DNFSB 94-2 Implementation Plan
Section IX, Research and Development
Task 2: DOE R&D Needs Assessment

R. L. Devries

March 1997

Idaho National Engineering and Environmental Laboratory
Waste Operations Department
Lockheed Martin Idaho Technologies Company
Idaho Falls, Idaho 83415

SUMMARY

The purpose of this report is to identify research and development (R&D) needs for the Department of Energy (DOE) that relate to the management or disposal of low-level radioactive waste (LLW) and technology development. For the purpose of this report, technology development is defined as the development of a tool; this does not include the application of existing tools, refinement of existing models, performing more detailed analyses, or collecting data. This report explains the approach used to assess R&D needs, describes the sources evaluated, and lists the results of those evaluations.

The approach to DOE R&D Needs Assessment was to identify sources of R&D needs, evaluate each R&D need against two criteria, and prepare a letter report containing the results of the evaluation.

The sources of R&D needs used in this assessment included (1) Site Technology Coordination Group's (STCG) needs documents, (2) Site-specific and Complex-wide vulnerabilities and corrective actions, (3) DOE LLW disposal site performance assessments (PAs), (4) the DOE PA Task Team Progress Report, and (5) the LLW R&D Needs Statement.

Approximately 1,000 needs statements were evaluated against two criteria: management or disposal of LLW, and technology development. Of those evaluated, 56 received a Yes determination (met both criteria), 110 received an Unknown determination (insufficient information to determine if criteria were met).

CONTENTS

DNFSB 94-2 Implementation Plan
Section IX, Research and Development
Task 2: DOE R&D Needs Assessment

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 Low-Level Nuclear Waste and Disposal Sites." Part of Recommendation 94-2 focused on the need for the Department of Energy (DOE) to address certain research and development (R&D) needs and background studies that are critical to the effective management of low-level radioactive waste (LLW) within DOE.

On October 28, 1994, DOE accepted Recommendation 94-2 and in response created the 94-2 Implementation Plan. DOE recognized that although its Environmental Management Program has continuing research programs, there is currently no coordinated program specific to LLW that can (1) identify, implement, and guide LLW R&D, and (2) ensure that R&D needs are met. Consequently, as part of the Implementation Plan, DOE committed to establish an R&D Task Team (RDTT) to identify where LLW management R&D needs exist, and to define a strategy for addressing these needs. Because the RDTT no longer exists, the responsibility for the remaining deliverables in Section IX has been delegated to the Center of Excellence for Low-Level and Mixed Low-Level Waste under the direction of DOE-ID.

The R&D section of the Implementation Plan identifies five areas of concern for improving the management of LLW that can be addressed through research and development: (1) improving modeling and predictive capabilities of radionuclide migration, (2) enhancing the stability of buried waste forms, (3) enhancing the deterrence of intrusion, (4) inhibiting the migration of radionuclides, and (5) reducing the volume of waste to be disposed. The following task initiatives were proposed in the Implementation Plan that would identify strategies to address areas of concern:

Task 1. Catalog past, current, and planned LLW management program R&D initiatives
Task 2. Coordinate the identification of LLW management program R&D needs
Task 3. Determine outstanding LLW R&D needs
Task 4. Develop and recommend a strategy for outstanding LLW R&D needs.

To complete Task 1, a DOE R&D Activities Assessment was performed that evaluated 23,869 records from three separate databases. The result of the assessment was the identification of 166 activities that relate to LLW management and disposal and appear to represent technology development. Technology development is defined as the development of a tool. It does not include the application of existing tools, refinement of existing models, performing more detailed analyses, or collecting data.

Task 3 requires that the DOE identify those LLW R&D needs that are not being met by existing technology. To accomplish this task, it is necessary to complete Task 2. Task 2 requires the evaluation of currently identified LLW R&D needs to determine whether any of those needs can be met through technology development.

PURPOSE

The purpose of this report is to identify R&D needs that relate to the management or disposal of LLW and require technology development. The work plan accepted by DOE states that the purpose of Task 2 is to identify potential LLW management technical needs that enhance compliance with current requirements. As used in this report, technical need and technology development are equal terms defined as the development of a tool. Technology development does not include the application of existing tools, refinement of existing models, performing more detailed analyses, or collecting data. This report explains the approach used to assess R&D needs, and describes the sources evaluated and the results of those evaluations.

APPROACH

The approach to DOE R&D Needs Assessment was to identify sources of R&D needs, evaluate each R&D need contained within the sources against two criteria, and prepare a letter report containing the results of the evaluation.

The sources of R&D needs evaluated in this assessment included (1) Site Technology Coordination Group's (STCG) needs documents, (2) Site-specific and Complex-wide vulnerabilities and corrective actions, (3) DOE LLW disposal site performance assessments (PAs), (4) the DOE PA Task Team Progress Report, and (5) the LLW R&D Needs Statement. These sources were chosen because they were available and appeared to be current and comprehensive. The resources available to complete this task did not allow a more comprehensive search for other R&D needs. Approximately 1,000 records were evaluated against the following criteria:

- Does the R&D need relate to the management or disposal of LLW?
- Does the R&D need require technology development? Note that technology development is defined for this report as the development of a tool. It does not include the application of existing tools, refinement of existing models, performing more detailed analyses, or collecting data.

From this evaluation, R&D needs received one of three determinations: Yes, Unknown, or No. If both evaluation criteria were met, the need received a Yes determination. If either evaluation criterion was not met, it received a No determination. If the information provided did not contain sufficient detail to make a determination, it received an Unknown determination.

SOURCE MATERIALS

Site Technology Coordination Group's (STCG) Needs Documents

STCGs prepare hard-copy documents with input from working groups who have spent many hours putting together the needs and opportunities they considered important in waste management, buried waste, decontamination and decommissioning, high-level waste, mixed LLW (MLLW) transuranic waste, and LLW. These needs and opportunities have been approved by many different organizations, including DOE, stakeholders, Native Americans, etc. More than 800 records were evaluated; 32 received a Yes determination (see Table A-1 in Appendix A), and 107 received an Unknown determination (see Table A-2 in Appendix A).

Site-Specific and Complex-Wide Vulnerabilities and Corrective Actions

The DOE's Office of Environmental Management completed an assessment of its LLW management system for generation, treatment, storage, and disposal activities at sites that manage LLW. Forty-five site-specific vulnerabilities were identified and in turn used to identify six Complex-wide vulnerabilities. Corrective action plans for the site-specific and Complex-wide vulnerabilities, and a number of associated concerns, were addressed in two documents provided to the DNFSB as deliverables of the *DNFSB 94-2 Implementation Plan, Rev. I*, issued in April 1996.

These two documents, *94-2 Complex-Wide Review Corrective Action Plans, Site-Specific Vulnerabilities*, issued in July 1996, and *94-2 Complex-Wide Review Corrective Action Plans, Complex-Wide Vulnerabilities*, issued in July 1996, discuss how the assessment was conducted and the vulnerabilities identified. Each vulnerability and concern is addressed with a corrective action, and these responses are tied to a finding number. The vulnerabilities and corrective actions were reviewed to identify technology development needs.

A total of 74 vulnerabilities and concerns were evaluated; None received a Yes determination, and three received an Unknown determination (see Table B-1).

Performance Assessments, PA Task Team Progress Report, and LLW R&D Needs Statement

The following sources were reviewed to identify needs that could be met through the application of R&D: (1) DOE LLW disposal site performance assessments (PAs), (2) the *DOE PA Task Team Progress Report*, DOE/LLW-157, and (3) the September 29, 1995, review draft "Initial LLW Research and Development Needs Statement" (although never finalized, this draft exists and is frequently referred to by DOE as a source of R&D and technology development needs). The results of that review are listed and evaluated in Table C-1 (see Appendix C).

Each need listed in Table C-1 was then reviewed to determine whether it represented a technical or non-technical need (marked if nontechnical). If it represented a technical need, it was marked as to whether the technology already exists or is needed. Of the 63 needs evaluated, 24 received a Yes (are needed) determination, zero received an Unknown determination.

CONCLUSIONS

Approximately 1,000 needs statements were reviewed for applicability to the management or disposal of LLW; 56 received a Yes determination, 110 received an Unknown determination.

Task 3 combines the results of the R&D Needs Assessment with the results of the R&D Activities Assessment to determine if there are technology development needs related to the management or disposal of LLW that are not being met by current activities.

This study was limited by the lack of a complete data set, poor data quality, and having to rely on the use of best engineering judgment to make determinations regarding the inclusion of data entries into a set that represented R&D needs. These limitations are detailed as follows:

- DOE recognizes that although it has continuing R&D needs, there is no coordinated program specific to LLW to identify, implement, and guide LLW research and development to ensure

that the R&D needs are met. It is likely that the sources used in this study do not include all needs that currently exist in the Complex. However, it appears that the STCG process is a good start.

