



**Department of Energy**

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DNF SAFETY BOARD

The Honorable John T. Conway  
Chairman  
Defense Nuclear Facilities Safety Board  
625 Indiana Avenue, N.W.  
Suite 700  
Washington, D.C. 20004

Dear Mr. Chairman:

Enclosed is the *Complex-Wide Strategy for Maintenance of Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*. The Department has developed this plan pursuant to its commitments in the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2 Implementation Plan, and the "Quarterly Progress Report for DNFSB Recommendation 94-2 January through March 1998."

This plan describes the Department's integrating strategy for maintenance of low-level waste disposal facility performance assessments and composite analyses. Through this program of maintenance, the Department will address the research and development for the low-level waste disposal program. The plan contains a general strategy for addressing research and development for the low-level waste disposal program but does not include an implementation process. A specific implementation process is under development and will be shared with the DNFSB staff by the end of the calendar year 1998.

The Department has completed the actions related to commitment IX B.3 "Determining Outstanding Low-Level Waste Research and Development Needs" and proposes closure of the commitment. Commitment IX B.4 "Prepare Strategy to Address Low-Level Waste Research and Development" will be proposed for closure once the implementation process is completed. If you have any questions concerning this information, please contact me at (202) 586-7710 or Mark Frei at (202) 586-0370.

Sincerely,

James M. Owendoff  
Acting Assistant Secretary for  
Environmental Management

Enclosure



**COMPLEX-WIDE STRATEGY FOR MAINTENANCE OF  
DEPARTMENT OF ENERGY  
LOW-LEVEL WASTE DISPOSAL FACILITY  
PERFORMANCE ASSESSMENTS AND COMPOSITE ANALYSES**



September 30, 1998

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## 1. INTRODUCTION

The purpose of this plan is to describe the Department of Energy's (DOE's) integrating strategy for maintenance of low-level waste disposal facility performance assessments and composite analyses. Through this program of maintenance, the Department will address research and development to resolve issues relating to the long-term safety of low-level waste disposal facilities. This plan addresses a DOE commitment in the *Implementation Plan: Defense Nuclear Facilities Safety Board Recommendation 94-2, Conformance with Safety Standards at DOE Low-Level Nuclear Waste and Disposal Sites*.

### 1.1 Background

In the review of the Department's low-level waste management program, the Defense Nuclear Facilities Safety Board (DNFSB) identified five areas of technical study that should be addressed by DOE. These include: 1) improving modeling and predictive capabilities of radionuclide migration, 2) enhancing the stability of buried waste forms, 3) deterring intrusion, 4) inhibiting the migration of radionuclides, and 5) reducing the volume of waste to be disposed.

DOE recently completed *The Current and Planned Low-Level Waste Disposal Capacity Report, Revision 1*. In this report, DOE concluded that there is adequate disposal capacity for the low-level waste projected to be generated by the Department's programs. Reducing waste volumes for the purposes of conserving disposal capacity is not considered a high priority since the report projects adequate volumetric and radiological capacity for low-level waste disposal. Therefore, it is appropriate to focus low-level waste research and development activities on technical study areas, including the five identified by the DNFSB, as they relate to low-level waste disposal facility closure, long-term performance, or analysis of performance.

The Department has completed three documents related to DOE's low-level waste research and development needs, namely: a "Preliminary LLW Research Management R&D Activities Catalogue;" a "DOE Research and Development Activities Assessment;" and a "DOE Research and Development Needs Assessment." As a result of the preparation of these documents, DOE has determined that a site-specific, needs-based approach to identifying research and development must be undertaken. This is consistent with the Environmental Management Office of Science and Technology, EM-50, approach to identifying and funding research work.

### 1.2 Purpose

The Department will ensure that low-level waste technical studies (including research and development) will address any issues relating to the long-term protection of the public and the environment from low-level waste disposal. Identification of these issues and the technical studies to address them occur during both the preparation and the approval of the performance assessments and composite analyses. During development, the preparers will identify key areas where data are lacking or analytical tools need improvement. As the documents are undergoing

review and approval by Headquarters, additional technical weaknesses that need to be addressed may be identified. Addressing the issues (i.e., data needs, analytical needs, technical weaknesses) is key to closure of the facilities and must be addressed as part of the performance assessment and composite analysis maintenance programs.

This plan presents the Department's complex-wide strategy for performance assessment and composite analysis maintenance. Performance assessments and composite analyses are performed for continuing and future disposal of low-level waste at seven DOE sites. These sites include: Savannah River Site, Oak Ridge Reservation, Los Alamos National Laboratory, Idaho National Engineering and Environmental Laboratory, Nevada Test Site, Hanford Site, and Fernald Environmental Management Project.

