

**Department of Energy**

Washington, DC 20585

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DWF SAFETY BOARD

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

Dear Mr. Conway:

In the "Defense Nuclear Facilities Safety Board Recommendation 94-2 Implementation Plan," (March 31, 1995) the Department of Energy (DOE) recognized the need for research and development (R&D) to support data needs and improvements in the low-level waste (LLW) management program, and committed to a number of actions to improve this area of LLW management. The Implementation Plan identified that DOE would catalog applicable R&D activities, coordinate the identification of R&D needs, correlate the needs with the catalog of activities, and develop and recommend an R&D strategy for the LLW R&D not being addressed.

I am pleased to report that we have completed the first milestone to develop a preliminary LLW management R&D Activities Catalog addressing the five R&D needs areas identified by the Board. Enclosed is our report which provides an overview of the R&D task, summarizes the process and results of the R&D data searches, and provides detailed information on how to access the R&D Activities Catalog.

The catalog is provided as a Microsoft Access database for ease of searching and is accessible on the Internet for maximum accessibility by all users of the information. The database contains approximately 5,000 records composed of several fields including: classification by one of the five Board areas, cognizant individual, performing organization, summary of results, and an assessment of research maturity. The catalog is based on a search of printed data sources including DOE's Office of Technology Development, Technology and Integrated Program Summaries, and Nuclear Regulatory Commission's Summary of LLW Research Program, and electronic sources including the Integrated Technical Information System and the National Technical Information System.

The records have had a preliminary screening for applicability to LLW needs by technical experts at Pacific Northwest Laboratories. Additional screening of the catalog by the R&D Task Team will take place as the R&D needs are defined for the September 30, 1995, milestone.

We will keep you advised of our progress in this area through contact with your staff and our progress reports to the Board.

Sincerely,



Jill E. Lytle  
Deputy Assistant Secretary  
for Waste Management  
Environmental Management

Enclosure

**DNFSB Recommendation  
94-2 Implementation Plan  
Preliminary LLW  
Management R&D Activities  
Catalog**

**Version 1.0 / June 27, 1995**

**Research and Development Task 1.b.1**

## INTRODUCTION

On September 8, 1994, the Defense Nuclear Facilities Safety Board (DNFSB or the Board) issued recommendation 94-2, Conformance with Safety Standards at Department of Energy (DOE) Low-Level Nuclear Waste and Disposal Sites. The DOE accepted Recommendation 94-2 on October 28, 1994, and in response created the Recommendation 94-2 Implementation Plan. Part of Recommendation 94-2 focused on DOE addressing certain research and development needs that are critical to the effective management of low-level nuclear waste (LLW) within DOE. In addition, DOE recognizes that there is currently no coordinated program to (1) identify, implement and guide LLW research and development (R&D), and (2) ensure that R&D needs are met. Consequently, as part of the Implementation Plan, a research and development (R&D) task was created to identify where LLW management R&D needs exist and define a strategy for addressing these needs.

### Overview of the Research and Development Task

In their review, the Board identified five main R&D needs for improving the LLW management program. Based on the recommendations made by the Board, these needs are described as follows:

Improving modeling and predictive capabilities of radionuclide migration. This refers to the need to reduce the "high-level of uncertainty" introduced by use of predictive models. Recommendation 94-2 cites the following sources of uncertainty, in no specific order: simplifying assumptions, model and scenario development, long simulation times required, complexity of site characteristics, and radionuclide and contaminant transport mechanisms.

Reducing the volume of waste to be disposed. Recommendation 94-2 specifically asks the DOE to study "more environmentally-acceptable incineration," and other volume reduction techniques. The Board believes that the DOE will be constrained by disposal capacity soon, and would like to see the DOE avert such a problem by reducing the volume needing disposal.

Enhancing the stability of buried waste forms. Commercial stabilized wastes have undergone several "environmental" tests to determine their ability to meet the regulatory technical position published by the NRC. The NRC has published much research to confirm the results of the tests and verify that the waste forms will last.

Enhancing the deterrence of intrusion. The Board is critical of DOE cover designs. The Board would like to see what DOE is doing to design and build better covers to deter inadvertent human intrusion.

Inhibiting the migration of radionuclides. Again, the board is critical of DOE cover designs. The Board would like to see what the DOE is doing to design and build covers that reduce infiltration of water through the waste. This activity will also feed into reducing model uncertainty, as one of the major areas of uncertainty in the modeling exercise is "source term."

The approach being taken by the R&D task will be a two-phased approach. In the first phase, a strategy will be defined to address the R&D needs identified by the Board. In the second phase, a strategy for addressing any other R&D needs identified through the execution of other tasks in the Implementation Plan will be defined. Primarily, the other tasks from which this information will come include Systems Engineering for LLW Management, Complex Wide Review, and Performance Assessments.