- In many cases, it was difficult to assess whether the need listed in a source required technology development because the information in was often vague. Best engineering judgment and experience were used to categorize needs as R&D efforts related to technology development. It is possible that individuals with more experience concerning particular projects or a different point of view as to what constitutes an R&D need would arrive at different conclusions.

- Reviewing site-specific PAs was more difficult than it should have been because there was no clear or consistent location where needs and concerns were discussed. It is recommended that PAs contain a specific section or location where needs, concerns, and future activities can be discussed or documented.

REFERENCES

Department of Energy, March 31, 1996, *Implementation Plan, Defense Nuclear Facilities Safety Board Recommendation 94-2, Conformance with Safety Standards at Department of Energy Low-Level Nuclear Waste and Disposal Sites.*

Department of Energy, April 1996, *Implementation Plan, Defense Nuclear Facilities Safety Board Recommendation 94-2, Conformance with Safety Standards at Department of Energy Low-Level Nuclear Waste and Disposal Sites*, Revision I.

Low-Level Waste Management Task Group, July 1996, 94-2 *Complex-Wide Review, Corrective Action Plan Complex-Wide Vulnerabilities*.

Low-Level Waste Management Task Group, July 1996, 94-2 *Complex-Wide Review, Corrective Action Plan Site-Specific Vulnerabilities.*

Radioactive Waste Technical Support Program, May 1994, *Performance Assessment Task Team Progress Report*, DOE/LLW-157, Revision 1.

Sandia National Laboratories, September 29, 1995, "Defense Nuclear Facilities Safety Board Recommendation 94-2 Implementation Plan, Initial LLW Research and Development Needs Statement," Review Draft.

APPENDIX A
STCG Needs that Require Technology Development

Table A-1. STCG Needs with Yes Determination

ID	Site	Site No.	Abbreviated Title	Short Description
6	IN	28	SSDP LLW	5.1.01 - Technology development is required for processing Site Specific Disposal Problem Low-Level Wastes (SSDPLLW) so that they will meet the INEEL site specific disposal requirements (SDR) or the WAC for processing by another EM product area. Waste descriptions are presented in the INEEL report 94/0065, Rev. l.
60	OR	WM-9	Internal Drum Pressure	There is need to determine the internal pressure of drums and containers using non-intrusive pressure sensing techniques. These drums and containers contain transuranic, low-level, and mixed waste. Current methods for determining pressure include visual checking (which is unreliable) and drilling a hole (which is slow, expensive, and hazardous to workers). During drilling, workers are close to the old corroded pressurized drums and the gases which are vents. Techniques and requirements to protect inadvertent intruders who enter waste disposal site premises hundreds of years from now are also needed. Current regulations require that all drums containing waste be opened and inspected. In the DOE Complex there are over 3,000 inactive waste sites where waste is contained in 55 gallon drums and other containers. Procedures require that container internal pressure be determined first before the drums are opened and waste inspected.
63	OR	WM-5	Wastewater MFP removal	Improved methods are needed for removing radionuclides such as Cs, Sr, Tc, and Co from aqueous wastes without generating large quantities of secondary waste.
153	LEHR	OAK-10	Alternate Barrier (Other Than Capping)	Need an alternate barrier (other than capping) for buried waste areas where groundwater recharge into the area contributes to groundwater contamination.
154	LLNL	OAK-2	Technology to Determine Integrity of Buried Drums	Need innovative technologies to determine structural integrity of buried drums without digging them up and risking puncturing them.
158	LLNL	OAK-2	Technology to Remove Tritium from Groundwater	Need cost effective technology to remove tritium from ground water. Explosives experiment debris containing tritium, depleted U, metals, and PCBs were disposed in adjacent unlined mixed waste landfills. A plume of tritium in ground water extends 600 to 2,000 feet from Pits 3 and 5, respectively. Maximum tritium activities are 200,000 and 150,000 pCi/L, respectively.
161	SR	LLW-03	Spent Deionizer Resins	Need technology to treat/immobilize spent deionizer resins and other long lived waste to meet the performance assessment requirements of current disposal facilities.

Table A-1. STCG Needs with Yes Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
163	SR	LLW-03 #14	Spent Resin Treatment	Treatment technology is needed to treat/immobilize spent deionizer resins and other long lived waste to meet disposal PA requirements.
169	SR	HLW-TPP, SR-2011	Characterization of Tank Wastes	Develop in situ methods for characterization of tank wastes.
179	SR	SR0009	In Situ Barrier Technology	Develop in situ barrier technologies for immobilization, containment and treatment of VOCs, metals and/or radionuclides in unconsolidated subsurface sediments; i.e., sandy/clayey soils.
200	RF	RF-ER09	Segregation of contaminated Soil	The site requires a technology to segregate soils contaminated with RCRA regulated metals above their action levels and/or radionuclides at an activity that would result in a dose greater than 15 or 85 millirem per year depending on its use, from uncontaminated soils, or soils contaminated below those levels. Soils contaminated above the action levels will be disposed, all else will returned to the ground.
256	BN/ANL	CH-0020	Decontamination of Fixed Surface Contamination of Concrete	Concrete has become contaminated. The purpose of surface decontamination is to reduce radiation exposure by removing the radioactive contaminant. Minimization of secondary waste is key in an effective decon technique. An ideal system will be equipped with a vacuum system to limit the amount of airborne contamination. The ability to decontaminate corners and hard to reach or elevated areas is necessary. Speed of the system with the maximum removal rate is desirable. An adjustable removal depth is desired. Typical removal depths range from 1/8 in to 1/2 in.
260	NT	NV0003	Nonintrusive Surveys in Pipes and Vessels	A method is needed for identifying and quantifying materials inside pipes and vessels from only one exterior side of the vessel or pipe.
261	NT	NV0004	Improved Detection and Characterization of Concrete	A cheaper, faster, and/or safer method for characterizing large concrete and metal surfaces is desirable.
266	NT	NV0012	Improved Groundwater Transport Model	Current groundwater transport models do not adequately account for subsurface physical and chemical variability, and may predict different concentrations or travel times than observed. The impact and complexity of fractured media are not adequately represented in the models. The need is to improve radionuclide transport models that incorporate geologic heterogeneity and other real-world factors.

Table A-1. STCG Needs with Yes Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
267	NT	NV0013	Real Time Monitoring for Radiation in Boreholes	The need is for a durable, reliable, and accurate system that will monitor relatively low levels of radiation in deep monitoring wells. Tritium is the major radionuclide of interest, but other radionuclides associated with underground testing are also of interest. Also parameters such as water level, temperature, pH, and conductivity would be of interest.
269	OR	HY-14	Containment/Stabilization of Rad Cont Sediment	Radionuclide contaminated sediments are a source of direct exposure to humans and may also be mobilized by erosion. The most common form of remediation, excavation/removal, may have a greater environmental impact than any no action alternatives. Encapsulation of the sediments by capping does not eliminate the problem of future releases via unrestricted tree growth. Containment and stabilization techniques are needed that are inexpensive, easy to accomplish and will assure minimal release from the contaminated area as well as minimal damage to the environment through their use.
272	OR	HY-16	Hydrologic Containment and Control	Methods and equipment need to be developed to install hydrologic barriers as cutoffs and collector systems such as trench drains in a cost-effective and reliable manner. These technologies need to address the use of installation equipment on sloping terrains and the ability to excavate and place materials in saprolite formations. Focus also needs to be placed on equipment that can be operated safely in contaminated soils and will minimize production of waste.
274	OR	HY-02	Low-Waste Volume Subsurface Monitoring	Virtually all sites within the DOE complex are faced with the high costs of handling and disposing of exploration and monitoring derived wastes. New methods are being sought to perform subsurface drilling and sampling as well as monitoring well installation methods that will significantly reduce the volume of excavated material, drilling fluids, and purge waters.
286	OR	DD-05	Improved Technology - Reduction of Secondary Waste	Improved technology is needed to reduce the large volume of secondary wastes that will be generated in D&D operations. The cost of D&D operations could be reduced considerably if the cost of waste disposal could be cut significantly. Technologies to reduce such secondary waste generation such as, scabbled concrete residue, or liquid residues from metal scrap leaching operations would be very cost effective. Technologies that employ reagent recycle for decon techniques or that eliminate certain grit or blasting medium are examples of useful approaches to secondary waste reduction.
299	OR	BW-06	Non-Intrusive Techniques to Identify Wastes	Non-intrusive techniques to identify areas of free liquids, areas of buried containers, or other hot spots.

