Calcine Disposition Project

Presented To: U.S. Nuclear Waste Technical Review Board

Presented By: Joel Case  
Federal Project Director  
Calcine Disposition Project

__________________________
January 9, 2012
Presentation Objectives

- Project Background
- Project Drivers
- Project Scope
- Current Status
Background - Calcine
Calcine is Solidified radioactive waste from Spent Fuel Reprocessing

- Converted the liquid high level waste into a granular solid using a thermal process referred to as calcination
- Resulted in a 7 to 1 volume reduction
- Calcine Properties
  - Mixed hazardous/high-level waste
  - Dry, friable powder that is dispersible and can be mobilized in both air and water
  - Stable noncorrosive form
- Regulated by the State of Idaho under its RCRA authority
  - Eight RCRA Metals
    - Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver
  - Four RCRA Listed Waste Codes
    - F001 & F002 – Spent halogenated solvents
    - F005 – Non-halogenated solvents
    - U134 – Unused hydrofluoric acid
Background - Calcine Solids Storage Facility (CSSF) Inventory

- Stored in 43 stainless steel bins
- Regulated under a 10-year RCRA Part B Permit Issued November 2006
- Compliance is based on a State-approved exemption from RCRA double containment requirement that requires periodic State approval to remain valid.
Calcine Solids Storage Facility
Project Drivers

- **Idaho Settlement Agreement milestones**
  - Issue a Record of Decision (ROD) by December 31, 2009 to identify method to treat calcine (issued December 23, 2009, identified Hot Isostatic Press as calcine treatment process)
  - Submit RCRA Part B Permit Application or Permit Modification Request for HIP process and calcine retrieval to the State of Idaho by December 1, 2012
    - May include SBW HIP processing schedule
  - Calcine road ready for transport out of Idaho by December 31, 2035

- **Idaho Site Treatment Plan Milestones**
  - Submit project milestones by December 31, 2012
Calcine Disposition Project Scope

- Design and construct processing system using the Integrated Waste Treatment Unit (IWTU) facility to the maximum extent practical
- Retrieve calcine from bin sets and process using hot isostatic pressing (HIP) technology
  - 4,400 m$^3$ (155,000 ft$^3$) or 5.5 million kg (12.2 million lbs) of calcine
- Utilize Waste Acceptance System Requirements Document (WASRD) for Yucca Mountain
- Package treated waste form in canisters
- Ship off-site or place canisters in interim storage pending off-site shipment for disposition
- Current Project TPC cost range is $0.9 B to $2.0 B
Hot Isostatic Pressing

- HIP in commercial use since 1941
  - Commercial temperatures to 2,550 degrees C and pressures to 60,000 psi
- Technology consists of a pressure vessel containing an electrically heated furnace.
- Components are placed in a sealed can inside the furnace and isostatically pressed with argon gas to maximum density
- Temperature range for Calcine treatment 1,050-1,200 °C
- Pressure range for Calcine treatment 7,200-15,000 psi
- Produces glass-ceramic waste form
- Results in large life-cycle cost savings through final disposition
- Volume reduction expected to be 40% to 60%
Process Overview
IWTU Facility
Facility Overview

- Fully utilizes existing IWTU PC-3 cells for HIP machines
- Re-uses the existing IWTU canister fill cells for HIP Can fill
- Calcine Surge (day) storage and bake-out cell within IWTU footprint
- Packaging and shipping located in new east annex
Project Focus

- Project priority for FY2012 is activities leading to submission of RCRA Part B Permit Modification Requests (Calcine Retrieval & HIP Treatment Process) to State of Idaho by December 1, 2012
  - Conceptual Design
  - Technology maturation to support treatment process permit needs
• **Advanced the CDP design**
  – Completed Integrated Test Facility (ITF) technical and functional requirements
  – Revised System Design Descriptions (30%)
    • Developed supporting engineering files, drawings, and reports

• **Technology Development**
  – Commenced waste form testing
  – Completed furnace (filter) testing and analysis
  – Commenced HIP Can testing at Avure
  – Awarded master contract for HIP Can profile testing (ANSTO and Bodycote)
Technology Risks & Technology Readiness Levels (TRL)

- System Engineering Per DOE G 413.3-1
- Technology Development Per DOE G 413.-4A
- DOE-HQ TRA Assessment of CDP Process June-July 2010
  - 11 Critical Technical Elements (CTE)
  - Testing currently underway to achieve TRL-4 for CD-1 Review
  - HCC Filter Testing recommended by TRA team to achieve TRL-4 is complete (Oct-2011)

<table>
<thead>
<tr>
<th>Critical Technology Element (CTE)</th>
<th>TRA Evaluation (7/10)</th>
<th>Current TRL Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrieval/Pneumatic Transfer System</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Batching and Mixing System</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Ceramic Additive Formulation (Waste Form)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hot Isostatic Pressing HIP Can Design</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hot Isostatic Pressing HIP Can Confinement (HCC)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>HIP Can Filling and Closure</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Bakeout System</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Canister Loading/Closure</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Remote Operation and Maintenance</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Characterization (feed, admixture, product)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Simulant Formulation</td>
<td>3</td>
<td>*3</td>
</tr>
</tbody>
</table>
Objectives for Waste Form Technology Development

- What defines “success” for a glass-ceramic waste form
  - Retention of radionuclides
    - Meet WASRD PCT requirements
  - Retention of RCRA hazardous metals
    - RCRA permitted disposition may not be available
    - WASRD states accepted waste forms shall not be subject to regulation as hazardous waste under RCRA
    - Meet RCRA LDR nonwastewater UTS
    - Allows RCRA delisting, if required
- Support Designation of HIP treatment as BDAT for HLW Calcine
  - Provide data for BDAT rulemaking
Technical Readiness Approach – Waste Form

- Fiscal Year 2012
  - Demonstrate immobilization (mineralization) of RCRA constituents in glass-ceramic matrix
    - Develop individual formulations for the 3 general calcine types
    - Test at 100 g and 1 kg sample sizes
    - Successfully completed three CWI developed recipe tests
      - One recipe test met all requirements (ANN/SBW)
      - Two recipe tests met all requirements except TCLP for Cadmium
Recent Project Reviews

• Consortium for Risk Evaluation with Stakeholder Participation (CRESP) – May 2011
  – Purpose - carry out an independent technical review regarding the planned implementation of hot isostatic pressing (HIP) for treatment of calcine waste, and the potential for cold-crucible induction melting to be a back up treatment technology as a project risk reduction strategy
  – Conclusion - HIP processing of calcine should be pursued and that vitrification to produce both a borosilicate glass or glass ceramic should be pursued as an alternative.

  – Purpose - determine the level of technology maturation development and if this would support a project CD-1, and identify project risk.
  – Conclusion - the HIP process is the most attractive approach for processing INL calcine waste; however, identified two risks in regards to waste acceptance of the glass-ceramic waste form
Look Ahead FY12 – FY15

- Complete PMR Development and issue PMR as scheduled
- Continue waste-form testing
  - Demonstrate scale-up at 25-kg sample size
  - Develop a single formulation suitable for all calcine types
  - Initiate BDAT sample data collection
- Continue HIP can testing
- Complete furnace filter testing
- Integrated Test Facility (ITF) Test Design
  - Calcine & Additive Mixing System
  - Bake-Out System
  - Fill & Seal System
- Proposal to issue CD-1 on June 30, 2014 for approval by December 31, 2014
- Proposal to achieve TRL-4 for all critical technology elements by CD-1 submittal