Performance assessments present the technical analyses required to provide a reasonable expectation that low-level waste disposed of after September 26, 1988 will meet the performance objectives in DOE Order 5820.2A (or DOE O 435.1 when issued). Sites are to implement performance assessment maintenance programs which include conducting studies, performing monitoring, and evaluating and updating the performance assessment analyses to ensure that long-term performance of the facility is based on the best data available.

The composite analyses present evaluations of potential doses to an offsite member of the public resulting from releases from all sources on the site that could overlap with releases from a low-level waste disposal facility. The estimated doses are compared with DOE criteria for radiation protection of the public. The composite analysis provides information for use in planning for future radiation protection of the public and to address mitigative actions before potential radiation protection problems occur. The site composite analysis maintenance program is to ensure that the composite analysis incorporates up-to-date information (e.g., on source terms, land use plans, potential interactions) and improved analyses (e.g., modeling) to support long-range radiation protection planning.

The Department requires that performance assessments and composite analyses are maintained to evaluate changes that could affect the performance, design, and operations of the low-level waste disposal facility. Maintenance, in the form of collecting additional data, conducting studies, improving models, and performing additional analyses, is a necessary element of the performance assessment or composite analysis process which must continue over the life of the disposal facility. The site-specific maintenance program is defined as a program for updating performance assessments and composite analyses based on the acquisition of new information on waste streams or inventories and system component performance. It includes a process for improving confidence in projections about the long-term performance of a disposal facility, based on iterations between data collection (e.g., characterization, transfer coefficients), studies (e.g., infiltration through barriers, concrete degradation), and model improvement efforts.

### 1.3 Regulatory Background for Performance Assessment and Composite Analysis Maintenance

The requirements for preparing and maintaining performance assessments for DOE low-level waste disposal facilities are set forth in DOE Order 5820.2A (and DOE O 435.1 when issued). The performance assessment includes calculations of potential releases from the facility and potential doses to representative future members of the public. The analysis is to provide a reasonable expectation that the performance objectives identified in the Order will not be exceeded. Additional DOE documents detail guidance on performance assessment preparation (DOE 1996a) and maintenance (DOE 1996b).

Over the operating life of the disposal facility, changes in the information used in the performance assessment may occur. Changes that may affect the performance assessment include the design of currently operating and any future disposal units; the closure plan for the facility; plans for future land use near the disposal site; the physical, chemical, or radiological characteristics of wastes intended for disposal; current understanding of the long-term performance of the disposal facility based on new data obtained from environmental monitoring at the facility or relevant environmental and laboratory research programs; and approaches to modeling the long-term performance of the facility. Maintaining the performance assessment is intended to ensure that relevant changes in information are considered and incorporated in a disciplined and timely manner.

The requirement for a composite analysis comes from DOE's *Implementation Plan: Defense Nuclear Facilities Safety Board Recommendation 94-2* (DOE 1996c). The *Implementation Plan* was prepared in response to Recommendation 94-2 in which the DNFSB expressed concern that potential doses to the public resulting from all sources of radionuclides at a DOE site were not taken into account in performance assessments prepared in accordance with DOE Order 5820.2A (DNFSB 1994). The Order requires that the performance assessment consider waste disposed of since September 26, 1988. In order for the Department to properly plan so that long-term protection of the public is provided, a composite analysis which evaluates the potential offsite impacts of other sources that may contribute to the offsite dose from the low-level waste disposal facility is prepared to complement the performance assessment.

The composite analysis differs from the performance assessment in several respects. First, the composite analysis focuses on radiation protection of offsite members of the public at the expected future site boundary, whereas the performance assessment generally considers protection at a nearer point of assessment and protection of future inadvertent intruders. Second, the composite analysis evaluates potential releases from all sources on the site that could add to the releases from the low-level waste disposal facility. Third, the projected doses to individual members of the public are compared with dose criteria based on requirements for radiation protection of the public (DOE 1990), rather than the performance objectives in DOE Order 5820.2A. Finally, the composite analysis is intended to be a planning tool to help make decisions affecting long-term site plans from the standpoint of radiation protection whereas the

performance assessment affects the design, operation, and closure of the low-level waste disposal facility only. An additional DOE document provides guidance on composite analysis preparation (DOE 1996d).

