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Complex Waste Streams and Legacy Environmental Liabilities at Idaho National Laboratory

March 2022

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Changing the World's Energy Future

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Managing Environmental Liabilities And Newly Generated Waste Streams

- Strategy
  - Establish timely and cost-effective disposition paths for legacy and anticipated new waste streams to minimize environmental liabilities' impact to INL R&D mission
  - Maintain and enhance only necessary core onsite treatment capabilities
  - Establish off-site treatment and disposition options as preferred option
  - Initiate RD&D of technologies required to support preparations for off site disposition and/or safe storage (Ex: inDRUM Pyrolysis capability development , Universal Drum Assay System (UDAS) and Geo-Melt)
- Challenges
  - Complex configurations present handling and treatment challenges
  - Less than adequate historical records
  - Regulatory Agreements
    - Idaho Settlement Agreement Milestones
    - INL Site Treatment Plan Milestones

Drum Assay System

Analytical Laboratory Glovebox Waste – TRU candidate material

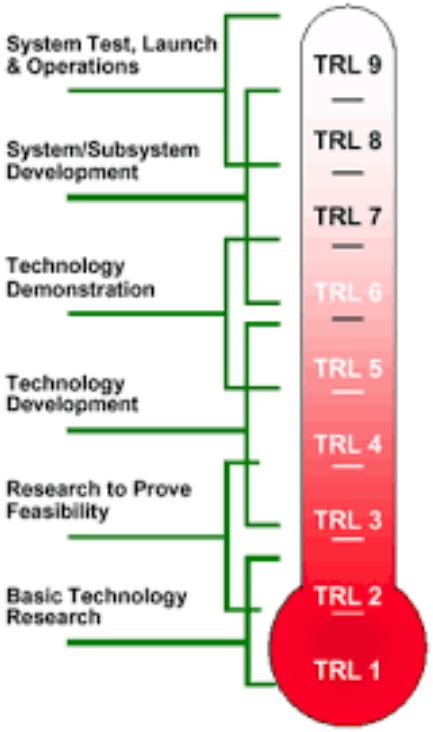
inDRUM Treatment Flow Path

inDRUM Treatment Unit

inDRUM Treatment - residuals

Treatment Alternative Development

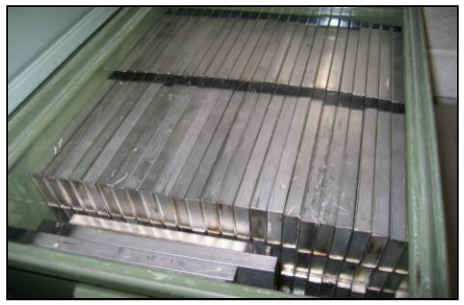
- FY16 thru present - BEA initiated a phased approach to evaluate the feasibility of alternative commercial treatment technologies with offsite subcontractors for MLLW while maintaining the onsite capability for future waste streams

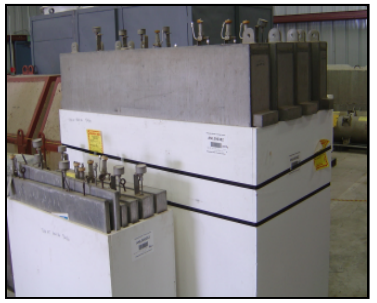


  - Phased approach targeting easier, large volume waste streams resulted in two viable offsite treatment technology providers
  - Resulted in several reactive liabilities eliminated and viability to address future complex waste challenges
  - Capitalized on early successes to expand the phased approach to other existing inventories and a phased treatment approach for the more difficult-to-treat waste forms
  - Continued efforts to develop treatment technology alternatives for future applications

Successful Elimination of Liabilities to Date

Liability	Liability Statistics		Eliminated
Fermi Sodium Drums	1,435 55-gal and 85-gal drums	~7,175 lbs Na	2018 - 2019
ZPPR Na Filled Plates	~66,000 rectangular plates	~10,000 lbs Na	2019 - 2021
ZPPR Na Filled Calandria	1,376 box-shaped calandria	~600 lbs Na	2019
Tin Bismuth Cans	1.85 m^3 of Na/SnBi quart cans	~300 lbs Na	2018
Lithium Hydride Shields	4.24 m^3 large 3' - 5' wide shields	~3,522 lbs LiH	2019

