

# Overview of the High Level Waste (HLW) Program

*at the*

## Idaho National Laboratory (INL) Site

*Description, Challenges, Technology, Issues, and Needs*



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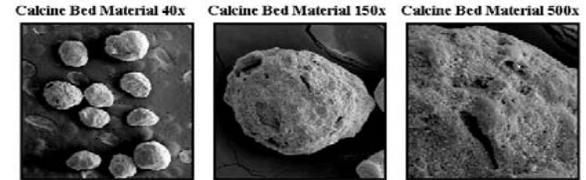
safety ❖ performance ❖ cleanup ❖ closure

*April 1, 2008*

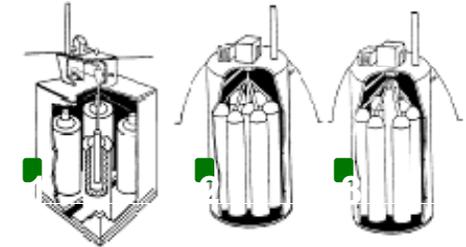
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# INL Site HLW is in Dry Storage in the Form of Calcine

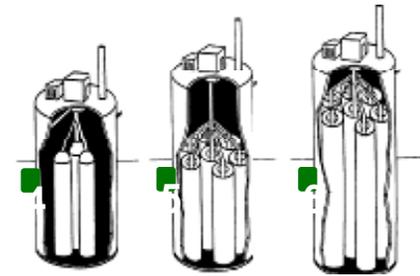
- **8-9M gallons of liquid HLW were converted to 4400 cubic meters of granular solid (calcine) through a fluidized bed calcination process**
  - 7 to 1 volume reduction achieved
    - Average particle size is 0.4 cm
    - Bulk density is about 1.5 to 1.8 g/cc
  - Contains roughly 44 metric tons heavy metal



- **Calcine is stored in 43 bins in 6 concrete-shielded binsets with one spare**
  - 7<sup>th</sup> set of bins – intended for calcined SBW
  - Designed for 500 year service life



- **Calcine is classified as hazardous waste under RCRA**
  - Exhibits hazardous waste characteristics for toxicity for meta
  - Contains listed wastes



- **Currently stored under 10-year RCRA Part B permit issued November 2006**
  - 2007 visual inspection of bins – no adverse findings

- **The Calcine Disposition Project (CDP) is established to meet:**
  - Settlement Agreement and Site Treatment Plan requirements



