EPRI Low and Intermediate Level Waste (LILW) Program Update

Darcy Campbell, CHP
Principal Technical Leader

Low Level Waste Forum – Spring 2023
March 23, 2023

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.

Together…Shaping the Future of Energy®

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

Radioactive Waste Management

- Research and Development on methods, strategies, guidance, technologies associated with radwaste management

- RadBench Database (https://radbench.epri.com)

- Radwaste Hub (https://radwaste.epri.com)

- EPRI Low-and-Intermediate Level Waste Technical Strategy Group (LILW TSG)
  - Site-Specific Assessments
  - Training
  - Quarterly webcasts (recordings available for LILW TSG members)

- ASME / EPRI Radwaste Workshop & EPRI International Low-and-Intermediate Level Conference
  - July 24 – 28, 2023 (Nashville, TN)
  - July 24, 2023 – **Radwaste Fundamentals Training** – Open to the public!

Presentation Overview

- EPRI|U – Common Initial Training
- Radwaste Hub
- Accurate Estimation of Tc-99 and I-129 in Nuclear Power Plant Low and Intermediate Level Waste
- KOH Injection & Radwaste Considerations
- Impact of Cellulose on Low and Intermediate Level Waste

EPRI | U

Challenges with Traditional Training

Costly

The industry collectively spends money **duplicating** efforts to provide initial training

Inefficient

Expending resources (i.e., staff, time) that could be used elsewhere

Resource intensive to the update learning materials

Limits Hiring

Scheduling a class depends on the number of students & instructors available

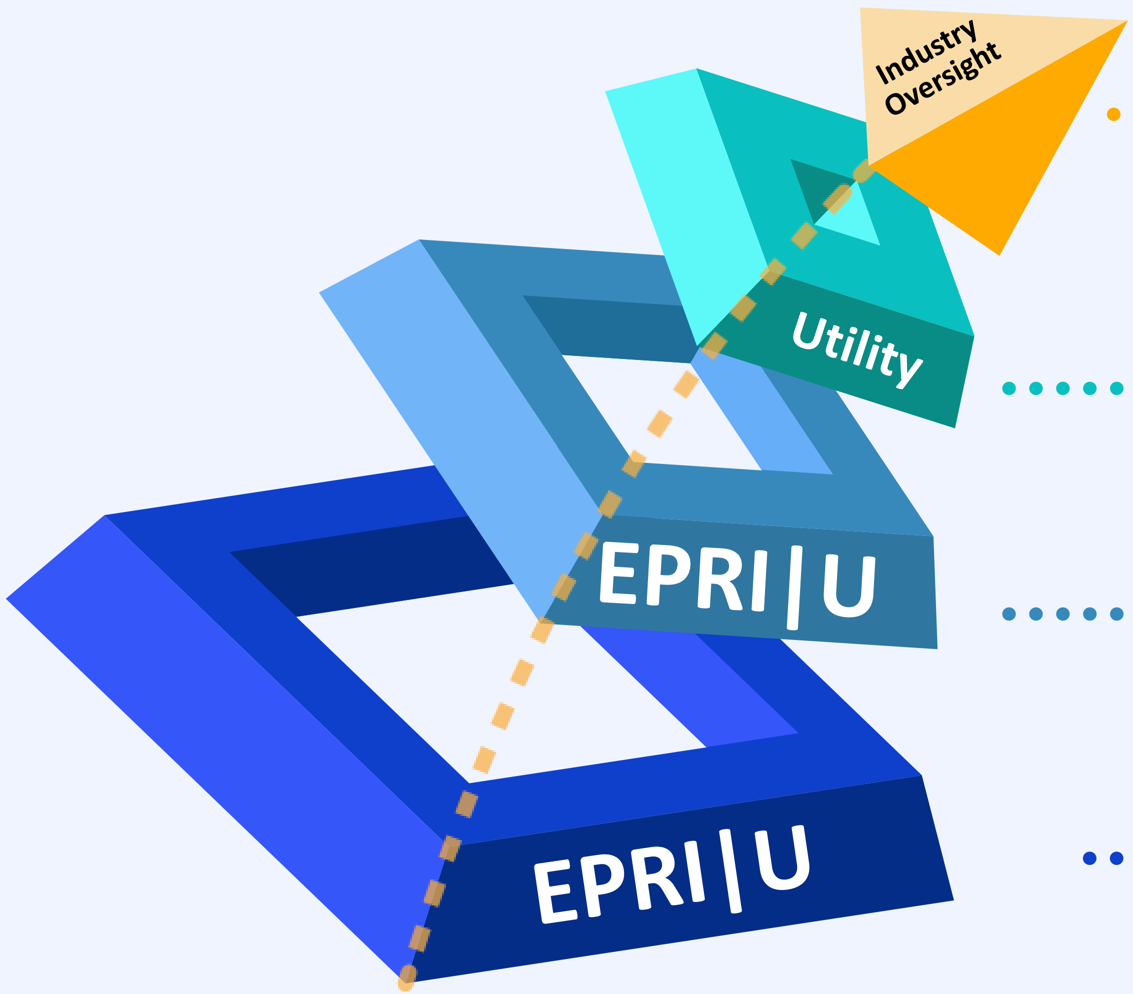
Current practices introduce artificial restrictions on when fleets can hire

