Demonstration Bulk Vitrification System

Project Status

Presented by:
PK Brockman

October 18, 2006

Office of River Protection

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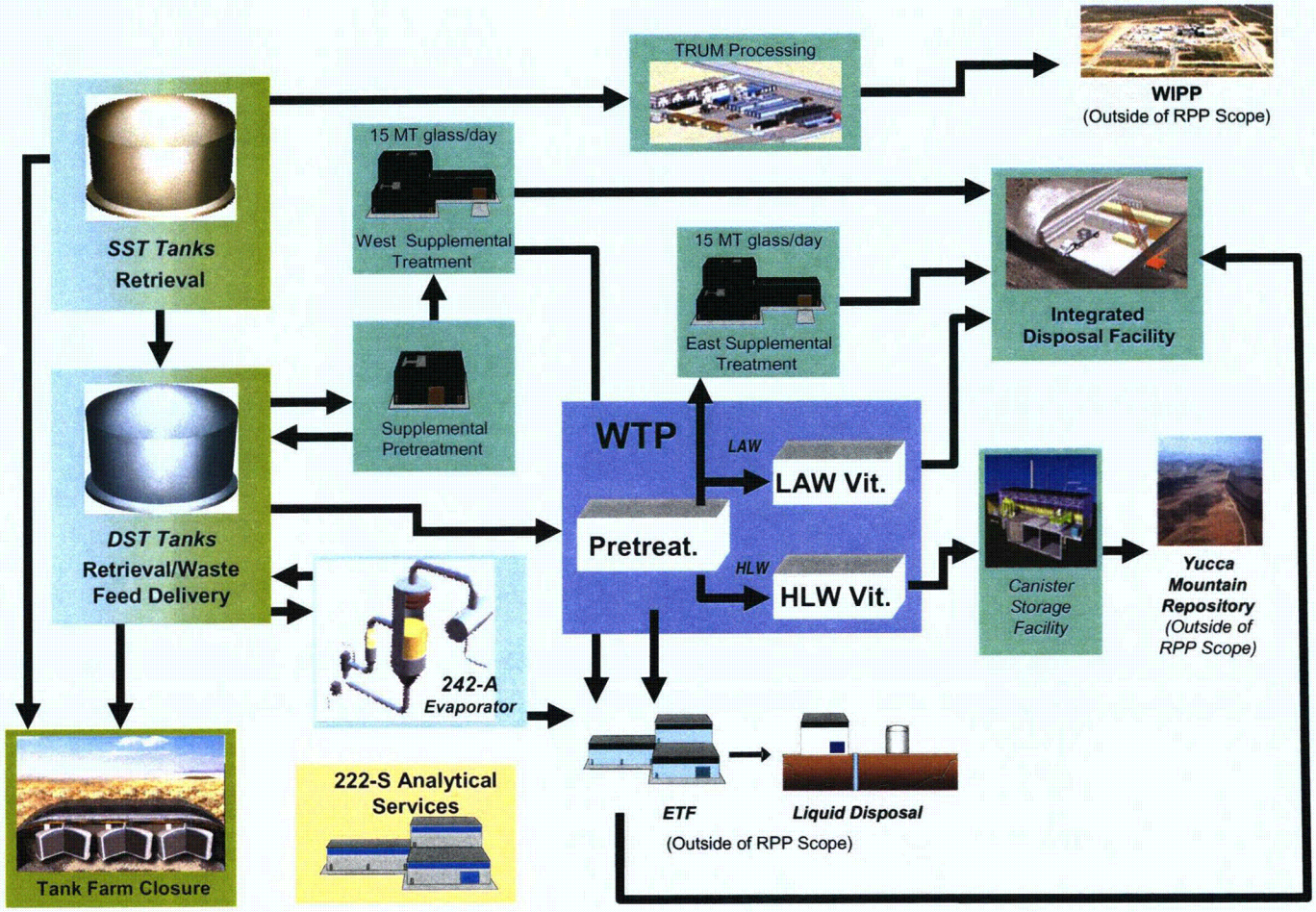
Hanford Group, Inc

RPP Tank Waste Treatment System Diagram



Bulk Vitrification Timeline

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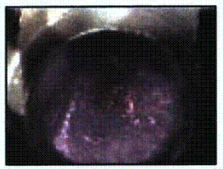
- BV R&D undertaken
  - Crucible, engineering scale testing

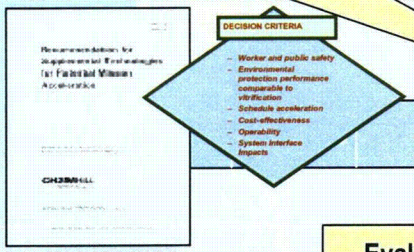
- Large Scale Cold Tests (3 Tests to Date)
  - Box waste volume
  - Scoria (Tc99)

- Large Scale 38A test of bottoms up (3 Tests to Date)
  - Box confinement (leak)
  - Metal Iron Slag (300Kg)

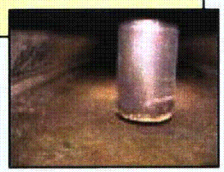


Large-Scale 38B
- 2/3rd full box
- Reduced Starter Path/Box Charge by 50%
- Less than 700g Free-iron

- 24 Technologies evaluated
  - BV, SR, CS selected for further evaluation



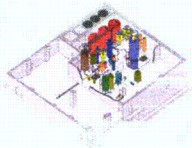
Large-Scale 38C
- Full box
- Reduced Starter Path/Box Charge by 50%
- Deconstruction Initiation 5/22



02 03 04 05 06 07

Evaluation of 3 technologies
- CS waste performance not acceptable
- BV and SR further evaluation

Glass

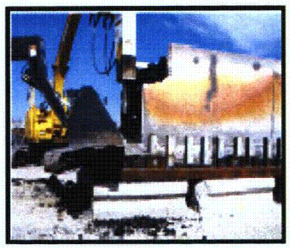


Steam Reforming

Cast Stone

- BV modifications (bottoms up) tested at engineering-scale with simulants and real waste

- Large Scale 38A1
  - Redesigned refractory–performed as designed
  - Reduced Starter Path by 50%: 250Kg metal slag



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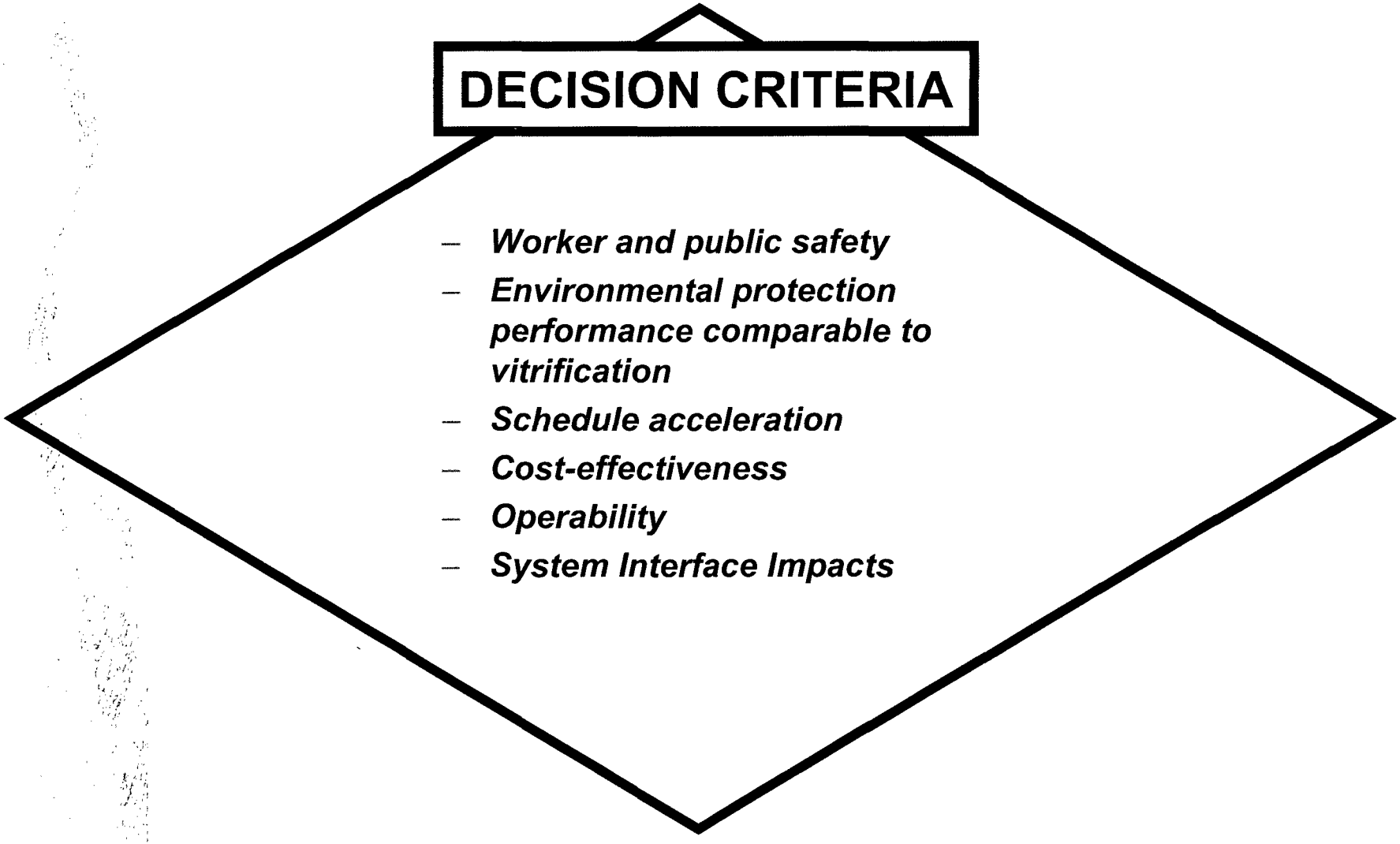
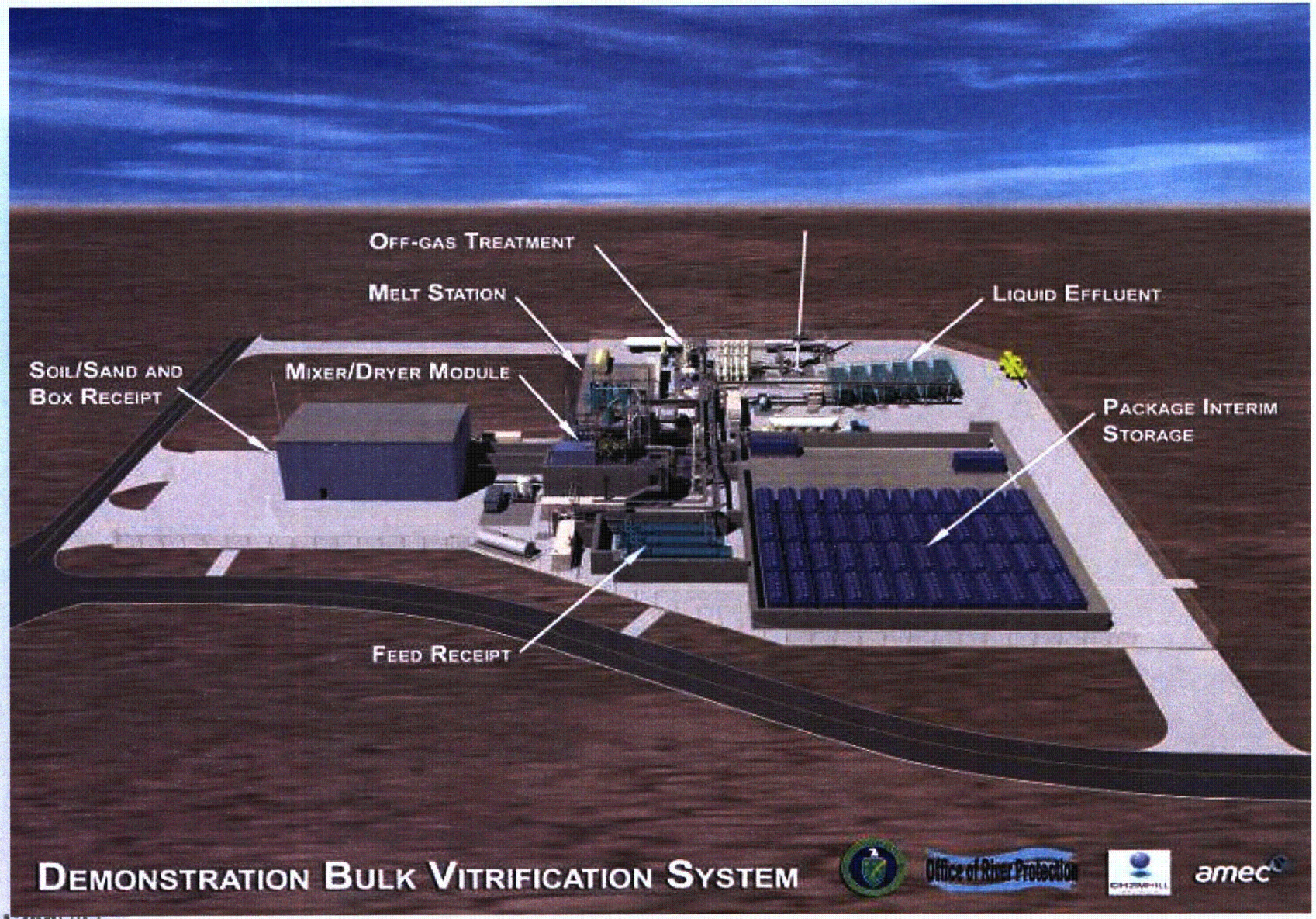
Decision Basis for Selection

