

Low-Level Waste Management and Radiation Protection

Program Overview

Program Description

The Low-Level Waste and Radiation Management Program investigates improvements to nuclear plant operational practices that can reduce risks associated with waste management and radiation exposure. The program develops guidelines and technologies for waste disposal volume reduction, dose and radiation field reduction, and groundwater protection, resulting in lower electricity production costs, better informed regulatory oversight, and improved public perception.

Industry Needs and Issues Addressed

- Technical guidance for early detection, mitigation and remediation of groundwater contamination
- Strategies for managing uncertainty regarding availability of low-level waste disposal sites
- Technologies and strategies to reduce low-level waste generation and handling/disposal costs
- Approaches for managing risks around low-level waste transportation security/liability and effluent management
- Reduced radiation exposure through development of radiation protection and source term reduction techniques
- Cost and risk reduction associated with nuclear plant decommissioning

Impact

- Significant waste handling and disposal cost savings through waste reduction technologies and techniques
- Reductions in radiation fields and worker dose through new technology implementation
- Regulatory risk reduction from groundwater protection guidance
- Improved public perception through safe and efficient waste and effluent management strategies

Key Accomplishments

- Technical guidelines and supplemental site evaluations to assist nuclear power plants in implementing and optimizing groundwater monitoring programs
- Low-level waste assessments providing operational recommendations amounting to more than \$75 million in annual industry cost savings
- Operational strategies for reducing volume of Class B/C low-level waste generated, saving U.S. nuclear power plants more than \$27 million per year when fully implemented
- Radiation source term reduction studies identifying methods for reducing radiation fields by as much as 50% over five years

Current Year Objectives

- Technical basis for regulatory changes to low-level waste classification criteria
- Dose mitigation analysis for future Alloy 600 inspections
- Implementation of Electric Power Research Institute (EPRI) groundwater protection guidelines and technologies
- Site-specific implementation of source term reduction technical guidance

Industry Involvement

- Estimated 2009 funding: \$2.1

Program Technical Lead

Sean Bushart, 650-855-2978, sbushart@epri.com

Summary of Projects

Project Number	Project Title	Value
	Low Level Waste Disposal Technology	Base-funded technical development addressing low-level waste (LLW) disposal, characterization, and transportation issues.
	Advanced Techniques for Low Level Waste Management	Base-funded project focused upon technology development to minimize LLW volumes and disposition costs.
	Groundwater Protection	This project provides EPRI support for the industry Groundwater Protection Initiative through guidelines and technology development as well as site-specific support.
	Low Level Waste & Software Applications	This project area includes the Waste Logic (LLW software) User Group activities and site-specific LLW Assessments.
	Demonstration/Application New Techniques	This supplemental project provides collaborative demonstrations of LLW processing and volume reduction technologies.
	Development of Radiation Control Techniques	Base-funded development of source term and radiation field reduction techniques.
	Radiation Protection	Base-funded development of radiation protection technology and guidelines.
	Plant ALARA Assessment	Site-specific as low as reasonably achievable (ALARA) reviews and support.
	Technical Development for RP outage Management	Supplemental applications of remote monitoring technologies.
	Demonstration/Application of Radiation Control	This supplemental project provides collaborative demonstrations of radiation field reduction technologies.

Project Descriptions

Low Level Waste Disposal Technology (061432)

Issue

Ninety percent of the U.S. industry will lose access to Class B/C low-level waste (LLW) disposal after 2008. EPRI has developed a three-part strategy to address this issue: 1) minimize Class B/C waste 2,) provide industry guidance on on-site storage of waste, and 3) examine alternatives to existing disposal regulations. The program will provide immediate benefits as well as support a long-term strategy based on regulatory action.

Description

In 2006, EPRI initiated dialogue with the Nuclear Regulatory Commission and other disposal authorities on regulatory initiatives to alleviate potential restraints on LLW disposal capacity for Class B and Class C waste. EPRI expanded this effort in 2007 to evaluate classification alternatives that could be adopted to permit greater flexibility in the classification of low-level waste, but would not violate the performance objectives of 10 CFR 61.

