current levels of funding and staff.

4. The biggest problems facing the sites revolve around data quality issues.
5. These problems are expected to be present at the other sites as well. Communication with personnel at SRS indicate that similar problems exist there.
6. In addition to time and money, dedication on DOE's part is needed to address many of the problems facing them. Personnel at the site do not feel that DOE is committed to the performance assessment effort. No feedback has been received on the site's implementation plan, leaving site personnel with no idea as to whether they are spending too much or too little on the process. Site personnel don't know what is expected of them in the performance assessment, where they can make assumptions and where they can't. An apportionment plan

has been submitted for the disposal facilities at Oak Ridge, no indication of its adequacy has been received from DOE.

7. While much of the technical information needed is site-specific, and better left to the sites, the Performance Assessment Center could provide support in certain areas. One of these areas is long-term concrete performance.

There is a concern that the Performance Assessment Center and Peer Review Panel are not coordinated in their functions. To the extent that this is the case, the Center is relatively less useful as a source of information.

8. No. Some sites are looking into subcontracting the assessment out. Site personnel considered that approach but decided they had the technical expertise to do it themselves. Pieces of the assessments may be done by subcontractors, e.g. concrete performance, but the bulk of the assessments will be done at the sites. They consider themselves the best qualified to do it correctly.
9. Yes, guidance from the Peer Review Panel would be useful if it had real substance. The Panel should express their expectations for the performance assessment. Questions for which answers are needed include whether the sites should use detailed geohydrological models or use bounding assumptions; how much detail is expected for the various pathways, whether the sites can eliminate some pathways from detailed consideration; whether site-specific data are needed for all aspects of the performance assessments.

Site personnel would also like some reaction on the scheduled completion dates of their performance assessments. Nothing has been heard along the lines of whether their proposed schedule is adequate or not.

There is also a question as to whether a performance assessment for SWSA-6 is necessary. Most of the waste in the demonstration has been disposed in the pre-5820.2A era and will be closed in the relatively near future. This may be able to be addressed by the Peer Review Panel as well.

B. AS-GENERATED WASTE SOURCE TERM

Technical Participant: Tim Myrick

1. Generators at each of the three sites provide information on the source term on waste shipment forms. Forms vary among plants but contain similar information. The generators provide curie content, the type of package and the dose rate associated with the shipment.
2. Very little confidence exists in the radiological source term data. Generally, the process knowledge used in estimating the source term is not considered very good and is in need of significant improvement.
3. New types of data are not required, just better quality data.
4. A new waste certification plan will be instituted to acquire these higher quality data. This plan will force the generators to prove that their waste will qualify for burial as a given class

of waste (1,2,3,4) at the disposal facilities. Some of this proof will probably involve analytical work. Generators will also have to measure source term characteristics, e.g. alpha and beta, prior to packaging.

As part of the implementation of the improved waste acceptance program, disposal operations will perform an initial audit of how the various generators are characterizing their waste, to see if the data generated are adequate. They will have a verification program wherein personnel sample some portion of each generator's waste periodically to make sure no misrepresentation of the waste is occurring.

The improved certification program will be implemented at all three sites.

5. Full implementation of the improved certification program will probably require 5 years. Part of this delay has to do with the fact that disposal facilities at the three sites are still in planning and/or demonstration phases. As site specific disposal limits for the various waste classes have to be calculated, the disposal facility designs must be finalized.
6. Potentially great changes in the source term are expected in the future at all three sites. For the Y-12 plant, and the Paducah and Portsmouth sites roughly 50 percent of the waste generated may be done so on a consistent basis. The rest of the waste will vary with time. Waste from the X-10 plant varies widely, K-25 waste is also inconsistent.

In addition to changes in the wastes generated, waste volumes may be reduced through waste minimization efforts. The use of the Scientific Ecology Group commercial incinerator for treatment will also impact the source term. It has not yet been determined how much waste will be incinerated at this facility.

In addition to the impact on waste volumes, these efforts will also impact waste nuclide concentrations. As waste concentrations change, the waste streams that can be accepted at the sites may change.

7. Waste source term data for the three sites are generally not based on analytical measurements. Rather, data are based on process knowledge, nuclide scaling, and dose rate to curie conversions factors. Some plants, e.g. Y-12, have instrumentation for measurement, including gamma scintillators and waste curie monitors. These are usually used for TRU waste. Characterization techniques at the site are applied on a per-package basis.
8. No formal database of physical characteristics of the waste from the three sites exists. Physical data required on waste shipment forms include the waste's physical state (solid, liquid, gas, sludge, other) and its weight or volume.
9. No database of waste chemical characteristics exists. Information required on shipment forms includes PCB, asbestos, and hazardous substance contents.
10. Few physical or chemical data exist to have confidence in. Confidence in existing data ranges from high to low. Overall, confidence is low.
11. Additional types of data may be generated through implementation of the certification program. It is expected that pH and compressive strength data for the waste, not correctly collected, will be required.

Additional data will be collected as required by the regulations influencing waste disposal, data will not be collected expressly for the 5820.2A performance assessment. Additional data may, however, be collected with respect to nuclides and/or waste characteristics identified as being problematic in screening calculations.

As detailed physical and chemical characteristics of the waste will not be available for the assessment, the most restrictive waste stream characteristics will be assumed to apply to all of the waste.

12. If there is to be a national waste source term database, e.g., the TSD (Treatment, Storage, Disposal) Information System, people at the sites need to know what is to be expected of them, especially at the generator level.

Money would be beneficial in terms of being able to characterize the waste, both at the generator and disposal system level.