# Calcine Bin Set # 6



**Model of Bin Set #6**



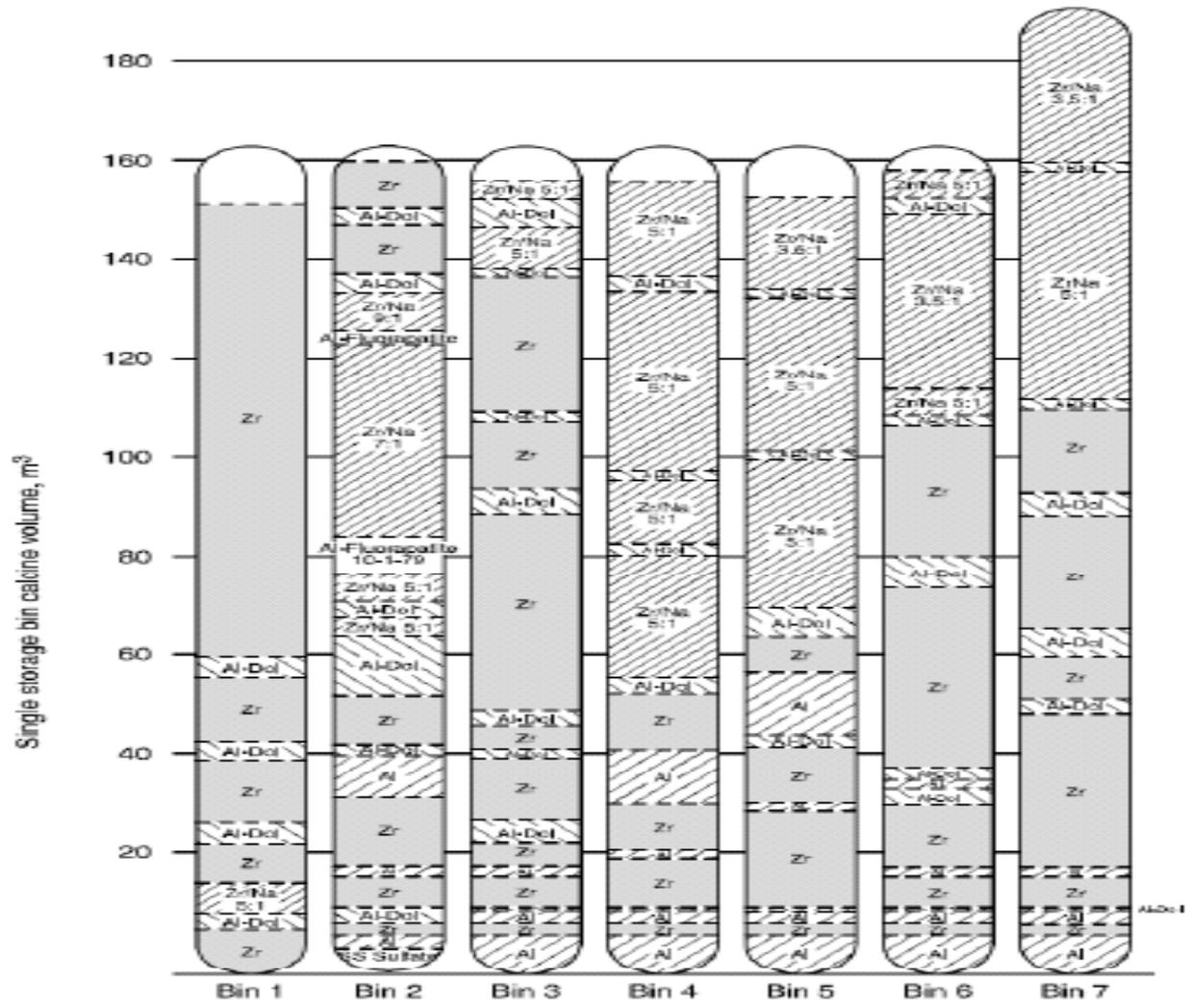
**Top view of CSSF #6 bins**



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# Technical Challenge: Layering of Calcine (Bin Set #3 shown)



05-GA50176-00



# Current Disposal Options for Calcine Remain as Follows:

- **Retrieve, package and *dispose of as is* (direct disposal option)**

- Idaho baseline approach – highest regulatory risk, lowest cost
- Requires conditional exemption from RCRA
- Granular waste form

- **Treatment by hot isostatic pressing**

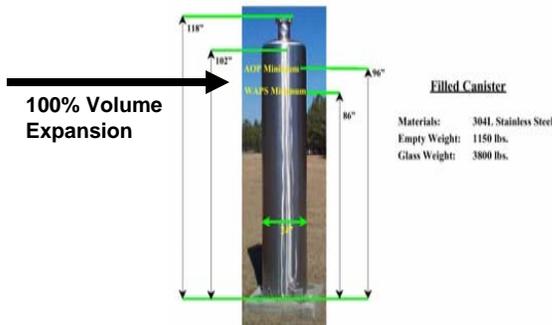
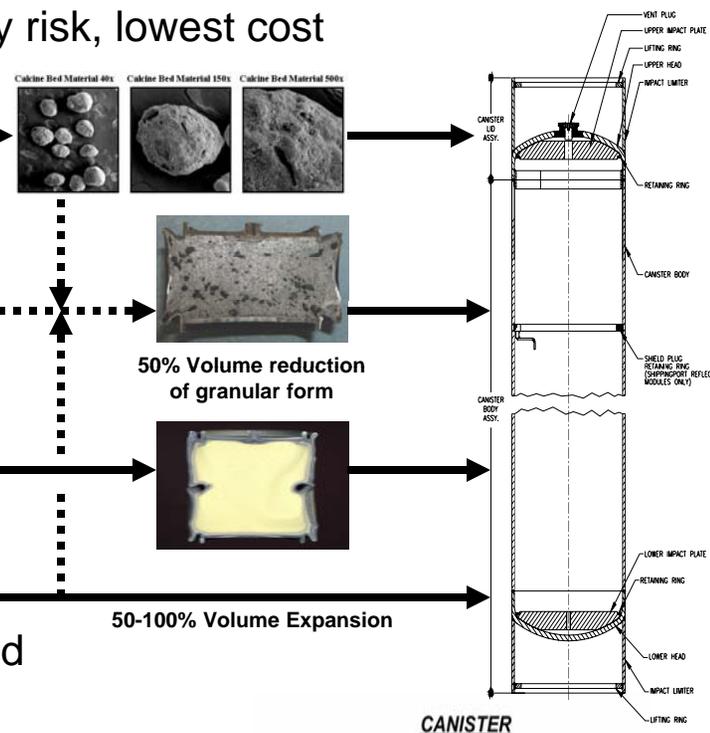
- Volume reduction – being evaluated by BEA and ANSTO, Inc.
- Monolithic waste form – requires delisting
- Could compact (~50% volume reduction) either of above