Table A-1. STCG Needs with Yes Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
324	FM	0H-F015	Real-Time, Automated Liquid Analyzer	Need an automated device/system capable of monitoring and analyzing liquid waste streams for contaminants of interest (principally U to 20 ppb, associated radionuclides, and RCRA metals) and reporting concentration in real-time with quantitative accuracy.
330	FM	OH-F026	Process Piping Characterization	Need radiological characterization of internal piping by an external means. Many process systems (piping) contain unknown contamination.
336	FM	No Number	Technicium 99 Detector/Analyzer	A need exists for a mechanism/device to quickly and reliably detect the presence of Technicium 99 in soils and groundwater samples. Current methods for determining the presence of Technicium 99 require analytical laboratory analysis which precludes process remediation of contaminated soils and groundwater.
360	RL	HLW 1.1.1.2.1	In-Tank Hardware Cutter	In-tank hardware cutter.
374	RL	HLW 1.1.1.3.2	Technetium Removal	Technetium removal
409	IN	2.1.07	Immobilize ICPP Low Activity Wastes	Technology is required for grouting the LLW generated at ICPP. These wastes include the LLW from separations operations, facility decontamination solutions, and low-level process equipment wastes. LLW from the separation of high activity wastes will be acidic and high in nitrates. Both of these are detrimental to grout chemistry; thus, basic research is needed to develop grout formulations that will solidify and stabilize these wastes. Annually, about 100,000 to 150,000 gallons of liquid waste are added to the tank farm inventory from decontamination and process equipment wastes, much of which could be grouted.
410	IN	2.1.10	Characterize Tank Farm Heels	When the ICPP high activity tanks are emptied, a heel may remain. It is proposed to grout any such heel in place upon tank closure. Technology is required to characterize tank farm heel residuals to allow development of grout formulations. The heel characterization must take place in highly radioactive and limited access environments. Methodologies and platforms for deploying heel retrieval equipment are needed for heel mixing, hose deployment, ventilation, shielding, containment, heel sampling, etc.
414	IN	6.1.02	Real-Time Inst. For Characterization of Cont. Soil	Real-time field instrumentation for characterization, evacuation control, and cleanup verification of radionuclide and metal contaminated soil. Most soils at the INEEL are destined for a repository. Soils entering this repository must meet certain regulatory requirements. Field instrumentation is needed for rapid and accurate determination of whether soils being excavated can go to the repository without treatment.

Table A-1. STCG Needs with Yes Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
415	IN	6.1.05	Digface Characterization to Reduce Vol of Waste to	A technology(s) that would allow locating specific contaminants in buried waste as the waste is being removed for processing. The technology or system should be able to detect one or more of the following: actinides (especially Pu, U, and Am), VOCs, C-14, Tc-99, Sr-90, Cr, Hg, nitrates, or Ni-59.
416	IN	6.1.07	In situ Characterization of Tank Contents	A method is needed for in situ characterization of tank contents, including capability of detecting small, heavy particles lying on the bottom of tanks (i.e., not suspended in the slurry or sludge). Method should be able to obtain data at distances of up to 50 feet from tank openings and from regions of the tanks with restricted access, and in sumps or baffles.
425	IN	6.2.09	Ex Situ Treatment of Groundwater Contamination with Radionuclides	Develop an alternative, ex-situ method for treating groundwater that is naturally rich in Ca and Mg to remove the radioactive contaminants Sr-90, Cs-137, Co-60, U, and Tc-99. Currently used treatment methods employ ion exchange resins, however the naturally present Ca and Mg ions are of similar valence states as the radionuclides to be removed; this competition for ion exchange sites results in very low radionuclide removal efficiencies and high secondary waste generation. An alternative radionuclide removal technology is needed to: a) reduce overall remediation cost, b) reduce secondary waste generation, c) ensure compliance with the maximum contaminant levels.

