EPRI Low and Intermediate Level Waste Program

Program Overview & Research Update

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Low Level Waste Forum
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Vision

To be a world leader in advancing science and technology solutions for a clean energy future

Mission

Advancing safe, reliable, affordable, and clean energy for society through global collaboration, science and technology innovation, and applied research.

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Low and Intermediate Level Waste (LILW) Program Overview

EPRI Radioactive Waste Management Research

Generation & Management

- Dry Solid Waste
- Wet Solid Waste
- Mixed waste (hazardous and rad waste)
- Liquid radwaste processing and effluents
- Radwaste Characterization

Volume Reduction

- Strategies to optimize generation by waste stream/form and classification
- Concentration Averaging and Encapsulation

Storage & Disposal

- Disposal site waste acceptance criteria
- Very Low Level Waste
- On-Site Storage

Low and Intermediate Level Waste Base Program Overview

- **Recently Completed Projects**
  - 3002010640, *Guidelines for Operating an Interim On-Site Low Level Radioactive Waste Storage Facility; Revision 2*
  - 3002008190, *Comparison of Global Nuclear Power Plant Low and Intermediate Level Radioactive Waste Management and Classification Methods*
  - 3002026555, *Accurate Estimation of Technetium-99 and Iodine-129 in Low and Intermediate Level Waste*
  - Radwaste Hub
    - https://radwaste.epri.com
    - Knowledge transfer and benchmarking site

- **Current Projects / Activities**
  - Accurate Estimation of Tc-99 and I-129 in Nuclear Power Plant Low and Intermediate Level Waste
  - Determining the Capacity of Liquid Radwaste Processing System Resins for Nickel-63
  - Impact of Chlorine-36 on Waste Classification and Disposal
  - Initial Radioactive Material Shipper Training
  - Radwaste Considerations for Pressurized Heavy Water Reactors
  - RadBench Database
    - https://radbench.epri.com
    - Performance monitoring site

Low and Intermediate Level Waste Technical Strategy Group

Activities

- 4 Webcasts/year
- Access to LILW TSG Collaboration site
- Member specific assessment / training
- LILW TSG Research
- Training and Knowledge Transfer

2024 Training Sessions

- Radiochemistry for Waste Management
- Waste Characterization
- Liquid Radwaste Fundamentals

2024 Research Projects

- Outage Optimization for Radwaste
- Comparison of Waste Characterization Sampling Methods
- Demonstration of Nano Bead Filtration Media
- Irradiated Hardware / Spent Fuel Pool Cleanout Handbook

2024 MEMBERS	
Ameren	CGN Power Co.
CFE (Laguna Verde)	Constellation
DTE Energy	Duke Energy
Emirates Nuclear Energy Corporation (ENEC)	Entergy
Korea Hydro & Nuclear Power Co. (KHNP)	Nebraska Public Power District (NPPD)
Pinnacle West (Palo Verde)	Southern Company
STP Nuclear Operating Company	Tennessee Valley Authority (TVA)
Vistra / Energy Harbor	

Accurate Estimation of Tc-99 and I-129 in Nuclear Power Plant Low and Intermediate Level Waste