- What Information is Being Gathered for Evaluation)



Demonstration Bulk Vitrification System



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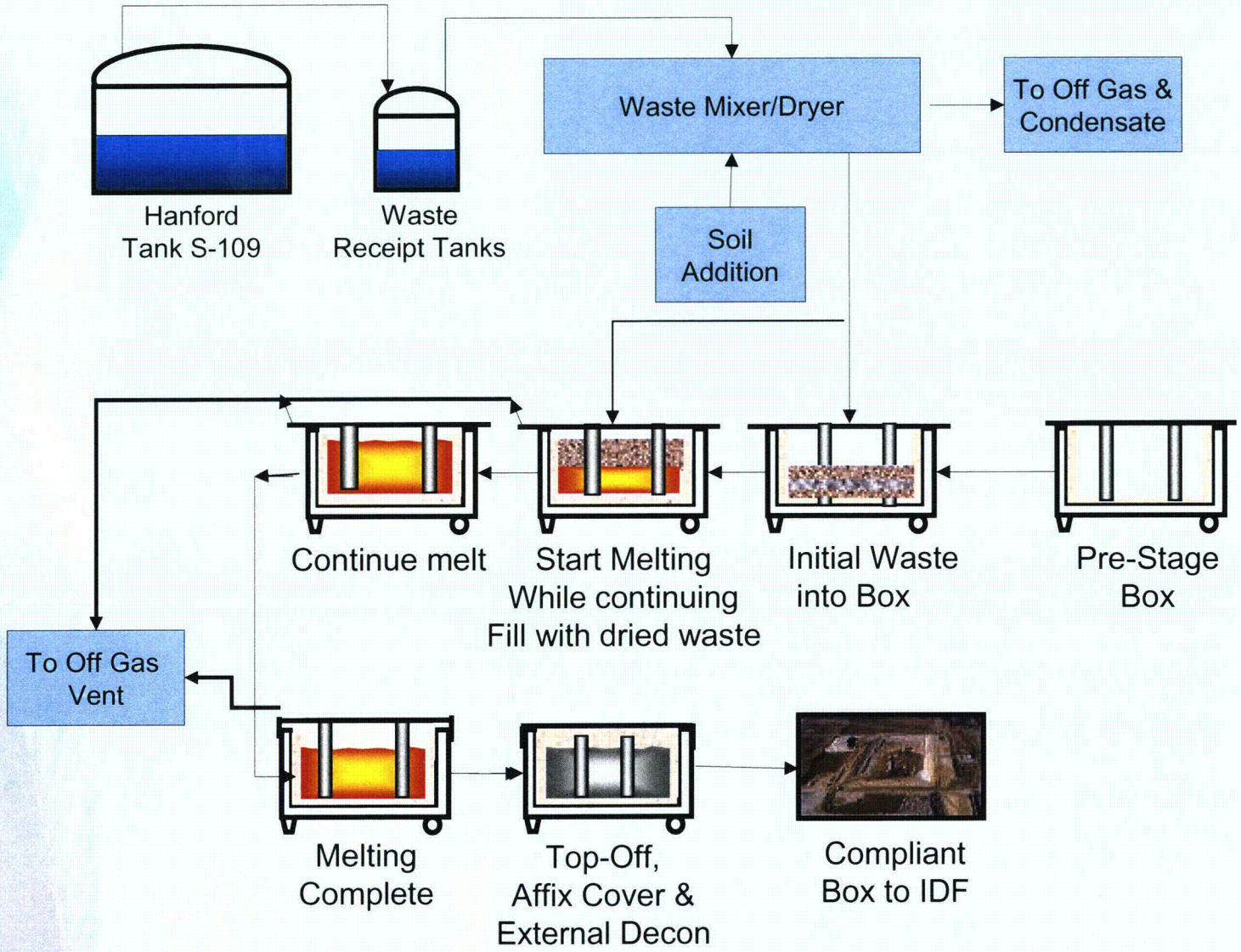
Simplified BV Flow Diagram



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Design Engineering/Testing Status

- DBVS facility design completed. July-06
- RCRA Design Packages approved by WDOE. July-06
- Baseline estimate and schedule submitted for DOE review and approval. September-06
- 130-liter dryer testing completed at Littleford-Day. October-06
- Preparation underway for FY2007 Integrated Dryer/Full-Scale Melt 38D. October-06

July 2006 Facility Design Completion

Waste Form Qualification and System Operability

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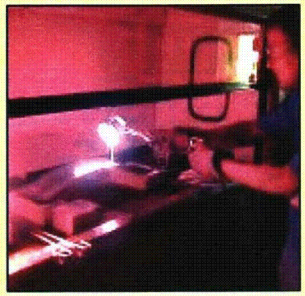
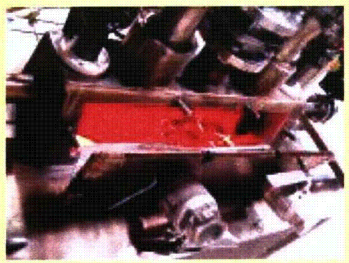
Scale	Tests to Date	Test Objectives	Tests Objectives for DBVS
 Crucible Scale Melts	>45 tests	•Glass Formulations •Waste Loading •Test Full Range of Wastes (hot/cold) •Indicate Waste Form Performance	•Addition Glass Formulations for Range of LAW •Waste Form Performance •Validate Scaling
 Engineering Scale Melts	16 tests (3 hot, 1 actual tank waste)	•Waste Loading •Test System Design (hot/cold) •Waste Form Performance •Mass Balance of System (off-gas, refractory, etc)	•Test Proposed System Modifications •Pre-Test System Optimizations •Waste Form Performance
 Full Scale Melts	7 tests	•Waste Loading •Test system design (hot/cold) •Waste Form Performance •Mass Balance of System (off-gas, refractory, etc)	•Test System Operability •Baseline Operability •Test Waste Variability and Waste Loading •Confirm Data from Eng. and Crucible Tests •Waste Form Performance

Objectives For Large Scale Series 38 Tests

The DBVS Series 38 testing was designed to:

- Provide initial large-scale data pertaining to the performance and design of the ICV container during actual operations using the "bottoms-up" approach (Tests 38-A and A-1)
- Provide data on temperature profiles and off-gas generation to validate design (Test 38-B)
- Validate engineering design inputs to support demonstration facility

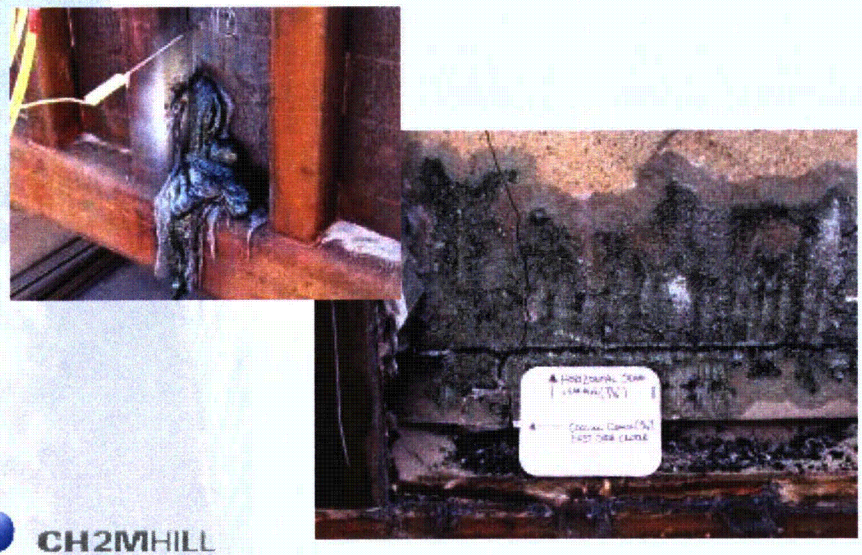
Tests 38A and 38A1 Results

38A

Test was stopped early due to leak that developed during melt.

Evaluation of root causes:

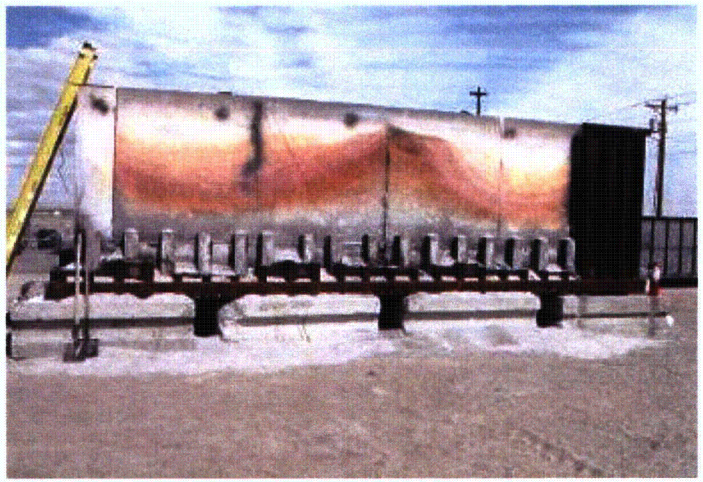
- Refractory design and support (separation of bottom refractory panels from side panels
- Molten metal from reduction of iron oxide in soils
- Insulation in box did not allow for heat exchange
- Thermocouples allowed for electrical short circuiting to box



38A1

Box and refractory redesigned using lessons learned from test 38A.

- Overall test objectives satisfied (refractory re-engineering successful)
- Identification of slag metal phase noted
- Temperature control/monitoring appear to have a dramatic impact on iron liberation within the glass melt
- Starter path volume has incremental impact
- Sodium bi-carbonate feeds (used in 38A -38A1)appreciably enhance the reducing environment



Full-Scale Test 38B

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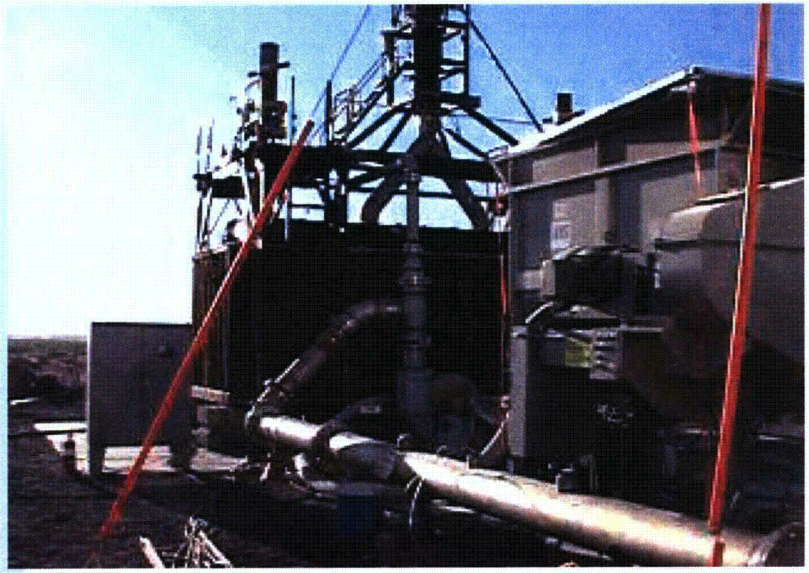

Objectives

- Used a 6-tank composite simulant waste with nitrated feed
- Provides full-scale melt data
- Obtains full scale performance data associated with NOx generation for Off-gas System Design
- Confirm Waste Form Qualification data
- Provide information on the fate for constituents of potential concern (non-radioactive Cs, I, Re, and heavy metals)
- Mitigate slag iron pooling identified in 38A1

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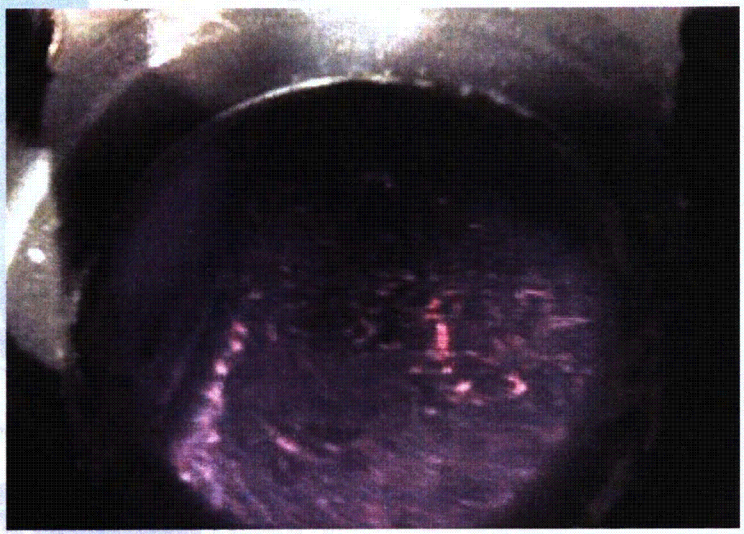
Full-Scale Test 38B

Molten pool during the test from ICV camera.