Create A Centralized Training Hub

- Follow Systematic Approach to Training
- Incorporate Adult Learning Science
- Common Elements of Institute of Nuclear Power Operations (INPO) ACAD Initial Training Requirements
- Use Technology

Remove Duplication of Effort

A Collaborative Training Model Rooted Common Processes



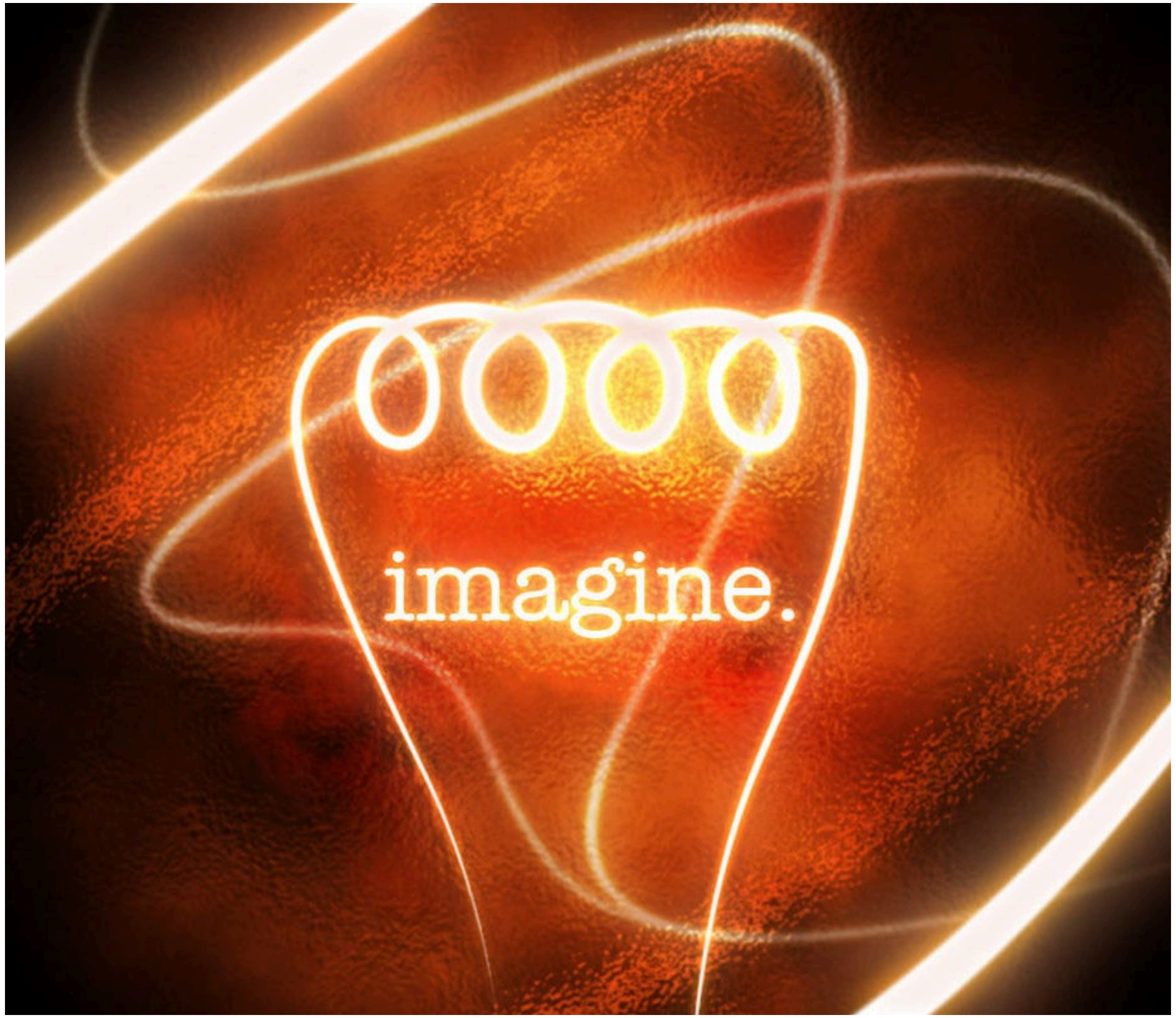
Processes that connect all foundations and **support accreditation** requirements