- **Treatment by steam reforming**

- Maximizes re-use of IWTU
- Requires re-dissolution of calcine in nitric acid
- Granular waste form – requires delisting

- **Treatment by direct vitrification**

- Lowest regulatory risk – highest cost and volume
- Monolithic waste form – requires delisting



## Basis for Pursuing the Direct Disposal Option

- ***INL conducted preliminary long-term performance sensitivity analysis using Yucca Mountain Total System Performance Assessment (TSPA) model used in the Final EIS***
  - Hazardous constituents do not migrate beyond the repository boundary in concentrations above health-based levels at the radionuclide compliance point established in 40 CFR 197 during the proposed 1,000,000-year regulatory period
- ***INL also ran EPA's Industrial Waste Evaluation model using conservative site-specific data/assumptions for Yucca Mountain***
  - Results show that health-based limits are not exceeded at the hypothetical well (1 mile away) for any hazardous constituent
- ***Modeling suggests no significant environmental benefit associated with further treatment***
- ***DOE is thus planning to petition EPA for a **conditional exemption of calcined HLW from the regulatory definition of hazardous waste based on disposal at an NRC-licensed geologic repository and an exemption from land disposal prohibitions based on a no-migration demonstration*****
  - Regulatory precedent is “Conditional Exemption for Low-Level Mixed Waste Storage and Disposal” found at 40 CFR 266, Subpart N
  - Human health and environmental protection requirements for geologic repository more stringent than requirements for low-level waste disposal



## Basis for Pursuing the Direct Disposal Option (cont.)

- ***An INL petition would seek to demonstrate that an NRC-licensed repository will be as protective or more protective than a disposal unit permitted under RCRA***
  - DOE-ID needs access to the revision of the TSPA model supporting the NRC Yucca Mountain License Application to update the 2004 draft petition
  - NRC's confirmatory model will also be run
- ***DOE-ID has recently opened discussions with EPA (Region 10) on the regulatory feasibility of the direct disposal approach and well as the treatment alternatives***
  - Obtain feedback as to what EPA's expectations are regarding the proposed petition for direct disposal without further treatment and the three treatment alternatives
  - The impact of the state of Nevada's RCRA authority was also discussed



## Further Evaluation of HIP Option Appears Warranted

### Consolidation:

Matrix:

Waste loading:

Durability (PCT-B):

Final volume:

(relative to untreated calcine)

Temp:

Pressure:

Off-gas:

### HIP

glass-ceramic

**60-90%**

10-100 x EA glass

**15-45% reduction**

2200°F

4500 psi

minimal

### Vitrification (JHM)

borosilicate glass

**20-35%**

10 x EA glass

**100+% increase**

2100°F

atmospheric

medium-high

### Facility

Future Mission Flexibility: diverse/flexible

extremely limited/inflexible



Cold calcine in glass-ceramic matrix



Direct SBW compaction (no additives)



Metal encapsulation of uneconomic feeds  
(Swedish SNF in copper shown)



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## Technology Initiative: HIP Evaluation Funded by EM-20