Four main activities were defined in the R&D task, each consisting of the two phases just described. The first R&D activity (Task 1) will provide a comprehensive catalog of LLW R&D activities that might apply to any LLW management function. In the second activity (Task 2), the areas where R&D needs exist will be identified through the development and application of guiding criteria. It is being proposed that the criteria will first identify major risk (dose) contributors and the corresponding needs to lower risks, and second identify

major uncertainty contributors to risk (dose) and the corresponding needs to reduce uncertainties. As defined in the implementation plan, the task of cataloging LLW R&D activities chronologically precedes the task of identifying R&D needs. As a result, it has been difficult, at least initially, to provide focus to the cataloging task. Therefore, the task to identify R&D needs will be started as soon as possible to assist in screening information to be retained in the catalog database. The initial deliverable of the R&D catalog contains many entries that will be screened out based on refinement of keyword searches and the needs identified by the RDTT. In the third activity (Task 3), a systematic gap analysis will be conducted to identify which R&D needs are or have already been addressed and which R&D needs have yet to be addressed. Finally, the fourth activity (Task 4) will develop and recommend an overall LLW R&D strategy that will identify R&D resources and options, develop preliminary strategies for applying options to meet unaddressed LLW R&D needs, coordinate the preliminary strategies with the appropriate field elements and the LLW management task group to define final strategies, and present the recommended strategies. The schedule for completion of milestones is provided in the DNFSB Recommendation 94-2 Implementation Plan.

A research and development task team (RDTT), consisting of individuals with experience in several areas of LLW management and/or associated with DOE LLW management facilities, will be responsible for guiding the activities under the R&D task and will also provide technical input as the activities proceed. As a result, the RDTT is the group intended to eventually provide the strategy to guide the LLW R&D program and provide increased priorities for LLW R&D projects. To do this, the RDTT will interface and coordinate with other groups within the DOE and with other related groups outside the DOE (e.g., Nuclear Regulatory Commission, commercial, international). Specifically within the DOE, RDTT interfaces will exist with the DOE Office of Technology Development and its five Focus Areas, the DOE Environmental Research and Development Steering Committee, and the Office of Waste Management Focus Area Representatives. LLW management facility operators will also be consulted and informed during the process. As there are other activities associated with the Implementation Plan (e.g., Complex Wide Review, Systems Engineering for LLW management, Performance Assessments), the RDTT will be working with the groups conducting these activities to coordinate activities, exchange information, identify issues, and report to the LLW management task group.

## **TASK 1.B.1 DESCRIPTION**

The work reported here was done to address Task 1.b.1 of the DNFSB Recommendation 94-2 Implementation Plan Research and Development Task, namely, "Catalog DOE and non-DOE LLW Management R&D activities."

The objective of this milestone is to conduct an R&D survey to identify those activities where results and expected results are applicable to LLW management improvements. Existing Technology development database systems were to be utilized where available to support this survey. The scope of this survey was to be comprehensive and includes: past, present, and planned R&D projects; OWM, OTD, other DOE, other government, commercial and international supported R&D projects; and, local site initiatives and activities. This current milestone is a "Preliminary LLW management R&D Activities Catalog issued for initial needs identified by the Board," consisting of the five R&D areas previously identified.

This database is an essential resource for the RDTT. The database will provide them a readily accessible and searchable catalog of research activities relevant to LLW R&D. The preliminary catalog to meet this current milestone as well as the final catalog deliverable due December 31, 1995, is a compilation of previous and current R&D studies relevant to the release and movement of low-level radioactive waste (LLW) in the ground (i.e., in the unsaturated soil or in the saturated groundwater aquifer) volume reduction, waste form stability, and deterrence of human intrusion.

The searches of R&D activities focussed on processes affecting radionuclides in LLW or with radionuclides in general (i.e., not with organic chemical or non-radioactive metal contamination, etc). However, other substances, such as organic chemicals, are not completely irrelevant because their presence can in some circumstances affect the release and migration of the radionuclide (e.g., organic chemicals that form complexes with radionuclides can alter the mobility of the radionuclides in soil).

Many types of waste sources (waste forms) are relevant (e.g., leaching ponds and cribs, buried drums and tanks, buried vaults of grouted/cemented waste, unmodified contaminated soil, vitrified contaminated soil). However, sources that release contamination only to the air or to surface water are not included because contaminant migration in those media were not considered in this preliminary search. In performance assessments to evaluate DOE LLW, subsurface transport pathways dominate the analyses.