Table A-2. STCG Needs with Unknown Determination

ID	Site	Site No.	Abbreviated Title	Short Description
5	IN	19	Waste Form performance	3.1.14 - Need 'final waste form performance standards, a performance model, and data' to qualify the proposed treatment technology, address potential permitting issues, and to prove treated product characteristics to support out year planning (storage, shipment, disposal, etc.). EM-30 funding is presently insufficient to address this need.
11	IN	36	Stab of thermally treat from SDA	
""	IN	2	Advanced Air pollution Control	3.2.15 - Opportunity to develop advanced air pollution control methods that improve control of emissions (e.g., volatilized metals, radionuclides, dioxins, particulates, acid gases) below future potential limits and achieve ALARA.
14	IN	3	CEM	3.2.32 - Opportunity to develop continuous emission monitor (CEM) systems for off-gases, toxic metals, dioxins, radionuclides, and thermal treatment processes. CEM performance must exceed anticipated EPA contaminant emission standards.
15	IN	4	Hot Off-gas - metal HEPA	3.2.18 - Opportunity to develop hot offgas filter capability to separate entrained non-volatile radionuclides from volatilized solid condensable particulate off-gases.
22	IN	11	Robust secondary reaction chamber	3.2.19 - Opportunity to develop a robust process secondary reaction chamber for completing combustion and destruction of offgas VOCs and organic particulates, which must be highly tolerant to incoming process material variations and be able to minimize offgas volume.
45	FM	10	Radon removal from off-gas streams	Off gas from the Vitrification facility will contain Radon and effective removal is necessary to comply with Regulatory requirements. Currently the limited testing of the radon removal has been at a laboratory scale with closely controlled experiments. The results of these experiment should be tested and verified at a pilot level before costly implementation of full scale systems. The current design of the off gas system for the vitrification facility incorporates the use of Carbon Beds for Radon removal. Although carbon has been shown to be an effective way to remove Radon, there are potential concerns with other constituents in the off gas that may impact the carbon efficiency. Molecular Sieves (Zeolites) have been tested in the laboratory for removal of potentially detrimental components to the carbon (NOx and water). These tests have provided information regarding individual components on a laboratory scale with simulated off gas streams. Testing of the Carbon/Zeolites in the actual streams at a pilot scale will greatly reduce the risk in the final design and operation of the system.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
53	OR	WM-19	LLW Ash Stab	A permanent disposal method or long-term storage method for solid radioactive waste and inorganic LLW ash is needed. Solid radioactive waste and inorganic LLW ash are in temporary storage. The Department of Energy (DOE) desires to meet all environmental regulations while cleaning up radioactive waste.
58	OR	WM-13	Hg	Systems capable of continuous measurement of total, elemental, and speciated gaseous mercury effluent from DOE waste treatment units are needed. Mercury is difficult to monitor because of the many forms it takes in gaseous emissions. Mercury can be emitted as elemental mercury or other speciated compounds such as mercuric chloride, dimethyl mercury, and methyl mercuric chloride. Current technologies primarily change air pollution into a solid and liquid waste problem. Mercury is not eliminated from the biosystem, and additional volumes of contaminated waste are produced. Current technologies also do not control the range of mercury species produced in thermal remediation processes. DOE desires to remediate facilities and equipment contaminated with mercury. One of the greatest challenges for gaining approval for waste treatment processes is convincing the public and regulators that effluent from treatment processes will be within regulatory limits and not pose a health concern to the public. Convincing is made much easier when monitoring techniques are continuous and real-time. Continuous real-time monitoring provides assurance that the effluent is always within regulatory limits and can also be used for on-line process control to optimize operations.
62	OR	WM-6	Removal of sodium nitrate	An efficient process to remove and destroy sodium nitrate ions in LLLW is needed. Currently ORNL is storing wastes containing radionuclides. These LLLW wastes needed to be removed and properly processed.
66	OR	WM-1	Lab pack char	A technique is needed to detect the amount of low-level radioactivity in chemicals being discarded from laboratories. Waste must be classified as hazardous or mixed before it can be sent for treatment and disposal. A technique to detect low-level radioactivity is needed to dispose of the large amounts of chemicals being discarded from research laboratories.
74	BN	1	Treat of process liquids	Radiologically contaminated process liquids are produced at the BNL AGS and HFBR. A treatment technology is needed to reduce or eliminate the current methods of treatment (subcontract for microfiltration and reverse osmosis) and shipment of the contaminated liquid.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
75	BN	2 CH-0009	Dried sludge w/PCBs	A treatment technology is required for 270 55-gallon drums of low level radioactive waste currently stored at Argonne National Laboratory-East (ANL-E). The waste is dried sludge from the site's laboratory wastewater treatment plant and is contaminated with PCBs at concentrations slightly above 50 ppm. Due to regulation under TSCA, the concentration must be reduced below 1 ppm for disposal as LLW at Hanford.
84	AL	p34	Compressed gasses	19 items, compressed gas cylinders requiring either oxidation or caustic scrubbing, including radioactive constituents. Radiological contaminants include tritium, levels unknown. While commercial firms are capable of providing mobile treatment of hazardous gases, there appears to be no capability for treating gases with radioactive constituents. All waste streams are cited in the Los Alamos site Treatment Plan (STP) and are subject to compliance order milestones; permit application by 3/98, treatment by 8/2003. Treatment technology must be capable of recontainerization, characterization, chemical/thermal oxidation, caustic scrubbing, and residuals containment.
103	SR	TRU-04	TRT alpha <100 managed as TRU	A need exists for systems/facilities to treat less than or equal to 100 nCi/g Mixed Waste (managed as TRU) to meet LDR standards.
117	OK	LLNL-22	Chloro solvent	Through various machining and degreasing operations at Lawrence Livermore Laboratory, chlorosolvents are generated--primarily perchloroethylene (PCE) and methylchloroform (MCM). The targeted waste stream consists of 1900 gallons of neat solvents. This waste stream is difficult to treat and has no incineration alternative at this site. The waste stream is described in DOE/OAK Site Treatment Plan as LLW-008 and has U and Th contamination (both <10uCi).
133	RF	WM-7	NDE of Head gas sampling	A non-destructive technique to analyze the head space of drummed waste is needed that will not destroy the integrity of the drum filter. Conversely, a filter is needed that can be punctured by a sampling needle that will maintain its integrity after being punctured (such as a septum). After sampling the headspace of a waste drum with the current technique, the filter must be replaced. This is a costly process as each filter costs approximately $25 and the labor required to replace the filters is an issue from both cost and exposure to ionizing radiation. The new assay technique or filter must allow sampling of the drum headspace without comprising the integrity of the drum.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
146	LBNL	OAK-3	Removal of Tritium	LBNL needs a cost-effective technique to remove tritium from water as tritiated groundwater is reaching the surface through hydraugers. This groundwater can potentially escape into the Berkeley community. LBNL is on state land and the tritiated water cannot be disposed onsite through reinjection, but because it is getting to the surface it must be disposed.
148	RL	1, 15, 17	Processing/treatment of RH-LLMW and TRU waste	1. Develop/identify/demonstrate treatment technologies, including encapsulation, that reduce treatment cost and the need for characterization. If technology can be selected (developed) that requires less characterization, it may lower the costs of management of these wastes. Incremental costs in treatment could potentially save overall system costs. Encapsulation may be one of these technologies. 15. Develop technologies to treat RH organic wastes. Low cost remote thermal or non-thermal treatment methods will be needed to process the wastes to meet the intent of LDR. 17. Develop a technology that can destroy PCB's and remove the ignitable characteristics, in a facility that can safely handle waste that contains transuranic nuclides.
149	RL	19	Fast, effective survey of transportation packages	Develop and demonstrate technologies that would decrease the time to survey waste packages. It is the objective of this need to develop safer and more rapid methods of surveying transportation packages for radiological release and reuse.
152	LLNL	OAK-1	Separate Tritium from VOC in groundwater	LLNL needs a cost effective technique to remove VOC from tritiated groundwater in situ. Negotiations with the regulators have allowed LLNL to temporarily treat groundwater containing VOCs and tritium and re-injecting the tritiated groundwater through a treatability test. No treatment technology has been officially approved by the regulatory agencies.