Site specific

Common to specific plant type: BWR, PWR, CANDU, VVER

Common to all plant types

Centralized Training

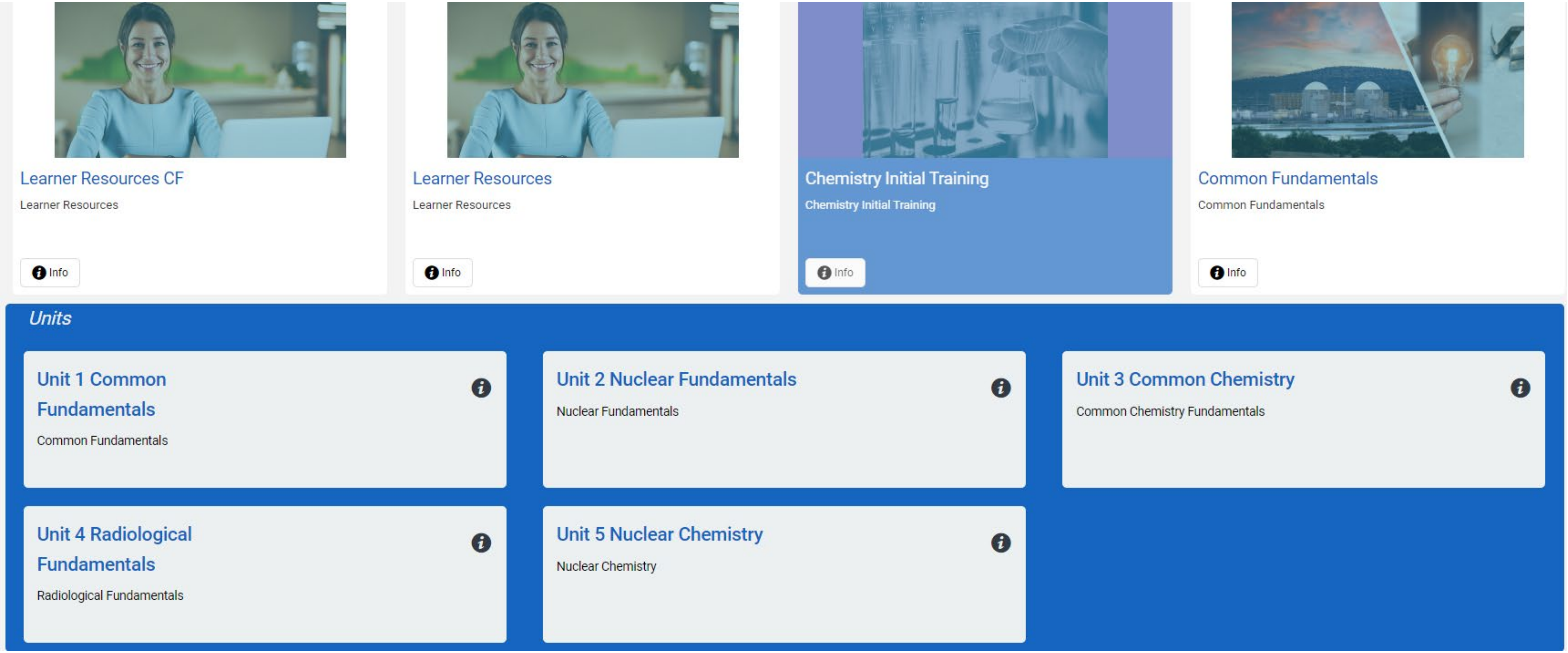


Imagine:

- **Hire When You Need To:** Training is available year-round to increase hiring flexibility
- **Accelerate Training:** Condense the time between a job opening and a qualified technician: No waiting for an initial class to start, common classroom training can be completed in about 3 months
- **Optimize Resources:** On-site instructors focus on performance improvement, continuing training and just in time training

Many Benefits

Landing Page



Participation is Required For Access

Sharing a Path to the Future

Common Initial Training

Optimize Resources

Focus Site Resource on Performance Improvement

Accelerate Training

Condense the time between hiring and training

Leverage EPRI Investments

Reduce long-term cost of initial training

First Step on the Path to Sustainable Workforce Development

Radwaste Hub

Radwaste Hub

- EPRI Radwaste ***Desk*** References developed in the 1990's for knowledge transfer:
  - Dry Active Waste
  - Liquid Radwaste Management and Processing
  - Transportation and Disposal
  - Mixed Waste

- Some of the Desk References are outdated and are not in a format that is readily used by current/future generations.

- Radwaste ***Hub***:
  - Online, accessible via computer, tablet, smartphone **(https://radwaste.epri.com)**
  - Provide a complete knowledge transfer write-up each topic