Fermi Drums, ZPPR Plates. Calandria, SnBi Boxes, LiH Shields

Capitalizing on Successes for CH MLLW Disposition

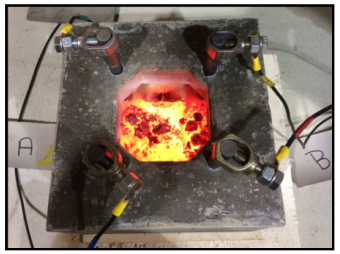
CH MLLW Legacy Inventory - Subject to the Idaho Site Treatment Plan (STP)

- Remaining Inventory - sodium (Na) and sodium-potassium (NaK) contaminated:
  - 55 containers remain totaling ~12.4m^3
  - Complex, unique configurations present significant handling, treatment, and disposition challenges
- Characterization records were not reliable; significant improvements made in last 2 years
- Phased approach utilizing surrogate materials resulted in viable offsite treatment option
- Initial offsite treatment plan developed in 2020, first shipment made in 2021 for offsite treatment
- Additional shipments utilizing vendor technology for treatment anticipated in 2022 and beyond

Remaining Legacy CH MLLW Inventory Examples

CH-MLLW Treatment Disposition Pathways

CH MLLW Backlog



Veolia ICV GeoMelt®

Perma-Fix Deactivation Vessel

INL Sodium Water Wash Vessel

NNSS Radioactive Waste Disposal Facility (EM Operated)

Offsite Commercial Waste Disposal Facility

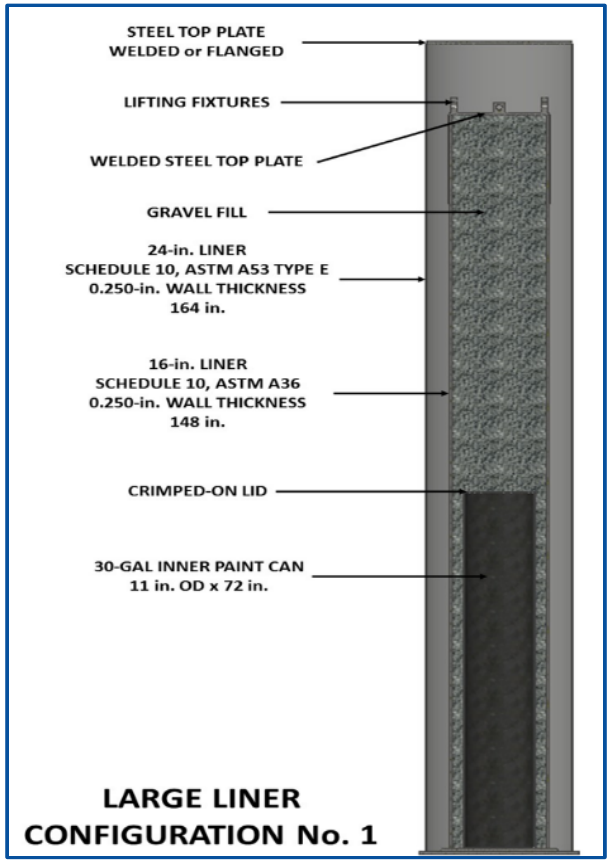
Legend
CH = Contact Handled
LLW = Low-Level Radioactive Waste
MLLW = Mixed Low-Level Waste