159	SR	MW-04	Method and Equipment to take Sample of Tank Deposit	Need a method and equipment that is time and cost efficient for taking a representative sample of tank deposits on the inner walls without inappropriate exposure of personnel.
162	SR	LLW-01 #6	Performance Assessments Models	Develop alternative model for removing conservatisms in existing Performance Assessment Limits for disposal of LLW.
166	SR	HLW-TPP, SR-2002	Heel Removal	Develop methods to remove tank heel (sludge heel, hardened sludge, zeolite, sand, etc.)
167	SR	HLW-TPP, SR-2003	Salt Removal	Demonstrate alternative salt removal techniques, such as modified density gradient, steam circulate jets, water jets, agitators, etc. for salt dissolution.
168	SR	SR0004	In Situ and Ex Situ Vitrification	Demonstrate cost-effectiveness/superior performance of in situ and ex situ vitrification when compared to conventional remediation technologies of both radiologically and radiological/chemically contaminated soils at the SRS.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
173	SR	SR0001	Ex Situ and In Situ Treatment	Ex situ and in situ treatment systems for immobilization, volume reduction and/or stabilization of radiologically contaminated vegetation.
176	SR	SR0004	Cost/performance of in situ/ex-situ vitrification	Demonstrate cost-effectiveness/superior performance of in situ and ex-situ vitrification when compared to conventional remediation technologies of both radiologically and radiological/chemically contaminated soils at the Savannah River Site
177	SR	SR0006	Tritium Treatment	Tritium hydrogeological control and/or treatment technologies
178	SR	SR0007	In Situ/Ex Situ Groundwater Treatment	IN situ and ex situ groundwater treatment technologies for radionuclides, VOCs and hazardous constituents in unconsolidated subsurface sediments; i.e. sand/clayey soils.
180	SR	SR0010	In Situ/Ex Situ Groundwater Removal Technologies	In situ or ex situ groundwater interim removal action/containment technologies for radionuclides, VOCs, and metals in unconsolidated subsurface sediments; i.e., sandy/clayey soil.
181	SR	SR0012	In Situ Characterization Technology	In situ (direct push) characterization technologies to provide real time analysis of VOCs, metals, and radionuclides; real time measurement of hydraulic conductivity.
182	SR	SR0013	Sample and Well Drilling Technology	Sample collection and well drilling technology that eliminates aqueous or non-aqueous Investigative Derived Waste (IDW) and control of contaminant migration along well casings.
185	RF	DD-1	Characterization of Contaminated Surfaces	Need improved mobile, field deployable characterization methods which have certified accuracy and precision for the determination of actinide contamination of process equipment, structural materials, and other property. Improvements are needed in characterization techniques capable of discerning contaminated areas within equipment internals and interstitial spaces such as inside pipes and ventilation ducts. Reduced decontamination costs and waste management requirements are the primary drivers. Methods must be capable of distinguishing between TRU versus LLW surfaces, debris, rubble and equipment internals.
186	RF	DD-2	Characterization of Contaminated Surfaces	Need improved mobile, field deployable characterization methods which have certified accuracy and precision for the determination of actinide contamination on process equipment, structural materials, and other property. Improvements are needed in characterization techniques capable of discerning contaminated areas within equipment internals and interstitial spaces such as inside pipes and ventilation ducts. Methods must be capable of distinguishing between clean (free release) versus low level (<100 nCi/g) actinide contamination on surfaces, rubble, debris and process equipment internals.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
187	RF	DD-3	Particulate Control	Need improved aerosol prevention and control for interior size decontamination and size reduction activities. Airborne particulate contamination, dust created during demolition of radioactive, contaminated concrete structures will need to be contained to protect the worker and the public. Many decontamination and size reduction activities are limited by the generation of spray and dust.
188	RF	DD-4	Characterization for Free Release of Property	As buildings are emptied for demolition, cost-effective methods are needed to rapidly segregate non-contaminated excess equipment for free release and ultimate property disposal. Methods will ideally be capable of detecting contamination contained within inaccessible equipment interior spaces and under painted surfaces. An improved accountability and tracking system which includes the full spectrum of information required for disposition decisions is also needed to expedite property disposal.
190	RF	DD-8	Worker Protection Clothing	Need cost effective, durable, safer, and more comfortable Personal Protective Equipment (PPE) to maximize worker effectiveness while minimizing worker contamination risk. Potential exposures are to both radioactive and hazardous materials.
195	RF	RF-ER03	Remediation of Organics in Groundwater	The site requires passive groundwater treatment technologies to remediate the effluent from plumes of chlorinated aliphatic solvents and dense nonaqueous phase liquids. The solvents of interest are vinyl chloride, tetrachloroethane, trichloroethane, carbon tetrachloride, and other volatile organic contaminants. The treatment technology, in some cases, needs to remove low levels of radioactive material.
198	RF	RF-ER06	Characterization Methods	The site requires improved methods for characterizing the type and extent of contamination associated with Individual Hazardous Substance Sites, Potential Areas of Concern, and Under-Building Contamination especially in difficult to access locations which cannot be sampled directly due to building structures. This information will be used to estimate the volume of waste to be generated during remediation activities, define remediation approach, and estimate remediation cost. Methods to sample below gilding foundations without spreading building contamination to the subsurface is required. Non-intrusive methods for verifying the placement of building utilities prior to intrusive sampling are also desired. The technology must be able to characterize the soil below building foundations without contaminating the soil with hazardous or radioactive materials.
202	RF	WM-1	Size Reduction Technology	Need improved methods for size reduction of glove boxes and metal, with capabilities for both TRU and low levels of radioactive contamination are needed at the site to accomplish the facility clean up per schedules in the 10-year plan.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
203	RF	WM-6	Treatment and Disposal Options	Need integrated treatment capabilities for treating high to medium risk low level mixed waste to LDR requirements. Cost effective options for offsite treatment and disposal are desirable. If suitable offsite treatment cannot be identified, an integrated system including hazardous constituent removal and destruction plus immobilization capabilities is needed. Integrated skid mounted modular processing systems are desirable which establish a safety authorization basis independent from aging facilities. An integrated modular system should provide flexibility in the processing of a broad variety of waste matrixes. The treatment systems must be mobile, skid mounted and self-contained. Secondary waste streams must also be handled.
204	RF	SNM-12	Process Tank Closure	Technologies are needed for verification of compliance, e.g., quantification of performance, against the closure criteria/parameters for tanks and associated ancillary equipment, through the use of nondestructive, nonintrusive, and/or intrusive techniques including structural, radiological and chemical aspects; quantification; isotopic identification; metals, and remaining organics inventories (sludges and liquids). Technologies are needed to clean residual contaminants in the tank and tank systems. These technologies would enable cleaning to target levels that are reasonable to attain and verify. This process could include chemical and mechanical isolation technologies. Identification and technical justification is needed for materials selected to fill the tank/pipe voids. Measurement technologies must quantify the effectiveness of the void filling operations to satisfy quality assurance requirements.
212	AL	Page 16	Monticello Surface and Ground Water Project	Need ground-water modeling parameter estimation. Develop instrumentation system that simultaneously measures areal precipitation, evaporation, transpiration, and percent moisture content of soils below the root zone. This system (measurements) would be used to obtain a quantitative measurement of an areal recharge, a primary input parameter for ground water modeling.
215	AL	Page 27	Characterize Heterogenous Deposits	Better intrusive and nonintrusive methods are needed to characterize heterogenous deposits found in landfills and leakage of contaminants from landfills.
216	AL	Page 36	Treatment of Certain MLLW Streams	Los Alamos is aggressively shipping low-level mixed waste to existing commercial and DOE treatment and disposal facilities. A number of waste streams, however, cannot be treated with existing technologies. All TCLP metals, spent and unspent halogenated solvents, oxidizers, caustic solutions, acutely-toxic gasses. Volume = 50.06 cu meters