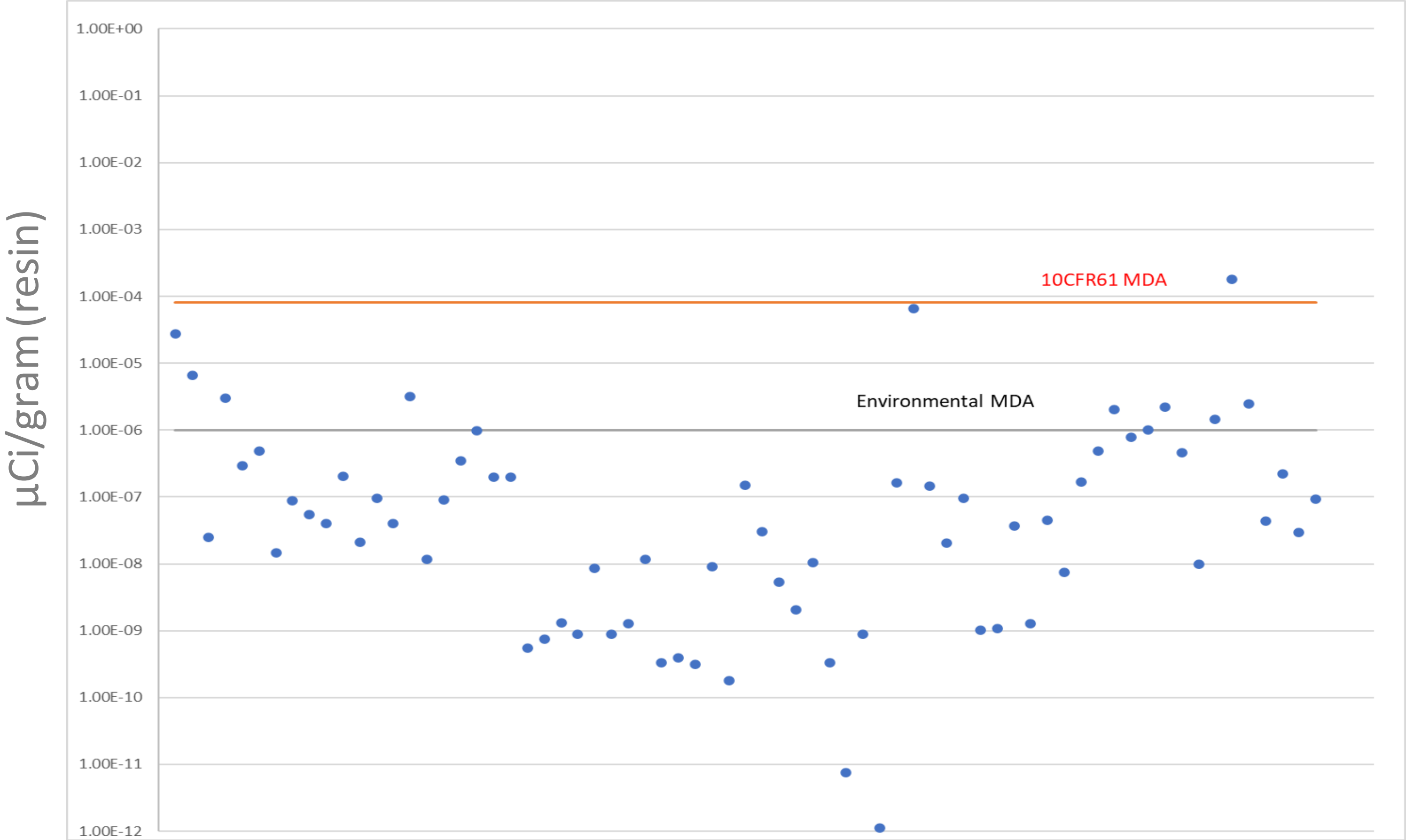
Background & Purpose

- Tc-99 and I-129
  - Hard-to-detect radionuclides that are required (and important) to characterize for radwaste disposal
- Current Methods of Characterization
  - Lower limit of detection (LLD) of currently commercially available laboratory analysis for Tc-99 and I-129 are several orders of magnitude higher than actual concentrations.
  - Utilities typically use LLD values for waste classification and waste disposal reporting purposes
- Problem
  - Current, typical characterization methods could:
    - inaccurately quantify Tc-99 and I-129
    - limit options for disposal of low and intermediate level waste (LILW) for nuclear power plants

Objective: Develop more accurate estimation methods for Tc-99 and I-129 in Nuclear Power Plant LILW

Current Estimation Practices – U.S. Examples

NUREG/CR-6567 I-129 Analysis Results Compared to U.S. Commercial Laboratory Minimum Detectable Activity (MDA)



Radionuclide	NUREG/CR-1759 DCF* Value, Ci/m^3 (Bq/m^3)	ICRP 60 DCF Value, Ci/m^3 (Bq/m^3)
Tc-99	3.0 (1.1E+11)	0.14 (5.2E+09)
I-129	0.08 (3.0E+09)	0.024 (8.9E+08)

* DCF = Dose Conversion Factor

EPRI Report 3002003121 – Dose Conversion Factor Evaluation and IMPACTS Analysis of Low Level Radioactive Waste

Background & Purpose

- Previous Efforts
  - 1990s: Pacific Northwest National Laboratory (PNNL) measured the Tc-99 and I-129 content in nuclear power plant wastes using mass spectrometric methods (NUREG/CR-6567)
  - 2015: EPRI developed generic scaling factors for Tc-99 and I-129 for LILW using the PNNL dataset (EPRI Report 3002005564)
- 2018 – NRC Request for Additional Information
  - Additional justification needed for:
    - Use of PNNL dataset
    - Statistical methods employed
    - Scaling factor relationships
- 2021
  - NRC expressed openness to review industry submittals of calculated generic scaling factors
  - EPRI emerging issue project funded and prioritized due to impact of potential change in U.S. regulations as well as U.S. and international member feedback