Surface view following clean soil addition.

Results

- Concluded 11/ 22; a trend of increasing differential pressures across the non-prototypic NOx scrubber was observed.
- At test conclusion, roughly three quarters of the planned waste stimulant had been melted into glass with approximately 160 hours of melting operations.
- Start up and operational difficulties caused schedule delays impacts test completion.
- Preliminary assessment of test results indicates that the majority of the test objectives have been met.

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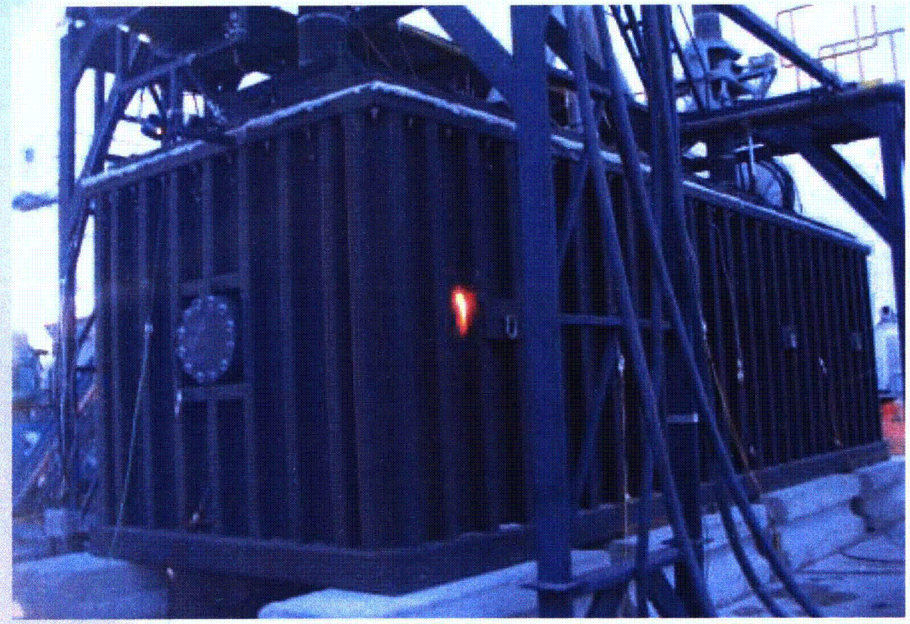
Full-Scale Test 38C

- Seventh full-scale test with S-109 simulant in May 2006
- Test "Hot Spot" Identified
- Test condition modified – Test Completed



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Full-Scale Test 38C

- Glass Product
  - Homogeneous
  - Enhanced Zirconia incorporation
  - Excellent feed incorporation

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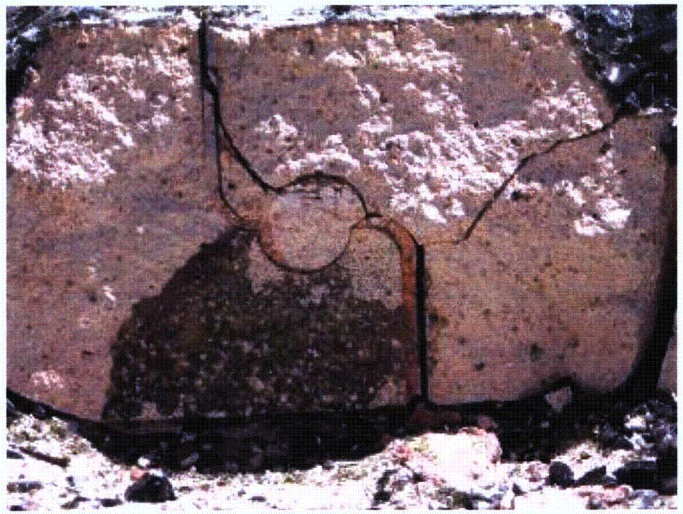
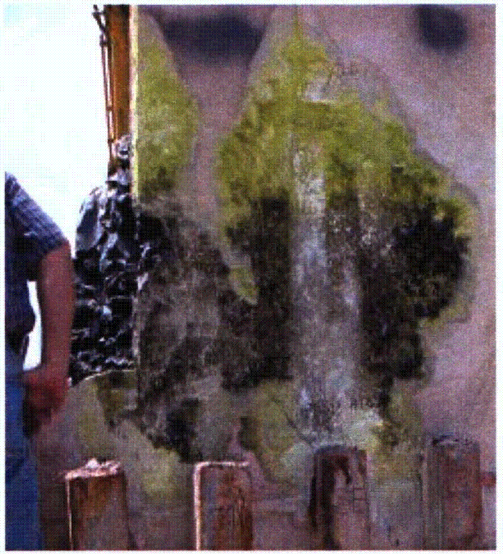
Full-Scale Test 38C

- CRB Joints
  - Redesigned base joint
  - Best glass containment to date



Full-Scale Test 38C

- Hot Spot /CRB Penetration
  - Parallel electrical circuit (resistive heater)
  - Higher heat promoted MIS and glass leakage and localized corrosion
  - Eventually melt height high enough for glass leakage
  - Hot spot eliminated with removal of thermowells



Full-Scale Test 38C

- Molten Ionic Salt (MIS) Leakage
  - MIS is 1000x less viscous than bulk glass (like water)
  - Very electrically conductive (sodium component)
  - Lower melting temperature than glass (300°-600°C vs 800°C)
  - Leaked where glass did not

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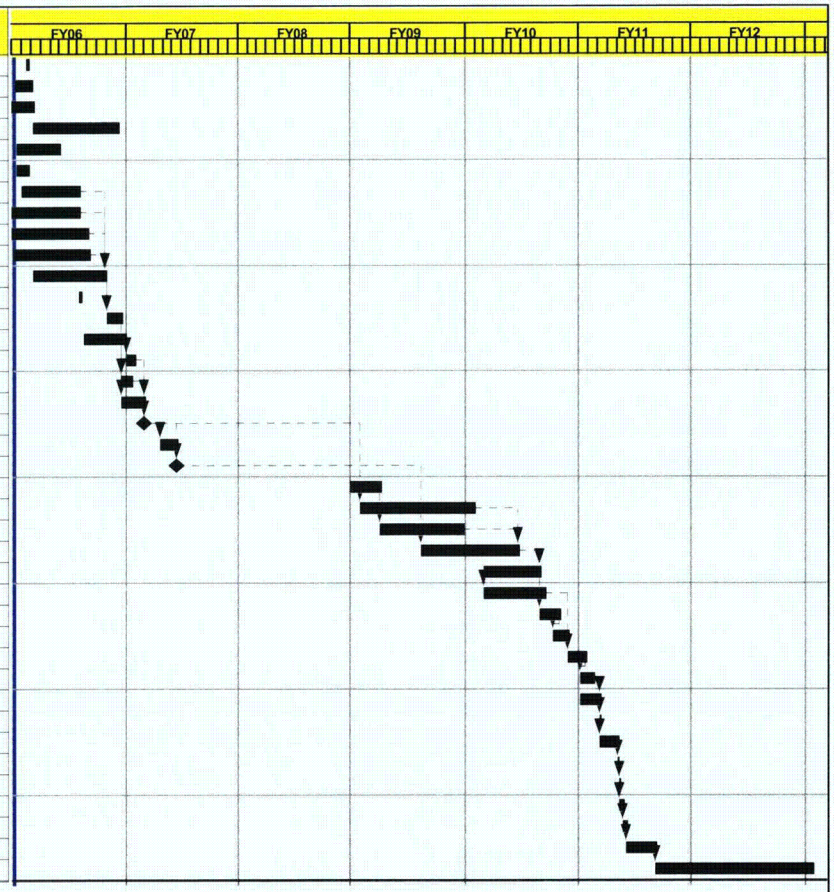
DBVS Master Schedule

LINE	Activity Description	Orig Dur	Early Start	Early Finish
1	38B - Melt	6	15NOV05*	22NOV05
2	Process Hazards Analysis/Facility Worker Safety	3€	12OCT05*	02DEC05
3	DNFSB Interface/Status Update	4€	30SEP05	05DEC05
4	Develop PDSA Revision	19₄	05DEC05*	07SEP06
5	Waste Form Qualification	9₃	17OCT05*	28FEB06
6	DOE Approve Design Cost Estimate/Schedule	24	18OCT05*	18NOV05
7	Vendor Design for Fabrication	12₇	31OCT05*	01MAY06
8	Design Package - #5 DWH Pkg Update/State Review	15₁	30SEP05	04MAY06
9	Design Package #6 - ICV Pkg Update/State Review	16€	30SEP05	30MAY06
10	Design Package #7 - OGS Pkg Update/State Review	16₇	05OCT05*	01JUN06
11	Design Package #8 - Balance of Design	16₃	08DEC05*	28JUL06
12	38C - Melt	6	02MAY06*	09MAY06
13	Project Baseline Estimate/Schedule	3€	31JUL06	18SEP06
14	Expert Panel Review	9₂	22MAY06*	29SEP06
15	Expert Panel Recommendations Evaluation	2₂	02OCT06	31OCT06
16	DOE EAC Review	2₂	19SEP06	18OCT06
17	DOE CD-2 Review	51	19SEP06	30NOV06
18	DOE Issue CD-2	0		30NOV06
19	CD-3 Review	3€	22JAN07	14MAR07
20	DOE Issue CD-3	0		14MAR07*
21	Fab/Construction Ramp Up	6₃	01OCT08*	31DEC08
22	Long Lead Equipment Fabrication	25₂	30OCT08*	27OCT09
23	Equipment Fabrication	18€	02JAN09*	22SEP09
24	Construction	21€	12MAY09*	18MAR10
25	Construction Acceptance Test	12₇	30NOV09*	27MAY10
26	IQRP/Ecology Rev/Approve (DBVS Const.)	13₇	30NOV09	11JUN10
27	Testing	4C	28MAY10	26JUL10
28	39A - Box Prep/Melt/Flush (IT)	3€	09JUL10	26AUG10
29	40A - Box Prep/Melt/Flush (OAT)	5€	27AUG10	21OCT10
30	Operational Readiness Checklist	3C	08OCT10	18NOV10
31	Conduct Startup Mgmt. Self-Assessment	4C	08OCT10	06DEC10
32	Issue Declaration of Readiness Letter	1	07DEC10	07DEC10
33	Operational Readiness Review's	4C	08DEC10	03FEB11
34	CH2M Letter Request Permission to Startup to ORP	1	04FEB11	04FEB11
35	ORP Issue Start-up Letter	1	07FEB11	07FEB11
36	Transfer S-109 to DBVS	7	08FEB11	16FEB11
37	41A - Melt (1 Box)	8	17FEB11*	28FEB11
38	Melt Operations (4 Boxes)	9€	01MAR11	03JUN11
39	Melt Operations (45 Boxes)	50€	04JUN11	23OCT12



Start Date 01JUN04

Early Bar
Progress Bar
Critical Activity

DBVS Project

Sheet 1 of 1

Date	Revision	Checked	Approved

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Demonstration Project Issues/Uncertainties

- Resolution of Molten Ionic Salt Challenge
- Finalize Demonstration Facility Confinement Strategy and Validate (DNFSB, et. all)
- Validate Prototypical Feed and Off-Gas System Performance
- Demonstrate Final Waste Product Equivalency
- Demonstrate Overall System Integration Process

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DBVS FY 07 Planned Activities

- Conduct 130-liter scale dryer screening tests
- Conduct 10,000 liter full-scale dryer testing
- Conduct crucible and engineering scale testing to address Molten Ionic Salt issue
- Conduct integrated test of full-scale dryer and eighth full-scale melt 38D
- Address issues identified by FY2006 Expert Reviews

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River Protection Project R&D Program