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
219	AL	Page 41	D&D Characterization, Monitoring, and Verification	D&D characterization, monitoring, and verification methods are needed to do simultaneous monitoring measurements during surface decontamination; increase alpha and beta radiation scan rates for surfaces, during characterization, monitoring, and verification activities; do nondestructive concrete crack sampling to determine depth and concentration of radioactive contaminants; and method to verify existence or absence of contamination in drain lines, including discrimination between internal and external contamination.
224	AL	STN40	Contamination Removal	Cost-effective technologies for removing contamination in ductwork, pipelines, glove boxes.
229	AL	STN27	Intrusive and Non-Intrusive Characterization	Improved intrusive and non-intrusive methods to characterize heterogeneous deposits.
235	AL	STN12	Locating Buried Structures	Field methods for locating buried structures.
238	AL	STN37	Drum Characterization	Non-intrusive drum characterization for radioactive and RCRA organics.
241	AL	STN34	Treatment for Compressed Gases	Treatment technologies for compressed gases.
242	AL	STN32	Treatment for Reactives	TATB treatment to remove reactive characteristics.
243	AL	STN31	Treatment for Weapons Components	Treatment for mixed and low-level waste for classified weapons components.
244	BN	CH-0001	Subsurface Barriers/Reactive Rad Barriers	Parts of the BNL site have been contaminated with hazardous chemicals and radioactive isotopes. Monitoring has indicated that contaminants have entered the groundwater and plumes have been detected moving towards the site boundaries and down to the aquifer. There are currently two pump and treat systems for control of VOC plumes. The current treatment proposal for radiological groundwater contamination is through natural decay. This option may not be acceptable to the public. A barrier system could enhance regulator and public acceptance of an on-site disposal option for rad contaminated soils and debris. Rad barriers could also enhance acceptance of not pumping and treating rad contaminated groundwater.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
245	BN	CH-0004	Treatment of Rad Contaminated Soils	Soils in several areas within the BNL site have been contaminated with radionuclides as a result of historical waste handling practices. A treatment technology to reduce concentrations of radionuclides in the contaminated soils to risk-based cleanup levels could be more cost effective than off-site disposal. The principal radionuclides of concern in the soil are cesium-137 and strontium-90; strontium-90 has also been found in the groundwater above drinking water standards. Several areas used top soil contaminated with fission products for landscaping.
250	BN/ANL	CH-0014	Metal Decontamination (Tank Internals)	The interior of the Building 310 Retention Tanks are contaminated with radioactive material. Since it is proposed that the tanks be removed whole, it is important to decontaminate the interior of the tank prior to disposal.
252	BN/ANL	CH-0016	Size Reduction of Large Concrete Structures	Methods need to be available to segregate concrete both for ease of removal as well as for waste reduction. Concrete reduction techniques should be easy to operate and maneuver with the minimal number of operators. Minimization of secondary waste is key in an effective reduction technique. Systems must be able to limit the amount of airborne radioactivity generated.
253	BN/ANL	CH-0017	Size Reduction of Massive Metal Structures	The D&D of the ZPR Facilities will require the removal of large metal structures. Methods need to be available to segregate the metal both for ease of removal as well as for waste reduction. Metal reduction techniques should be easy to operate and maneuver with the minimal number of operators. Minimization of secondary waste is key in an effective reduction technique. Systems must be able to limit the amount of aerosols generated. Speed of the system is also a primary concern.
254	BN/ANL	CH-0018	Improved Waste Packaging for RH Waste	Radioactive waste generated through the D&D of facilities is either considered contact handled or remote handled. The primary need here is for a new waste container that meets DOT requirements and which will enable easy packaging by remote methods would be an asset to all D&D projects.
255	BN/ANL	CH-0019	Standardized Robotics Tooling	Robotics tooling is utilized in D&D when work ares are inaccessible or unsafe for occupancy. Robotic devices are required for performing various operations during D&D.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
257	BN/PPPL	CH-0021	Cutting Device for Segmenting	A technology for cutting the vacuum vessel of the Tokamak Fusion Test Reactor (TFTR) into segments is required. The vacuum vessel is a toroidal shell steel vessel containing several interior layers of graphite and stainless steel tiles/devices. The vessel is encircled by 20 copper, toroidal field coils which limit access and cannot be removed prior to vessel segmenting. The vessel will need to be segmented into a minimum of 10 segments and may require segmentation to 20 pieces. The cutting technology sought must simultaneously cut through several layers of stainless steel, Inconel, and graphite composite. The cutting technology must minimize the spread of activated and contaminated filings, grinding products, or torch leavings. Mitigating or minimizing the release of tritium during these evolutions is essential and critical. Approximately 15,700 cubic feet of LLW will be generated.
259	NT	NV002	Precision Soil Excavation	Past nuclear weapons safety experiments have resulted in large areas of near-surface soil contaminated with Plutonium. The profile distribution of plutonium is predominantly limited to one inch in depth. There is a need to remove indigenous vegetation and uniformly excavate one inch of contaminated soil efficiently without over excavation or "leaving behind" significant levels of plutonium.
263	NT	NV0006	Long-Term Stability of Waste Forms	Methods to control or accommodate the break-down of materials in arid desert environments and minimize the effects of subsidence are needed.
265	NT	NV0011	Deep Well Sampling	A cost-effective well design and sampling technology for sampling groundwater for radionuclides and other parameters in remote areas is needed. Sampling should be unaffected by well design or well materials.
268	OR	HY-12	In Situ Dissolved Phase Treatment Systems	Many plumes do not lend themselves to containment or reactive barrier systems due to the scale of the plume or hydrogeologic conditions. Some plumes may be best treated in situ by using horizontal wells or other robust collection and recirculation systems augmented by various forms of in situ treatment wherein a reactive treatment zone is created across the selected portion of the contaminated aquifer. Development of treatment technologies to be coupled with treatment zone installations is needed.
270	OR	HY-06	Fractured Media Flow Characterization	Contaminant migration at some of the Oak Ridge facilities is controlled by fractures, joints and bedding planes. Technology advancement is necessary to better characterize and predict how contaminants will be transported through fractured formations on a local as well as large scale in order to assess potential remediation and design exit pathway monitoring systems.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
275	OR	HY-03	Noninvasive Technologies to Identify Leaking Utili	All DOE facilities using large volumes of water anticipate significant losses from utility line leakage to the subsurface. This anthropogenic source of groundwater recharge may significantly affect contaminant release and migration within the zone of influence of that recharge. To facilitate location of significant leak zones and to address remediation needs required by those leaks, development of more effective noninvasive detection methods and instrumentation is needed.
277	OR	HY-19	Techniques to Overcome Matrix Diffusion	There is a concern that in areas of high concentration release to the bedrock system, significant levels of contaminants may have been driven (diffused) into the rock matrix by high chemical gradients. Inasmuch as this might cause a persistent release of contaminants at an unacceptable level over a long period of time, consideration needs to be give to methods to either fix the contaminants within the matrix, or to accelerate their release for treatment within a short time frame.
282	OR	DD-11	Improved Methods for Disposition of Depleted Urani	Need to implement a disposition method for depleted uranium that alleviates the high cost associated with conventional stabilization/burial.
290	OR	TK-02	Tank Solid Waste Retrieval	Need a system to remove the process heels, hard sludge, and debris from the inside of old concrete storage tanks. Decontamination of in-tank hardware needs to be considered.
301	OR	BW-14	Sorting Techniques	Sorting techniques to remove debris from soil, radiologically contaminated from non-radiologically contaminated materials, and materials that exceed TCLP from that which do not.
302	OR	BW-17	Techniques to Remove RCRA Metals & Radionuclides	Debris and soil extraction cost effective techniques to remove RCRA metals and radionuclides from heterogeneous waste in small volumes.
305	OR	BW-06	Monitoring Technique for Treatment	Monitoring techniques for assessing completeness of treatment.
312	OR	BW-02	Development of Contaminant Specific Inc intro Permeable	Development of containment specific ion exchange, sorption, and/or bioremediation media that can be incorporated into permeable (flow through) treatment barriers.
317	OR	BW-20	Treatment of Tc Contaminated	Treatment of Tc contaminated surface and groundwater.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
320	FM	OH-F009	Real-Time Waste Stream Analyzer/Segregator	Need exists for capability to monitor in real-time all waste streams to ensure WAC compliance. Current methods of quantifying contamination from U and associated radionuclides require analytical laboratory methods which do not provide information in real-time. Detection and discrimination of U and associated radionuclides at levels down to FRL and drinking water standards with emphasis on long term monitoring of release levels.
326	FM	OH-F018	Improved Surface Removal of Concrete	Need aggressive surface removal for slabs, walls, and ceilings to support containment removal and/or waste stream segregation. Controllable depth removal from 1/8" to 1/2" + per pass. Total expected depth removal requirement is 1".
327	FM	OH-F019	Geochemical Barrier for U in Soil	Need a chemical method to bind soluble/mobile forms of U. This method would be used to enhance the containment provided by the On-site Disposal Facility and may be applicable to bind U in the perched areas of the aquifer overlayment.
332	FM	No Number	Tri-Mixed Waste Treatment Demonstration	This waste must be treated by a non-thermal technology for disposal. As no proven technology exists, a Rapid Commercialization Initiative demonstration was arranged. The final phase implementation project is actually a scale-up to full scale of the currently funded demonstration phase, which is a proof-of-process. There is no data on the "true" cost of treatment using the Terra-Kleen process and the demonstration will not provide "true" cost. Also, there is no operation data available for the treatment of specific mixed wastes, such as the FEMP sludges, debris, and heavy clay soils that will be processed in this project.
334	FM	No Number	Gravel Contamination Analyzer	A need exists for a process/system to analyze U contamination levels in imported gravel (used for roads, parking lots, etc.) and to effectively reduce levels to acceptable background levels. Up to 100,000 cu yds of imported gravel contaminated to varying degrees with U has been inventoried at the FEMP site.
338	FM	No Number	Real-Time Detection for Alpha Emitters	Real-time detection capability for alpha emitters is required to ensure proper control of off gases and particulates generated in the removal and processing of silo materials.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
347	RL	MWFA No 13	Fixative Systems for Pack/Treat Materials	The objective of this need is to treat various waste types as they are generated with a fixative so that they are less likely to spread contamination during subsequent handling and processing. For equipment that is contaminated but have relatively smooth surfaces, fixative agents could be applied to the surface to provide shielding of radioactivity. This may permit this equipment to be packaged and transported by contact methods. This does not apply to equipment being retrieved from the HLW tanks since the possibility of introducing the fixative into the tank system is undesirable.
348	RL	MWFA No 15	Surveying of Transportation Packages	Develop and demonstrate technologies that would decrease the time to survey waste packages. It is the objective of this need to develop more rapid methods of surveying transportation packages for radiological release and reuse.
352	RL	NEEDs Page 1	Detection of Contaminants	Detection and delineation of radioactive contaminants, organics, and metals in the vadose zone.
353	RL	NEEDs Page 1	Detection & Delineation of Burial Ground Contents	Detection and delineation of burial ground contents.
356	RL	NEEDs Page1	In Situ Treatment of Radioactive Contaminants, Etc	In situ treatment of radioactive contaminants, organics (including DNAPLs), and metals in groundwater.
357	RL	NEEDs Page 1	Real Time Quantification of Rad Contaminants	Real time quantification of radioactive contaminants and metals to support free release of buffer areas.
361	RL	HLW 1.1.2.1	Enhance Tank Monitoring	Enhance tank monitoring with artificial intelligence technology.
362	RL	HLW 1.1.1..2.2	Direct/Indirect In Situ Waste Measurement	Direct/indirect in situ waste energetics measurement capability.
363	RL	HLW 1.1.1.2.2	In Situ Core Drilling-Speciation	In situ core drilling - speciation.
364	RL	HLW 1.1.1.2.2	In situ Core Drilling-Moisture	In situ core drilling - moisture
369	RL	HLW 1.1.1.2.4	Micro Sampler/Analyzer	Micro sampler/analyzer.
371	RL	HLW 1.1.1.2.4	LDUA Control System Enhancement	LDUA control system enhancements.
377	RL	HLW 1.1.1.3.2	LLW - On-Line Analysis	LLW - on-line analysis.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
378	RL	HLW 1.1.1.3.2	Process for Immobilization of Tc-Rich Waste Stream	Process for immobilization of Tc-rich waste stream.
382	RL	HLW 1.1.1.3.2	LLW - Separable Phase Organics	LLW - Separable phase organics.
383	RL	HLW 1.1.1.3.3	High-Frequency Induction Melter	High-frequency induction (cold crucible) melter.
391	RL	HLW 1.1.1.3.4	Evaluation for Soil Moisture Monitoring	Evaluation of alternative data acquisition technologies for soil moisture monitoring for the Hanford barrier.
392	RL	HLW 1.1.1.3.4	Colloidal Transport	Colloidal transport.
399	RL	HLW 1.1.1.3.4	Effectiveness of Water Conditioning Layers	Effectiveness of water conditioning layers.
400	RL	B-Plant Project	Decon Tech, Characterization Tech	Low life-cycle cost surface decontamination technologies; waste characterization technologies (low level versus low-level mixed versus hazardous; also contaminated versus non-contaminated).
403	RL	PFP Subproject	Decon Tech, Remote Applied Decon Tech, characterization	Low life-cycle cost, remote, cutting technologies; low life-cycle cost surface decontamination technologies; remotely applied decontamination technologies; characterization technologies (radioactive versus nonradioactive LL versus LL Mixed versus Hazardous, quantification in addition to detection). Other needs include low life-cycle cost, easy to use, remote handling devices and long-life fixatives that are easily applied and removed. Recently the following specific technology needs were identified: PFP process lines cleanout technology; cost-effective glove box decontamination/disposal technology; metal consolidation techniques; glove box cleanout and in situ characterization, ductwork and piping with Kg quantities of fissile materials.
404	RL	Advanced Reactor TRA	Surface Decon Tech, Characterization Tech	Low life-cycle cost surface decontamination technologies and improved characterization technologies.
412	IN	4.2.02	Develop a Rapid Wood Rad Cont Monitor	Opportunity to develop technology that can quickly determine the level and type of radioactive contamination in cracks and crevices on large pieces of wood so that uncontaminated pieces can be separated and not require disposal of in an LLW disposal facility.