Phase 1 – Completed

TASK	RESULT
Re-evaluate data from NUREG/CR-6567 to: 1. Address technical questions related to EPRI Report 3002005564 on generic scaling factors for Tc-99 and I-129. 2. Determine an alternative, generic method for more accurately estimating Tc-99 and I-129.	• Sampling and analysis methods are not consistent between samples • Errors identified in NUREG/CR-6567 dataset • EPRI Report 3002005564 removed from epri.com – Generic scaling factor being re-calculated based on new information.
Explore other datasets (including those from non-US organizations), methods, technologies, and strategies that may be available.	• Limited data is available due to inadequate sample representativeness, sampling difficulties, and large expense for analysis • Difference in U.S. versus international disposal site performance assessment
Publish EPRI Technical Update	• Completed – 3002005564

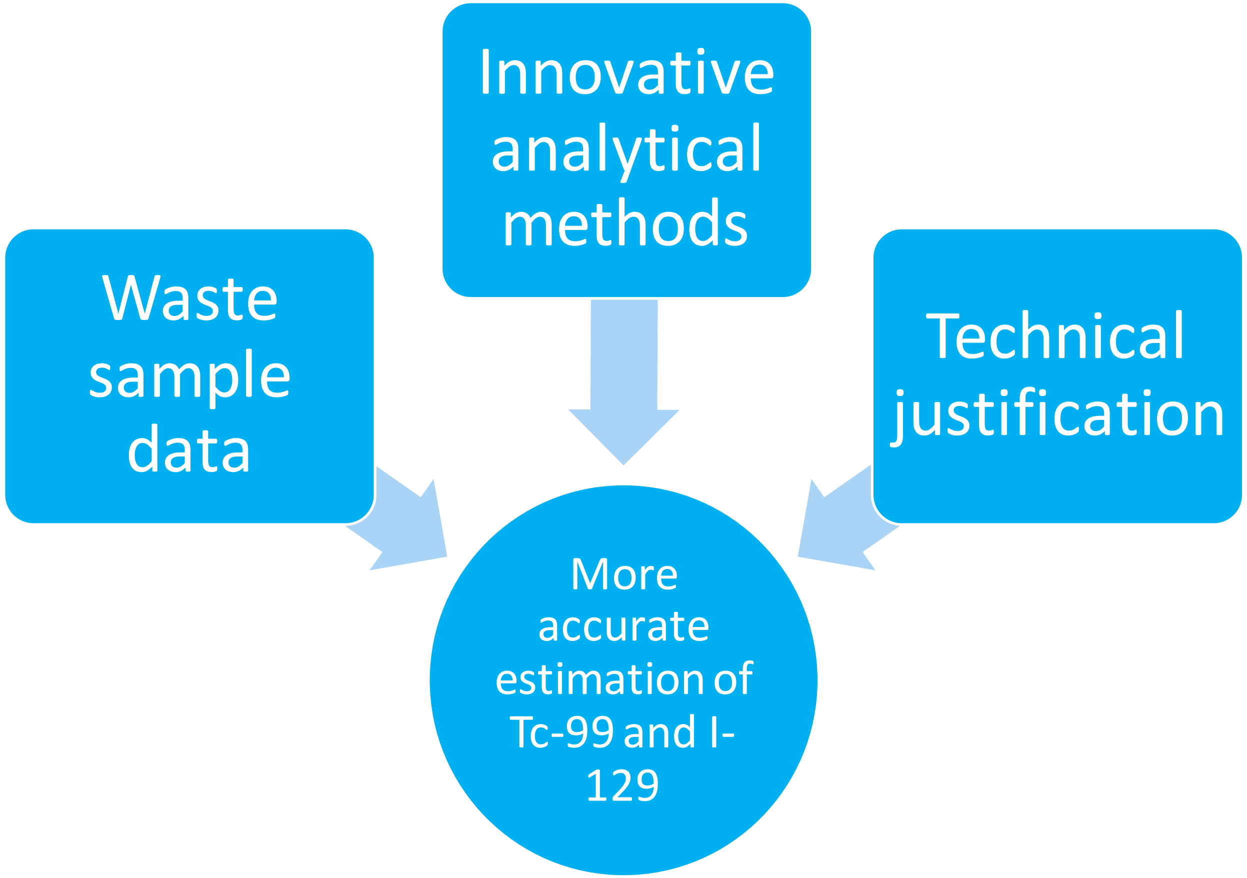
Phase 2 Initial Task (2024)

- Determine the necessity and/or urgency of more accurate estimation based on recent regulatory developments:
  - Re-calculate the US 10 Code of Federal Regulations (CFR) Part 61, Table 1 and 2 limits using the most recent ICRP Dose Conversion Factors (e.g., ICRP 103)
  - Review non-US disposal facility practices / regulations and related technical justification for the quantification of Tc-99 and I-129.