Efforts will continue in 2008 and 2009 to examine alternatives to the existing disposal regulations and to minimize the accumulation of B and C wastes on-site. EPRI will evaluate the impacts of regulatory changes as they relate to public health risk, collateral impacts, implementation challenges, and industry costs/benefits.

Value

- Implement innovative media, operational practices, and volume reduction methods.
- Update *On-Site Storage Guidelines* to ensure compliance with regulatory concerns regarding interim waste storage.
- Provide regulatory relief to the concentration limits defined in 10 CFR 61 based on existing knowledge of performance assessment technology and realistic dose-pathways of existing disposal facilities. For classification controlling nuclides (C-14 and Ni-63), this could have up to a factor of 800 increase in the concentration limits for Class A disposal.

How to Apply Results

Program results are used by radwaste managers in developing a strategy for minimizing the generation of Class B/C waste. Members also can apply technical support to ensure compliance with regulatory concerns regarding interim waste storage. Long-term research results will provide regulatory relief of current disposal limitations.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Draft Technical Feedback for NRC on 10 CFR 61.58	12/31/2009	Technical Update

Advanced Techniques for Low Level Waste Management (061433)

Issue

EPRI efforts to minimize solid waste and reduce liquid effluent releases include investigation of new technologies for treating liquid radioactive wastes. Membrane technologies perform well, but may have limitations in liquid radioactive waste treatment because of membrane fouling concerns. Alternative membrane processes are desirable, but their efficacy must be proven.

Description

This project will evaluate the use of hollow fiber filtration in liquid radwaste (LRW) systems and in a plant demonstration. Hollow fiber filtration is a possible alternative to other membrane processes such as ultrafiltration and reverse osmosis because membrane failure is usually limited to individual fibers and not entire membrane banks. Vendor cost-sharing is probable as a vendor has already expressed interest in a product demonstration.

Value

- Minimize B/C waste generation through advanced removal technologies
- Allay public concern by assisting plants in reducing liquid waste effluents
- Prove the efficacy of a liquid radioactive waste treatment technology

How to Apply Results

Members will gain access to a report describing the efficacy of hollow fiber filtration technology, including plant demonstration experience with actual plant waste. The report will discuss preparations required for hollow fiber filter installation, expected diagnostics capabilities, liquid waste characterization, and potential challenges.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Development of Adv LLW Processing Technology—Hollow Fiber Filtration: This report discusses the application of hollow fiber filtration to liquid radwaste systems, reviews the efficacy of the technology, and presents a cost analysis.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Summary of EPRI Advanced Liquid Radioactive Waste Technology Demonstrations: This report would summarize development and evaluation status of the EPRI Liquid Radioactive Waste Processing technologies and provide commentary about the recommended implementation strategy for advanced technology demonstrations.	2010	Technical Report

Groundwater Protection (052332)

Issue

Decommissioning plants have spent millions of dollars in the characterization and mitigation of contaminants (for example, tritium) from groundwater and soils due to minor leaks from spent-fuel pools, transfer lines, and liquid storage tanks. More recently, several operating plants have experienced similar leaks. Although there is little to no public risk from the leaks, these unplanned discharges damage nuclear power’s credibility with the public. Significant time and resources are needed to characterize the extent of groundwater contamination and assure public health and safety.

Description

In 2007, the U.S. nuclear industry committed to the Groundwater Protection Initiative [NEI 07-07] to implement groundwater monitoring programs at all nuclear power plant sites. EPRI’s Groundwater Protection Project provides members with advanced strategies and technologies for improving nuclear plant management of situations involving radiologically contaminated groundwater. This project provides technical guidance for implementing site-specific groundwater monitoring programs geared toward mitigation, early detection, and remediation of groundwater contamination. Methods and technologies for evaluating and preventing the failure of systems, structures, and components containing radioactive liquids will be explored for proactive action against groundwater contamination.