C. AS-DISPOSED WASTE PACKAGE/FORM

Technical Participant: Tim Myrick

1. The Class 1 landfill will accept bulk waste (soils, metals), and waste packaged in 55-gal drums and B-25 boxes. No restrictions in terms of grouting of the waste will be enforced. The generators will be required to meet Department of Transportation requirements and get the waste to the site. This type of waste is generated at Oak Ridge at an annual rate of about $1.5E6 \text{ ft}^3$.

The Class 2 tumulus facilities will accept B-25 boxes, with or without drums inside, and special large volume vaults. All waste will be grouted within the boxes. As site personnel are trying to ensure a minimum lifetime of 300 years for the waste form, stability in the disposed waste must be ensured. Class 2 waste comprises about $30,000 \text{ ft}^3/\text{year}$.

It is expected that most of the waste from K-25 and Y-12 will go into the Class 1 facility. The majority of the X-10 waste will be disposed in the Class 2 facilities.

Waste generated at Paducah and Portsmouth, at a rate of about $20\text{-}30,000 \text{ ft}^3/\text{year}$, is expected to be primarily Class 1 waste.

2. Site personnel know what they are disposing of in the tumuli and know (or will know) what they (will) accept in the future in terms of waste form and packaging. There are no plans to take credit for waste form or packaging for the landfill. As a result, personnel expect to have less knowledge on waste form and packaging of this waste.
3. The primary solidification agent to be used for tumulus disposal will be grout. Some other agents have been experimented with, e.g. bitumen, but are not expected to play a major role in disposal.
4. The Class 1 facility will have a leachate collection system, allowing site personnel the opportunity to see what is leached from the waste. There is currently a lysimeter study in place at Y-12 in which waste is soaked down and the leachate is collected and analyzed.

Leachate is also being withdrawn from disposal sites at Y-12. In addition to providing help with respect to contaminant leaching, the data collected are expected to provide input into the design of the Class 1 disposal facility.

Similar leaching data are not available for the X-10 waste or Class 2 waste in general. There is less emphasis placed on leaching from this waste as it is to be solidified with grout, and diffusion limited release rates are expected to be quite low. These releases are not expected to drive the doses for the Class 2 facilities.

Very little work has been done on leaching at either Paducah or Portsmouth, in part because of the lack of disposal. Some work has been done at Paducah on how to immobilize Tc, a nuclide creating some problems at that site.

5. The major area in which system-wide support would be of help is in terms of concrete performance and service life. Many states and DOE sites are focusing on the use of concrete and need performance data and information on expected longevity. Oak Ridge, Paducah and Portsmouth may all need to rely on the benefits afforded by concrete and personnel need to know what they can count on in terms of performance. Oak Ridge personnel are currently planning on a 300 year lifetime associated with the waste form, but would like to extend that to 500 years if data support it.

Site personnel realize that a lot of concrete data will depend upon site-specific features and that they will have to cover those aspects themselves. Nevertheless, nation-wide support could help address many aspects of this work. One unknown is how to go about conducting accelerated testing of concrete and grout.

A lysimeter study is already in place at the site. To the extent that a nation-wide program would add to the database, e.g., through consideration of other waste forms, it would be considered helpful. There is concern that a nation-wide study would prove less applicable to their specific site characteristics than their own study. Still, site personnel would be interested in input on experimental design and the additional data generated by the study.

D. DISPOSAL TECHNOLOGY

Technical Participant: Tim Myrick

1. Disposal at the Bear Creek Burial Ground has been going on for 30 to 40 years using shallow-land burial. It will continue until the landfill is full, expected in 1992 or 1993. Waste disposed there now is from the Y-12 plant, primarily U and depleted U from weapons work. Some storage of waste is done at the plant.

Small shallow land burial sites were created at K-25 during operations, although Y-12 disposal facilities were the primary disposal path. Nuclides disposed at K-25 included U and Tc. The bottom floor of this facility is now being used for waste storage.

Waste is currently being disposed of in the tumulus demonstration project at SWSA-6. The initial tumulus is full and the second is awaiting loading of the waste. Together with the Interim Waste Management Facility, waste disposal will continue here until 1995-1996.

Greater confinement silos are being demonstrated at SWSA-6. These silos will continue to be used for disposal at SWSA-6 until the site is closed. They are not expected to be used at the new sites.

The proposed Class 1 facility will be a landfill for long-lived nuclides such as U. It will be equipped with a leachate collection system and liner system, and will meet all state industrial landfill requirements. The liner and collection system are expected to last 30 years. The liner will include compacted clay and a HDPE liner.

The Class 2 facility will be the tumulus as demonstrated at SWSA-6.

A Class 3 facility is, as yet, not defined. It is expected that the mobile constituents in the waste will be leached out at controlled rates during the institutional control period to ensure compliance. The insoluble fraction of the waste will remain in the trench, over which a permanent intruder barrier will be constructed. It is not expected that this design will be accepted by DOE, thereby necessitating shipment of Class 3 waste offsite for disposal (along with Class 4 waste).

Disposal facility designs have not been finalized for the Paducah and Portsmouth facilities. Feasibility studies are investigating numerous disposal options at this time, ranging from trench disposal to technologies employing multiple engineered barriers.

There is some question as to whether waste will be disposed at these sites. Given each site's low generation rate (20-30,000 ft³/year), the advisability of constructing expensive disposal facilities is being considered.

2. The basic design of the disposal facilities is not expected to change, however they will be modified with respect to materials and construction practices as necessary. These changes will be based on information gained from demonstration projects, experimental studies and improved concrete performance knowledge.
3. Class 1 disposal facilities incorporate an earthen cover system, liner and leachate collection system. These are included to meet state industrial landfill requirements. The cover system will be on the order of 3 ft thick and constructed of compacted clay or another material with a permeability of 1.0E-7 cm/s.