  - Wiki format to allow members to contribute content
  - Online forum for benchmarking
  - Links to EPRI and other important references
  - Enhanced search of contents of References and other related EPRI radwaste reports
  - Website format allows for more frequent update to ensure content stays up-to-date.

Key Features

Search

ALL TOPICS LIBRARY EXPERIENCES

scaling factors

Low-Level Radioactive Waste Scaling Factors, 10 CFR Part 61 (NRC Information Notice 86-20) DETAILS

Library
March 28, 1986

licensees to use generic scaling factors to determine waste classification, provided that the licensee was actively developing specific scaling factors … factors As a sample analysis history of facility waste streams is compiled, licensees may choose to determine new scaling factors based on the … factors may need to be considered Inspections also have disclosed questions in licensee identification and determination of scaling factors for …

Regulatory Issue Summary 2015-02, Reporting of H-3, C-24, Tc-99 and I-129 on the Uniform Waste Manifest (NRC ML14272A217) DETAILS

Experiences

General Experiences

3 reports

- Inadequate Component Tracking
- Inadequate Surveys
- Non-Representative Sampling

Add an experience report...

Topics

Table of Contents

Radwaste Hub

Radwaste Hub Topics (Current Plan)

- LILW characterization technologies, methods, and experiences (2020-2022)
- Shipping & Transportation (2023 - 2024)
- Liquid Radwaste Processing and Management Radwaste Hub
  (2023-2024)