The Department has established a process for approving the operation of a low-level waste disposal facility based on reviews of both the performance assessment and composite analysis. Upon finding the performance assessment and composite analysis to be acceptable, Headquarters issues a *disposal authorization statement* which documents the conditions for operation of the low-level waste disposal facility: Typical conditions include continued application of waste acceptance criteria that are based on the analyses in the performance assessment and/or composite analyses. In addition, there may be conditions that relate to the acquisition of additional data, validation of assumptions, or conduct of additional analyses. In order to comply with the conditions included in the disposal authorization statement, the site must implement a performance assessment and composite analysis maintenance program that addresses these technical needs.

## **2. SCOPE**

This plan describes the roles of the field and Headquarters in implementing a performance assessment and composite analysis maintenance program. The field has the principal responsibility for implementing changes in the design, operation, and/or closure of a low-level waste disposal facility based on the analyses in the performance assessment or composite analysis or as directed by Headquarters in the disposal authorization statement. Field organizations are also responsible for identifying and pursuing activities, such as data collection, monitoring, technical studies, and additional analyses required to sustain confidence in the results of the analyses and for closure of disposal facilities. The centralized activities are those conducted for Headquarters and the field. These activities include ensuring operations are consistent with the analyses in performance assessments and composite analyses, tracking implementation of conditions imposed by the disposal authorization statements, and providing complex-wide coordination of research and development in support of disposal activities.

## **3. FIELD-LEVEL MAINTENANCE ACTIVITIES**

Performance assessment and composite analysis maintenance activities at the field level involve conformance with constraints that are identified as a result of the preparation, review and approval of the performance assessment and composite analysis, and identifying and conducting data collection, studies and research, and analyses needed to support the future closure of the low-level waste disposal facility.

### 3.1 Implementation

During development of a performance assessment or composite analysis, the analysts incorporate data or assumptions for the design, operation, and closure of the disposal facility into the analysis. In addition, the review and approval of a performance assessment or composite analysis may result in constraints being placed on facility or closure design, or on concentrations or quantities of radionuclides that can be received at the disposal facility. As part of maintenance, field personnel must ensure that the facility design and operations reflect the analyses included in the performance assessment and composite analysis, and any conditions placed on the facility.

The development of waste acceptance criteria should be closely associated with the analyses included in the performance assessment, and to a lesser extent, those in the composite analysis. Developing waste acceptance criteria is a continuing process. Revisions to waste acceptance criteria may be necessary to address changes in waste characteristics, waste disposal operations, and analysis results. Updates to the waste acceptance criteria must be consistent and coordinated with the performance assessment and composite analysis.

Similarly, design of the disposal facility or of the closure cover (barrier) must reflect the results of the performance assessment and composite analysis and the conditions contained in the disposal authorization statement. As necessary, unproven design concepts will be evaluated to ensure that the performance attributed to the cover can be reasonably expected. Research and studies as discussed in the next section may be necessary to provide proof of concept for cover designs.

### 3.2 Needs Identification

Site preparation and Headquarters review of performance assessments and composite analyses have identified important areas of study or analysis that need to be addressed through the site performance assessment and composite analysis maintenance program for each facility. Many of these needs are common to several sites and are consistent with the concerns identified by the DNFSB in Recommendation 94-2. Addressing the needs identified in this section will improve performance of low-level waste disposal facilities and improve understanding of and thereby reduce uncertainty in the performance of the facilities. The remainder of this section identifies and discusses several major performance assessment and composite analysis maintenance needs.

*Waste Characterization.* The physical, chemical, and radiological characteristics of low-level wastes are a major source of uncertainty in every performance assessment and composite analysis. Some improvements in waste characterization methods have been incorporated into procedures across the DOE complex, but waste characterization remains a significant source of uncertainty for many waste streams, especially those containing difficult to detect radionuclides such as  $^{14}\text{C}$ ,  $^{99}\text{Tc}$ , and  $^{129}\text{I}$ . Although difficult to detect, these radionuclides can be significant contributors to projected doses. Improvement in the methods used for waste characterization are



needed to increase the confidence in the results of performance assessments and composite analyses and to support decisions on inventories that can be received at a facility.

*Waste Form.* The performance assessment and composite analysis may include credit for improved performance of certain treated waste forms or waste packaging. Consideration of the impacts of waste treatment technologies and packaging is often limited by the understanding of the long-term performance of the waste form or packaging. Uncertainties in performance assessments would be reduced and the selection of the best options for the management of waste would be improved if the long-term performance of treated waste forms and packages were better understood. Treating waste to a different waste form has the potential of reducing the volume of waste to be disposed; treated waste forms and packaging also have the potential of enhancing site stability and inhibiting the migration of radionuclides.