The important feature of the landfill is the very low waste concentrations encountered. These low concentrations permit the use of a relatively simple disposal technology.

The Class 2 facility relies upon solidification of waste inside of concrete casks or vaults, placed on a concrete pad. The design relies heavily on the long-term performance of the grout and concrete vaults, credit on the order of 300 to 500 years is needed for the concrete used in the facility. The earthen cover system is on the order of 4 to 5 ft thick, and is designed to minimize root intrusion into the waste. The performance of the cover is assumed to deteriorate after 100 years.

Critical features of the greater-confinement disposal silos include concrete components used in construction and the grout seal applied after waste placement. These features slow the release of contaminants and deter intrusion.

4. The behavior expected of the Class 1 landfills is being demonstrated currently by existing RCRA disposal sites. The cover system is assumed to perform for 30 years, then deteriorate in performance. The liner and leachate collection system are assumed to operate for 30 years. No other credit is taken for engineering design and is not considered necessary as the waste concentrations are so low as to be little concern.

With regards to the Class 2 facility, near-term data exist on freeze-thaw cycling and stress-strain relationships for the pads. The long-term behavior of the tumuli is not known. The cover system is expected to perform for 100 years, and will be maintained to achieve this.

5. Site personnel plan to conduct accelerated testing to better understand long-term performance of the tumuli. Specifically, they want information on the structural capabilities of the tumuli and diffusion/leaching characteristics of the technology. Significant progress on these items can only be made when the money for the work becomes available.
6. A nationwide database on concrete performance would be of great benefit to the site. A lack of money is also holding up initiation and completion of necessary work.

E. EXPOSURE SCENARIOS AND PATHWAYS

Technical Participant: Tim Myrick

1. The transport of contaminants via ground and surface water are the most important pathways at Oak Ridge, and are expected to be most important at Paducah and Portsmouth as well. At SWSA-6, the hydrology is storm-event driven. Approximately 90 percent of the water ends up in surface streams, while 10 percent percolates downward. Water percolating into the soils may intercept a well or surface stream further down-gradient.

Atmospheric pathways will be less important due to the stabilized waste form. While bio-intrusion by plants and animals, and consumption of contaminated plants by game animals occur, they are relatively unimportant under reasonable circumstances, resulting in exposures 5 to 6 orders of magnitude less than doses from other pathways.

2. The primary exposure pathways/scenarios expected to be considered in the performance assessments for the three sites are the onsite intruder and the downstream individual. Other exposure pathways will be considered to the extent that will be dismissed from further consideration on technical bases. For instance, atmospheric exposures would likely be modeled on a cursory basis to illustrate that they are negligible.
3. Essentially all exposure pathways/scenarios will be considered. Some pathways will be addressed in a cursory manner, sufficient to dismiss them due to their insignificance at the sites.
4. It would be helpful to know how much effort the sites must expend to eliminate pathways from consideration for the final performance assessment. How much supporting documentation must accompany these efforts?

It is important to be able to use exposure scenarios which are consistent with resource use patterns in the area of the disposal site. For instance, people do not irrigate in the Oak Ridge

area as assumed in the typical intruder-agriculture scenario. Can the sites account for these differences, or are they going to be required to consider standard scenarios, regardless of the site location?

Funding is important for this and all other aspects of the assessment.

F. COMPUTER CODES

Technical Participants: Tim Myrick, Don Lee

1. Site assessments have been performed for the Oak Ridge site. These analyses were screening calculations and examined projected doses from exposure pathways considered important at the site. The calculations were performed to identify radionuclides that may give rise to excessive exposures.

NUS is conducting performance assessments for the future disposal sites, at West Chestnut Ridge and West Bear Creek Valley.

2. The scoping calculations were done informally, no specific computer codes were used. The PATHRAE code is being used by NUS.
3. The scoping calculations considered all transport and exposure pathways expected to dominate doses projected for the disposal facilities.
4. Some sensitivity analyses were performed with respect to groundwater flow at Bear Creek Valley. Tracer flow was monitored with variations in head and conductivity, these results were also used in model validation work. Groundwater flow was not very sensitive to changes in conductivity, but was sensitive to the head distribution. The groundwater flow system is head-driven along structurally defined flow paths, i.e. cracks in rocks and tilted orientations of rocks.

No uncertainty analyses were performed. The scatter in the data for just about every geohydrologic aspect of the site is great. Consequently, it is difficult to come up with a representation of the uncertainty.

5. The scoping calculations are generally expected to bound human exposures at the site. The intrusion scenario modeled is expected to be a conservative representation of the situation. Groundwater doses were modeled in an extremely crude manner. Whether these calculations bound expected exposures or not is unclear.

6.

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	BARRIER (?)	Y	
Water infiltration to the disposal unit	UTM BARRIER	Y	
Penetration of water into the disposal units and around/through the waste	BARRIER	Y	
Degradation of the disposal unit	BARRIER (?)	Y	
Radionuclide releases from the disposal unit	BARRIER (?)	Y	
Surface water transport	UTM	Y	
Transport through the unsaturated zone	UTM	Y	
Transport through the saturated zone	USGS	Y	
Atmospheric transport	EPA-AIRDOS	Y	
Radionuclide uptake	Empirically	Y	
Health effects	ICRP 26/30/48	Y	

The BARRIER code is expected to play a role in projecting long-term performance of the tumulus. The code will probably require some site-specific modifications to be useful.

UTM (Unified Transport Model) will be used for modeling the unsaturated zone and the shallow subsurface. The USGS method of characteristics code has been rebuilt for use with head surface data from the site, this code will be used for saturated flow modeling.