Radwaste Hub Value

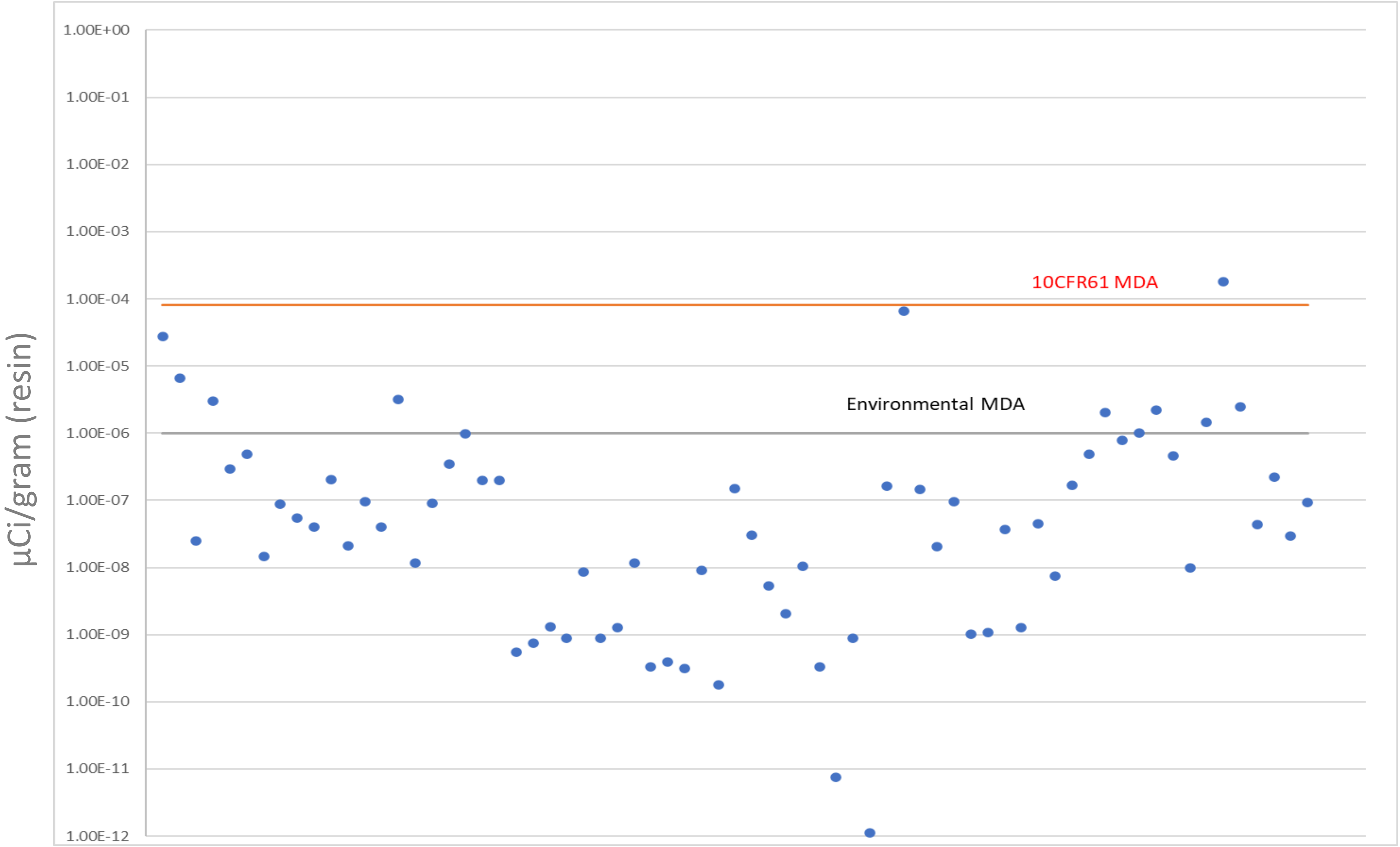
- Access to up-to-date information for identifying optimization opportunities
  - Radwaste management technologies that optimize the amount and type of radwaste that is generated, packaged and disposed
  - Methods to accurately and cost effectively characterizes waste to ensure that radwaste is packaged, transported, and disposed of safely and within regulatory compliance
  - Recent lessons learned and operating experience that protect the health and safety of the public by ensuring that releases are kept below regulatory limits and are As Low as Reasonably Achievable (ALARA)
- Web access facilitates
  - Future updates by EPRI and members
  - Easy and quick accessible on computers, smartphones, and tablets.

