Calcine Disposition Project

Status, Issues, and Challenges

Idaho Cleanup Project

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Mission Need

Environmental Management (EM) has identified a need to establish the Calcine Disposition Project to disposition high level waste (HLW) calcine including characterization, retrieval, treatment (if necessary), packaging, and onsite interim storage pending shipment to a geologic repository or offsite interim storage facility.

Liquid High Level Waste (HLW) was Converted to a Solid (Calcine)

- ***Calcine is HLW by source-based definition***
  - Byproduct of reprocessing (ended in 1992)
  - Also classified as mixed waste regulated under the Resource Conservation and Recovery Act (RCRA)
- ***Accomplished 7 to 1 volume reduction***
  - 8-9M gallons acidic liquid converted to 4400 cubic meters of solid calcine
  - Stored in 43 shielded bins in 6 bin-sets
    - *Seventh bin set in empty*
    - *Designed for 500 year service life*
- ***Calcine is granular, abrasive, and hydroscopic***
  - Particulate size similar to laundry detergent

Calcine Storage

Calcine – Up Close and Personal

Calcine Bed Material 40x

Calcine Bed Material 150x

Calcine Bed Material 500x

Calcine Disposition Project Drivers

- ***Meet Idaho Settlement Agreement (SA) milestones***
  - Issue a **Record of Decision (ROD) by December 31, 2009** to identify method to treat calcine (if necessary)
    - *Dual path ROD will also carry forward both a treatment and the direct disposal option*
  - Submit a **RCRA Part B Permit application by December 1, 2012** to the state of Idaho for retrieval and treatment (includes packaging)
  - Have all **calcine ready for transport out of the state of Idaho by a target date of December 31, 2035** (so-called "road ready")
- ***Meet Idaho Site Treatment Plan (STP) milestones***
  - Approval of **CD-0 by March 31, 2007**
    - *State approved revision from previous 12/31/2006*
  - Approval of **CD-1 by March 31, 2008**
  - Submit an **enforceable schedule** for disposition of calcine (including design, construction, and start of operations) **by June 30, 2010**

- ***Prepare Calcine for disposal in the Repository as required by the Nuclear Waste Policy Act***
- ***Fulfill commitments in 2005 ROD from the Idaho HLW and Facilities Disposition Environmental Impact Statement (EIS) - DOE/EIS-0287***

What will be Accomplished

- ***Design, permit and construct retrieval systems (applies to all options)***
- ***Design treatment systems (critical path) pending decision on viability of Direct Disposal***
  - Construct treatment facility (if necessary) as documented by ROD
- ***Retrieve 4400 cubic meters of calcine from current storage in the Calcine Solids Storage Facility (bin sets)***
- ***Treat calcine to address RCRA characteristic wastes, if necessary***
- ***Remove calcine from RCRA regulation:***
  - By petition to EPA for direct disposal of untreated calcine
  - By petition (i.e., delisting of borosilicate glass) for treated calcine, if necessary
- ***Package either resultant treated waste form or untreated calcine in canisters meeting Repository waste acceptance criteria***
  - 10 foot tall by 2 foot diameter DOE standardized canister or HLW package
- ***Ship or store/stage resultant canisters pending shipment to Repository***
- ***Perform RCRA closure on existing Calcine Disposition Project facilities and clean closure of retrieval/treatment/storage facilities***

Project Status

- ***Demonstrated pneumatic retrieval with cold calcine***
- ***Down-selected to 3 treatment technology options (plus direct disposal)***
- ***Canister Modeling & Selection for direct disposal option***
- ***Detailed calcine characterization nearing completion***
  - Process models, legacy sample analysis, thermodynamic computer modeling
- ***Groundwater modeling and Land Disposal Restriction evaluations***
  - Untreated Calcine disposal at the Repository will meet Total System Performance Assessment (TSPA) for both radioactive and chemical (RCRA) constituents
  - New EPA radiation standard for groundwater has no expected impact on modeling
- ***Obtained 10-year RCRA permit for ongoing current storage (11/9/2006)***
- ***Environmental Management Acquisition Advisory Board held 12/15/2006***
  - Energy Systems Acquisition Advisory Board for CD-0 planned for February
- ***Closely following Repository and regulatory developments***
  - Petitioning the Environmental Protection Agency (EPA) for Conditional Exemption for direct disposal of packaged calcine in the repository is currently on hold