The approach to this task was to conduct searches of electronic and hard copy databases for R&D programs, projects, and products (publications) pertinent to LLW management. The guidance provided in the DNFSB Recommendation 94-2 and in the DOE Implementation Plan was sufficiently general that additional refinement was necessary to narrow the search range for the electronic and hard copy databases. It is important to note that this deliverable is a preliminary catalog based on an initial effort to identify and capture as much information as possible. In the process of capturing pertinent information, much extraneous material was captured that will be screened out. The catalog will be screened and updated based on review of record titles and as Task 2 is initiated and the RDTT begins to identify LLW R&D needs. Details about the specific focus of the five areas are given below.

### **Area 1: Improved radionuclide migration modeling and prediction**

Find studies that reduce or treat uncertainty in modeling of radionuclide migration/transport in soil/aquifers (so that more robust analyses of transport can be made: qualitative predictions, simple quantitative predictions, more complex mathematical models or transport simulators). Included in this area are simulators that represent chemical and microbial processes that are significantly coupled to transport.

### **Area 2: Reduction of waste volume**

Find studies aimed at understanding or developing processes to reduce the volume of waste that ends up going into the waste source. The primary focus of this area is not on waste minimization (i.e., reducing the amount of waste generated). It is reducing the overall

volume of waste generated or recovering some components of the waste for some use other than disposal. This area additionally includes finding studies aimed at reducing the needed size of waste disposal sites for a given amount of waste. A secondary effect of R&D activities in this area is to develop means of reducing the amount of contamination potentially released and transported from the LLW disposal facility in the future.

### **Area 3: Enhanced waste-form stability**

Find studies aimed at understanding or developing processes to reduce the degradation of waste forms by increasing their stability. Slower release from the waste form, or binding the radionuclides in the waste form so that ultimately not all of them can be released, means that concentrations moving through the ground at any time will be lower than they would be from the "unenhanced" waste form.

### **Area 4: Enhanced deterrence of intrusion into waste form**

Find studies aimed at understanding or developing processes to reduce the hazard from radionuclides in the ground by reducing the possibility that the waste form will be disrupted by either direct human intrusion or by the intrusion of environmental processes (i.e., reduced intrusion into the waste form means that direct exposure hazard during human intrusion is eliminated).

### **Area 5: Inhibition of radionuclide migration**

Find studies aimed at understanding or developing processes to reduce the hazard from radionuclides in the ground by reducing the mobility of the radionuclides in the ground (e.g., by reducing water flow through the waste zone with covers and protective barriers, by altering sorption or precipitation of the radionuclides in the soil) means that it will take longer for the decaying radionuclide to move through the ground to a potential point of human exposure). Note that this area includes studies on protective barriers that are designed to isolate waste forms from the normal unsaturated soil water flow.

## CATALOG DESCRIPTION

This catalog contains records describing a diverse set of publications and projects that have relevance to LLW R&D. The records come from a variety of sources including both electronic and printed sources. Each record is composed of several fields including: a detailed abstract; investigators/authors; funding organization; and an assessment of the maturity and relevance of the technology to various identified R&D needs. The catalog is provided as a Microsoft™ ACCESS™ database file for easy searching and filtering.

### Catalog Sources

Information in both electronic and printed sources are included in the catalog. A diverse set of sources have been reviewed. Many electronic sources provide duplicate records with other sources, therefore, secondary sources will only be selectively tested to ensure that they do not provide any new information unavailable from the primary sources. Table 1. provides a list of the catalog sources including a brief description of the source and the current status of searches being performed on the source.

The information captured in the database represents a significant portion of the final product. The database entries need to be manually screened for applicability to the five research areas, but the entries were screened as much as possible electronically. Additional screening by review of titles will reduce the total number of records. With the primary database sources (NTIS, ITIS, EDB), there is considerable overlap. An additional part of the screening process will be to ensure that the areas unique to each database are captured. The phrase "...results not in database" in Table 1 means that this cross checking has not occurred, but the contents are likely included from the primary ITIS database.