*Monitoring.* In addition to demonstrating compliance with the environmental release criteria, monitoring can be used to verify projected near-field performance of a disposal facility or other source, thereby increasing confidence in analysis results. Generally, waste disposal facilities are not expected to release contaminants to the environment for many years after waste has been disposed. Consequently, monitoring of properly operating waste disposal facilities at the point of assessment is not anticipated to provide any meaningful data during the operating lifetime of the facility. However, monitoring the performance of the disposal facility can indicate movement of water and/or radionuclides within a waste disposal facility long before releases occur. Developing performance monitoring technologies to provide data on the mechanisms associated with the transport of radionuclides would benefit the modeling and enhance the predictive capabilities of a performance assessment or composite analysis.

*Subsidence.* Subsidence could compromise the performance of a disposal facility and is thus a concern at any low-level waste disposal facility. Current approaches to addressing the effects of subsidence in a performance assessment or composite analysis are approximations at best. Limited capabilities are available to project the occurrence of subsidence or the consequences of a subsidence event at a specific facility. The contributions of enhanced waste forms and disposal technologies to reducing subsidence and providing long-term stability to buried waste is largely unknown. Better understanding the occurrence and consequences of subsidence will enhance confidence and reduce the inherent uncertainties in performance assessment and composite analysis results.

*Deterrence of Intrusion.* Protecting inadvertent intruders from exposure to disposed low-level waste has long been recognized as an important consideration for safe disposal of wastes. However, the most appropriate means for deterring an intruder from inadvertent exposure to waste is not clear. Performance assessments and composite analyses often rely on institutional controls as a form of intruder protection. Design features that deter inadvertent intrusion are much less understood. Not understanding the long-term performance to be attributed to intruder protection, substantial uncertainties are associated with current measures being proposed for

intruder protection. A more thorough understanding of the most effective steps for deterring inadvertent intrusion and properly considering these measures in analyses are needed.

*Episodic Natural Phenomena.* Performance assessments and composite analyses use long-term projection of climate based on available data. This approach to considering climate has been reviewed and endorsed several times. It is typically associated with annual climatological characteristics. However, meteorological events and other natural phenomena events of significance to the performance of a low-level waste disposal facility are episodic over very short periods of time (e.g., tornadoes, hurricanes, severe storms). The effects of such natural phenomena are substantially diminished when the event is averaged over a year's time. But the consequences of episodic events can be significant and have impacts on performance that are long-lasting. Better understanding of how episodic events can be represented in the performance assessment and composite analysis is needed. Such understanding will reduce uncertainties in performance assessment and composite analysis and enhance confidence in their results.

*Media Exchange Characteristics.* The transfer of radioactivity from solid material in waste to liquid or gas in a disposal unit and then to soil or water in the environment is included in the source term analysis, and the analysis of the transport through the environment. These complex physical-chemical interactions are typically represented as simple linear processes. This simplification in modeling leads to conservative representations for source terms and environmental transport. Similarly, large uncertainties are associated with these simplified representations. Improvement in understanding the generation of source terms, and the transport mechanisms and characteristics of radioactive material will contribute to reducing the largest source of uncertainty in transport modeling leading to an improved predictive capability.

*Waste Projections.* Performance assessments and composite analyses for operating or future low-level waste disposal facilities rely on projections of future waste characteristics. These waste projections influence the projected dose, contribute to the development of waste acceptance criteria, and affect planning for replacement or expansion of disposal facilities. Projections of waste characteristics have rarely been compared with the actual characteristics of wastes. Such comparisons can provide a reasoned basis for planning future waste disposal facility design.

*Barriers.* Physical or chemical barriers for inhibiting the infiltration of water and the migration of radionuclides effectively enhance disposal technologies. An understanding of the long-term stability and effectiveness of physical and chemical barriers for inhibiting migration of radionuclides needs to be improved. Better understanding the performance of physical and chemical barriers over time will contribute to improved modeling and greater confidence in the results.

The studies and research activities identified in this section are extensive, but not comprehensive. Sites will identify other studies or research that will be needed as part of the maintenance of their performance assessments and composite analyses. Sites will have to prioritize the research and

studies needs and execute those that are most important to facility operations, closure, and increasing confidence in the long-term protection from waste disposal activities.

Following is a list of criteria that sites should consider in prioritizing performance assessment and composite analysis research and development needs:

- How sensitive are results to the research need?
- How uncertain are results to the research need?
- What is the potential for successfully addressing the research need?
- What is the complexity of the research?
- What is the anticipated cost to address the research need?
- How much time is required to conduct the research?
- What is the potential for the research providing useful results?
- What is the anticipated effect of the research results on waste management constraints derived from the performance assessment or composite analysis?
- Can other DOE sites benefit from addressing the research need?
- What regulatory issues are associated with addressing the research need?
- What political or social issues are associated with addressing the research need?