EPA-AIRDOS may be used to quickly dismiss further consideration of atmospheric pathways. Site personnel have done a lot of work on biotic uptake of nuclides, this work would likely be used for the uptake modeling portion.

Little or no thought has been given to what codes would be used for the assessments for the Paducah and Portsmouth sites.

7. All decisions on codes will be finalized by about April 1990, an intermediate deadline for the draft performance assessment for SWSA-6.
8. Codes listed in question 6 would probably be used. In terms of confidence, the assessment would be defensible.
9. Yes, several of the codes listed above are from other sites.
10. Validation is recognized as being very important and very difficult. The tracer study performed at Bear Creek Valley will be implemented at SWSA-6 to help in validating groundwater flow modeling. Site personnel also have permission to do some validation work on Knox Ridge.

The UTM has been shown to be consistent with field data in a forested area. As SWSA-6 is a field, it is unclear how to 'walk' the model through succession to the forest successional stage. Therefore, only partial validation can be claimed.

BARRIER is largely unvalidated.

If a model can't be fully validated, the level of conservatism used in modeling will be increased to try and compensate.

11. Money and staff would be the biggest help.

Waste form and disposal technology codes would be helpful to their effort. BARRIER has some things to offer with respect to concrete degradation but doesn't include everything. Waste form degradation and nuclide release codes would also be of assistance. Waste leaching remains an enigma.

While a national lysimeter study would help with some of these problem areas, it is not expected that such a study would address site-specific waste.

G. SITE CHARACTERISTICS

Technical Participants: Tim Myrick, Don Lee

1. Groundwater parameters are the most important in terms of modeling site transport processes. Of these parameters, the structural properties of the site and head distributions are most significant.

Data relating to storm flows in the shallow sub-surface are also important. Collecting these data at SWSA-6 is difficult as the area has been repeatedly disturbed over the years as a result of experiments and other work. Construction of new disposal facilities will involve the removal of large amounts of soil, making it difficult to model the sub-surface zone at those areas as well.

2. Lots of data exist on the Oak Ridge disposal sites, interpretation of these data presents the biggest problem. The sites are very heterogeneous making it difficult to know if site personnel

have enough data or the 'right' data. How to use the data in modeling is made difficult by this great degree of heterogeneity. Confidence in the data is not clear given this heterogeneity.

The status of data at Paducah is weak. Data are being collected for the remedial action program going on at the site but are not likely to be sufficient for a performance assessment. The site is extremely heterogeneous which, as described for Oak Ridge, makes data collection and interpretation confusing. Personnel are trying to find a relatively homogeneous area for the disposal site at Paducah.

A lot of data exist for Portsmouth, although the surface water regime is not well known. It is expected that, with only minor additions to the database, a performance assessment could be conducted for the site.

3. Monitoring is an on-going activity thing at SWSA-6, West Bear Creek and West Chestnut Ridge, serving as a source of data for modeling. More model validation will be performed at West Bear Creek Valley and West Chestnut Ridge as soon as money is available.
4. Data used in modeling are generally site-specific, little reliance is made on literature values. Site personnel would rather make an assumption about the site than use data that are not site-specific.

Site-specific data for Oak Ridge include hydrologic information. Waste form data are based on literature values, although some of these data are specific to ORNL waste. Food chain parameters also are taken from the literature.

Site-specific data for Paducah include waste form information; hydrologic data for Portsmouth are site-specific. Literature-based data on hydrology are used for Paducah, while waste form data for Portsmouth are taken from the literature. Food chain parameters for both Paducah and Portsmouth are literature based.

5. Data on concrete degradation, technology performance and waste form behavior from other sites could be helpful at Oak Ridge.
6. Time, staff and money are required to collect necessary data.
7. Participants would like to see that the national group recognizes the uniqueness of each DOE site, that it realizes each site has its own set of strengths and weaknesses. These site properties require unique codes and approaches to complete the performance assessment.

The lack of recognition of each site's unique properties makes it difficult to get the necessary resources, time and money, to do the necessary work. As an example, support for model validation has been hard to obtain as a result of this lack of recognition of site peculiarities.

H. COMPLIANCE STRATEGIES AND COMPLIANCE POINTS

Technical Participants: Tim Myrick, Don Lee

1. Compliance points include a 100 m well for the general public, the site boundary during the institutional control period, and a 1 m well for the intruder. No population locations are considered.
2. Oak Ridge has submitted a report on the apportionment of doses among the various disposal facilities at the reservation. The report maintains that the areas in which disposal will occur, including SWSA-6, West Chestnut Ridge, and West Bear Creek Valley, are separated hydrologically and will not result in cumulative exposures.

Only one disposal facility each will need to be considered for Paducah and Portsmouth.

Oak Ridge is limiting the acceptable exposures to the intruder to 10 (and 4 mrem/year for groundwater protection), as opposed to the 500/100 mrem intruder limits. The general public is held to the same limits. If these restrictions severely limit the amount of Class 1 and/or 2 waste that can be disposed at the site, the higher limits of 25, 100 and 500 mrem/year may be reconsidered.

These more stringent performance objectives will apply to the proposed facilities at West Chestnut Ridge and West Bear Creek Valley and to the interim Waste Management Facility. The performance objectives stated in Order 5820.2A will be used for current operations at SWSA-6.

Oak Ridge personnel are not planning on doing performance assessments for disposal sites on the verge of closing down. By the time these assessments were completed, the sites would be closed.

The systems assessment is seen as a good idea, but one that will be practically impossible to accomplish. Site personnel do not see how they will be able to bring all the facilities together and arrive at a site-wide exposure.