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:
    - increase the cost of disposing LILW for nuclear power plants
    - negatively impact waste classification

Example – I-129 Analysis Results Compared to U.S. Commercial Laboratory Minimum Detectable Activity (MDA)

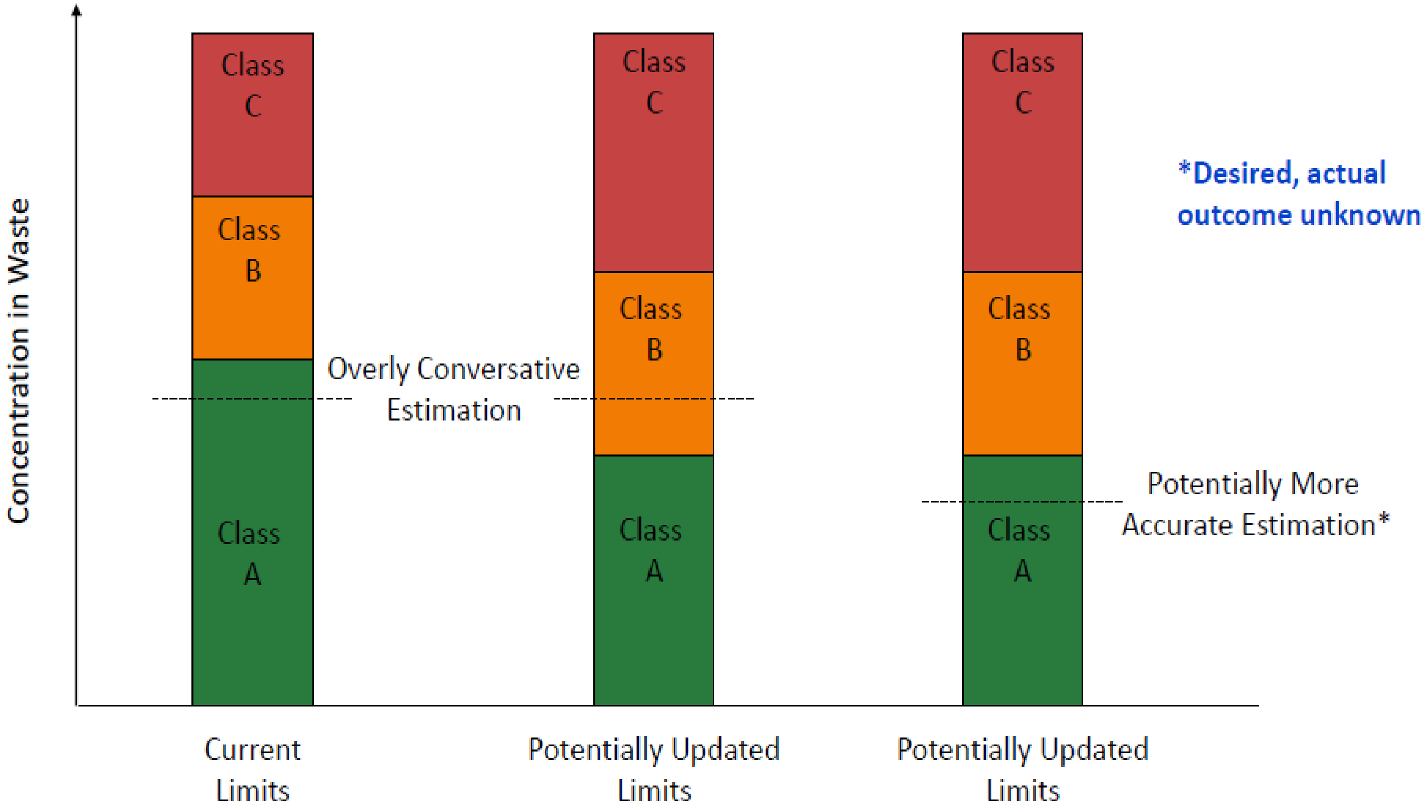


Background & Purpose – Previous Efforts

Radionuclide	NUREG/CR -1759 DCF* Value, Ci/m³ (Bq/m³)	ICRP 60 DCF Value, Ci/m³ (Bq/m³)
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