Historic disposition path

New Alternative disposition paths

Applying Successes to RH MLLW Inventories

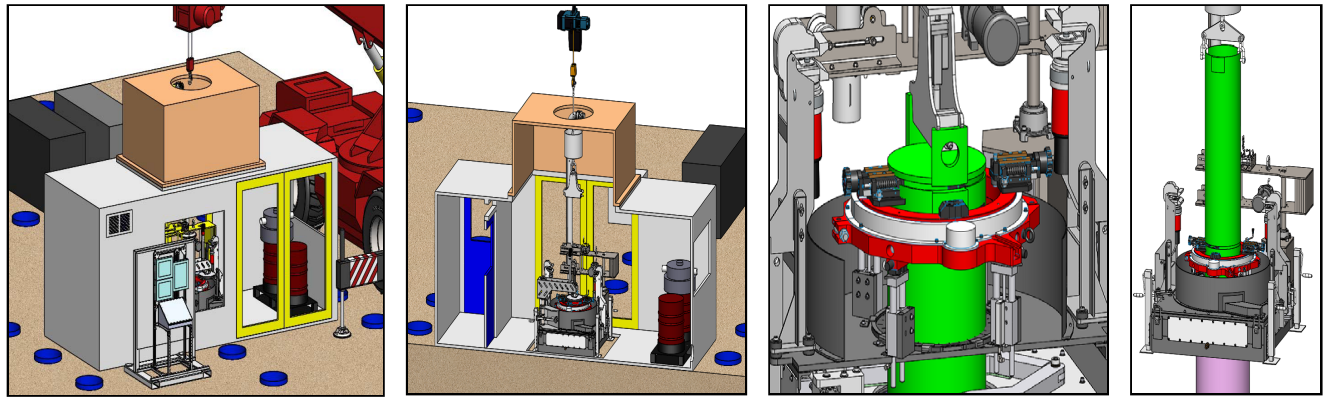
- There are over 150 RH MLLW containers currently in temporary in-ground storage liners at INL
- Nested liner (smaller waste containers nested in a 30-gal paint can nested in a 12.5’ liner then overpacked in a 13.8’ liner) is most common configuration (~120 liners) and represents the largest liability
- Configuration presents significant difficulties in accessing actual contents for treatment
- Strategy developed to employ a phased approach to improve retrieval coupled with alternate treatment options utilizing offsite vendor
- Capitalizes and expands on technology development for CH MLLW and includes vitrification demonstration on size-reduced inner liner and contents



Nested Liner Configuration

Advanced Retrieval Approach for RH MLLW Liners

- INL partnered with Veolia to develop a semi-remote, mobile retrieval system prototype to improve the access to the nested waste liner configuration
- First retrieval was successfully executed, and the RH MLLW was shipped offsite for treatment and final disposal in 2021
- Additional retrievals and treatment are planned in 2022 and beyond

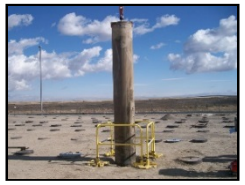


Advanced Retrieval Prototype Renderings

Advanced Retrieval System In Use

RH-MLLW Treatment Disposition Pathways

RH MLLW



Retrievals Using Advanced Retrieval Prototype System

Retrievals with Excavation and Facility Transfer Containers

Liner Processed Using GeoMelt

Liner Processed at INL (EM Operated)

Nevada Nuclear Security Site Radioactive Waste Disposal Facility (EM Operated)

Offsite Commercial Waste Disposal Facility

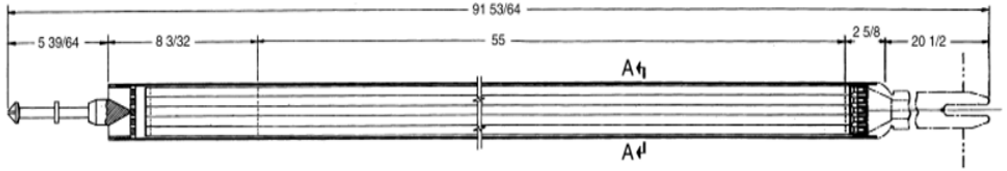
Legend
RH = Remote Handled
LLW = Low-Level Radioactive Waste
MLLW = Mixed Low-Level Radioactive Waste
RWDP = Remote-Handled Waste Disposition Project

Established disposition path

Alternate disposition path

Expanding the Phased Approach to Other Waste Streams

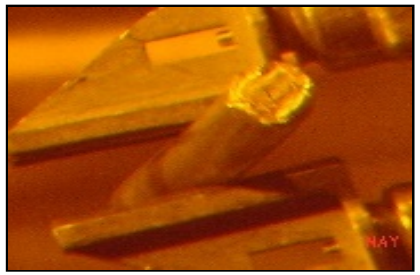
- DOE O 435.1 interpretation will provide an opportunity at INL to reanalyze or reclassify/recategorize several liabilities
- A phased approach will again be employed, as before, to demonstrate proof of concept application of methods or technologies to eliminate liabilities for INL
- Initial demonstration on treatment viability was proven in earlier phases
- Strategy development and characterization validity is underway



EBR-II Blanket Element Subassembly

Unirradiated Subassembly Proof of Concept Treatment

Cladding Hulls



Plenum Tips in Cell

Planning for Future Success

- Continue partnering with industry to explore offsite opportunities for commercial MLLW treatment options while maintaining onsite core capabilities
- Expand strategy for applying a phased approach to other complex waste streams
- Expand on initial evaluations for potential upgrades or modifications to optimize onsite capabilities
- Capitalize on complex-wide initiatives for identification, deployment, and final disposition options for difficult-to-treat waste streams