Table 1. Catalog Sources

Source	Description	Format	Status
NTIS	National Technical Information System- A collection of bibliographic citations and abstracts to scientific, engineering, and technical reports collected by the National Technical Information Service.	Electronic	Preliminary Search Complete, results not in database
SARIS	Statutory and Regulatory Information Service - A full-text database of regulatory documents including: the daily Federal Register, Code of Federal Regulations, NRC Regulatory Guides, and DOE Orders.	Electronic	Preliminary Search Complete, results not in database
SITE	Superfund Innovative Technology Program - Includes status, results, and detailed descriptions of technologies.	Paper	Preliminary Search Complete, results not in database
VISITT	EPA database	Electronic	Preliminary Search Complete, results not in database
	Nuclear Science Abstracts Database	Electronic	Preliminary Search Complete
DOE-OTD	OTD Database, Technology and Integrated Program Summaries	Paper	Preliminary Search Complete and results in database except Mixed Waste Integrated Program and Mixed Waste Integrated Demonstration
	Nuclear Information System - IAEA		Not searched



CURRENT CONTENTS	The complete table of contents of over 1300 journals in the area of Life Sciences; over 930 journals in the areas of Agriculture, Biology, and Environmental Sciences; over 840 journals in the Physical, Chemical & Earth Sciences disciplines; and over 830 journals in Engineering, Technology & Applied Sciences. An excellent source for current awareness.	Electronic	Not searched
ITIS	<p>Integrated Technical Information System - An online system developed and maintained for the U.S. Department of Energy by the Office of Scientific and Technical Information. The ITIS databases provide access to a variety of scientific and technical information collected worldwide in support of DOE's R&amp;D activities and interests in energy and energy-related fields. The databases currently available within ITIS includes:</p> <ul style="list-style-type: none"> <li>A. Energy Science and Technology Database (EDB)</li> <li>B. Research in Progress (RIP)</li> <li>C. Report Holdings File (RHF)</li> <li>D. Management Information File (MIF)</li> <li>E. Controlled Access File (CAF)</li> <li>F. Nevada Nuclear Waste (NNW)</li> <li>G. National Energy Software Center Database (NESC)</li> <li>H. Foreign Research in Progress (FRP)</li> <li>I. Minority Economic Impact Database (MEI)</li> <li>J. New Technology from DOE (NTD)</li> <li>K. Numeric Database Directory (NDB)</li> </ul>	Electronic	Preliminary Search Complete, EDB results in database (this is the primary source of information for this version of the catalog)
NRC	Summary of LLW Research Program	Paper	Search Complete, results in database
POLTOX	Electronic abstract database	Electronic	Search Complete, results not in database
EPRI	EPRI Database	Unknown	Not searched

## SEARCH STRATEGY FOR ELECTRONIC DATABASES

Table 2 documents the keyword search strategies that were used to query DOE's Energy Science and Technology Database (EDB) from the Hanford Technical Library. Unless otherwise specified, record fields that were searched included TITLE, SUBJECT HEADINGS, and ABSTRACT. This electronic database includes overlap with other electronic databases that were searched. Similar search strategies were used for those databases.

Table 2. Keyword Search Strategies.

Relevant Area	Database	Keyword
Modeling	ITIS/EDB	(waste? ? or contaminant? ?) and (radionuclide? ? or nuclide? ? or radioactive) and (transport or migration) and (model? or predict? or simulate? or forecast? or projection) and (soil? ? or aquifer? ? or groundwater or ground()water or subsurface or sub()surface) and PY=1985:1995 not (organic? ? or NAPL or petroleum or fossil()fuel? ? or sewage or municipal()waste? ? or landfill? ? or medical()waste? ? or flue()gas? ? or exhaust()gas?? or waste()gas?? or natural()gas or fly()ash or slag or atmospher? or air()pollution or marine or ocean?? or economic or exposure or record(2w)decision or surface()contamination or air or airborne or remed? or decontaminat? or cleaning or lake? ? or monthly()report or annual()report or quarterly()report or management/TI,AB or dt=patent or dt=legislative)
Reduction of waste volume	ITIS/EDB	(waste? ? or contaminant? ?) and (radionuclide? ? or nuclide? ? or radioactiv?) and (waste? ?(3N)reduc? or waste? ?(3N)recover?) and PY=1985:1995 not (organic? ? or NAPL or petroleum or fossil()fuel? ? or sewage or municipal()waste? ? or landfill? ? or medical()waste? ? or fly()ash or flue()gas?? or exhaust()gas?? or waste()gas?? or natural()gas or slag or atmospher? or air()pollution marine or air()pollution or marine or ocean?? or sulfate()reduc? or nitrate()reduc? Or minimization)
Enhancement of waste form stability	ITIS/EDB	((waste? ? or contaminant? ?) and (radionuclide? ? or nuclide? ? or radioactive)) or (waste()form? ? or vault? ? or tank? ? or drum? ? or container? ? or canister? ?)) and (stab? Or low?()release or slow()release) and PY=1985:1995 not (organic? ? or NAPL or petroleum or fossil()fuel? ? or sewage or municipal()waste? or landfill? ? or medical()waste? ? or flue()gas?? or exhaust()gas?? or waste()gas?? or natural()gas or fly()ash or slag or atmospher? or air()pollution or marine or ocean?? or decommission? or record(2w)decision or seismic or earthquake? ? or explos? or NMR or nuclear()magnetic()resonance or management/TI,AB or annual()report or monthly()report or quarterly()report or dt=legislative? or dt=patent)
Enhancement of intrusion deterrence	ITIS/EDB	(waste? ? or contaminant? ?) and (radionuclide? ? or nuclide? ? or radioactive) and (intrusion or barrier? ? or marker? ? or biointrusion or physical()protection) and PY=1985:1995 not (organic? ? or NAPL or petroleum or fossil()fuel? ? or sewage or municipal()waste? ? or landfill? ? or medical()waste? ? or flue()gas?? or exhaust()gas?? or waste()gas?? or natural()gas or fly()ash or slag or atmospher? or air()pollution or marine or ocean?? or tomography or transportation or record(2w)decision or contaminated()building? ? or contaminated()facilit? or annual()report or monthly()report or quarterly()report)