3. Peak exposures will be identified for each disposal facility, otherwise the simulation will probably extend 10,000 years.
4. Feedback on their apportionment plan for the site has been requested, none has yet been received.

Guidance is needed with respect to how to go about conducting the system performance assessment.

I. DOSE CONVERSION FACTORS

Technical Participants: Tim Myrick, Don Lee

1. ICRP 26/30/48.
2. No.

SAVANNAH RIVER SITE

Site interviews were conducted at the Savannah River Site on January 16 and 17, 1990. Comments on the interview notes were received by telephone on February 9, 1990.

A. GENERAL

Technical Participant: Jim Cook

1. SRS personnel are developing a total of four new disposal facilities. The draft performance assessment for the Z-Area Saltstone Disposal Facility is scheduled for the end of 1991. This schedule is dependent on receiving the necessary funds to do the work.

The performance assessment for the Radioactive Waste Disposal Facility, the replacement facility for the existing Burial Ground, will be pursued in parallel or directly after the assessment for the Z-Area Disposal Facility. This assessment may follow the saltstone assessment by as much as 3 to 6 months.

Performance assessments for the Mixed/Hazardous and Y-Area Disposal Facilities have not been scheduled. Given the design similarities between these and the other two facilities, the performance assessments may be able to be adapted from the assessments of the Z-Area and Radioactive Waste Disposal facilities. These assessments are expected to be complete within about 2 years after the Z-Area assessment. While SRS personnel are contracting outside parties for the Z-Area and Radioactive Waste Disposal Facility assessments, it is expected that they will conduct the other, using the first two as a guideline.

2.

<u>Component</u>	<u>Amount of Data Available</u>		<u>Level of Confidence</u>		<u>Relative Degree of Importance</u>	
	<u>Z-Area</u>	<u>Radwaste</u>	<u>Z-Area</u>	<u>Radwaste</u>	<u>Z-Area</u>	
<u>Radwaste</u>						
Source Term	1	3	1	3	1	1
Waste Package/Form	2	3	1	3	3	4
Disposal Technology	3	3	3	3	4	3
Computer Codes	N/A	N/A	-	-	N/A	N/A
Site Characteristics	2	2	2	2	2	2

The amount of data available for waste form for the Z-Area Facility will improve at the time grouting is begun and actual waste form exists.

The vaults for the Z-Area Disposal Facility are considered to be part of the waste form. Answers given above reflect placement of about 50 percent of the vault technology into the waste form. Relatively low confidence in the disposal technology reflects, in part, uncertainty about concrete performance.

The importance of the Radioactive Waste Disposal Facility technology is relatively small. Of all the waste disposed in the facility, the tritium waste is, perhaps, most dependent upon the disposal technology. However, as this waste will be stored for 120 years, the importance of the technology is reduced.

No values are given for computer codes as final decisions on codes have not been reached.

3. There were not any quality assurance programs in place when much of the existing field data were collected. Currently, a full quality assurance program exists; contractors being used in the assessment have programs as well. Laboratory data to be used in the assessment, e.g. diffusion leaching data, have been subjected to a quality assurance program. No concerns are anticipated with respect to data quality in the future.
4. The lack of funding is the biggest problem facing site personnel. With budget reductions, performance assessments appear to have dropped in priority.

On the technical side, modeling releases of contaminants from waste within the Radioactive Waste Disposal Facility vaults is a problem that must be dealt with. Releases from these vaults are considered more complex than those for Z-Area vaults as the waste in the former is not a consistent stabilized mass.

5. Financial needs are not expected to be unique to SRS. The Radioactive Waste Disposal Facility leaching issue may or may not be.
6. More funding will alleviate financial needs. Leaching issues can be rectified by establishing the processes involved and quantifying the diffusion characteristics of the unstabilized waste.
7. Probably not, SRS has the personnel to address the problem.
8. No.
9. General guidance on how the performance assessments are going to be 'graded' would be helpful. The Performance Assessment Center may be able to play a role in this by writing the document, and getting it reviewed and issued by the Peer Review Panel.

B. AS-GENERATED WASTE SOURCE TERM

Technical Participant: Jim Cook

1. The waste to be disposed in the Z-Area Saltstone Facility exists, some of it has been in storage for up to 30 years. The waste has been characterized quite well during this time; yielding nuclide activities and waste volumes.

Source term data for the Radioactive Waste Disposal Facility will be based on waste disposed in the existing Burial Ground. Activity and volume data for the Burial Ground have been collected since 1963. Waste source term data were averaged over the three previous years for prior assessments of the Burial Ground. A similar approach will be used for the 5820.2A assessment. Adjustments will be required to account for the fact that a number of reactors at the site have been off-line in recent years.

Waste to be disposed in the Y-Area Disposal Facility already exists and is a consistent waste stream, primarily from the M-Area fuel fabrication facility. Volume and activity data exist for this waste.

Waste for the Mixed/Hazardous Facility is currently in storage. The normally-generated waste streams are known quite well, more information is being collected on rates of generation and who generates it.

2. The level of confidence in the Saltstone Facility source term data is quite high. These data will be improved further during the grouting process. Waste will be sampled before it is processed, i.e. before solids are separated from the liquids, and will be sampled again as grout.

It is recognized that some of the data for the Radioactive Waste Disposal Facility are suspect.

Site personnel are confident with respect to Y-Area and Mixed/Hazardous Facility waste data. Confidence in the latter may be degraded due to generation of mixed waste during the course of site remediation projects.