Presented by:
Jim Honeyman

October 18, 2006

Office of River Protection

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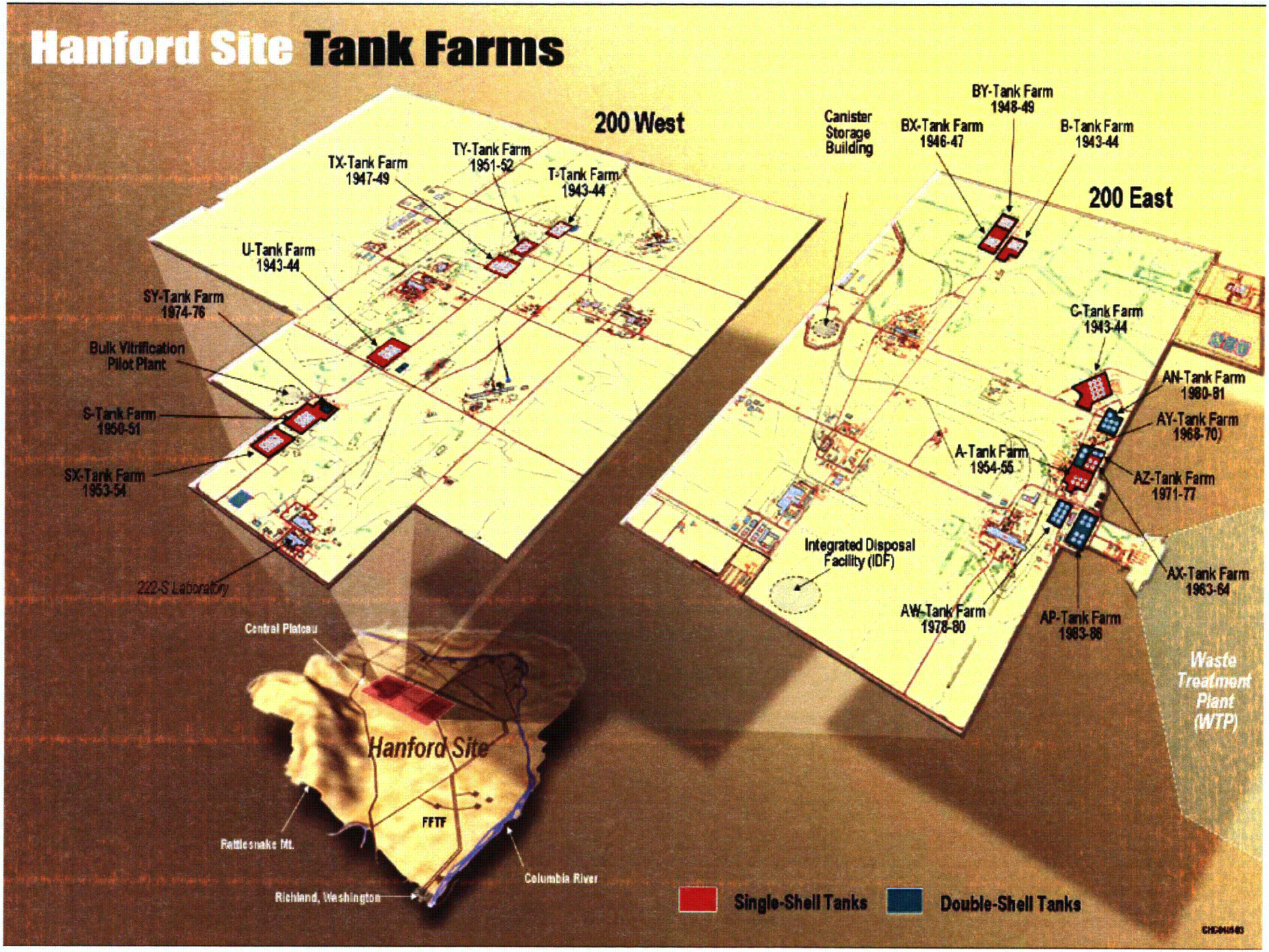
Hanford Site Tank Farms
200 West
200 East
TX-Tank Farm
1947-49
TY-Tank Farm
1951-52
T-Tank Farm
1943-44
U-Tank Farm
1943-44
SY-Tank Farm
1974-76
Bulk Vitrification
Pilot Plant
S-Tank Farm
1950-51
SX-Tank Farm
1953-54
222-S Laboratory
Canister
Storage
Building
BY-Tank Farm
1948-49
BX-Tank Farm
1946-47
B-Tank Farm
1943-44
C-Tank Farm
1943-44
AN-Tank Farm
1980-81
AY-Tank Farm
1968-70)
A-Tank Farm
1954-55
AZ-Tank Farm
1971-77
Integrated Disposal
Facility (IDF)
AX-Tank Farm
1963-64
AW-Tank Farm
1978-80
AP-Tank Farm
1983-86
Waste
Treatment
Plant
(WTP)
Central Plateau
Hanford Site
FFTF
Rattlesnake Mt.
Columbia River
Richland, Washington
Single-Shell Tanks
Double-Shell Tanks

Hanford Site Waste Tanks

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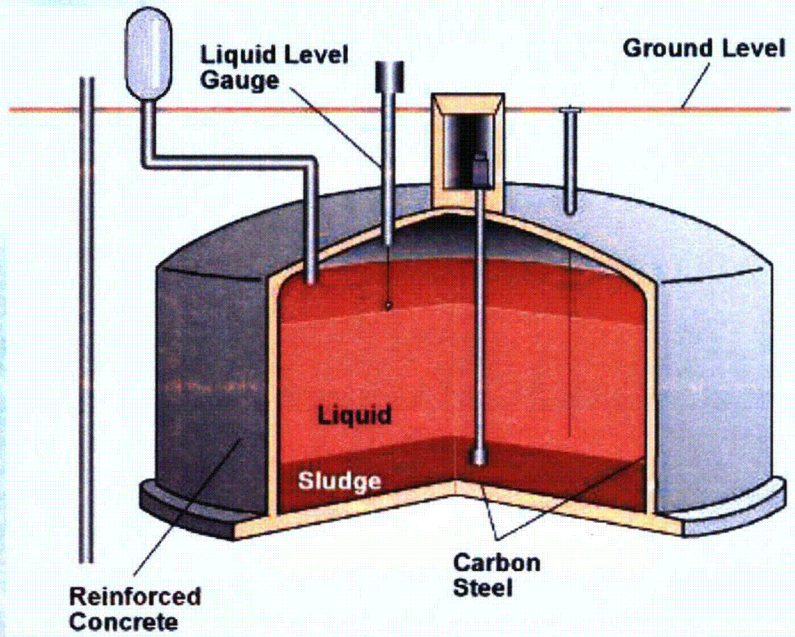
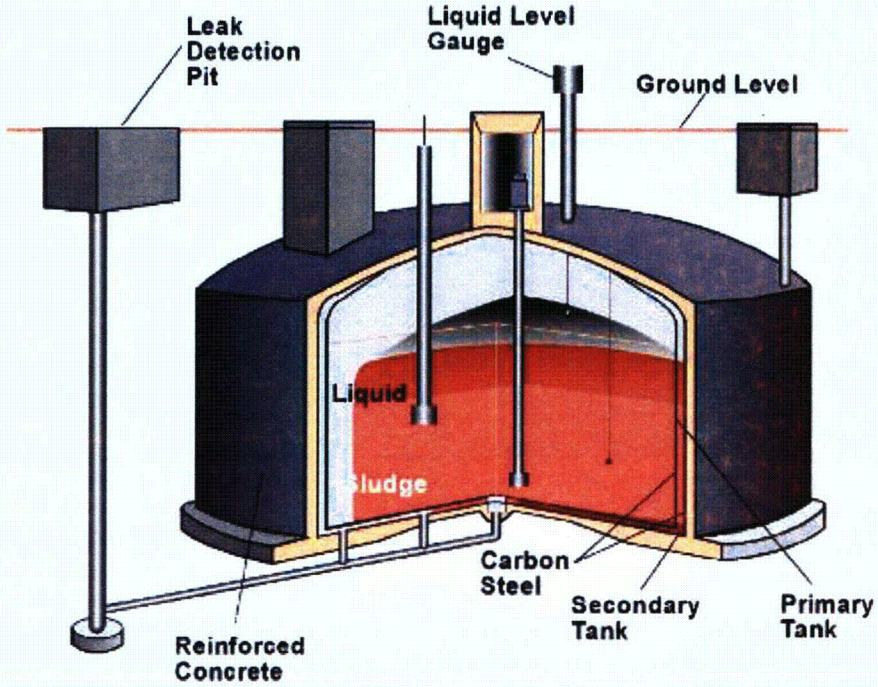
Single-Shell Tanks



- 149 tanks constructed 1943-64
- No waste added to tanks since 1980
- 67 are assumed to have leaked (~1 Mgal)
- Tanks currently contain ~ 31 Mgal of saltcake, sludge and liquid
- 5 tanks now retrieved

Double-Shell Tanks



- 28 tanks constructed between 1968-86
- None have leaked
- 1 to 1.2 Mgal capacity
- Tanks currently contain:
  ~ 22 Mgal of mostly liquids (also sludges and salts)

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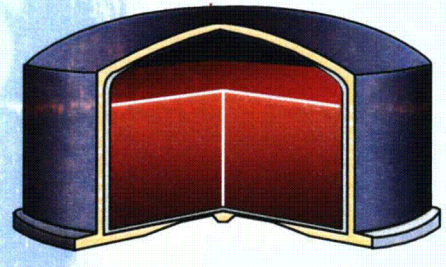
The Plan: Send ~97% of Radioactivity and ~5% of Waste Volume to Yucca Mountain



Initial Waste Volume:

8 M gal HLW

42 M gal LAW

Previously Removed - Cs/Sr Capsules and German Logs [Repository Disposal]

Vitrification and SF/HLW Repository Disposal (Yucca Mountain)

330 M Ci

14 M gal → ***WTP LAW Vitrification***

28 M gal → ***Any One or Combination of:***

- ***Bulk Vitrification***
- ***WTP LAW Vitrification***

~5-10 M Ci

3 M gal TRU → ***Package for WIPP Disposal***

Eliminates 1500 HLW Canisters

Waste Remaining in All Tanks:

~0.5 M gal residuals @ 99% retrieval

~1-2 MCi

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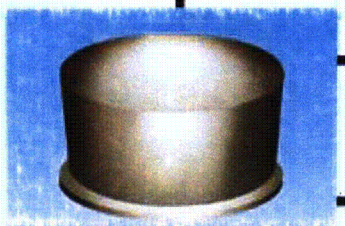
Office of River Protection

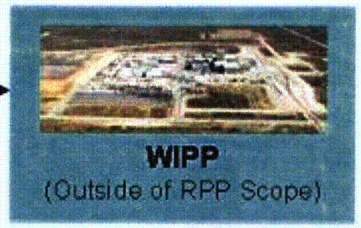
Bechtel National, Inc.

Washington Group International

River Protection Project Mission

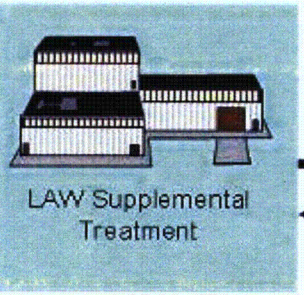


SST Tanks
Retrieval



WIPP
(Outside of RPP Scope)

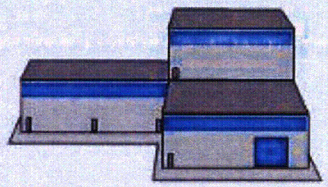
Tank Farm Closure



LAW Supplemental Treatment

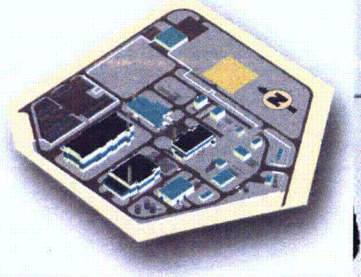
Integrated Disposal Facility

222-S Analytical Services



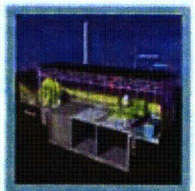
DST Tanks
Retrieval/Waste Feed Delivery

Waste Treatment & Immobilization Plant

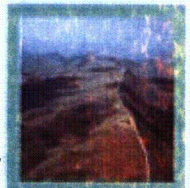


ILAW

IHLW



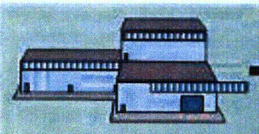
Canister Storage Facility



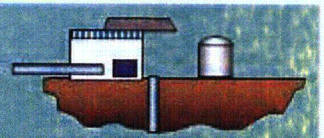
Yucca Mountain Repository
(Outside of RPP Scope)

242-A Evaporator

Condensate



ETF



Liquid Disposal
(Outside of RPP Scope)

CHG0310-04 Rev C.0

Key Elements of Overall Tank Waste Treatment/Closure Strategy

Office of River Protection

- Avoid construction of new DST's
- Pretreat Waste to produce LAW and HLW streams for immobilization
  - Radionuclide removal to meet overall NRC established site material balance and facility exposure limits
- Optimize the HLW glass volume to shorten overall mission duration
  - Feed selection and blending
  - Sludge Washing and Leaching to remove non-radioactive metals from HLW feed
  - Enhanced glass formulation
- Package and ship TRU waste in tanks to WIPP to reduce HLW glass production
- Supplement LAW vitrification capability to complete balanced mission
  - Bulk vitrification
    - Supplemental pretreatment
  - 2nd LAW facility
- Retrieve SST wastes
  - Retrieval from sound and assumed leakers
  - Effective heel retrieval
- Close SST Waste Management Areas
  - Tank heel characterization and stabilization
  - Ancillary equipment disposition
  - Historical leaks already in the environment
  - Closure Caps
  - D&D of legacy, existing, and newly constructed facilities