<p>Inhibition of radionuclide migration</p>	<p>ITIS/EDB</p>	<p>(waste? ? or contaminant? ?) and (radionuclide? ? or nuclide? ? or radioactive) and (transport or migration) and (soil? ? or aquifer? ? or groundwater or ground()water or sub()surface or subsurface) and (mobility or retardation or adsorption or sorption or precipitation) and PY=1985:1995 not (organic? ? or NAPL or petroleum or fossil()fuel? ? or sewage or municipal()waste? ? or landfill? ? or medical()waste? ? or fossil()fuel? ? or exhaust()gas?? or waste()gas?? or natural()gas or fly()ash or slag or atmospher? or air()pollution or marine or ocean?? or record(2w)decision)</p>
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As can be seen in the table, the searches were constrained by items not to be included as much as a listing of areas for inclusion. Care was taken to not eliminate areas of potential interest. This will require additional manual screening.

**DATABASE FIELDS**

Table 3 is a template of the contents included in the Microsoft™ ACCESS™ database.

Table 3. Fields for Microsoft™ ACCESS™ Database

<b>Field</b>	<b>Description</b>
Title	Title of the research program or published report, journal article, or conference paper
Relevant Area	One of the five R&D areas identified by the Board
Descriptive Keywords	Keywords assigned for later searching (not included in this version)
Cognizant Individual	Principal investigator (PI) or lead author with co-PI or co-authors
Performing Organization	Organization responsible for the product
Funding Organization	Organization providing funding for R&D
Country	Country in which R&D was performed
Objective or Abstract	Description of the objectives, abstract, or summary of R&D
Summary of Results to Date	Description of R&D results obtained to date (not provided if a published report; information is contained in the abstract or summary)
Summary of Expected Results	Description of R&D results expected in the future, if applicable (not provided if a published report; information is contained in the abstract or summary, if applicable)
Maturity	Description of the form of research; basic, applied research, development, demonstration, or deployment (provided for a few research projects in the current database)
Reference	Source of information or client report number
Begin	Starting time for R&D activity (available for only a few entries in the current database)
End	Ending time for R&D activity (available for only a few entries in the current database)
Contract Number	Number of the contract, if available (available for only a few entries in the current database)

## PRELIMINARY SEARCH RESULTS

The results of the initial search to produce this preliminary R&D catalog are a mixture of research (in the form of published reports, journal manuscripts, and conference papers) and a description of research programs. Most of the database submitted for this milestone consists of published results; current research programs are included where they are available (e.g. DOE-OTD and NRC). One area identified by the Board that is not adequately captured is local site initiatives and activities, other than what is published and in electronically searchable databases. Current research initiatives and activities will be captured through participation of site representatives on the RDTT.

Even the optimum set of keywords and search strategy will retrieve extraneous material. The goal in developing a keyword search strategy is to maximize the number of relevant records identified while at the same time minimize the number of irrelevant or marginally relevant records included. For this effort, electronic source databases were searched several times for each of the five R&D areas, refining the keywords and search strategy each time, before the final set of search strategies reported in Table 2 were obtained.

The electronic catalog was created primarily by taking results files generated by the electronic source database searches and modifying them for importation into Microsoft<sup>™</sup> ACCESS<sup>™</sup> with an appropriate format. This process did not result in a one-to-one translation between entries in the original database and the Microsoft<sup>™</sup> ACCESS<sup>™</sup> database. Therefore, the format of this preliminary database may be revised based on input from the RDTT and others. A smaller amount of catalog records were entered manually resulting from searches of a few non-electronic databases. During the electronic search process, each record in the catalog that was derived from a results file obtained by searching according to a particular keyword search strategy was electronically "tagged" as being relevant to the R&D needs area that the search strategy corresponded to. If the same record was identified by more than one keyword search strategy, it was initially "tagged" as being relevant to more than one R&D needs area. In other words, the initial classification of records in the catalog was done automatically; and was only as accurate as the source database search itself. The small amount of manual entries were classified manually.