- **Contract between Battelle Energy Alliance and the Australian National Science and Technology Organization, Inc. was signed 2/28/2008**
  - Currently funded at \$2.5M (FY-07 funds)
  - Will provide data to be used in downselection of treatment alternatives
- **Presents opportunity to maximize return on investment by:**
  - Diversifying DOE's technology platform and reducing technical risk by producing and evaluating wasteforms with surrogate (non-radioactive) materials
    - Glass-ceramic waste forms for INL calcines
    - Direct HIPing of INL calcines and SBW (50% volume reduction plus monolith)
    - Encapsulation of corroded fuel cladding, hulls, pins etc.
    - Immobilization of other waste difficult to vitrify in conjunction with ceramic or glass-ceramic matrices such as:
      - Technetium, U-233, impure Plutonium, Cesium, Iodine, ...
- **DOE-ID currently has a HIP unit installed in the HFEF hot-cell at INL**
  - Will use to evaluate remote operations (filling, crimping, etc.)
- **DOE-ID needs an additional \$2.5M to complete scope**
  - FY-09 funding may not be timely if in a continuing resolution



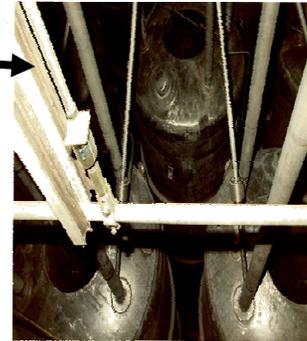
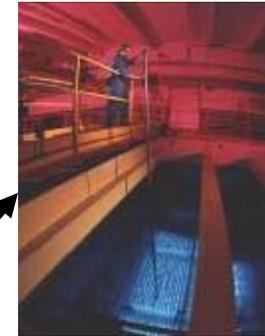
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## DOE is in the Process of Meeting with EPA

- ***EPA regulatory action will/may be needed to allow disposal of certain Department of Energy (DOE) wastes at a Nuclear Regulatory Commission (NRC) Licensed Geologic Repository***
  - Meeting with Dr. Bartus (EPA R-10) held February 5, 2008
- ***Wastes that may require EPA regulatory action include:***
  - Hanford Richland Office cesium/ strontium capsules
  - Idaho National Laboratory (INL) Site sodium-bonded fuel
- ***Wastes that will require EPA regulatory action include:***
  - Hanford Office of River Protection Immobilized HLW
  - INL HLW calcine



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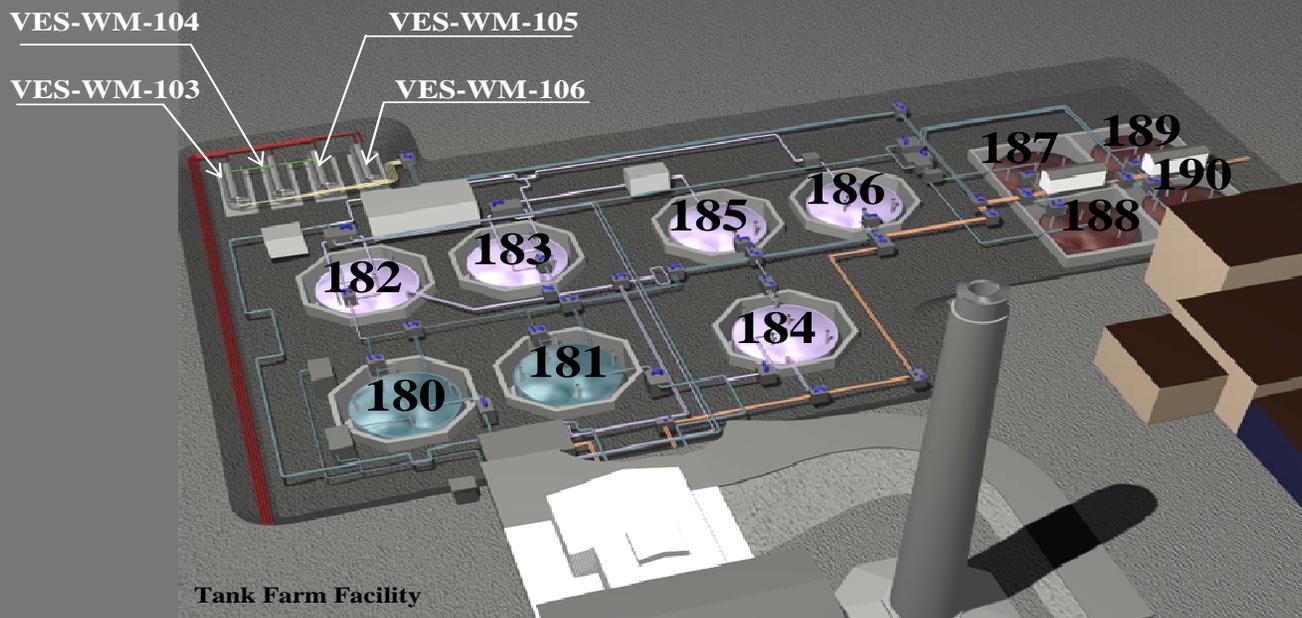
## FERMI & EBR-II Sodium-Bonded Spent Nuclear Fuel (SNF)