3. No new data are required, improvements in data quality will be pursued.
4. Better quality data will be pursued through the implementation of more rigorous waste acceptance criteria. Generators will be required to provide an initial characterization of their waste and adopt scanning procedures to check the waste over time. Much of the waste is process waste and is quite consistent over time, so this approach is suitable. It is expected that testing will be necessary to keep the generators honest.
5. Improved data resulting from the new waste acceptance criteria won't be available for the next facility performance assessments, they will be available for later maintenance runs.
6. The source term could change significantly in the future for a number of reasons. A single reactor is being planned as a replacement for the five existing reactors (two of which are shut down). The reactor to be built incorporates the same heavy water design as the existing reactors, so the same types of waste will be generated. However, this change is expected to influence the activity and volume of waste requiring disposal.

SRS may not continue to produce Pu in the future given changes in current thinking regarding defense spending, resulting in a loss of certain waste streams.

Significant decontamination and decommissioning work is expected within 5 to 10 years. This would increase the amount of this type of waste, and change the nature of the total site waste as well.

7. Waste radionuclide data are collected on a per package basis. Process knowledge is used for characterizing most waste, although some waste data are based on analysis. Waste for the Saltstone Facility is characterized analytically.

A good deal of the waste disposed in the Burial Ground is characterized through analysis. Uranium waste is always quantitatively determined.

Generators have protocols for converting scan readings to curie contents and nuclide concentrations for a number of general categories of waste, e.g. fission products. These protocols are based on process knowledge.

8. Few physical data, save for volume, are requested on the disposal/shipment form. Unpackaged waste is generally accompanied with a better description. The waste form for packaged waste is largely unknown.
9. Chemical data requested include the generator's assurance that the waste contains no free liquid, cadmium, lead, oil, mercury or listed RCRA materials.
10. It is expected that the generators are reliable in stating that the substances listed above are absent from the waste. No checks on this information are conducted. The new waste acceptance criteria would probably include some checking of these data.
11. The new waste acceptance criteria will request weight of the waste package to allow calculation of density and concentration on a mass basis.

Additional information on uranium chemistry and its impact on transport may be needed for the assessment. Generally it is assumed that the most mobile form of U (+6) is present. If this approach results in compliance problems, more effort will be necessary to investigate the chemistry of uranium to see if this assumption can be eliminated.

Site personnel do not think more information on the chemical or physical characteristics of the waste should be demanded on the disposal/shipment form.

12. Informal communication links should be set up among the sites. These lines of communication may involve telephone contact and/or face-to-face get-togethers. The communications should involve the people involved with the technical work, not management types. These get-togethers might help in finding out what is going on at other sites with respect to performance assessment. These get-togethers would be helpful for all aspects of the performance assessment, not just waste source term issues.

Establishment of a communications network between sites is viewed as being much more useful than guidance documents, which are generally received after they are needed.

C. AS-DISPOSED WASTE PACKAGE/FORM

Technical Participant: Jim Cook

1. The predominant waste form at the Z-Area Saltstone Facility is slag-substituted grout, pumped directly into the concrete vaults. Most waste disposed of in the Radioactive Waste Disposal Facility will be containerized; bulk disposal will be approved on a case-by-case basis. No grout is placed in waste containers, nor is grout placed around the containers within the vaults. Standardized containers are used for disposal to the extent possible. Primary containers currently used include B-25 boxes, 4 by 4 by 6 ft in dimension and constructed of carbon steel.
2. SRS has spent considerable time characterizing the grouted waste form for the Saltstone Facility, including analyses of EPTOX, diffusion coefficients, and compressive strength. Additional testing will accompany the grouting process.

Less is known about the containerized waste for the Radioactive Waste Disposal Facility. What is in the boxes is essentially unknown, outside of the activity of the nuclides present.

Waste to be disposed at the Y-Area Facility will be treated and grouted similar to the Z-Area Facility. The mixed/hazardous waste will be incinerated to burn off the organics and tritium; the ash and blowdown will be solidified in concrete vaults.

3. Solidification will be employed for waste going into the Z-Area, Y-Area, and Mixed/Hazardous Waste Facilities. Grout will be used in each facility.
4. Leaching is pretty well understood for the solidified Area-Z waste. Leaching will be diffusion limited until the waste form and concrete vaults degrade. Previous performance assessments have assumed the vaults do not degrade. Degradation will be modeled in the 5820.2A assessments.

Leachate diffusing from the waste/vault will be highly alkaline and saturated with nitrate/sodium. This caustic solution is expected to flocculate when it comes in contact with the more acidic clay (pH 4-5) around the vaults. This would tend to plug up the soil pores and slow the movement of contaminants. As the material does move through the soil and its pH drops, precipitation is expected, once again resulting in a slowing of the contaminants.

Overall, these effects may be quite important in the performance assessment. Modeling of these geochemical phenomenon is being pursued by Hanford personnel for the SRS. Some data collection may be necessary to support this effort.

The leaching behavior of the Radioactive Waste Disposal Facility is less well understood. The biggest problem is the transport of contaminants leached from the waste to the point where they can diffuse through the concrete vault. Diffusion through the vault is expected to differ from diffusion in the grout-filled vaults at Z-Area. The geochemical aspects discussed above will also have to be considered for this facility.

Work will be conducted by INEL personnel for the SRS with respect to modeling vault degradation and the release of contaminants from the vaults.

Site personnel have done some lysimeter work to quantify C-14 leaching from filters generated by heavy water reactors. Releases tend to be much slower than originally expected.

5. Help in quantifying the release of contaminants from the Radioactive Waste Disposal Facility would be helpful. National studies on concrete performance may be useful for performance assessments in the future.