The second phase of classification consisted of manually screening the records in the catalog and modifying their categorization by R&D needs area, if necessary. At the time of distribution of this report, this screening and recategorization process is still in progress. Therefore, the catalog still contains some records that may be categorized as relevant to a particular R&D needs area even though they are: 1) only relevant to a different R&D area, or 2) irrelevant or only marginally relevant to that area. The next screening step is to manually review titles to eliminate additional records that are not relevant. This will be done first by searching and deleting records based on title and then by reviewing contents. Based on a title screening search of the modeling area, approximately 25% of the records are irrelevant. Table 4 summarizes the distribution of records in the catalog among the five R&D needs areas based on the current status of the categorization. The total size of this database is 21MB, which will be reduced significantly by screening titles and abstracts, and by future definition of R&D needs by the RDTT. Searches in all R&D needs areas retrieved some records that could be classified as "waste characterization." When developing the catalog, these records were retained and electronically "tagged" as being relevant to a category called "waste characterization." However, because this is not one of the initially identified R&D needs areas, this categorization has currently been left invisible on the catalog record template.

All electronic database searches went back 10 years. Hence, the LLW R&D catalog consists of publications or projects produced within the last 10 years (with the possible exception of some records that represent older activities that for some reason were only

entered into the database within the last 10 years). The catalog includes both national and international (foreign language) LLW R&D activities; although the majority of entries are of US origin and are in English. The types of references in the catalog include: technical reports, journal articles, proceedings of conferences, symposia, and workshops, books and monographs (mostly collections of papers or chapters by different authors), programmatic reports, theses and dissertations, and patents (both U.S. and foreign).

Table 4. Statistics of the Number of Records in Each R&D Area.

R&D Area	Number of Records in Microsoft™ ACCESS™ Database
Modeling	1299
Reduction of waste volume	671
Enhancement of waste form stability	1596
Enhancement of intrusion deterrence	1756
Inhibition of radionuclide migration	646
Total number of records in all five areas	5197

Our approach has been to construct keyword searches to capture all relevant information. This approach has resulted in capture of a number of records that are not relevant to LLW R&D. The next tier of screening is to manually search titles and eliminate records that clearly are not relevant. Further screening will be based on input from the RDIT and others. The sum of the records listed in each area is greater than the total number of records because there is some overlap; some records are applicable to more than one R&D area.

Summaries of the subjects of records currently categorized into each of the five R&D needs area are provided below.

**R&D Area 1: Improving modeling and predictive capabilities of radionuclide migration.**

Records in this category include: studies of development of conceptual and mathematical models (deterministic or probabilistic) to describe aqueous-phase radionuclide transport (including advection, dispersion, sorption, and decay), studies of water flow at radioactive waste sites, studies to validate water flow and aqueous-phase nuclide transport models using existing site monitoring data or controlled experiments, documentation of computer codes for radionuclide transport, performance assessments of proposed radioactive waste disposal site designs, studies of overland runoff of nuclides with subsequent infiltration into soil, studies of the effect on nuclide transport of pH changes, studies of the effect on nuclide transport of water flow velocity variations over time, parameter sensitivity and uncertainty studies for nuclide transport modeling, dose and risk-assessment studies that incorporate a radionuclide transport module, documentation of computer codes for dose and risk-assessment calculations involving nuclides, studies of plant uptake of nuclides, and studies of gas-phase nuclide (radon) transport. In addition, the keyword search strategy of Table 2 retrieved into other categories some records relevant to this category. These records include: studies of nuclide sorption only and studies of nuclide transport with sorption (predictive modeling only, not modifying sorption to retard migration). Some of these records may currently still be tagged as being relevant to these other categories, but not this category.

The keyword search strategy of Table 2 also retrieved into this category some records that

are irrelevant or only marginally relevant to this catalog. These records include: studies of nuclide movement in surface water and sediments in lakes and streams, regulatory compliance reports for waste sites, and studies of migration of radioactive fallout onto soils. Some of these records may currently still be tagged as being relevant to this category. Furthermore, the keyword search strategy of Table 2 also retrieved into this category some records that actually should be categorized into another R&D area. These records include: descriptions of laboratory measurement techniques for soil solution speciation (Area 2 or 3), characterizations of waste-form leachate compositions (Area 3), and studies of the deterioration of cemented waste forms by percolating water (Area 3). Some of these records may currently still be tagged as being relevant to this category, but not these other categories. A broader interpretation of this R&D area would also include site characterization.