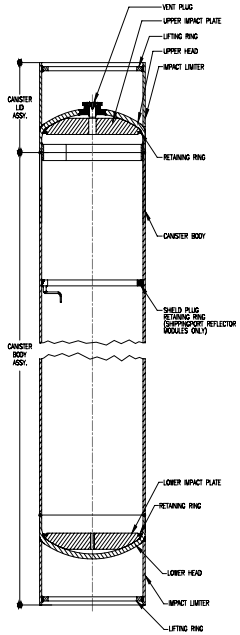
Summary of Value Engineering Analysis Performed March 2006

- ***Direct Disposal option (retrieve and package without treatment)***
  - Retained as one of the dual-path options (lowest cost, shortest schedule)
  - Meets Repository performance criteria, but EPA petition approval or legislation necessary to meet regulatory requirements
  - 6600 canisters – granular waste form
- ***Steam Reforming treatment option***
  - Re-uses major portions of Integrated Waste Treatment Unit
  - Moderate to high regulatory risk –granular, RCRA-hazardous waste form,
  - Highest technical challenge –minimum of 6,600+ canisters (up to 2 to 3X as much)
- ***Hot Isostatic Pressing treatment option***
  - Significant volume reduction (~3300 cans) - high pressure and temperature
  - Moderate regulatory risk – monolithic, RCRA-hazardous waste form
- ***Vitrification treatment option***
  - Borosilicate glass, - EPA and state of Idaho preferred waste form
  - Lowest regulatory risk – 11,200 canisters – monolithic, RCRA-hazardous waste form – highest cost

Direct Disposal (Retained for Dual Path ROD)

Top View of CSSF 6 Bins

ASME Spent Fuel Canister



- ASME B&PV Code, Section III, Division 1, Subsection NB (with Code Case N595-2)
- Constructed of 316L stainless steel
- Full penetration closure weld, ultrasonic & liquid penetrant NDE
- Sizes
  - 18 inch diameter, 10 or 15 ft long
  - 24 inch diameter, 10 or 15 ft long
- Designed for Transport and Storage at a National Repository

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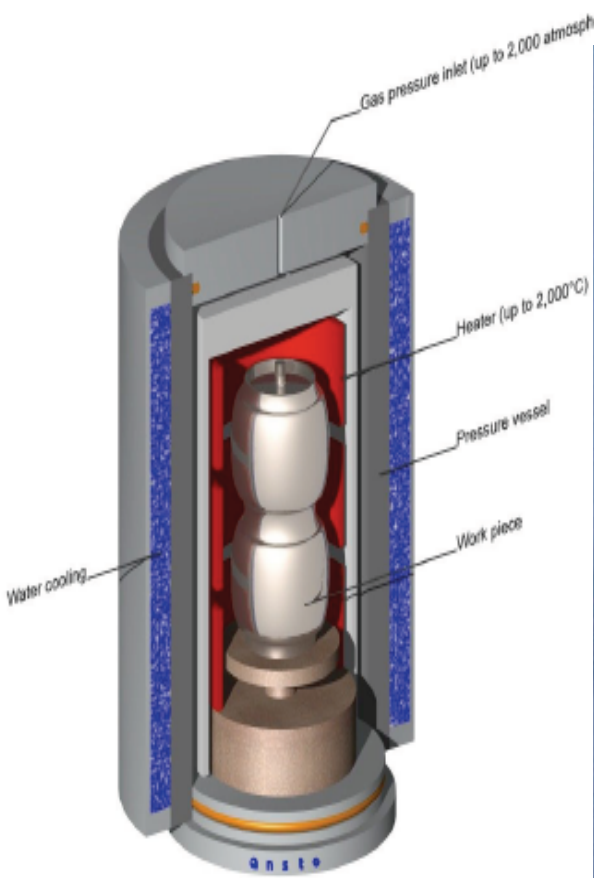
Foster Wheeler Environmental Corporation