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RPP Research and Development Activities

- DST Integrity
- SST Retrieval
- Waste Separations
- Waste Treatment
- Waste Characterization
- Waste Feed Delivery
- Tank Closure

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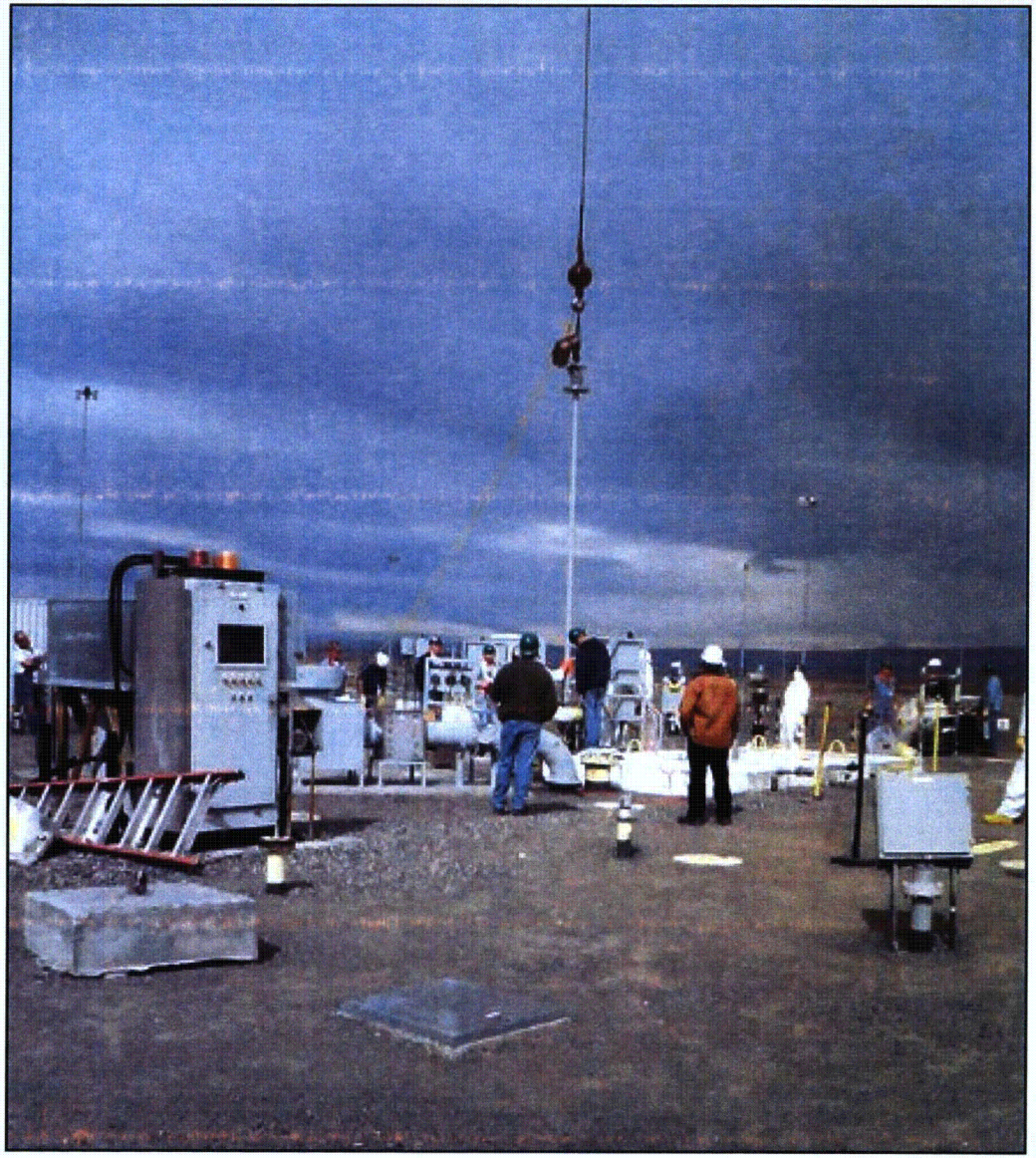
DST Tank Integrity

- Corrosion control and monitoring
- In-service inspection

Installation of Second Generation Corrosion Probes in DSTs



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SST Retrieval

- Sluicing Enhancements
- Tank Heel Retrieval
- SST Saltcake Dissolution
- Improve operational life for in-tank cameras and lighting

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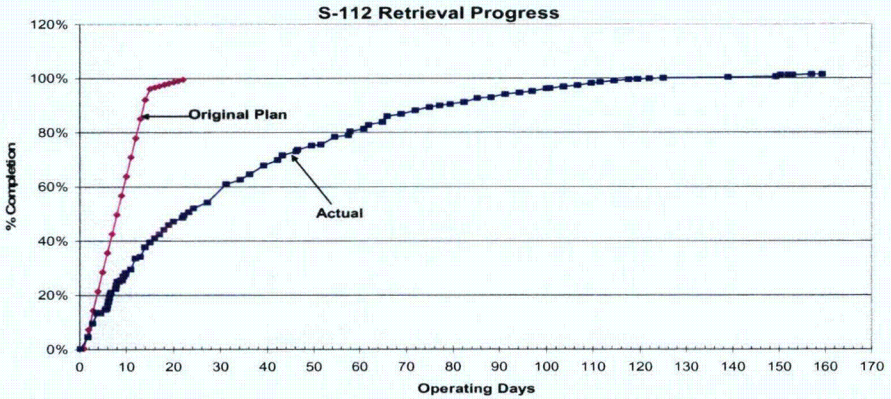
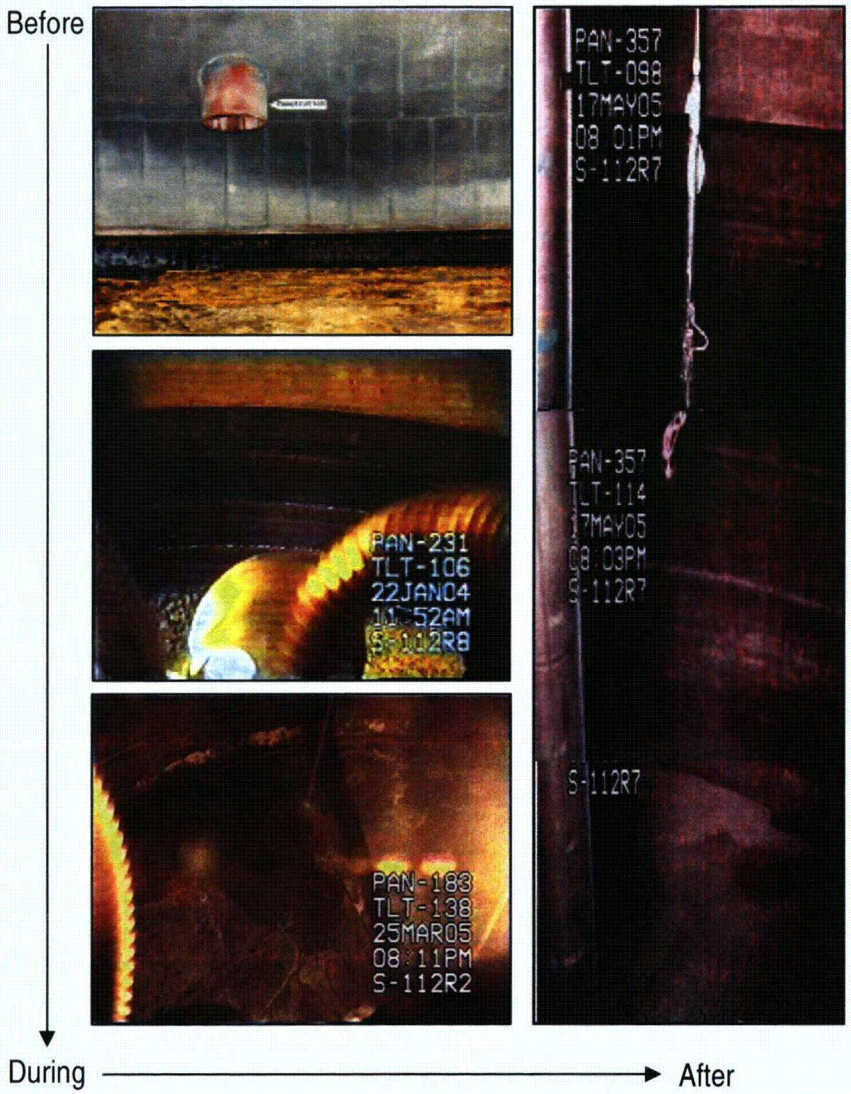
Tank S-112 Retrieval

- Completed S-112 retrieval to limits of technology on 5/17/05; Tri-Party Agreement (TPA) M-45-03C
- Technology: modified sluicing and saltcake dissolution
- 583 Kgal of waste retrieved; 95% of pre-retrieval volume
- 31 Kgal (~ 4,100 ft^3) of waste remains
- Alternate retrieval methods being considered to meet TPA volume goal



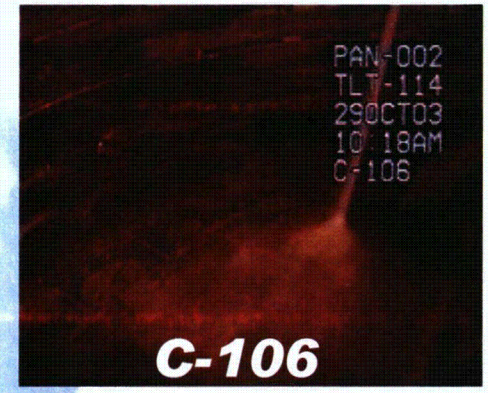


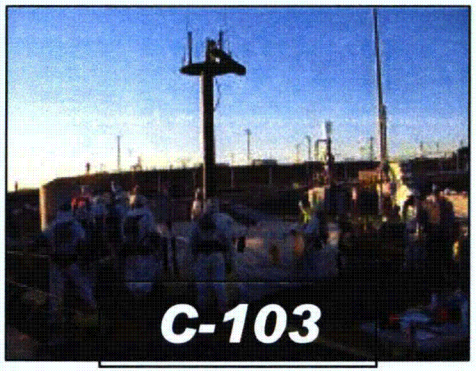
S-112 Retrieval – Before, During, and at Limits of Technology

Tank Waste Retrieval - Progress

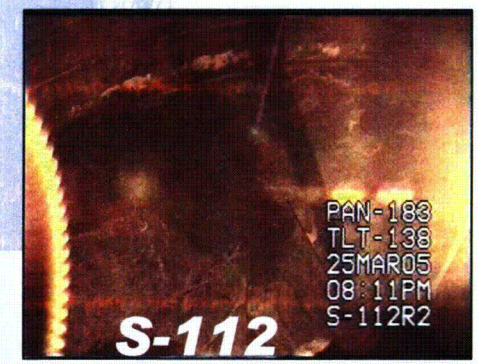
Office of River Protection

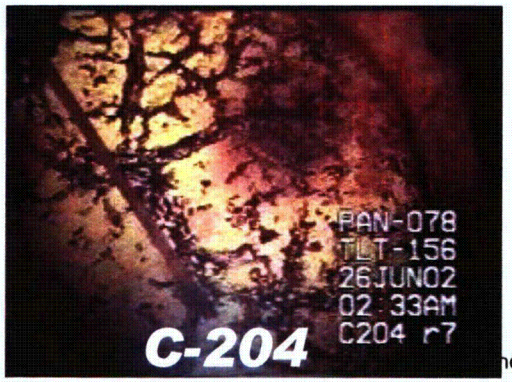
RETRIEVED





IN PROGRESS





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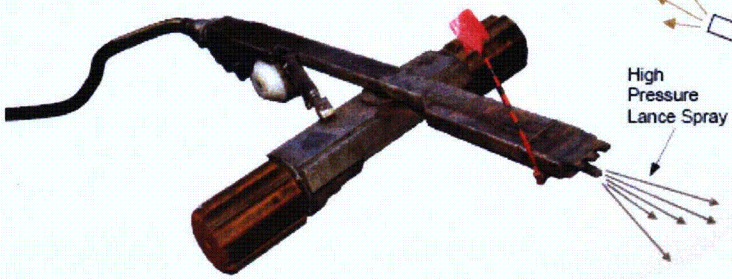
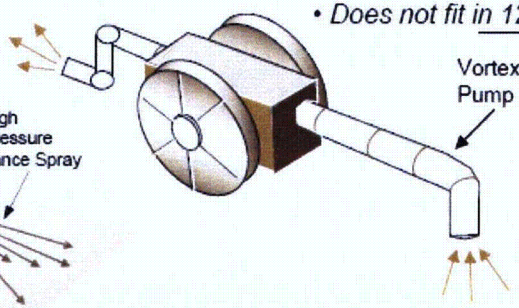
Salt Mantis: Waste Breakup and Mixing Tool