Value

- Improve relationship with communities, government, and the regulatory agency about the industry’s commitment to public radiation safety and environment protection
- Reduce costs at the decommissioning stage due to preemptive action during the operating stage
- Reduce costs due to advanced and efficient monitoring and remediation technologies
- Reduce costs due to prevention of radioactive liquid leakage to the environment

How to Apply Results

Members apply The Groundwater Protection Project as a suite of products that includes *EPRI Groundwater Protection Guidelines for Nuclear Power Plants* (1015118, 2007), technical support, technical reports, and advanced technologies. Groundwater protection managers and their staff use EPRI results to establish and enhance groundwater monitoring programs at their sites. Members also can implement EPRI knowledge through groundwater monitoring workshops and groundwater assessments to facilitate technology transfer and lessons learned.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
<p>Vadose Zone Soil Gas Monitoring for Early Detection of Groundwater Contamination: Pilot Test Results: Vadose zone soil gas monitoring has been implemented successfully at Department of Energy sites and represents a potentially cost-effective alternative for traditional groundwater monitoring wells. EPRI will modify and enhance the technology for application at nuclear power plants, including a 2009 pilot test at a host nuclear power plant.</p>	12/31/2009	Technical Resource
<p>Evaluation of EPRI Groundwater Protection Guidelines for Nuclear Power Plants Rev. 0: EPRI published the <i>Groundwater Protection Guidelines for Nuclear Power Plants</i> in 2007 contingent upon a two-year review cycle. EPRI and the Groundwater Committee will evaluate the guidelines to determine if a revision is needed. The review cycle may be initiated in 2009.</p>	6/30/2009	Technical Update
<p>Remedial Option Assessment Module (ROAM): Nuclear Version: The Remedial Option Assessment Module is an EPRI groundwater fate and transport modeling tool developed for evaluating groundwater contaminant plumes and potential remediation options. EPRI will upgrade this software with nuclear-specific features.</p>	12/31/2009	Software

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<p>EPRI Innovative Technology for Groundwater Remediation: Based on the review of current advanced technologies available for groundwater remediation, EPRI will identify and develop needed technology for groundwater remediation.</p>	2010	Technical Resource
<p>EPRI Groundwater Protection Guidelines for Nuclear Power Plants, Revision 1: Based on the evaluation of revision 0 of the EPRI Groundwater Protection Guidelines for Nuclear Power Plants, EPRI will revise and produce Rev. 1 of this document. The evaluation and revision will be based on industry groundwater monitoring experiences, lessons learned, and advanced technologies.</p>	2010	Technical Report

Low Level Waste & Software Applications (052333)

Issue

Radioactive waste processing, storage, and disposal are expensive and complex nuclear plant operations that demand targeted technical and engineering solutions. Plant feedback regarding lessons learned and best practices need to be integrated into new LLW processes and management tools.

Description

EPRI has developed a family of codes (Waste Logic™) to optimize low-level waste management and an accompanying user group to provide performance feedback, training, and consulting. In addition, EPRI provides LLW assessments that provide nuclear plants with site-specific recommendations to reduce costs and waste volumes. User group members are entitled to a 1.5-2 day on-site installation session from EPRI.

Included in the LLW assessment is a five-day on-site plant walkthrough and interview process to gather the processing and cost details needed for the evaluation. Plant-specific data is entered into the EPRI Waste Logic™ software to estimate costs and identify potential savings. Plant LLW processing and disposal costs also are benchmarked against the industry using the code. The results are discussed with plant staff and presented in a follow-up exit meeting with upper management.

Value

- Average annual savings and volume reduction for dry active waste (DAW) assessments performed since 1993 of \$1.3 million and 3074 m³ per unit for boiling water reactors and \$722,000 and 1739 m³ for pressurized water reactors
- Significant cost savings and volume reduction for plants performing second (continuous improvement) LLW assessments
- Recent corporate-wide assessments also have identified and documented more than \$1 million in cost savings for a three-site corporate group

How to Apply Results

Recommendations made through the assessment are evaluated and implemented by plant personnel. Once installed, the software application should be maintained and updated with the relevant data points.

Demonstration/Application New Techniques (061423)

Issue

Liquid radioactive waste treatment technologies and techniques have changed considerably since the 1990s. The design and implementation of these technologies requires characterization of the liquid waste generated during normal operations and outages. Utilities typically do not have the resources for detailed waste characterizations, nor are they able to test specialty media or other novel technologies.