Hot Isostatic Pressing



Technology Development Accomplishments

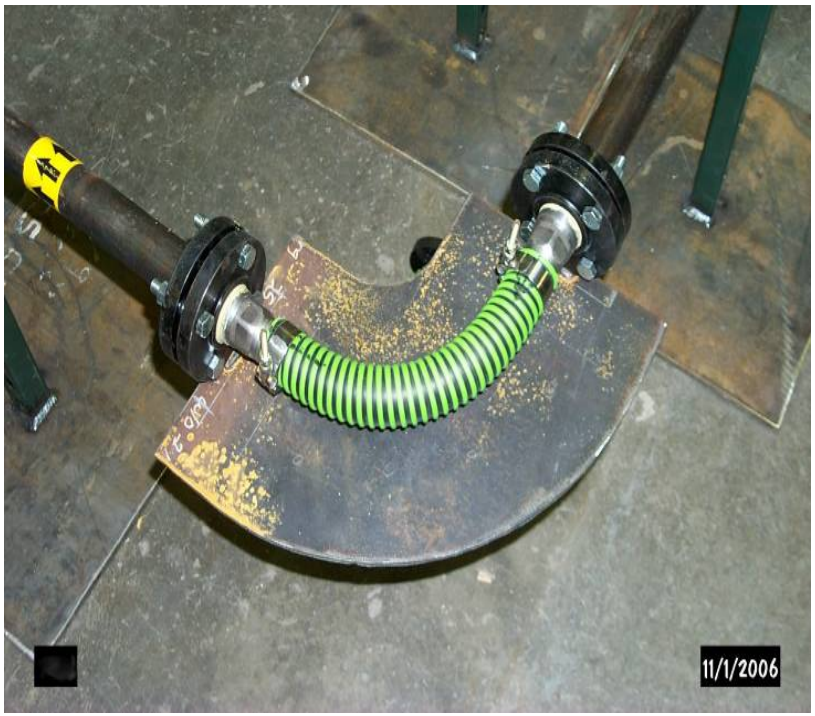
- ***Developed, installed and operated retrieval mock-up system (AEA Technologies)***
  - Pick-up nozzle development and enhancements
  - Automation of retrieval arm control system
  - Tests Completed:
    - *Vertical Lift (120')*
    - *Horizontal transfer (650')*
    - *Caked calcine retrieval*
    - *Extended duration (long distance transport system) <100 hours*
- ***Developed pre-conceptual design for retrieval and transport system including:***
  - Final layout design of retrieval arm
  - Final layout design of hose management system and remote controls
  - Identification of radiation tolerant materials
  - Draft implementation plans for system deployment, operation and decommissioning
  - Final report was issued in January 2007

Technology Development Accomplishments (Continued)

- ***Conducted pneumatic transport erosion test (approx. 500 hours)***
  - Obtained more data on erosion potential of rubber hose material considered for use in calcine retrieval arm
    - *Kanaflex 180 AR made of styrene butadiene rubber (SBR) with a polyvinyl chloride (PVC) reinforcing helix performed favorably*
    - *Kanaflex 300 made of ethylene propylene diene monomer(EPDM) rubber (seen in next slide) and stainless steel were also tested*
    - *Literature search indicates SBR and PVC would likely meet radiation resistance requirements for short-lived calcine retrieval*
  - Testing was completed during January
    - *Observation of test indicates material is as abrasion/erosion resistant as stainless steel*
    - *Final report will be issued in February*

Erosion Testing for Retrieval Arm

- ***Erosion testing of EPDM rubber for flexible joint***



Erosion testing (after)

Erosion testing (before)