D. DISPOSAL TECHNOLOGY

Technical Participant: Jim Cook

1. Shallow-land burial is used at the Burial Ground. Trenches are 20 to 24 ft deep with an interim cover of 4 ft of clean soil. Part of the Burial Ground is undergoing closure at this time. The final cover is composed of 2 ft of clay and 2 ft of vegetated topsoil.
2. No, the existing disposal technology will not be used as is. In order to provide greater intruder protection and groundwater protection, concrete vaults are to be incorporated into future disposal technologies.
3. The site for the new Radioactive Waste Disposal Facility, which will replace the Burial Ground, has been cleared and construction will begin within a few months. The facility will employ concrete vaults, with unstabilized waste within.

The new Radioactive Waste Disposal Facility will deal with five types of waste in different manners. Waste forms containing readily-separable, mobile, long-lived nuclides (C-14 and I-129) will be stored. This waste includes two waste forms, one for each nuclide, and is generated at a rate of about 200 ft³/year. It hasn't been decided as to what will become of this waste, it is expected to be disposed at a more suitable site.

If the waste has measurable tritium or is from a tritium facility, it will be placed in an abovegrade concrete vault and stored for about 120 years (10 half-lives). After this period, the vault will be covered with soil. Vaults will be constructed separately for high-activity tritium waste and low-activity waste.

If the waste contains no tritium it is disposed in a belowgrade vault. High- and low-activity LLW will be disposed in different vaults.

The various vault facilities will be sized such that a vault will be filled about every two years. The vaults for the low-activity, non-tritium waste will probably be about the same size as the Z-Area Saltstone Facility.

All vaults will be stand-alone, with peaked concrete roofs. An interim cover of 4 ft of clean soil will be applied and a final cover will be applied at closure. The cover system will be the same as that used for the existing Burial Ground, unless the performance assessment dictates changes in cover design.

Critical features of the Radioactive Waste Disposal Facility include the vaults. The vaults slow releases to the groundwater and provide intruder protection. The cover system also plays a role, especially for the high-activity LLW vaults. The cover over these vaults is 16 ft deep

from the top of the final grade to the top of the waste. This serves as intruder protection and is deeper than the root zone of the pine tree, the deepest-rooted natural vegetation occurring at the site. The cover over the low activity waste is on the order of 8 ft.

The Saltstone Disposal Facility at Z-Area is for the disposal of salts and liquids separated from sludge waste, the solids are vitrified and are not disposed as LLW. The waste is grouted and pumped into a series of large concrete vaults.

The Z-Area vaults will be constructed at 15 ft below grade, with 10 ft of each vault extending above natural grade. The vaults will be built in groups of 3 to 6, with common walls between the vaults of a group. The roof of each vault will be peaked. The interim cover of 4 ft of clean soil will be placed over all vaults of a group at one time. The final cover will be placed over the entire site at the end of operations.

The Z-Area vaults are 600 ft long and 100 ft in width. Each vault is composed of six 100 ft by 100 ft cells. Three vaults are currently constructed. One-half of one cell has been filled with cold waste as a test of the technology.

The waste-form and vaults are the most critical features of the Saltstone Facility. Both serve to slow the rate of contaminant release into the groundwater. This is especially important due to the nature of the waste. Nitrates in the waste move quickly and have very low groundwater contamination limits which must be complied with.

The technology expected to be used for the Mixed/Hazardous Facility is similar to that used for the Radioactive Waste Disposal Facility. The technology at Y-Area is likely to be similar to Z-Area. Each of these facilities will employ double liner and leachate collection systems as well, as the waste for both the Y-Area and Mixed/Hazardous Waste Facilities has hazardous components. Both of these facilities will employ grouting of the waste prior to disposal.

4. The behavior of the critical features of the Saltstone Facility is considered to be reasonably well known. However, questions about how the chemistry of the waste-form affects release and transport rates, and the long-term performance of the grout and vaults exist.

Behavior of the Radioactive Waste Disposal Facility vaults is less well understood. Their performance will be modeled as a part of the performance assessment.

The cover system for the Z-Area and Radioactive Waste Disposal Facilities will be assumed to remain intact throughout the assessment period.

5. The long-term performance of disposal vaults will be modeled as a part of the assessment. Data collection will be performed as required for this modeling. Materials testing data exist for the Z-Area, these data may be applicable to the Radioactive Waste Disposal Facility vaults.
6. Information on concrete performance would be welcome. Site personnel are interested in furthering the capability of codes such as BARRIER to aid in modeling their disposal technologies. Funding for this work has been difficult to obtain.

E. EXPOSURE SCENARIOS AND PATHWAYS

Technical Participant: Jim Cook

1. The significant transport pathway at the site is groundwater transport. Bodies of surface water exist, but are a fair distance away. Short-lived nuclides wouldn't make it to these waters, the long-lived nuclides would be diluted to insignificant concentrations.

Grouted waste forms also tend to minimize the importance of the atmospheric pathway. Pine tree roots may extend into the waste. The deepest burrowing animals are fire ants, no radioactivity has been detected in the mounds.

2. The standard intruder scenarios will be included. Scenarios unique to the site will be identified and assessed with respect to their significance. The prevailing opinion is that site personnel will perform whatever scenarios are required of them, including the 100 m receptor, populations, and any others.
3. All scenarios will be examined. Some, such as atmospheric, surface water and bio-intrusion pathways will probably be dismissed based on screening calculations.
4. Kennedy and Peloquin's document on intruders was considered helpful. Communication with other sites is important, especially with Oak Ridge.