Table A-2. STCG Needs with Unknown Determination (continued)

ID	Site	Site No.	Abbreviated Title	Short Description
413	IN	6.1.01	In Situ Debris Characterization for Partial Removal	A technology(s) that would allow locating specific high-risk COCs in buried waste is needed so that site-specific risk drivers could be located and removed with the minimum volume of secondary, i.e., uncontaminated waste. Such a system would substantially decrease the overall cost of remediation, allow timely completion of remediation, and significantly reduce worker exposure by reducing the amount of contamination to which workers would be exposed. Currently, there are no off-the-shelf systems that meet the functional performance requirements.
421	IN	7.2.03	Techniques to Improve Concrete Decontamination	Opportunity to develop new or significantly improved techniques to effect concrete decontamination. In contaminated facilities, much of the concrete is contaminated only on the surface or to a relatively shallow depth (typically less than one inch). Historically, such material has been handled by mechanically removing the surface layers of concrete through a mechanically scrabbling operation. This is slow and costly and directly exposes the workers to radiation. Dust control is also a problem. In addition to surface contamination, concrete often contains seams or cracks where contamination has penetrated deeper. Jackhammers are typically used to remove concrete from these cracks or seams in an attempt to remove the contamination. This is a labor intensive operation.

APPENDIX B
DOE Vulnerabilities Relative to LLW R&D Needs

Table B-1. DOE Vulnerabilities with Unknown Determination

Project No.	Project Name	Project Description
NT-7	CONCERN RELATED TO DESIGN AND CONSTRUCTION, SECTION 6.1.4, (VOLUME III)	Fire protection for the TPCB is being reevaluated and recommendations will be forthcoming in a report. It is apparent at this time that the forthcoming report will recommend installation of a fire detection system installed int he TPCB.
ORR-IWMF-WC-CC1	DISPOSAL CURIE INVENTORY AT THE X-10 IWMF (BLDG, 7886)	Radionuclides important to the performance of the Interim Waste Management Facility (IWMF) may not be accounted for in the IWMF disposal inventory.
SRS-V-96-03	INADEQUATE PROGRAM TO ADDRESS STORED MATERIALS WITH NO DISPOSAL PATH FORWARD	SRS does not have a program in place to dispose of LLW that exceeds existing on-site disposal facility waste acceptance criteria. SRS does not have a RCRA disposal facility for treated MLLW due to the indefinite postponement of the mixed/hazardous waste disposal vaults project. There are several mixed wastes at the SRS which do not meet the WAC of any currently available disposal facilities. The LLW, MLLW, and radioactive materials that are being stored with no disposal path forward include boxes that contain failed, spare equipment that has not yet been declared as waste, sealed radioactive sources (Co-60), cadmium control rods, tritiated waste oils, silver saddles, reactor deionizers, and in-tank precipitation filters.

APPENDIX C

LLW R&D Disposal Needs

Table C-1. LLW R&D Disposal Needs

Identified R&D and Technical Development Need	Source[1]	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
Develop waste disposal facility closure cap design and models of long-term cap performance.	1	X					X
Experimental programs (field data collection) are needed to verify performance assessment assumptions and improve projections, such as lysimeter (and other) tests to establish infiltration rates, cover performance, release rates, and parameters affecting migration of radionuclides from the disposal facility.	3,4,5,9	X	X		X	X	
Waste form and waste release analyses are needed to determine the inventory released from the disposal facility to the vadose zone.	3	X			X	X	
A quantitative assessment of the long-term performance of engineered barriers and disposal units is needed.	6	X	X		X	X	
The issue of determining radionuclide inventories in low-level waste, especially for the hard to measure isotopes that turn out to be important in performance assessment, like C-14 and Tc-99, was clearly identified as being quite important in the performance assessment for SWSA-6. When we did not have adequate means of determining what was in waste, we imposed severe penalty (uncertainty) factors on ourselves, with the result that some of our doses exceeded performance objectives. Even when we do not use a penalty factor, the uncertainty in our inventory estimates clearly is large and of concern. So, it seems clear that we could use some thoughtful R&D on determining radionuclide inventories in waste.	6,10	X	X				X
There are useful opportunities for field research on radionuclide mobilization and transport at existing disposal sites on DOE reservations. Observations on the behavior of all the stuff we put in the environment over the years should be able to tell us something about the adequacy of our performance assessment models.	10	X	X		X	X	

[1] Sources listed by number: 1. Nevada Test Site PA, Section 5.4. 2. Hanford Grout PA, Section 5.3. 3. Hanford 200-West PA, Section 5.4. 4. Los Alamos Area-G PA. 5. Idaho National Engineering and Environmental Laboratory Radioactive Waste Management Complex PA, Section 5.2. 6. Oak Ridge National Laboratory, Solid Waste Storage Area 6 PA, Section 5. 7. Savannah River Site Saltstone PA, Section 5.4. 8. Savannah River Site E-Area Vaults PA, Section 5.3. 9. PA Task Team Progress Report, DOE/LLW-157, Page 51. 10. E-mail, David Kocher to R.U. Curl, 01/31/97. 11. E-mail, David Layton to R.U. Curl, 02/10/97. 12. E-mail, Elmer Wilhite to R.U. Curl, 02/03/97. 13. E-mail, Charles T. Kincaid to R.U. Curl, 02/07/97. 14. Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 94-2 Implementation Plan, R&D milestone 2.B.1, Initial LLW Research and Development needs Statement, review draft, September 29, 1995, Performed under Section IX.B.2.b.1 of the March 31, 1995 Implementation Plan.

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
There needs to be an assessment of the hydrologic system below the Los Alamos Pajarito Plateau.	4	X			X	X	
Research and testing to improve the quality of data in the area of hydraulic properties of slag saltstone are needed.	7	X			X	X	
Field measurements over time are needed to determine the degree of saturation of slag saltstone.	7	X			X	X	
Experiments are needed to measure the root uptake of Tc-99 from a mix of crushed saltstone and soil.	7	X			X	X	
The SRS waste disposal facility closure design needs to be evaluated.	7	X			X	X	
In situ, near-field monitoring, of non-volatile contaminants is needed.	8	X			X	X	
Geochemical modeling and/or laboratory experiments to determine solubility values for radionuclides with low disposal limits, such as Np-237, are needed.	8	X			X	X	
Improved methods for calculating radon doses and risk estimation are needed.	11		X				X
There should be a co-operative effort around the DOE complex to develop laboratory and field data that each site's PA model(s) would be run against to test how well the model works.	12		X		X	X	
Neptunium Sorption – Neptunium-237 is a key radionuclide that, in the compliance cases analyses, is the primary contributor to dose in groundwater scenarios after 100,000 years. Unlike the other key radionuclides, a Hanford-specific data set on which to base the mobility of neptunium in the grout and soil does not exist. The distribution coefficients of 125 m1/g in the grout and 3 ml/g in the soil are conservative estimates based on the general literature. In actuality, the expected distribution coefficients are 10 to 20 ml/g in the soils and 1,000 to 6,000 ml/g in the grout. Obtaining specific distribution coefficients for the grout and soil could substantially reduce the impact of neptunium-237 and greatly reduce the calculated doses at times greater than 100,000 years.	2	X			X	X	

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
Timing and Magnitude of Degradation – One of the greatest uncertainties in the performance assessment analysis is the degradation of the engineered disposal system. The degradation estimates include predictions of the timing and magnitude of cracks in the asphalt, concrete, and grout as well as predictions of the transport properties of the materials in their degraded states. It is difficult to predict the timing and magnitude of cracks over time (i.e., when and where do cracks form, what are the differences in their orientation, size, interconnectedness, etc.). It is also difficult to predict the extent to which cracks in the grout and concrete would tend to plug as result of precipitation of solids within the cracks. In addition, the natural overburden pressure may tent to close cracks over time. Because of the uncertainty in this area, a conservative approach has been taken to modeling the degradation of the engineered system. Additional research to better define the degradation of the engineered system over time may permit a more realistic treatment of degradation, in turn permitting some conservatism to be removed from the model.	2	X			X	X	
Moisture flow is the driving force for contamination release from waste and the transport of the contaminants. This flow is poorly understood under the arid conditions frequently found in arid Western sites used for waste disposal and especially for fractured media. In particular, for those sites where moisture barriers or diverters are used at arid sites, the theory and parameters describing liquid and vapor flow under very dry conditions need to be better understood.	13	X	X		X		X

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
Develop a computer code using modern computer science techniques that combines time and spatially-dependent geochemical modeling with transient moisture flow and contaminant transport and which allows the determination on the results of modeling and data uncertainties. The simulator must handle geometrically complex objects and a large number of chemical species. Current extrapolated running times must be reduced by one to two orders of magnitude. The code should be structured to economically address the quantification of sensitivity of responses to uncertain physical and geochemical model parameters. Determine the real transport properties and phenomena at a western site having complex flow and transport conditions (such as the Hanford Site). Such properties should include chemical retardation (e.g. dependency on moisture and geologic layers) and unsaturated hydraulic data. Transport phenomena should include not only transport through homogenous media but also transport through fractured and perforated vertical flow paths (such as clastic dikes).	13	X	X				X
Develop a standard waste form release rate test method that is relevant to expected performance in the disposal environment and that can be used as a ILAW product specification. The test should be accepted by a standards test organization such as the ASTM. The test method must provide usable results within a 90-day time period such that the compliance of the waste form to the product specifications can be confirmed and payment to the private contractor authorized. The test method will be implemented in a production environment. The test method must be suitable over a range of temperatures (T = 14 to 90°C), moisture conditions (Θ^{H} = 0.1 to 1.0), and pH (ph = 6.0 to 12.0) conditions for use in performance assessment activities.	13	X					X
For the conditions expected to occur in the Hanford low-level tank waste disposal facility (pH around 10, various chemical species), identify and measure the geochemical and hydraulic properties of a material that can chemically trap technetium (and preferably selenium). The material must be low in cost because large quantities could be used and the disposal site should not represent an attractive natural resource following site closure. The getter material should not introduce any additional environmental hazard.	13	X					X