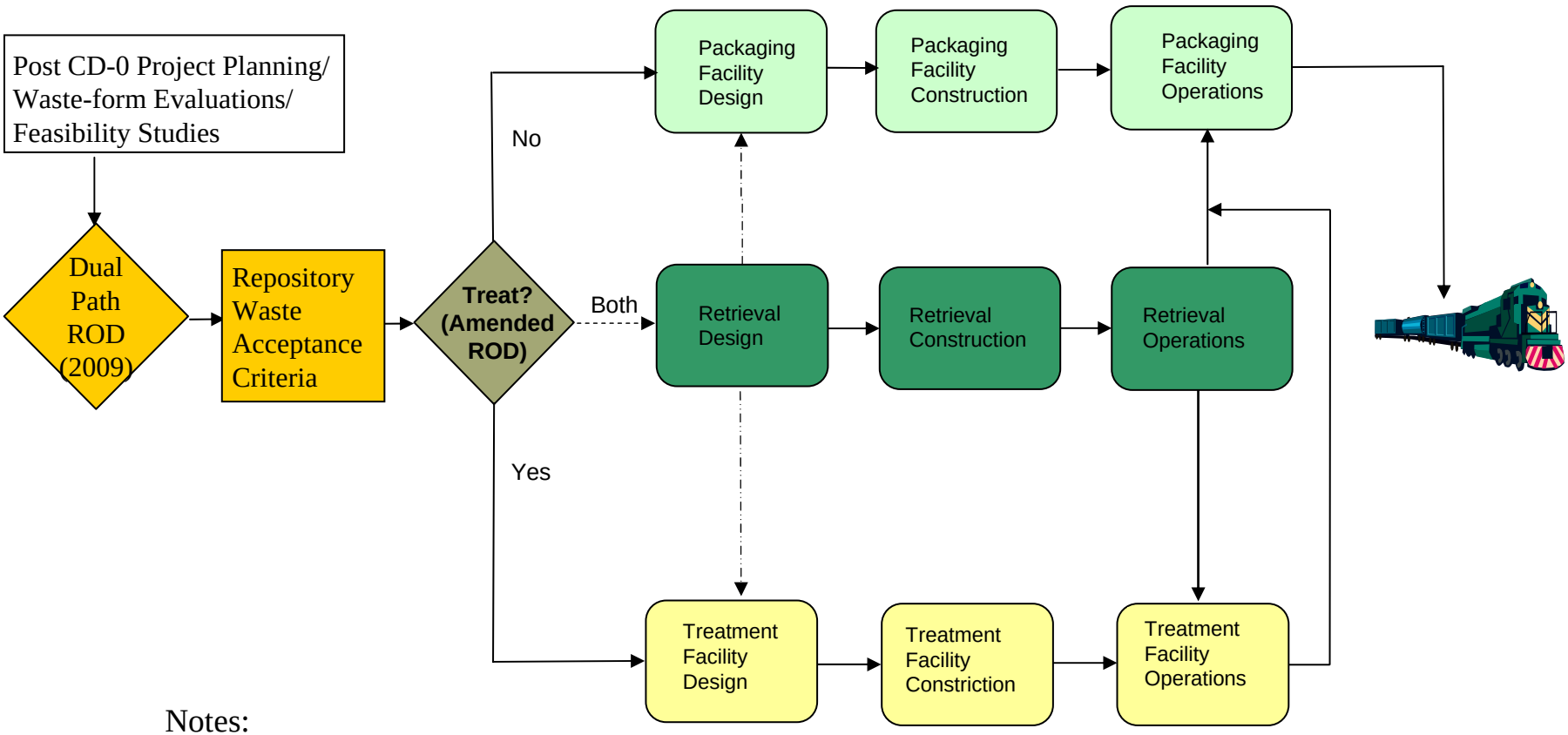
Future Technology Development

- ***Retrieval***
  - Determine optimum number and size of bin access points
  - Enhance test nozzle design to improve efficiency
  - Design equipment for remote operations, shielding, and contamination control
  - Test auxiliary tools and system functionality
  - Test methods to monitor calcine removal rate
- ***Packaging***
  - Demonstrate external canister decontamination
  - Qualify cap weld and inspection method
  - Demonstrate canister filling technique and sampling
  - Demonstrate compliance with sealed canister specifications

Future Technology Development (Continued)

- ***Bin set cleaning***
  - Demonstrate removal of loose and fixed residual calcine
  - Demonstrate methods to determine residual waste inventory after cleaning bins
- ***Treatment Technology Development (if necessary)***
  - Define and produce calcine surrogates and test their properties to support waste form demonstrations
    - Require adequate quantities of aluminum, zirconium, and sodium surrogates
  - Cold bench test three candidate treatment technologies and evaluate performance with each calcine surrogate
  - Conduct hot bench studies
  - Conduct bench scale studies to determine long-term effects of radiation fields on waste form performance
  - Select candidate treatment technologies and process control monitors for cold mock-up studies