Description

This project provides nuclear plants with the resources to conduct waste characterizations and evaluate new technologies. The EPRI team visits the site for two weeks to characterize the liquid radwaste for ionic contamination, radioactive contamination, and particulate burdens. Detailed charge characteristics of the particulate contamination are evaluated, as are the loading orders of the media. Recommendations for selecting the best available media configuration and treatment strategies are presented based on the results of the evaluation.

Value

- Allow plants to optimize liquid radioactive waste system
- Evaluate technologies using actual plant waste for small costs
- Develop more effective plans for outages and normal operations

How to Apply Results

Members receive a report describing the characteristics of the normal operations and outage water. The characterization will be compared to the liquid radioactive waste system, and the experiments will be designed so that the existing system can be modified to maximize the contamination removal. The report will identify potential issues with the waste and provide recommendations for preconditioning or drain discipline to reduce waste burden. Technology recommendations based on the waste quality will be reviewed.

Development of Radiation Control Techniques (052350)

Issue

In 2003, in response to a negative trend in cumulative exposure at nuclear power plants, EPRI, the Nuclear Energy Institute, and the Institute of Nuclear Power Operations collaboratively developed the RP2020 Initiative. The Initiative's main goal is to promote radiation protection fundamentals, leading to reduced dose and essentially "taking radiation off the table" as an industry metric.

Description

The EPRI Source Term Reduction Program is a multi-year project developed to investigate the causes for differences observed in boiling water (BWR) and pressurized water reactor (PWR) shutdown dose rates and crud burst peaks, and recommends strategies for reducing radiation source term. The 2009 project plan focuses on two areas: BWR cobalt source term reduction and correlation of the results of the Standard Radiation Monitoring Program (SRMP), and BWR radiation assessment and control (BRAC) for estimating cumulative dose. In addition, work will continue to evaluate plant benchmarking and technology analysis from the PWR Chemistry Monitoring and Assessment Database, Steam Generator Degradation Database, Fuel Reliability Database, and Standard Radiation Monitoring Program to provide plant-specific recommendations for source term reduction. Recommendations will address procedures to minimize ex-core contamination and sequences for technology implementation to reduce source term generation over the life of the plant.

Value

- Reduce crud burst peaks
- Lower radiation fields
- Improve fuel performance (less crud on fuel leads to fewer failures)
- Reduce low-level waste generation

How to Apply Results

BWR members will use the cobalt quantification results to identify potential cobalt sources and implement the lessons learned from newly developed shutdown activity quantification results. Plant data benchmarking will be applied to understand the impacts of in-core vessel components. PWR members will be able to identify their plants according to the recommended grouping and implement recommendations to minimize radiation fields and reduce activity generation.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
BWR Radiation Source Term Quantification: A technical report will discuss methods to diagnose cobalt sources (in-core and ex-core) from data and facilitate cobalt removal.	12/31/2009	Technical Report
Correlation of Radiation Field Dose Rate Data to Cumulative Dose Estimation: The product will examine the correlation between radiation field reduction and cumulative radiation exposure reduction. Currently, the SRMP and BRAC measure contact dose rates. This project will explore what is required to develop the correlation between contact or general area dose rates and exposure.	12/31/2009	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Radiation Field Control Manual: Update to the <i>Radiation Field Control Manual</i> , summarizing state-of-the-art practice in PWR and BWR radiation field reduction, including radiation field source terms and mitigations technologies.	2010	Technical Report

Radiation Protection (052355)

Issue

Concerns have surfaced in recent years regarding the practice of monitoring and releasing radioactive materials and personnel from the plant. A U.S. plant event in 2002 compelled the Nuclear Regulatory Commission to enforce a “zero atom” release policy for materials and personnel leaving nuclear plant sites. Such an undefined policy has meant that clearance limits are now defined by radiation detection instrumentation limits and technologies, which vary significantly from plant to plant.

Radiological control/monitoring of material and personnel continues to be a problem. The Institute of Nuclear Power Operations has reported that 24% of the 2005 and 2006 areas for improvement were related to radioactive material control. Further clarification and standardization is needed for personal and equipment contamination monitoring.