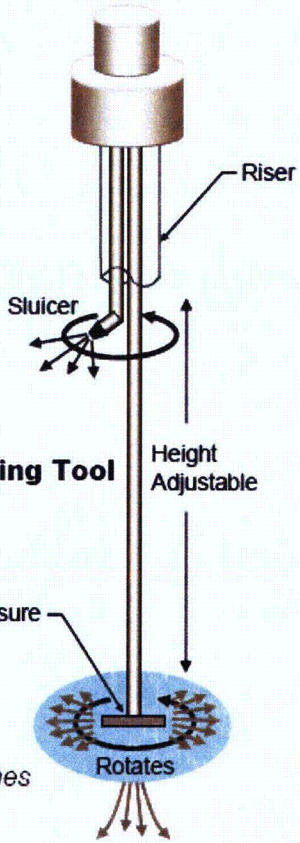
- *High pressure spray breaks up and mixes waste*
- *Augments other retrieval systems*



Aardvark: Waste Breakup and Transfer Tool

- *Developed for mining industry*
- *Pumps material with Vortex Pump*
- *Does not fit in 12" riser*

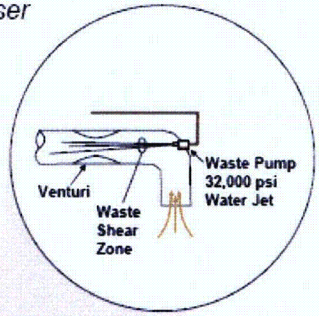


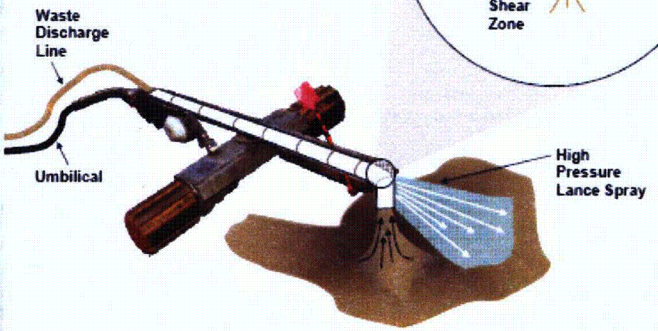


Sand Mantis: Waste Breakup, Mixing, and Transfer Tool

- *Waste transfer capability added to "Salt Mantis"*
- *Deploys through a 12" riser*

Sand Mantis





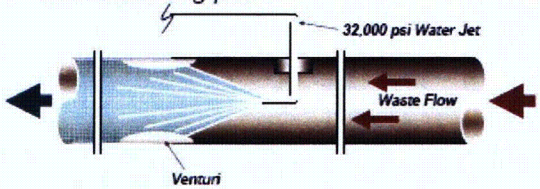
Rotary Viper: Waste Mixing Tool

- *Sluicer*
- *Mixes Waste*
- *Fits down 4" Riser*

Squid Pump:

In-Line Waste Transfer Tool

- *Small size allows installation of Transfer Lines and in existing pits*



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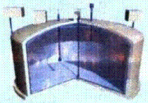
CHG0606-19.4

Hanford Tank Cleanup Progress

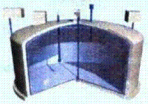
Office of River Protection

Retrieval Summary Updated through October 2, 2006

RETRIEVED

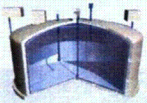


C-201
- Capacity of tank: 55,000 gallons
- Completion date: March 23, 2006
- Volume removed: 717 gallons
- Curies removed: 961
- Technology used: Vacuum retrieval



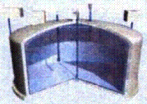
C-202
- Capacity of tank: 55,000 gallons
- Completion date: August 11, 2005
- Volume removed: 1,183 gallons
- Curies removed: 2,560
- Technology used: Vacuum retrieval

Lessons learned from first application reduced retrieval time from nine months to just six weeks.



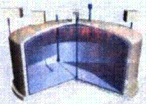
C-203
- Capacity of tank: 55,000 gallons
- Completion date: March 24, 2005
- Volume removed: 2,441 gallons
- Curies removed: 1,095
- Technology used: Vacuum Retrieval

First application of this innovative retrieval technology



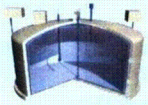
C-106
- Capacity of tank: 530,000 gallons
- Completion date December 31, 2003
- Volume removed: 194,229 gallons
- Curies removed: 8,885,700
- Technology used: Sluicing/Acid dissolution

C-106 was a high heat tank and was placed on a safety "watch list." Retrieval of the waste solved this safety issue.

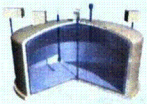


C-103
- Capacity of tank: 530,000 gallons
- Retrieval started: November 6, 2005
- Volume removed: 68,654 gallons
- Curies removed: 2,678,251
- Technology in use: Modified sluicing

IN PROGRESS

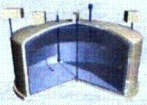


C-204
- Capacity of tank: 55,000 gallons
- Retrieval started: July 23, 2006
- Volume of waste to be removed: 1,486 gallons
- Volume of waste removed to date: 167 gallons
- Curies removed to date: 55 of 486
- Technology in use: Vacuum retrieval



S-102
- Capacity of tank: 758,000 gallons
- Retrieval started: December 17, 2004
- Volume of waste to be removed: 464,000 gallons
- Volume removed to date: 253,000 gallons
- Curies removed to date: 335,199 of 704,283
- Technology in use: Saltcake Dissolution

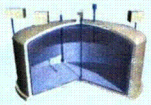
Engineers developed unique variable height pump to prevent clogging that occurred using conventional pump assembly.



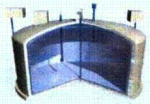
S-112
- Capacity of tank: 758,000 gallons
- Retrieval started: September 28, 2003
- Volume of waste to be removed: 614,000 gallons
- Volume removed to date: 610,900 gallons
- Curies removed to date: 601,663 of 628,068
- Technology in use: Remote Water Lance/ Modified Sluicing

Demonstration project under way to determine effectiveness of remote water lance to break up and mobilize hardened waste at bottom of tank.

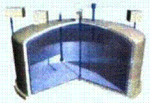
NEXT IN LINE



C-108
- Capacity of tank: 530,000 gallons
- Volume of waste to be removed: 66,000 gallons
- Curies to be removed: 167,198
- When retrieval to begin: FY 2007
- Technology to be used: Modified sluicing



C-109
- Capacity of tank: 530,000 gallons
- Volume of waste to be removed: 63,000 gallons
- Curies to be removed: ~ 844,000
- When retrieval to begin: FY 2007
- Technology to be used: Modified sluicing

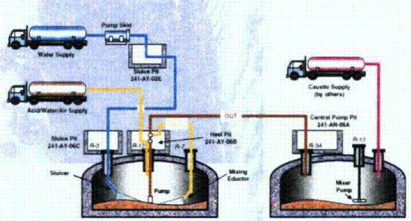


S-109
- Capacity of tank: 758,000 gallons
- Volume of waste to be removed: 400,000 gallons
- Curies to be removed: 35,214*
- When retrieval to begin: 2010
- Technology to be used: Selective Saltcake Dissolution

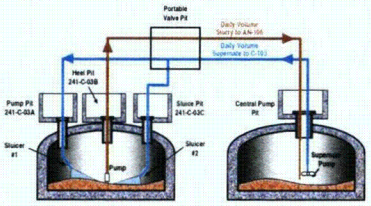
Up to 200,000 gallons are to be used in the demonstration Bulk Vitrification System to demonstrate a new technology with potential to supplement the Hanford Vitrification Plant for treatment of low activity waste.

** The 35,214 number of curies is based on assumption that 80% of the Cs-137 and Tc-99 will be retrieved.*

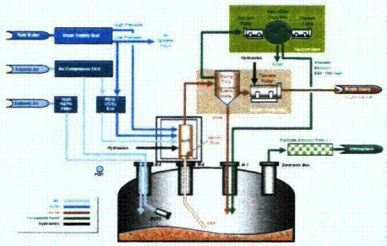
Acid Dissolution



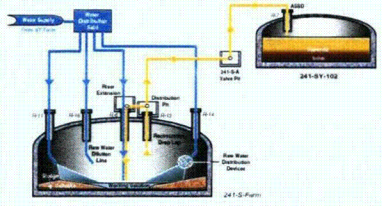
Modified Sluicing



Vacuum Retrieval



Saltcake Dissolution



Remote Water Lance (Salt Mantis)

CHG0511-09
7-24-06

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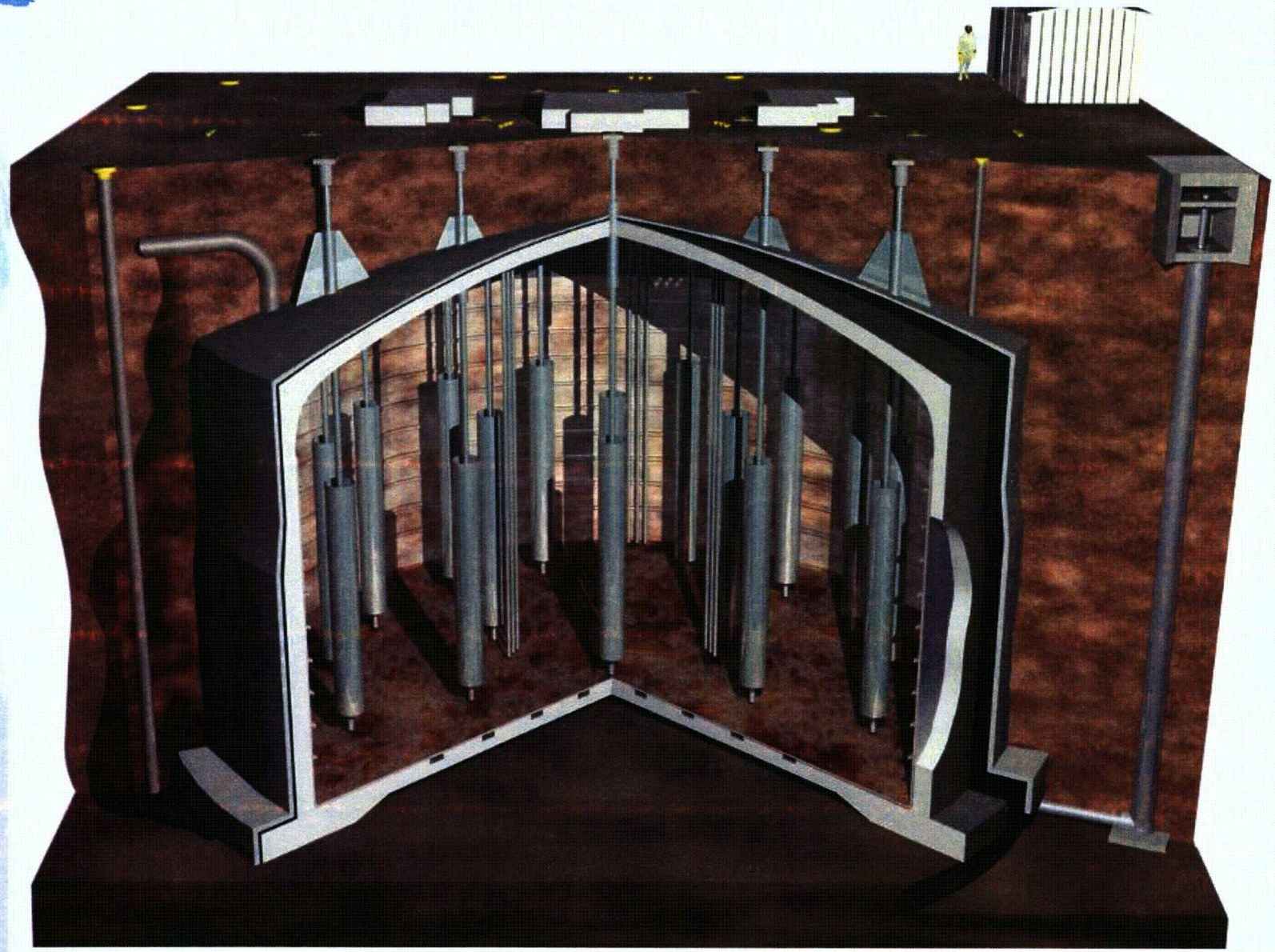