Calcine Disposition Project Dual Path Approach

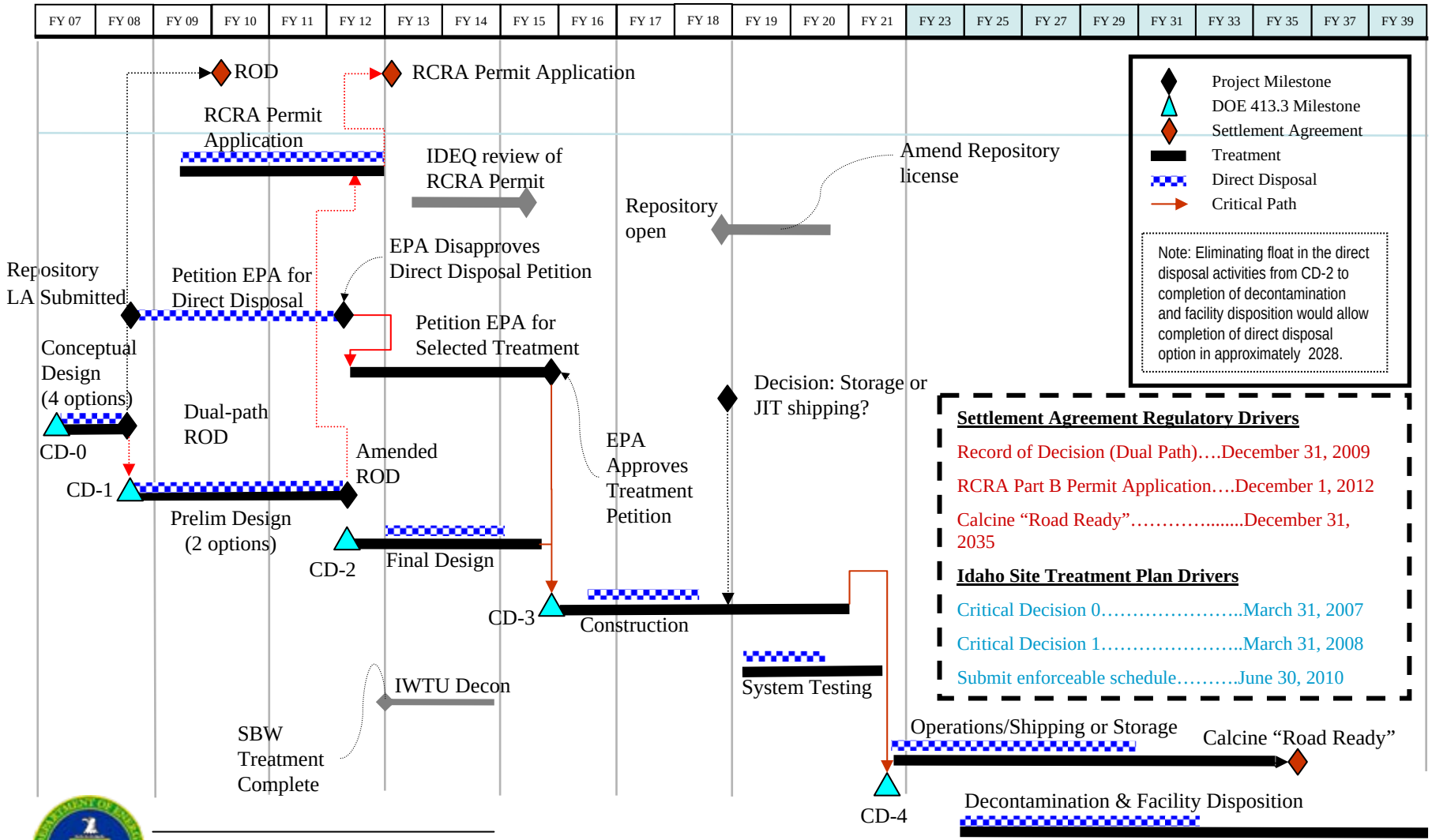


Notes:

(1) Repository Waste Acceptance Criteria factors in RCRA compliance and waste-form performance

(2) Project will re-use the Integrated Waste Treatment Unit to the maximum extent practicable upon completion of the Sodium Bearing Waste Project mission

Critical Path – Regulatory and Treatment Driven



Project Cost/Schedule Range

- ***Project life cycle cost will range between $2B (Direct Disposal) and $16B (Vitrification) in 2006$s (unescalated)***
  - Based on an Independent Cost Estimate (85% confidence level)
- ***Project schedule will range from roughly 20 years (Direct Disposal) to 30+ years (Treatment)***
  - Operations will be timed to meet Settlement Agreement

Project Issues and Challenges

- ***Both treatment and direct disposal require an EPA-approved petition(s)***
  - For direct disposal, approval of petition for No Migration/Land Disposal Restriction exemption (or equivalent) is required
    - *Submittal of petition to EPA is pending repository milestones*
  - Without removal from RCRA regulation for disposal, most defensible ROD is for treatment by vitrification
    - *Vitrification cost and schedule bounds steam reforming and hot isostatic pressing options*
    - *All treatment options require petitioning EPA for delisting of final waste-form*
  - *All treatment options require state of Nevada acceptance of RCRA waste form even if delisted or conditionally exempted by EPA*
    - *Material is subject to regulation under RCRA by state of Idaho as well – no known issues*
- ***Calcine treatment ROD in 2009 and submission of RCRA Part B permit application in 2012 are required SA milestones***
  - Preliminary design needed for technical completeness
  - Consequence of missed Settlement Agreement milestone is suspension of DOE SNF shipments into Idaho