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
Assessments of waste disposal require the knowledge of hydraulic properties in the unsaturated sediments (the vadose zone). Typically, these properties are inferred or estimated from small cores or particle size distributions obtained from a drilled borehole. Field measurements of hydraulic properties will eliminate the uncertainty when extrapolating laboratory small-scale laboratory measurements. Design, construct, and operate a device to measure hydraulic properties in the vadose zone under dry condition (moisture contents less than 10%). Measurement of variables such as water content and matrix potential, which are used to calculate conductivity, must be accurate (within 2% for moisture contents less than 10%) and quick (seconds). The device must be portable and reusable.	13	X	X				X
DOE needs to investigate site-specific "optimized" packaging for specific wastes.	14	X	X				X
Data are needed on the corrosion rates of activated metals and the decay rates of organic packaging throughout the DOE LLW disposal complex for use in the PA modeling process.	14		X		X	X	
All sites have unique problem in the area of climatic changes and geologic conditions. This affects the reliability of modeling and assessment of long-term performance. DOE should assimilate this work relating to climatic change and evaluate the effects of potential climatic change on disposal options for inclusion in the PA process.	14		X	X			
Techniques are needed to ensure full integration of boundary conditions, modeling assumptions, and other constraints between mathematical techniques used to model near- and far-field processes (e.g., numerical vs. analytical; one-dimensional vs. two dimensional vs. three-dimensional; finite-difference vs. finite element, near-term vs. long-term). Such integration is required to ensure that uncertainties are neither minimized nor accentuated through the PA analysis.	14		X				X
There is a need to develop a model for cliff retreat as a mechanism for shortening the environmental transport pathway.	14	X					X
Certain sites need to understand and model lateral migration of radionuclides through various transport mechanisms.	14	X					X

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
Three-dimensional evaporation effects of fractures need to be understood and mechanisms to model their transport capabilities need to be established. Studies (including model field validation) should be conducted to improve our ability to characterize and model flow through fractured media.	14	X			X		X
Techniques for the characterization of inventories in pre-disposal (during processing and packaging) and post-disposal (in place) waste are needed. A particularly difficult issue is identification of the spatial distribution of "hot-spots" in old burial grounds. It is expected that difficulties with narrowly characterizing legacy wastes will generate large uncertainties in the projection of associated doses. For example, ^{14}C, ^{129}I and ^{99}Tc are important for dose estimation, but difficult to accurately measure.	14		X				X
The uncertainty in the performance lifetime (hydrologic and environmental) of engineered facilities, such as passive and reactive barriers needs to be quantified.	14		X		X	X	
Improved source term models which incorporate time-dependent chemical, physical, and thermodynamic processes are needed.	14		X				X
Heterogeneity and spatial variability are a concern in the areas of fluid flow modeling. There is a need to incorporate spatial variability of hydraulic properties in both vadose zones and aquifer models, and scale-dependent dispersivity in the transport models routinely applied to DOE sites. These heterogeneities might include channeling of flow due to preferential pathways of hydraulic properties, the spatial distribution of waste, chemical properties, and "hot spots" in sources.	14		X		X	X	
The modeling of episodic events for infiltration (as opposed to steady-state approximations) is desirable for shallow land burial configurations, especially in arid sites. In general, better site-specific evapotranspiration studies are needed for sites experiencing episodic infiltration.	14	X	X		X	X	

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
Experimental programs are needed to quantify site-specific radionuclide K_d sorption coefficients and solubility in order to understand time-dependent near- and far-field transport. The K_d's generally cited and used for current PAs are constant, equilibrium sorption K_d's measured in the laboratory. These should be evaluated on a site-specific basis as a function of water content, intact material properties, waste forms disposed of or proposed for disposal, as they relate to desorption from solids. These evaluations should emphasize field rather than laboratory studies or provide a mechanism for transferring information from the laboratory to the field. It is perceived that there is limited value in generic K_d data, such as for a given soil class or mineral type.	14	X	X		X		X
The critical assumption that ^{129}I isotopic dilution in human thyroid reduces dose needs confirmation.	14		X		X	X	
Research is needed to better understand and model the effects of hazardous constituents (and other chemicals generated over time as waste forms decompose) on radionuclide migration, since much of the radioactive waste disposed at DOE facilities before the promulgation of RCRA is co-contaminated with hazardous and non-hazardous chemicals.	14		X		X	X	
Experiments are needed to develop or refine the theory and establish confidence in models used to estimate flow and contaminant migration in very dry environments. Examples include water movement through capillary barriers, water flow and contaminant transport in dry waste forms including low-activity waste glass, and water movement in the vapor phase toward wastes containing salts.	14	X			X	X	
Studies are needed to evaluate how physical and chemical "reactive" barriers should be handled in the PA. For instance, how long can the barriers with a given set of characteristics be assumed to last? Barriers play a potentially important role in release characteristics. The geochemistry of the source and near source environment can have dramatic effects on release rates. Furthermore, certain materials such as concrete may provide longer-term protection as a chemical barrier than as a physical barrier. Given these considerations, what are the implications for conceptual model formulation, and which conceptual models that incorporate reactive barriers are most defensible in the long term?	14		X		X	X	

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
DOE needs to develop decontamination techniques for radioactive components that are not currently defined as LLW so they can be treated and disposed of as LLW.	14		X				X
The approach, methods and materials used to backfill void space in vaults, such as the E - Area Low Waste Activity Vault at the Savannah River Site need to be evaluated and optimal approaches developed.	14	X			X	X	
DOE needs to develop a method of treatment for waste ^{14}C resins. This work may be underway as part of the Landfill Stabilization Focus Area efforts.	14	X	X				X
Methods need to be developed for ex-situ or in situ immobilization, volume reduction, and/or stabilization of radiologically contaminated vegetation.	14		X				X
DOE needs to evaluate the relative probability and resulting effects of shear failure of compacted waste in cardboard boxes to “catastrophic” failure of B-25 boxes with respect to subsidence, cover failure, ponding, etc.	14		X		X	X	
Site-specific studies are needed to ensure that the resident plant and animal communities would not intrude through the interim of final cover designs. Field-scale studies on prototype facilities are needed, perhaps over actual disposal trenches. These studies need to be long-term (i.e., decades) in order to capture the influence of climate cycles and the vegetation maturation process.	14	X	X		X	X	
DOE needs to study the use of subsurface drilling hazards as a deterrent to future intrusion.	14		X		X	X	
DOE needs to develop a durable, generic warning marker and/or monolith design.	14		X				X
Long-term evaluation and monitoring of existing cover systems should be initiated. New over designs should use this information for site-specific and problem-specific design. all new sites can be monitored for performance data. As a minimum, closure cover systems that can last at least 500 years should be sought.	14	X	X		X	X	

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
A better understanding of barrier performance could be gained by long-term, site-specific testing of barrier materials. This would include barriers beneath wastes consisting of materials other than clay (french drains, chemically reactive barriers, etc.).	14	X	X		X	X	
A better theoretical framework and/or empirical data are needed to understand the upward diffusion of contaminants in the gas and liquid phases at specific arid sites as a function of water content. This information should be used to design appropriate covers to mitigate access of the waste to the environment and subsequent migration.	14	X					X
DOE needs to address how to engineer the waste form, waste form packaging, and accommodate site-specific conditions to minimize migration resulting from poor cap performance and subsidence.	14	X	X		X		X
Each site needs to evaluate the value of information on hydraulic drainage properties.	14			X			
Site specific, design specific information is necessary on how long passive barriers will work considering variation in E_H, pH and other factors. The issue of whether lab tests can apply to uncertain field conditions should be addressed.	14	X	X		X	X	
Radionuclide-specific chemical tailoring of the waste package and reactive chemical barriers should be studied. Chemical barriers may play an important role in facility performance for key radionuclides. The focus should be long-term performance with attention given to anion retardation.	14		X		X	X	
Cover removal rate studies need to be made for farming (plowing of unconsolidated materials), erosion of unconsolidated materials that will not generally support vegetation, and freeze-thaw destruction of rock-based materials such as rip-rap and pea gravel.	14	X	X		X	X	
Better methods are needed for combining site characterization data such as geophysical, hydropunch or bore-hole sampling data, etc. to get a better understanding of the hydrogeology under and around a site. Statistical and other methods for data combination should be explored.	14	X	X				X

Table C-1. LLW R&D Disposal Needs (continued)

Identified R&D and Technical Development Need	Source	Site Specific	Complex Wide	Non-Tech	Applied Research	Tech Exists	Tech Needed
DOE needs to define space and cost limitations for each site based on an established DOE inter-site transportation policy.	14			X			
DOE needs to support monitoring of existing waste disposal cells for performance. Such monitoring should emphasize field testing/research rather than laboratory R&D.	14	X	X	X			
Methods are needed for remote and near-field monitoring of sites. In particular, methods are needed for field detection of near and far field plumes of non-gamma emitting radionuclides.	14	X	X				X
Better monitoring strategies are needed to account for subsurface variation (near- and far-field, using locally optimized sampling). These strategies should concentrate on optimizing within the sphere of site control, and should address both vadose and saturated zones.	14		X	X			
Monitoring methods are needed to shed insight on or confirm understanding of the evolution of waste (waste form lysimeters).	14		X		X	X	
Methods for monitoring infiltration over the long term (e.g., 30 years, now until site closure) using lysimeters or other approaches needs to be developed and tested.	14	X	X		X	X	
Emerging technologies need to be studied for possible application to vadose zone characterization and monitoring (e.g., nuclear magnetic resonance, pulsed neutron prompt gamma activation, and electrical resistivity tools).	14			X			