Change in Classification (U.S. Example)



2014: Dose Conversion Factor Evaluation and IMPACTS Analysis of Low Level Radioactive Waste (EPRI Report 3002003121)

Background & Purpose

- Previous Efforts (cont'd)
  - 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

Tasks & Preliminary Conclusions

- Re-evaluate data from the NUREG/CR-6567
  - Sampling and analysis methods are not consistent between samples
- Explore other datasets, methods, technologies and strategies
  - Limited data is available due to inadequate sample representativeness, sampling difficulties, and large expense for analysis
  - Commercial software was developed as an alternative to sampling and analysis
  - Difference in U.S. versus international disposal site performance assessment

Tasks & Preliminary Conclusions (cont'd)

- Address technical questions from the US NRC related to EPRI Report 3002005564
  - Due to limited sample data, questions could not be answered with a high level of confidence
  - Individual sites can still seek NRC approval for use of scaling factor in EPRI Report 3002005564
- Final Deliverable – EPRI Technical Report –Accurate Estimation of Tc-99 and I-129 in Nuclear Power Plant LILW (June 2023)

Future Activities & Research Questions (2023)

- Proposed tasks:
  - Collaborate with EPRI members and commercial laboratories to:
    - 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
- Industry participation is needed! Contact Darcy Campbell (dacampbell@epri.com)

KOH Injection and Radwaste Considerations

The Why

^{7}LiOH supply chain challenges

Purpose

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

Together…Shaping the Future of Energy®

KOH for Western-design PWRs: Overall Plan

IMR – Materials Testing
- Initiation & Crack Growth Rate Testing
  - Non-irradiated testing
    - Stainless Steel, Alloy 600, Alloy A-286, and Alloy 182 (CGR only)
  - Irradiated testing
    - Stainless Steel

Schedule: 2017-2022

Status:
- Follow-on testing of stainless steel in crevice chemistries completed in 2022.

FRP – Fuels Testing and Exams
- Fuel Vendor Assessment → 2017-2018
- Experimental Loop / Autoclave Testing → 2019-2022
- Fuel Exams (demonstration activity) → Plant Demo (3 cycles)

Status:
- Vendor assessments completed
- International fuel experience benchmarked
- Testing completed
  - Reports near completion

RS – Radiation Fields and Radwaste
- Activation species and dose pathways
- Effect on plant radiation fields
- Effluent and radioactive waste management

Schedule: 2017-2021

Chem – Chemistry/pH Control
- System review and impacts
- High temperature chemistry (MULTEQ)
- Purity specifications
- Multiple alkali (Li & K) modeling and control

Schedule: 2016-2021

Status:
- Assessments completed
- VVER experience leveraged
- Completion of 50.59 once all testing and assessments completed

10 CFR Part 61 Considerations

- The current radionuclide distribution of the RCS and radioactive contamination may change due to KOH injection and these changes may impact the isotopic contributors associated with reactor coolant and waste streams.
- Four key radionuclides of concern to consider for waste (Ar-41, K-40, K-42, Cl-36)
- 10 CFR § 61.55: Classification of wastes with radionuclides other than those listed in Tables 1 and 2. If radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.
- **Takeaway: no changes in waste classification are expected.**

10 CFR Part 61 Recommendation

- During the demonstration, conduct a Part 61 analysis of the impacted radionuclide waste streams approximately six months after KOH injection and, if needed, collect additional samples as needed to evaluate the waste streams considering the changes.
- The Part 61 analysis review should include the station scaling factors for changes that may impact the waste streams.
- **Takeaway: Monitoring and documentation are key components to a successful Part 61 program.**

Cl-36

- 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
- 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.