- **Though not HLW, the presence of metallic sodium (Na) may exhibit RCRA reactivity characteristics requiring treatment or EPA regulatory action**
  - Na is integral to the SNF (inside cladding), provides heat transfer bonding agent
  - Reaction rate of Na exposed to air or water is energetic
- **Fermi blanket assemblies have low burn-up and cladding is intact**
  - A process (MEDEC) is being evaluated that evaporates Na off into a deactivation trap
    - The assembly is then canned (if necessary) for disposal in DOE standardized canister
  - Fermi driver assemblies are not Na-bonded
- **EBR-II Driver assemblies are fissured and require treatment**
  - High radiation levels & burn-up caused sodium to permeate fuel meat
    - Cladding unravels in CPP-666 when storage cans (10% of which) leak
  - Pyrochemical processing is used to separate assemblies into uranium and two disposable wasteforms
    - A ceramic that stabilizes fission products that form chlorides
    - A stainless/zirconium wasteform stabilizes cladding hulls and noble fission products
  - EBR-II blanket assemblies are intact and may lend themselves to treatment similar to FERMI
- **Treatment of FFTF SNF is similar to EBR-II**



# Tank Farm Closure is Progressing at the INL Site

## INTEC TANK FARM CLOSURE



Tank Farm Facility

- Octagon Vaults: WM-180, WM-181
- Pillar and Panel Vaults: WM-182, WM-183, WM-184, WM-185, WM-186
- Square Vaults: WM-187, WM-188, WM-189, WM-190

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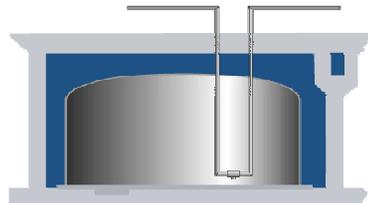


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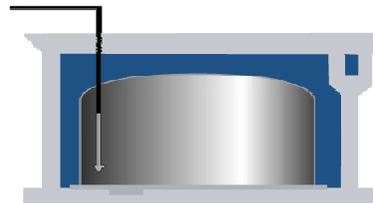
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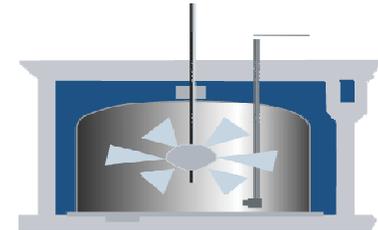
# Tank Closure Sequence