**R&D Area 2: Reducing the volume of waste to be disposed.** Records in this category include: studies of waste volume reduction by vitrification or solidification with ceramics, studies of solid waste volume reduction by combustion, studies of solid waste volume reduction by physical separations, studies of liquid waste volume reduction by chemical separations (e.g., ion exchange, specific sorption, precipitation) in batch reactors or fluidized beds, studies of waste volume reduction by biochemical processing, studies of waste volume reduction by leaching nuclides from solid wastes and processing leachates, studies of volume reduction of irradiated metal components by melting or compaction, risk assessments of waste treatment technologies, comparisons of different volume reduction methods, descriptions of methods for recovering liquid waste from tanks for subsequent volume reduction treatments, descriptions of methods for increasing the packing efficiency of disposal containers, and economic analyses of the impact of volume reduction methods. In addition, the keyword search strategy of Table 2 retrieved into other categories some records relevant to this category. These records include: descriptions of laboratory measurement techniques for soil solution speciation and nuclide content in wastes, studies of how to increase stability of particulate suspensions in waste separations processes. Some of these records may currently still be tagged as being relevant to these other categories, but not this category.

The keyword search strategy of Table 2 also retrieved into this category some records that are irrelevant or only marginally relevant to this catalog. These records include: characterizations of waste tank contents, periodic progress reports of site operations, and descriptions of methods for waste minimization. Some of these records may currently still be tagged as being relevant to this category. Furthermore, the keyword search strategy of Table 2 also retrieved into this category some records that actually should be categorized into another R&D area. These records include: studies of reducing waste leaching by vitrification of waste form (Area 3), studies of stabilizing liquid waste by mixing with cement/grout, polymers, or bitumen (Area 3), and description of methods for deterring intrusion at specific waste sites (Area 4). Some of these records may currently still be tagged as being relevant to this category, but not these other categories.

**R&D Area 3: Enhancing the stability of buried waste forms.** Records in this category include: studies of reducing waste leaching by vitrification of waste form, studies of stabilizing liquid waste by mixing with cement/grout or polymers, performance tests of waste-form production methodologies and simulated waste forms/containers, descriptions of laboratory measurement techniques for nuclide content in wastes, and descriptions of methods for sealing spent fuel and radioactive waste containers. In addition, the keyword search strategy of Table 2 retrieved into other categories some records relevant to this category. These records include: descriptions of laboratory measurement techniques for soil solution speciation, characterizations of waste-form leachate compositions, studies of waste form deterioration over time, studies of reducing waste leaching by vitrification of waste form, studies of stabilizing liquid waste by mixing with cement/grout, polymers, or bitumen. Some of these records may currently still be tagged as being relevant to these other categories, but not this category.

The keyword search strategy of Table 2 also retrieved into this category some records that are irrelevant or only marginally relevant to this catalog. These records include: studies of geologic stability of waste sites during seismic events, studies of the stability of reactor vessels under pressure, studies of weathering of naturally occurring nuclide-containing minerals, test reports on the stability of polymers using nuclear magnetic resonance, reports of radioactive gas processing, annual overview/surveillance/ maintenance reports for waste sites, studies of stability of subatomic particles, reports of hazards associated with waste forms (e.g., "stable" or explosive), and studies of integrity of containers used in facility operations. (Some of these records may currently still be tagged as being relevant to this category.) Furthermore, the keyword search strategy of Table 2 also retrieved into this category some records that actually should be categorized into another R&D area. These records include: studies of how to increase stability of particulate suspensions in waste separations processes (Area 2), studies of how to "stabilize" clay caps emplaced over waste sites (Area 4 or 5), and studies of "stabilization" of contaminants by having them sorb to barriers or in soil (Area 5). Some of these records may currently still be tagged as being relevant to this category, but not these other categories.

R&D Area 4: Enhancing the deterrence of intrusion. Records in this category include: designs of marker systems to deter human intrusion, designs and performance assessments of protective caps or barriers to prevent recharge water from impinging on the waste form, and performance tests of methods of checking for intrusion. The records pertaining to barriers for reducing infiltration will be moved to R&D Area 5. In this preliminary deliverable, these records are captured in R&D Area 4. In addition, the keyword search strategy of Table 2 retrieved into other categories some records relevant to this category. These records include: studies of how to "stabilize" clay caps emplaced over waste sites, theoretical studies of effectiveness of cover/barrier designs. Some of these records may currently still be tagged as being relevant to these other categories, but not this category.