- Consider the following questions:
  - How do the use of LLDs impact disposal facility capacity? (i.e., are LLDs treated as zeroes?)
  - How do regulatory revisions in progress impact site-specific waste acceptance criteria and waste class limits?
  - What is the impact of using default scaling factor relationships?

Phase 2 – Path Forward

- Tasks:
  - Collect waste sample data to create a new industry dataset to support statistical analysis of Tc-99 and I-129 in typical plant waste streams
  - Determine if changes can be made to laboratory analytical methods to achieve lower levels of detection for Tc-99 and I-129
  - Review U.S. and international guidance assumptions
  - EPRI Technical Report to capture findings (2025)



Impact of Cellulose on Low and Intermediate Level Waste

Project Background

- Cellulose:
  - Main constituent of the organic matter that makes up low and intermediate level waste (LILW)
  - Generated in operational and decommissioning nuclear power plants
  - Produces isosaccharinic acid (ISA) which can accelerate nuclide migration
- Application of previous research into regulations is limited and/or unclear
- Knowledge gap exists in U.S. and international waste management industry concerning this issue

Project Objectives

Overall Objective:

Identify, collect, and summarize existing research and guidance on the impact of cellulose on LILW

Supporting Objectives:

Provide information to Radwaste Managers on handling cellulose containing waste and

Identify where research gaps may exist

EPRI

Project Tasks

- Role of cellulose (and ISA) on nuclide migration in waste disposal facilities.
- Identification of nuclides that may be more susceptible to the impact of cellulose
- Identification of existing limits, restrictions, or regulations
- Identification of existing methods for detection and/or quantification of cellulose
- Correlation between cellulose degradation and waste type
- Correlation between cellulose degradation and disposal facility type
- Identification of existing methods or strategies for the mitigation or prevention of cellulose impacts
- Document relevant operating experience
- Correlation between cellulose degradation and waste container type
- Identify where research gaps may exist to information future EPRI LILW research projects

All findings to be documented in an EPRI Technical Report (2024)

Impact of Cl-36 on Waste Classification & Disposal

Cl-36 in Low and Intermediate Level Waste

Background:

- Half-life = 3.01 x 10^5 years
- NUREG/CR-6567, *Low-Level Radioactive Waste Classification, Characterization, and Assessment: Waste Streams and Neutron-Activated Metals*, Figure 5-4 notes that after about 550 years, Cl-36 becomes the third highest contributor in resin activity for PWRs
- Cl-36 is not included in US waste class limits (10 CFR Part 61)
- IAEA Safety Standard, *Classification of Radioactive Waste*, does address long lived nuclides and allows considerable flexibility on limits based on site and disposal facility needs.