F. COMPUTER CODES

Technical Participant: Jim Cook

1. Site assessments have been performed for the environmental impact documents for the new Radioactive Waste Disposal, Y-Area and Mixed/Hazardous Waste Facilities. An assessment of the Z-Area Saltstone as part of the Environmental Impact Statement for the vitrification plant. Some screening of the intruder doses has been done using the Kennedy and Peloquin document. Past assessments of numerous disposal sites, including the existing Burial Ground, have been done by RAE.
2. PATHRAE was used in the past assessments for the environment impact documents. No formal codes were used for the assessment of the Saltstone Facility.
3. Yes, the assessments addressed groundwater pathways and exposures to intruders.
4. Sensitivity and uncertainty assessments were not performed. These will be done for all 5820.2A performance assessments.
5. If the assumption that the vaults last forever is accepted, the past assessments are considered to model the facility in a consistent manner. As the vaults won't last forever, these assessments probably underestimate doses from long-lived radionuclides.

6.

<u>Component</u>	<u>Specific Code</u>	<u>Available (Y/N)</u>	<u>Will be Available (Give Date)</u>
Radionuclide release from the waste form	Diffusion Code	N	
	PHREEQE	Y	
Water infiltration to the disposal unit	HELP	Y	
Penetration of water into the disposal units and around/through the waste	HELP	Y	
Degradation of the disposal unit	BARRIER	Y	
Radionuclide releases from the disposal unit	Diffusion Code	N	
Surface water transport	?	-	
Transport through the unsaturated zone	FEMWATER FEMWASTE	Y	
Transport through the saturated zone	FEMWATER FEMWASTE	Y	
Atmospheric transport	EPA-AIRDOS	Y	
Radionuclide uptake	Hand Calculations	Y	
Health effects	Hand Calculations	Y	

'Diffusion code' refers to the work INEL personnel are going to do with respect to modeling the degradation of the vaults and defining releases from the waste-form/concrete vaults. PHREEQE will be used to model geochemical reactions in and around the vaults.

The codes to be used for screening surface water transport haven't been decided on yet, the FEMWATER and FEMWASTE codes may be used for this aspect of the assessment. EPA-AIRDOS, or a screening version of the code, may be used for the atmospheric portion.

The GRESS code will be used to do the sensitivity analyses.

7. Final decisions regarding surface water models will be made in time to meet assessment schedules.
8. If the assessment had to be done tomorrow (literally) the PATHRAE code would be used. Site personnel have used the code for prior assessment work and feel comfortable with it.
9. Yes, they are being used. EPA-AIRDOS, BARRIER, HELP and PHREEQE were all developed elsewhere.
10. Validation and verification exercises are being planned. Data for the burial ground exist which could be used for validation of FEMWATER and FEMWASTE. Saltstone lysimeter data will be useful for validation of geochemical modeling.
11. No special guidance is considered necessary. Site personnel are not interested in being told what codes to use in the assessments. They are most familiar with the site and should be left with these decisions.

G. SITE CHARACTERISTICS

Technical Participant: Jim Cook

1. Groundwater parameters are the most important. For assessments using PATHRAE, the leach rate was the most important, itself a function of several parameters.

With respect to the vaults, it is expected that parameters important in defining leaching via diffusion will be the most important. Given this, work on contaminant diffusion is seen as being quite important.

Hydrologic parameters for aquifer transport are considered unimportant. The intruder scenario, with a 1 meter well pathway, will likely be the most important scenario in terms of exposures. The short aquifer path minimizes the importance of aquifer parameters.
2. Enough data exist to define diffusion leaching for the Z-Area Facility. In the past, all contaminants were assumed to diffuse with the nitrates in the waste. Problems, however, were encountered with exposures from Tc, U and Cr. Additional leach studies were conducted for these nuclides and actual rates of release were found to be much lower than those for nitrate (which is very soluble and leaches quickly).

There are not enough data to describe leaching for the Radioactive Waste Disposal Facility. Site personnel don't know how to model the release of contaminants from the unstabilized waste to the vault walls.
3. Additional data may not be necessary to define Radioactive Waste Disposal Facility leach rates. Rather, the processes involved in the migration of contaminants from the waste to the vault's inner surface need to be determined. Some experimental work may be necessary as understanding of these processes is developed.

4. SRS uses site-specific data whenever it is available. Hydrologic parameters are, for the most part, site-specific in nature. Distribution coefficients are site-specific for the most important nuclides, including Co, Cs, Sr, Pu, I, Tc, C, H and Np.

Literature data are relied upon for distribution coefficients of other nuclides. Personnel expect to have site-specific distribution coefficient data for uranium for the performance assessment.

Biotics and food chain pathways parameters are generally taken from the literature. This is not considered a problem as the ingestion of plant and animal foodstuffs is not an important exposure pathway.

5. Probably not, with the possible exception of distribution coefficient data from Barnwell. However, the SRS probably has more data than Barnwell.
6. No.
7. No.

H. COMPLIANCE STRATEGIES AND COMPLIANCE POINTS

Technical Participant: Jim Cook

1. Compliance points include the intruder, the 1 m well, the 100 m well and the nearest stream. Others will be considered if required by the Order.
2. Apportionment of doses has not been considered as receptors would have to be located considerably further away than the intruder location to be able to receive exposures from multiple facilities. As exposures at locations away from the disposal site have been found to be negligible, significant cumulative doses are not expected.

Site personnel have started to think about how the systems performance assessment can be done. A spreadsheet approach is expected to be adopted to ensure cost-effectiveness and to calculate reservation-wide exposures. The results of the systems analysis would probably offer insight into the apportionment issue.
3. A simulation period of 1,000 years will be used, peak exposures will also be identified. For peaks occurring at very great times, results will probably be presented in such a way as to point out their timing, to keep things in perspective.
4. General guidance on compliance strategies and points would be helpful, in addition to knowing what other sites are doing in these regards.

I. DOSE CONVERSION FACTORS

Technical Participant: Jim Cook

1. ICRP 26/30/48.
2. No.

DATE

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2/7/94

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