The keyword search strategy of Table 2 also retrieved into this category some records that are irrelevant or only marginally relevant to this catalog. These records include: reports of intrusion into containers used to transport waste, reports of intrusion into contaminated buildings, waste disposal site performance assessments or environmental exposure and dose calculations that include hypothetical human intrusion scenarios, general environmental monitoring reports, and general performance evaluation reports of waste sites and national laboratories. Some of these records may currently still be tagged as being relevant to this category. Based on preliminary scans of the catalog, the keyword search strategy of Table 2 did not seem to retrieve into this category records that actually should be categorized into another R&D area.

R&D Area 5: Inhibiting the migration of radionuclides. Records in this category include: theoretical studies of effectiveness of cover/barrier designs, studies of nuclide sorption, studies of nuclide transport with sorption, and studies of plant uptake of nuclides. In addition, the keyword search strategy of Table 2 retrieved into other categories some records relevant to this category. These records include: studies of "stabilization" of contaminants by having them sorb to barriers or in soil and studies of how to "stabilize" clay caps emplaced over waste sites. Some of these records may currently still be tagged as being relevant to these other categories, but not this category.

The keyword search strategy of Table 2 also retrieved into this category some records that are irrelevant or only marginally relevant to this catalog. These records include: guidelines for waste site selection and general programmatic overviews. Some of these records may currently still be tagged as being relevant to this category. Furthermore, the keyword search strategy of Table 2 also retrieved into this category some records that actually should be categorized into another R&D area. These records include: studies of water flow at radioactive waste sites (Area 1), dose and risk-assessment studies that incorporate a radionuclide transport module (Area 1), characterizations of waste-form leachate



compositions (Area 3), and studies of waste form deterioration over time (Area 3). Some of these records may currently still be tagged as being relevant to this category, but not these other categories.

## USING THE CATALOG

The R&D catalog is available on the INTERNET on a file server at PNL called `pnlg.pnl.gov`. This enables the catalog to be updated, providing the most current version to potential users. Users can easily access the current version of the database. This approach also enables PNL to control versions of the catalog for configuration management.

### Obtaining the Catalog via the INTERNET

The file `llwrdb.mdb` can be obtained from the internet FTP site `ftp.pnl.gov` using `ftp` and logging into the ftp site as 'anonymous'. The follow describes this process with the windows application `WS_FTP` and with a command line FTP utility program.

Caution is required because the size of the current version of the database is 21MB. The size of this database will be reduced significantly by the screening of 1) titles, 2) abstracts, and 3) definition of needs by the RDTT. Approximately 2.5 minutes were required to upload this file using `ftp`; a similar amount of time can be expected for downloading, however, the user must have sufficient space on their computer to download the file.

### WS\_FTP (Windows)

1. Open the `WS_FTP` application. (double click on its icon)
2. It automatically opens up a "Connect to ..." window but if it does not, click on the "Connect" button to open this window.
3. Enter the following information in the indicated fields:

```

Config Name: PNL
Host Name:  ftp.pnl.gov
Host Type:  auto detect
User ID:    anonymous
Password:   <your email address>
            i.e. zz_smith@somedomain.gov
  
```

Note: The fields in your "Connect to ..." window may be named differently do to changes in different versions of `WS_FTP`.

4. Click on the "Ok" button. The "Connect to ..." window disappears and the connection to `ftp.pnl.gov` is made.
5. After the connection is made, `WS_FTP` will display a list of directories for the remote site. Navigate to the directory `/pub/llwrdb`. This navigation is performed with the directory list on the right side of the `WS_FTP` window.
6. In the `/pub/llwrdb` directory, select the `llwrdb.mdb` file.
7. Use the directory list on the left side of the `WS_FTP` window to select a directory (on your local PC) where you would like to copy the file to.
8. Click on the "<" button. This transfers the file from the directory on the right side of the window (the remote directory) to the directory on the left side of the window (the local directory).

### DOS command line FTP utility

Depending on the FTP utility you are using, the syntax may vary for following commands.

1. At the DOS command prompt, type `ftp`  
Your prompt should change to something like `FTP>`.
2. To initiate the connection type the following command at the FTP prompt:

```
FTP> open ftp.pnl.gov
```

3. Type **anonymous** at the username prompt that now displays.
4. At the password prompt, type your electronic mail address.

When you receive a message indicating that you are logged on to the remote system, you are ready to initiate file transfers.

5. To download the llwrld.mdb file to your local root directory, type in the following command at the FTP prompt.

```
FTP> get /pub/llwrld/llwrld.mdb c:\llwrld.mdb
```

6. Close the FTP connection with the following command.

```
FTP> quit
```

### **Loading the Catalog**

open

**Searching/Filtering with Microsoft™ ACCESS™**

**TEXT TO BE PROVIDED**