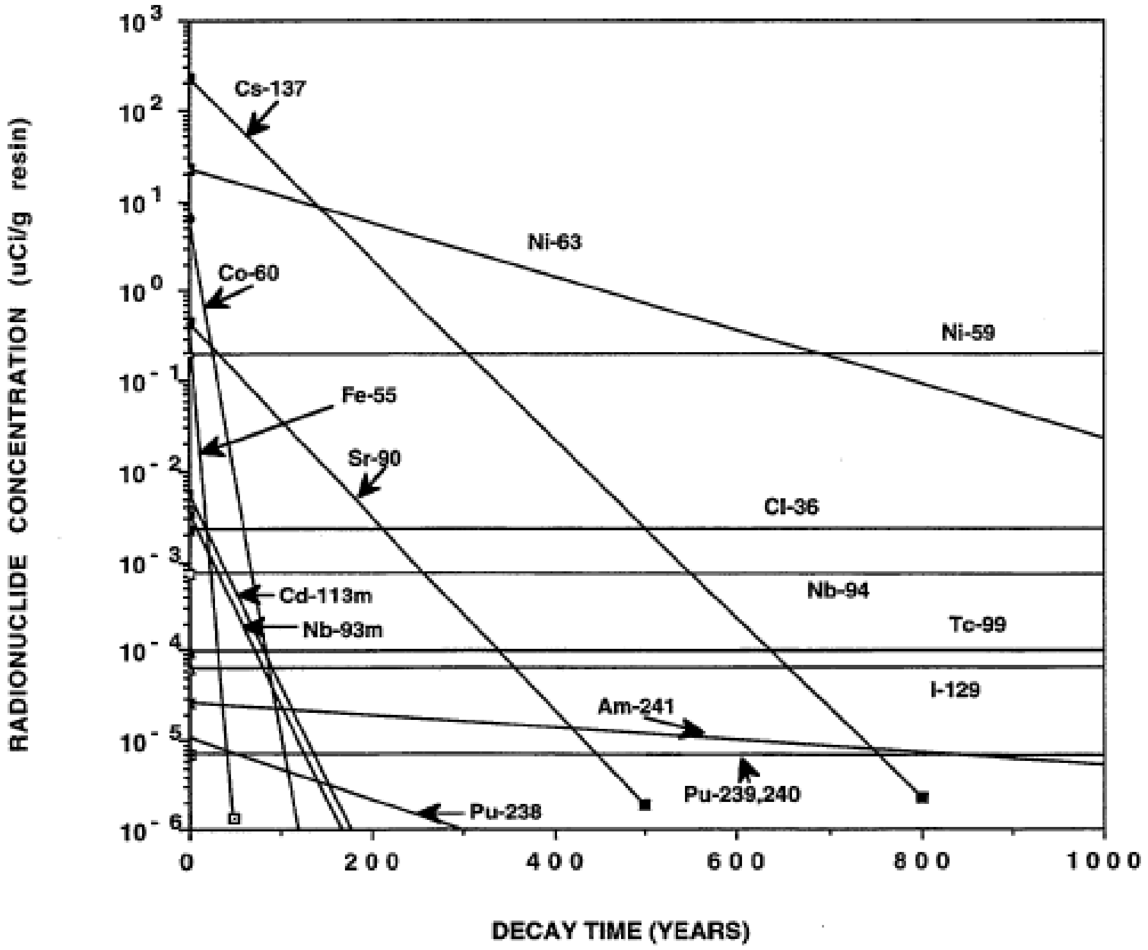


Figure 5.4 Change in Radionuclide Concentration with Time in Crystal River RWCU Resin

Source: NUREG/CR-6567, *Low-Level Radioactive Waste Classification, Characterization, and Assessment: Waste Streams and Neutron-Activated Metals*

The Why

$^{7}LiOH$ supply chain challenges

Purpose

This project is intended to demonstrate the application of KOH for primary system control.