Description

The project will develop a radiation material control guideline reflecting industry consensus that recommends alarm set points, instrument sensitivities and capabilities, and best practices for detecting radioactivity on personnel and materials (for example, small articles) being released from nuclear power plant sites. Three to four EPRI Guideline Committee meetings will be conducted over a two-year period to develop this industry guideline.

Value

- Promote consistent application of best practices across the industry for selection, calibration, and use of radiological monitoring instruments at nuclear power plants for release of small articles and personnel from radiologically controlled areas

- Reduce the number of AFI (area for improvement) designations associated with radioactive material control due to inadequate monitoring standards

How to Apply Results

Members will review the guidelines to ensure their radiation protection programs meet the intent of the recommendations and best practices.

2009 Products

Product Title & Description	Planned Completion Date	Product Type
Radioactive Material Control Guideline	12/31/2009	Technical Report

Plant ALARA Assessment (052353)

Issue

The effectiveness of a radiation protection program is evaluated by its ability to maintain exposure at levels as low as reasonably achievable (ALARA). An effective ALARA program involves all members of the plant staff and departments within the plant. ALARA is often underestimated, resulting in a lowering of expectations and a less effective ALARA program.

Description

EPRI has developed an assessment approach that provides a comprehensive review of a plant's current ALARA program in a consistent and meaningful manner. The approach uses a series of established "filters" to identify relevant criteria from various sources, including EPRI technology, information system of occupational exposure (ISOE) databases, and industry "good practices." The methodology contains more than 500 relevant criteria that define an effective ALARA program. The ALARA review team consists of nuclear radiation experts who conduct a five-day on-site assessment to review the plant's radiation protection program and address plant priorities such as source term reduction or remote monitoring.

Value

- Assess ALARA application during daily plant activities
- Summarize the status of the ALARA program and benchmark its effectiveness against the EPRI ALARA database
- Identify strengths of the plant's ALARA program
- Identify and prioritize potential improvements to the plant's ALARA program

How to Apply Results

The comprehensive review performed under this program provides members with added assurance that ALARA issues are addressed prior to regulatory and industry assessments. Members implement assessment recommendations to reduce radioactivity source term and improve ALARA work planning.

Technical Development for RP outage Management (057038)

Issue

Remote monitoring technology (RMT) can be used at nuclear plants to meet increasing demands on the radiation protection workforce and to enable monitoring in more challenging environments.

As stations upgrade remote monitoring capabilities, an initial assessment of existing hardware, software, and data transmission needs can form the basis for near-term and long-range expansion and identify critical constraints.

Description

This project guides successful implementation of remote monitoring technology through on-site plant assessments. EPRI guidelines on field implementation of remote monitoring are used to review the plant's RMT program and identify upgrade requirements.

Value

- Receive site-specific recommendations based on industry best practices and knowledge from industry experts in this field
- Facilitate successful installation and use of remote monitoring technology

How to Apply Results

Members review and act on recommendations developed by EPRI as a result of the RMT assessment.

Demonstration/Application of Radiation Control (052356)

Issue

Occupational dose goals for boiling water and pressurized water reactors have elevated interest in detailed ALARA planning. Several innovative technologies have been developed that could reduce radiation exposure or radiation fields, but the ALARA benefits of these dose reduction technologies need to be confirmed.

Description

This project identifies and evaluates technologies and processes that can be deployed to minimize the dose impacts associated with equipment replacement activities. The project is flexible in design and can be customized by members. Potential topics include ALARA for replacing steam generators, steam dryers, or reactor pressure vessel heads.

Value

- Identify potential technologies to minimize the dose impacts of large component replacements
- State the radiation exposure benefits of technologies or innovations
- Document procedures or technologies for implementing these technologies

How to Apply Results

Nuclear power plants are obligated by law to minimize the impact of ionizing radiation on plant personnel and the general public. Large component replacements add to the cumulative exposure for the plant outage, and with each new experience, industry feedback can assist in reducing the dose associated with the work. Members can apply these experiences to upcoming large component replacement ALARA planning.