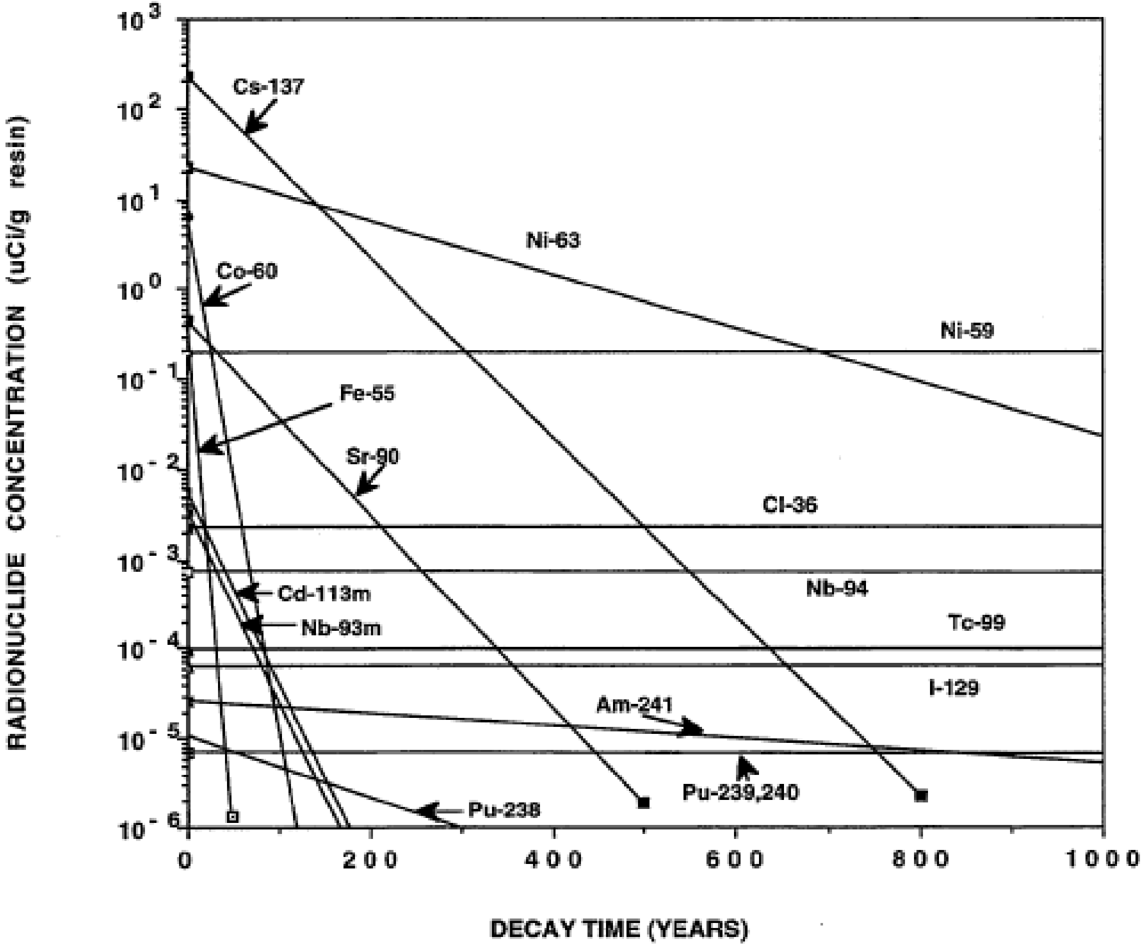


Figure 5.4 Change in Radionuclide Concentration with Time in Crystal River RWCU Resin

Impact of Cellulose in Low and Intermediate Level Waste

Impact of Cellulose in Low and Intermediate Level Waste

- Background:
  - Cellulose is a main constituent of the organic matter that makes up LILW.
  - When cellulose degrades, it produces isosaccharinic acid (ISA), an organic complexing agent that can accelerate nuclide migration.
  - Quantitative disposal limits are inconsistent throughout the nuclear industry.
- Objective:
  - Perform benchmarking and a literature review to identify the impact of cellulose on LILW and where research or guidance gaps may exist to inform nuclear power plant LILW management and any needed research needs.


Together…Shaping the Future of Energy®