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Waste Separations

- WTP Ultrafiltration enhancements
- Supplemental at/in tank Pretreatment technology development
  - Fractional Crystallization
  - IX
- Caustic management and recycle
- At or in-tank solids-liquid separation to support supplemental pretreatment
  - Spin Tek rotary filters
- HLW slurry concentration
- Caustic and Oxidative Leaching of HLW solids

Fractional Crystallization Process

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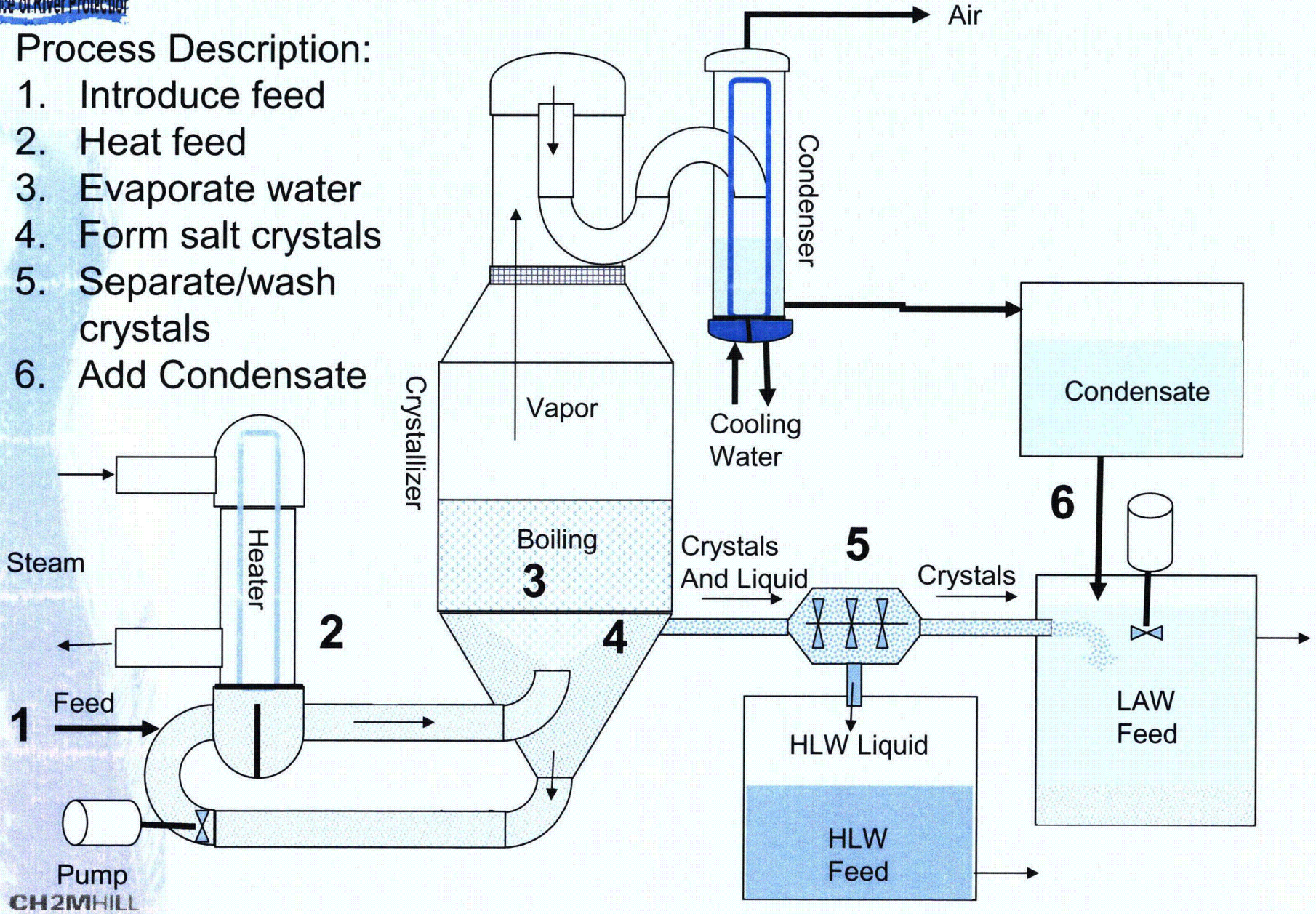
Process Description:

1. Introduce feed
2. Heat feed
3. Evaporate water
4. Form salt crystals
5. Separate/wash crystals
6. Add Condensate



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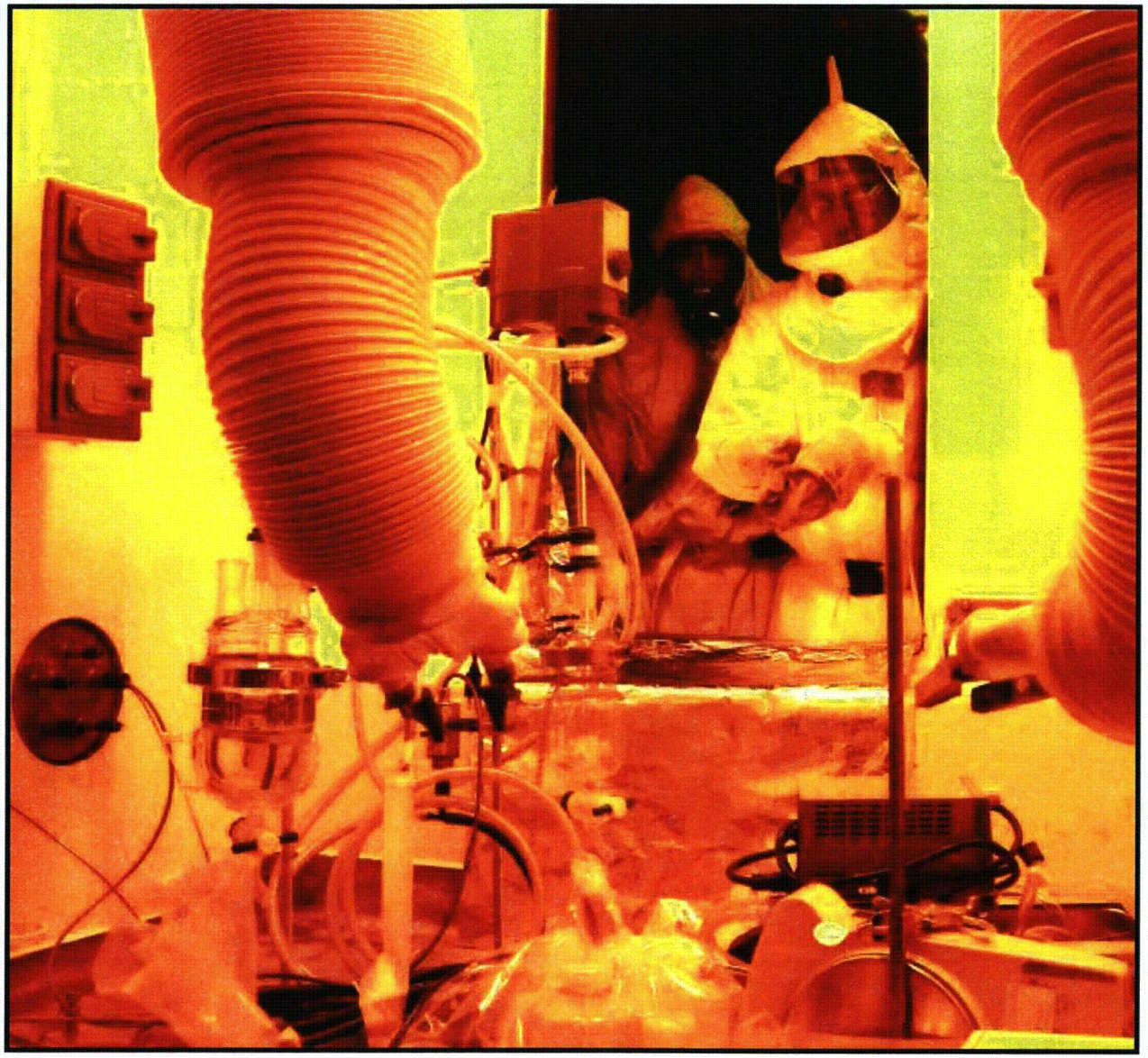
Hot Lab Demonstration of Fractional Crystallization



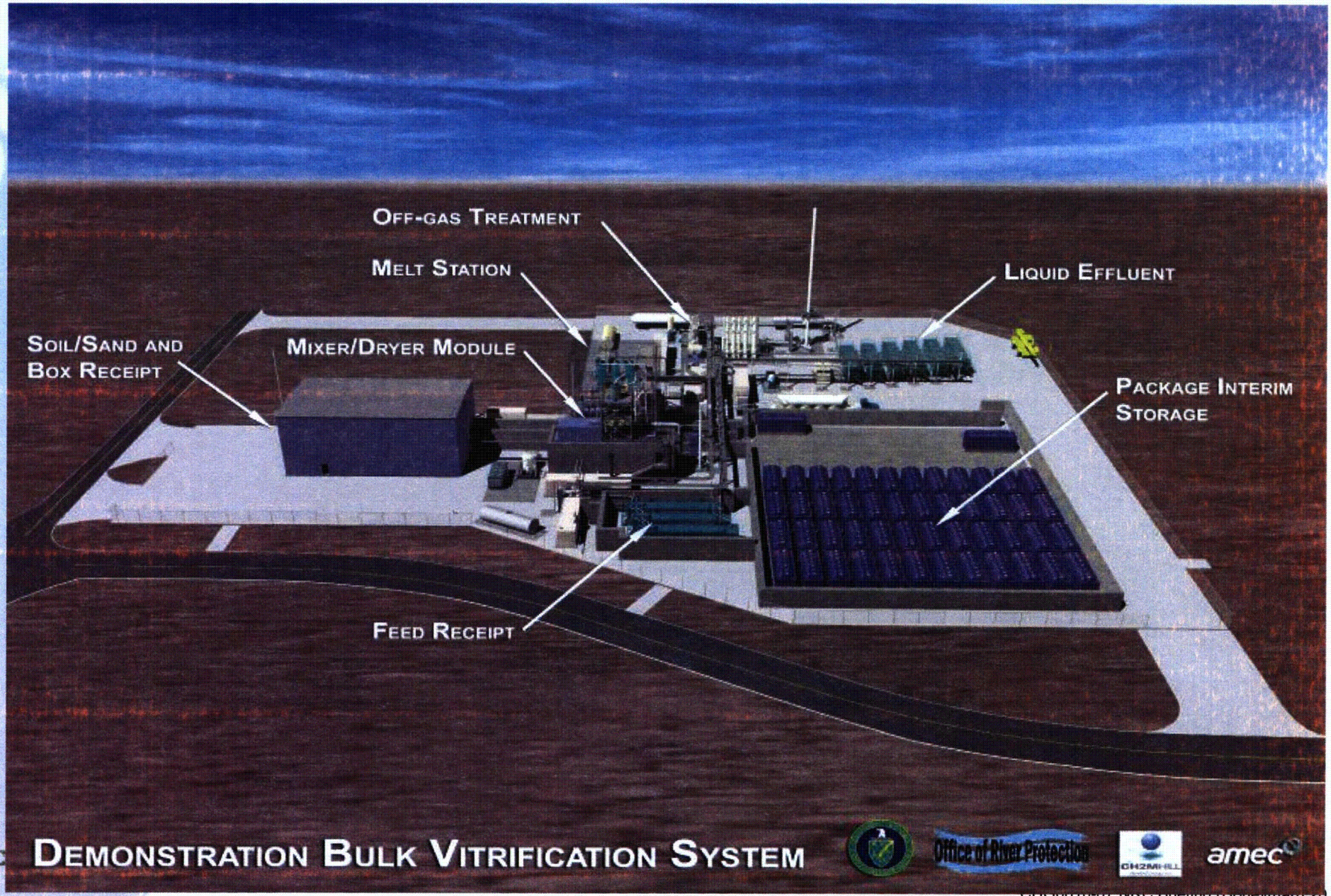
Waste Treatment

- Bulk Vitrification
- Improved Secondary Waste Treatment
- LAW/HLW Glass Formulations

Waste Treatment Plant (WTP)
World's Largest Radiochemical Processing Plant

Waste Treatment Plant Construction Site
February 2006

Demonstration Bulk Vitrification System



Bulk Vitrification Technology Demonstration Program

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- Results to date indicate that the technology can immobilize Low Activity Waste comparable to Waste Treatment Plant
- Bulk Vitrification allows for treatment flexibility in treating difficult waste streams
- Secondary waste is minimized and recycled within the process or sent to Effluent Treatment Facility (no orphan waste streams)
- Results from bulk vitrification testing have application to Waste Treatment Plant operations (i.e. off-gas system technology/performance and waste form qualification)
- May allow for interim Low Activity Waste treatment prior to Waste Treatment Plant startup