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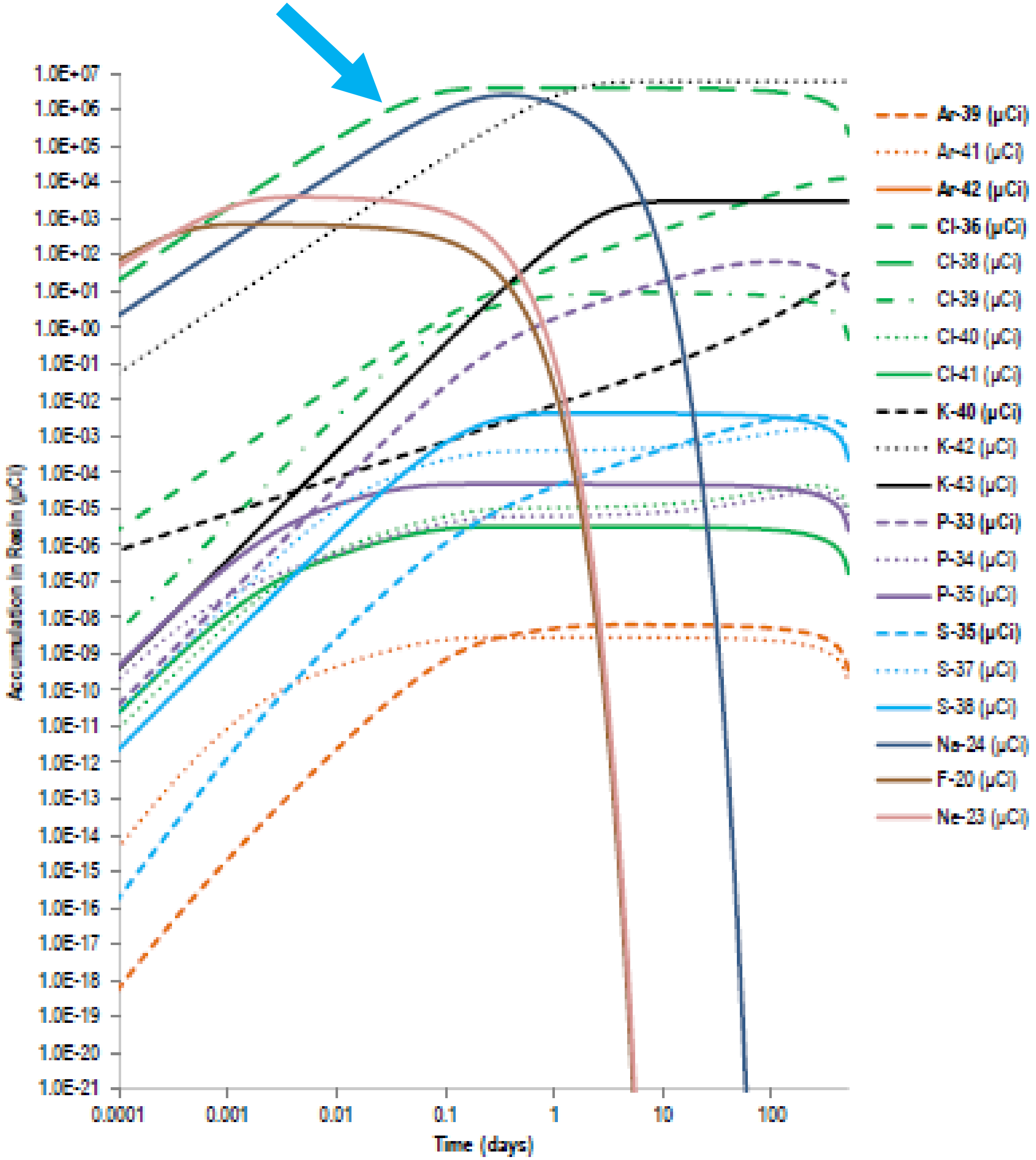
Impact of Cl-36 on Waste Classification & Disposal

- Current status: < 300 mCi disposed in the U.S. in the last 20 years

- Cl-36 generation is expected to increase following implementation of KOH



Project Task Overview

- 2024 – 2025:
  - Collect and analyze waste stream data from the VVER fleet
  - Compile IAEA Member State disposal facility:
    1. Waste acceptance criteria
    2. Disposal volumes of Cl-36
  - Identify key performance assessment modeling parameters for Cl-36
  - Complete modeling for behavior of Cl-36 based on expected generation
- Fall 2025 – Start of KOH application at US PWR Host Site
  - Six months post-application: initial site waste stream review
  - Continue annual waste stream review, dependent upon initial results

Initial Radioactive Material Shipper Training Program

Initial Radioactive Material Shipper Training Program

- Problem
  - EPRI members continue to be challenged by the time and resources needed to train and qualify personnel to package, ship, and receive radioactive material.
  - Commercially available training courses typically only provide a fundamental introduction to regulatory framework and do not include in-depth learning or practical experience on the necessary steps to complete a radioactive shipment.
- Action
  - Develop a radioactive material shipper training and qualification program that could meet the requirements of:
    - U.S. Department of Transportation (DOT)
    - International Air Transport Association (IATA)
    - International Atomic Energy Agency (IAEA)
    - Institute of Nuclear Power Operations (INPO)
  - Leverage experience from Nondestructive Evaluation (NDE) and Initial Chemistry & RP Training Programs
- Result
  - Elimination of duplication of effort of site qualification programs
  - Improved efficiency and effectiveness of focused training

Initial Radioactive Material Shipper Training Program

- Approach
  - Utilize the Standardized Task Evaluation (STE) process
  - Industry involvement is KEY. Feedback and agreement is needed on:
    - Task breakdown: what types of shipments / activities would be candidates for this program and highest priority?
    - Support for the ADDIE Process:

      Analyze

      Design

      Development

      Implementation

      Evaluation

2025 – Course Analysis, Design, & Development

Initial Radioactive Material Shipper Training Program

- Proposed Pre-requisites:
  - Senior RP Quals or equivalent knowledge (i.e., college degree in applicable field)
  - Leverage EPRI LMS platform and other EPRI Training & Development courses:
    - Math Review
    - Radiation Science Review
- Course Structure
  - Course delivery and length will be determined as part of ADDIE
  - Recorded for future reference and requalification
  - Cost associated with course registration
  - Led by appropriate SMEs (either internal EPRI Staff or contractors)

2026 – Course Development & Implementation

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