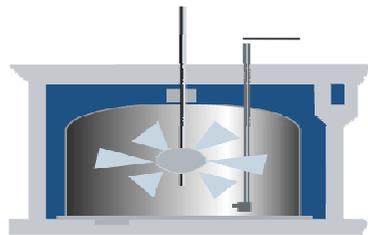
**Empty to heel with existing jets**



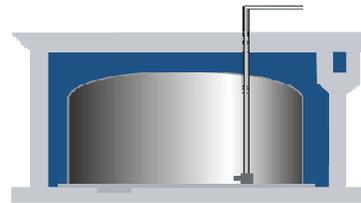
**Flush piping into tanks**



**Install new steam jet and wash equipment**



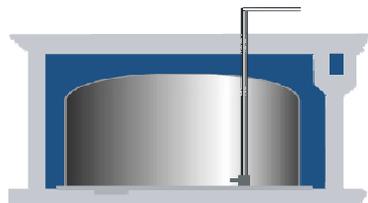
**Wash tank and empty with new jet**



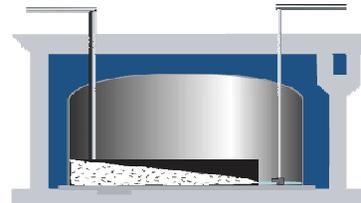
**Video and sample tank residuals**



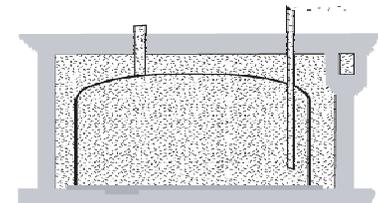
**Tank evaluation**



**Obtain authorization to grout**



**Displace heel with grout**



**Fill tank, piping and vault with grout**

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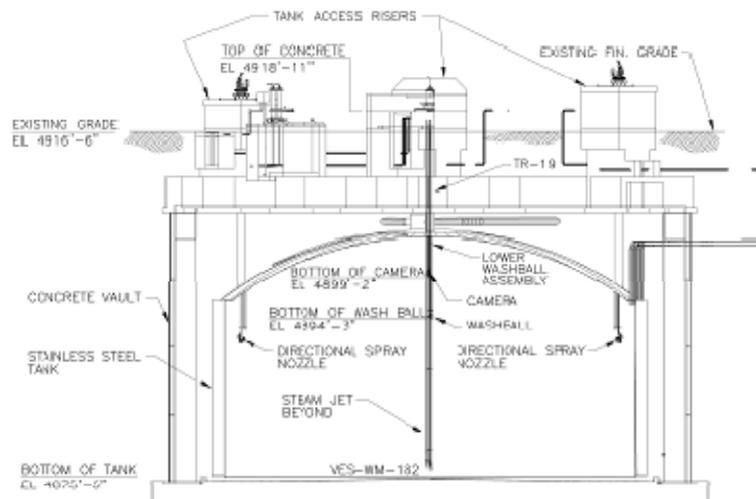
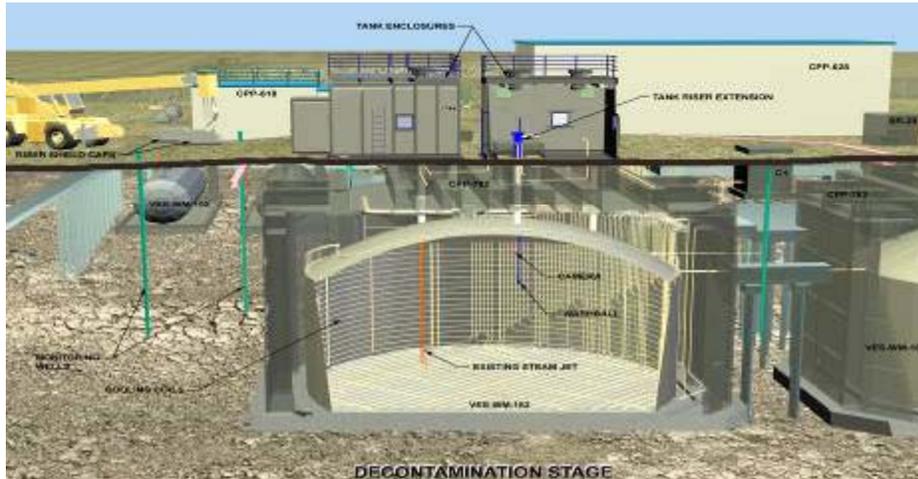


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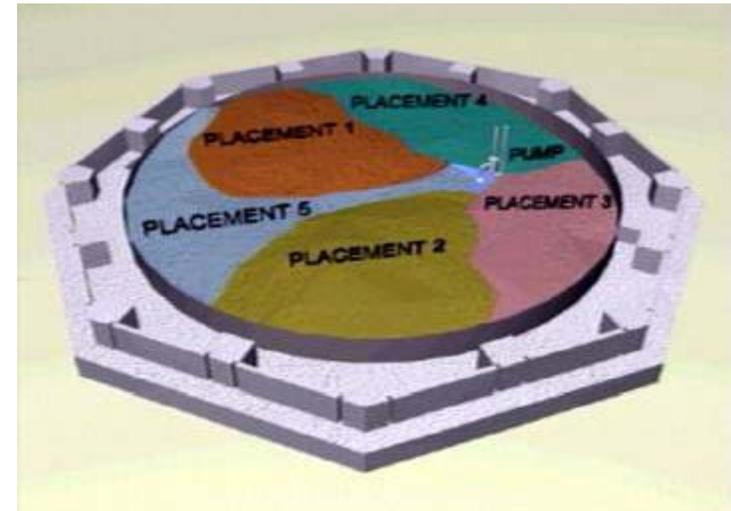
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# Cleaning of HLW Tank VES-WM-182