Other criteria may be identified that should be used for prioritization based on the development and synthesis of information and literature related to the various study, research, and development needs. Selected criteria are intended to provide a reasoned basis for distinguishing between research needs and identifying the relative benefits and risks associated with the research needs being prioritized

### 3.3 Technical Studies.

Site personnel must take advantage of all sources of information and all options available for responding to research and development needs. The field should utilize existing research conducted by DOE, other agencies, universities, the private sector, etc., that may resolve site information needs. If no previous research addresses the information need, the field should seek support for the study within DOE.

The Environmental Management Office of Science and Technology focuses on performing research and development activities that support the needs of environmental management activities. The program manager and technical staff responsible for performance assessment and composite analysis maintenance will work with the Office of Science and Technology through the Site Technology Coordination Group to ensure research needs that support low-level waste disposal activities are identified, justified, and pursued. The Site Technology Coordinating Group will evaluate the need and importance of the research and development, rank the needs with others, and forward the research and development requirements to the Office of Science and Technology for funding. Similarly, as discussed in the following section, sites will be asked for information on their research and development needs so that cross-complex needs can be submitted to the Office of Science and Technology.

In addition, site personnel need to factor activities necessary to maintain the performance assessment and composite analysis (e.g., monitoring activities, studies, research, and analyses) into the programs at the site. Through this mechanism, the site, in conjunction with Headquarters, can integrate maintenance needs with other environmental management activities in the budget planning. Site and Headquarters staff should integrate the maintenance needs (including research and development) into the budget priority list recognizing that some of the activities are conditions of operation of the low-level waste disposal facility or others are long-lead activities important to closing the facility in a manner that will provide long-term protection from the waste.

#### **4. CENTRALIZED MAINTENANCE ACTIVITIES**

The DOE strategy for low-level waste disposal facility performance assessment and composite analysis maintenance includes a centralized function that evaluates implementation of performance assessment and composite analysis results, provides follow-up of conditions contained in disposal authorization statements, and identifies studies and research to be performed by Headquarters, the Center, or a field element.

Environmental Management will ensure the conduct of follow-up assessments after the issuance of a disposal authorization statement for a disposal facility. The purpose of the assessments is to ensure that disposal facility designs and operations are consistent with assumptions and conditions that were the basis for the performance assessment and composite analysis. For example, the assessment would determine if waste acceptance criteria include limits on radionuclides consistent with the analysis and results in the performance assessment. The assessments will also evaluate the implementation of conditions contained in the disposal authorization statement. As an example, a disposal authorization statement may include a condition that personnel at the facility need to take action to demonstrate that a barrier can be constructed and will perform as it was modeled in the performance assessment. The assessment would determine if activities have been incorporated into the site's performance assessment maintenance program and if measurable progress is being made.

The Center of Excellence for Low-Level and Mixed Low-Level Waste (the Center) will take the lead in identifying studies and research to be proposed for funding by the Environmental Management Office of Science and Technology in support of low-level waste disposal. Working with other organizations (e.g., Offices of Waste Management and Environmental Restoration, the Low-Level Waste Disposal Facilities Federal Review Group, Office of Science and Technology Focus Teams) the Center will identify technical studies and research which has relevance to multiple sites or is otherwise appropriate to the mission of the Office of Science and Technology. In identifying studies or research to be proposed, the organizations will consider the number of sites that will benefit by the work and the significance of the benefits at each site.

The Center will also serve as an advocate for continuing improvement in performance assessments and composite analyses by actively searching out and disseminating information on studies and research in support of low-level waste disposal. In this role, the Center will provide information on research and development activities being conducted by the sites and by the Office of Science and Technology to Headquarters and field staff responsible for performance assessment and composite analysis maintenance. In addition, the Center will interface with other agencies (e.g., Nuclear Regulatory Commission, Environmental Protection Agency, International Atomic Energy Agency) regarding their technical activities related to low-level waste disposal. Finally, the Center and Environmental Management will work collectively to identify technical or policy studies with complex-wide significance that will be done by Headquarters, the Center, or a field element.

## 5. REFERENCES

- DNFSB (Defense Nuclear Facilities Safety Board) 1994, "Conformance with Safety Standards at Department of Energy (DOE) Low-Level Nuclear Waste and Disposal Sites," Recommendation 94-2, (September 8).
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