# Grouting of HLW Tank VES-WM-182



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## Integrated Waste Treatment Unit Project

- ***Project mission is to provide treatment of approximately 900,000 gallons of liquid tank waste stored at the Idaho Tank Farm Facility to a stable waste form for disposition at the Waste Isolation Pilot Plant***
  - Became necessary due to decision to cease New Waste Calciner operations
  - Integrated with Calcine Disposition Project to support follow-on calcine mission
- ***Project is a Line Item Capital Project within the Idaho Cleanup Project (ICP) contract awarded to CH2M\*WG, LLC on March 23, 2005***
- ***Steam Reforming is the treatment technology (December 2005 Record of Decision)***
  - Current flowsheet produces a carbonate waste form for disposal at WIPP
    - *Mineralized flowsheet is also developed*
  - Technology also under consideration for treatment of calcine (if necessary)
- ***Project Performance Baseline:***
  - Critical Decision (CD) -2 approved in December 2006
  - CD-3 approved in August 2007
  - Total Project Cost is estimated at \$461M (includes \$80M of management reserve/contingency)



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## Work Continues Through Idaho Winter



**Weather Enclosure In Place  
November 5, 2007**

**Shield Wall Formwork in Progress  
March 10, 2008**



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## Regulatory Challenges: Calcine Disposition & SBW Project Drivers

- **Meet Idaho Settlement Agreement (ISA) milestones**
  - Issue a NEPA **Record of Decision (ROD)** by **12/31/ 2009** to identify method to treat calcine (if necessary)
    - *Dual path ROD may carry forward both a treatment and the direct disposal option*
  - Submit a **RCRA Part B Permit application** by **12/1/2012** to the state of Idaho for retrieval and treatment (includes packaging)
  - **Complete “calcination” of all SBW liquid high-level waste by 12/31/2012**
  - Have all calcine ready for transport out of the state of Idaho by a target date of **12/31/2035**
- **Meet RCRA 1992 Non-Compliance Consent Order for Tank Closure**
  - **Closure of all liquid HLW tanks by 12/31/2012**
- **Meet Idaho Site Treatment Plan (STP) milestones**
  - Approval of **CD-0** by **June 30, 2007**
    - *Approved June 29, 2007 by Deputy Secretary Clay Sell*
  - Approval of **CD-1** by **September 30, 2009**
  - Submit an **enforceable schedule** for disposition of calcine (including design, construction, and start of operations) by **June 30, 2010**
- **Both required to fulfill commitments in 2005 ROD from the Idaho HLW and Facilities Disposition EIS - DOE/EIS-0287**



## INL Site HLW Program in a Nutshell

- ***The INL Site HLW program currently consists of 4400 cubic meters of calcine located in 6 bin sets and will require EPA regulatory action***
  - Classification of SBW waste is subject to a future Section 3116 waste determination
  - Sodium-bonded SNF may likewise require EPA regulatory action prior to disposal
- ***The INL Site HLW program is making progress in meeting the EM mission***
  - Idaho Nuclear Technology and Engineering Complex Tank Farm closure
    - *Seven large and 4 small tanks are grouted, with four large SBW tanks remaining*
    - *Upon closure, DOE-ID EM will be out of HLW, SBW, and SNF wet storage*
  - Calcine Disposition Project is working to meet regulatory/legal commitments
    - *Conceptual design of retrieval system is complete, technology downselection is on track*
    - *DOE-EM, ID, RW, and GC are engaged in the need to approach EPA on calcine disposition alternatives*
    - *Meanwhile, calcine storage is considered environmentally safe for the foreseeable future*
  - The IWTU facility is under construction
- ***DOE-ID needs the following assistance from EM-HQ***
  - Additional funding for the HIP technology evaluation initiative (2009 NEPA ROD)
  - Assistance in obtaining access to the RW TSPA model (2011 Amended ROD)