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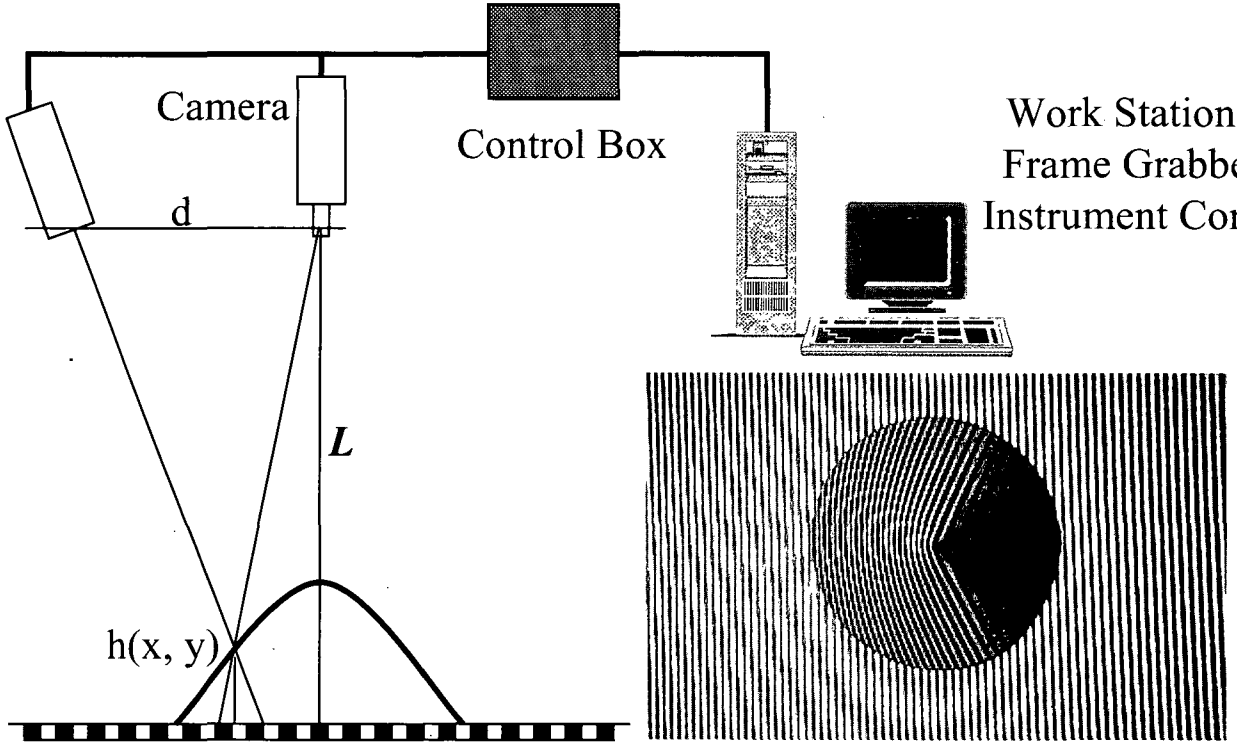
Waste Characterization

- Residual Tank Waste Measurements
- HLW slurry hardness and abrasivity determination

- Profilometry
- Sampling 'possum'

Principle of the FTP Technology



$$h(x, y) = \frac{L\Delta\Phi(x, y)}{\Delta\Phi(x, y) - 2\pi f_0 d}$$

Where:
h = height
$\Delta\Phi$ = phase variation
f_0 = fundamental frequency

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Waste Feed Delivery

- DST tank mixing and sampling
- On-line Monitoring of solids in feed slurries
- Slurry line transfer and line unplugging

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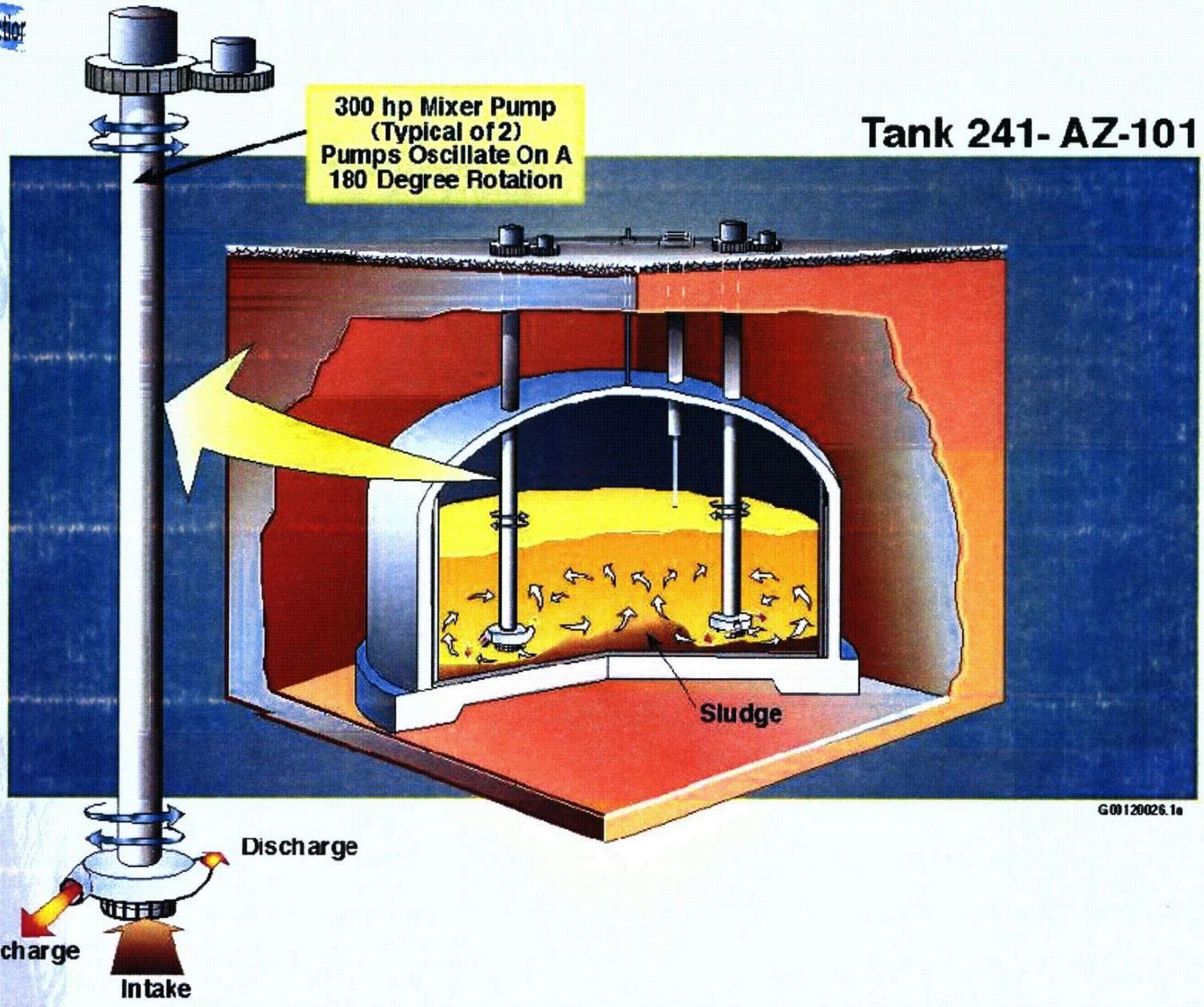
Tank 241- AZ-101



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Tank Closure

- Tank residual waste immobilization
- Abandoned pipeline characterization
- Subsurface characterization and leak detection
- Tank closure demonstration and performance monitoring

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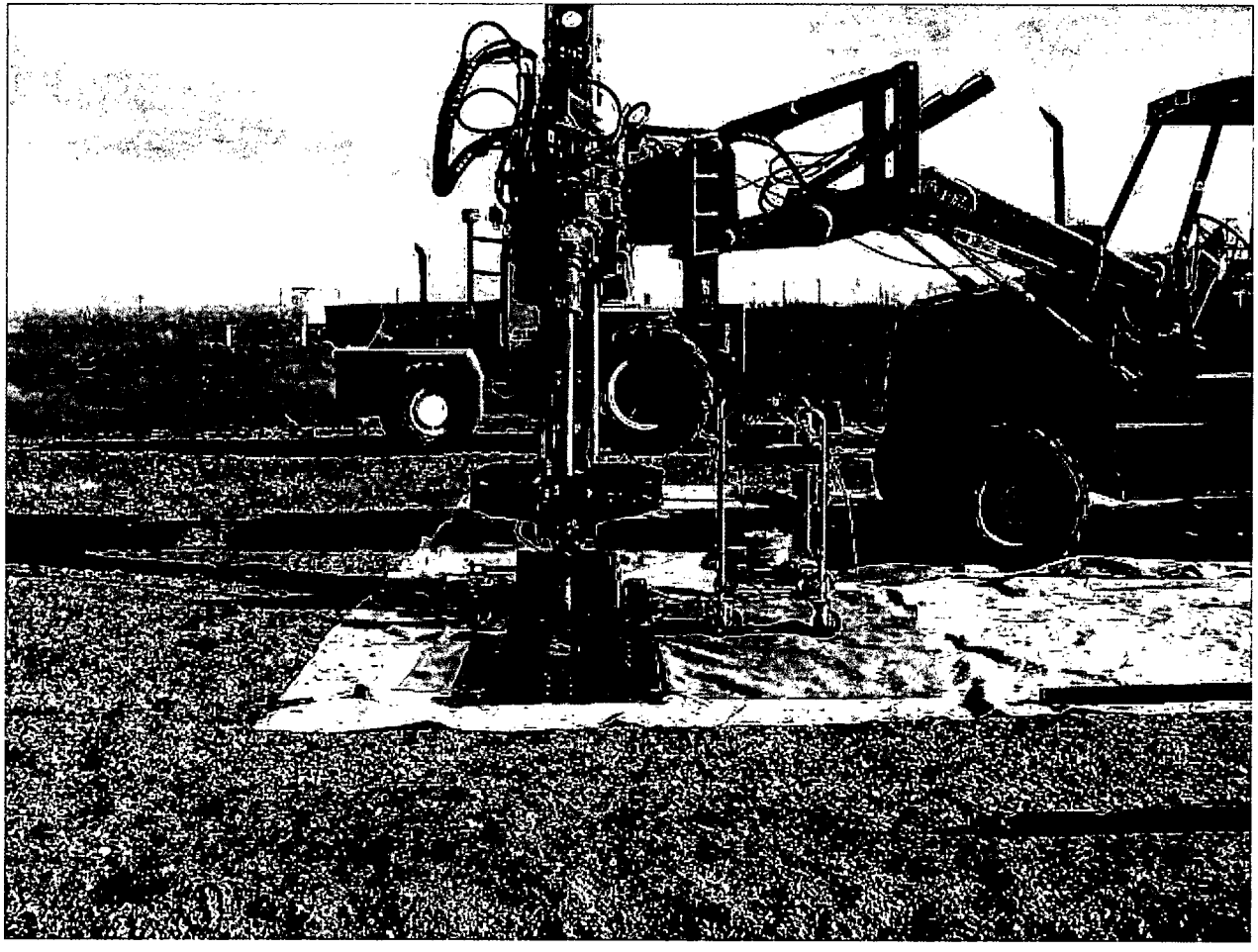
Slant Penetrometer for Subsurface Characterization



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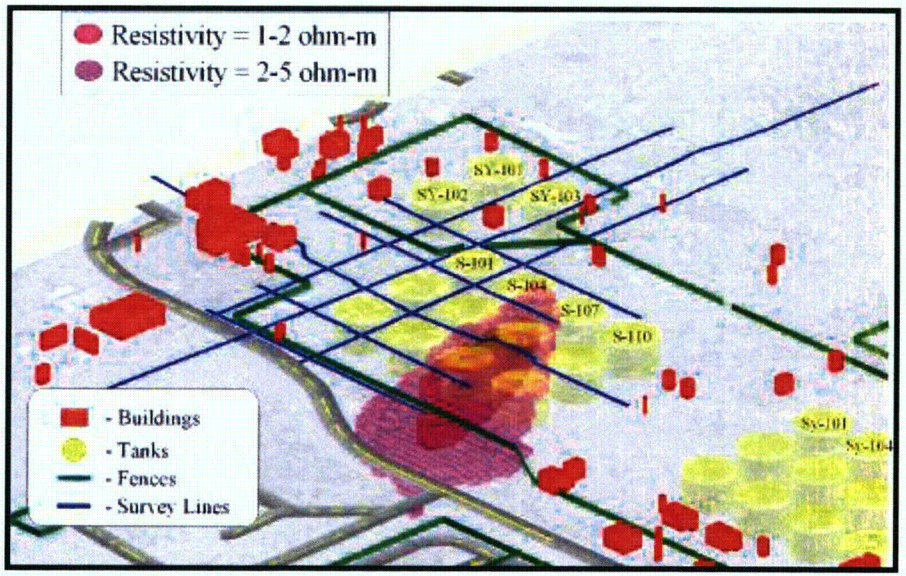
Field Demonstration of Subsurface Geophysical Examination



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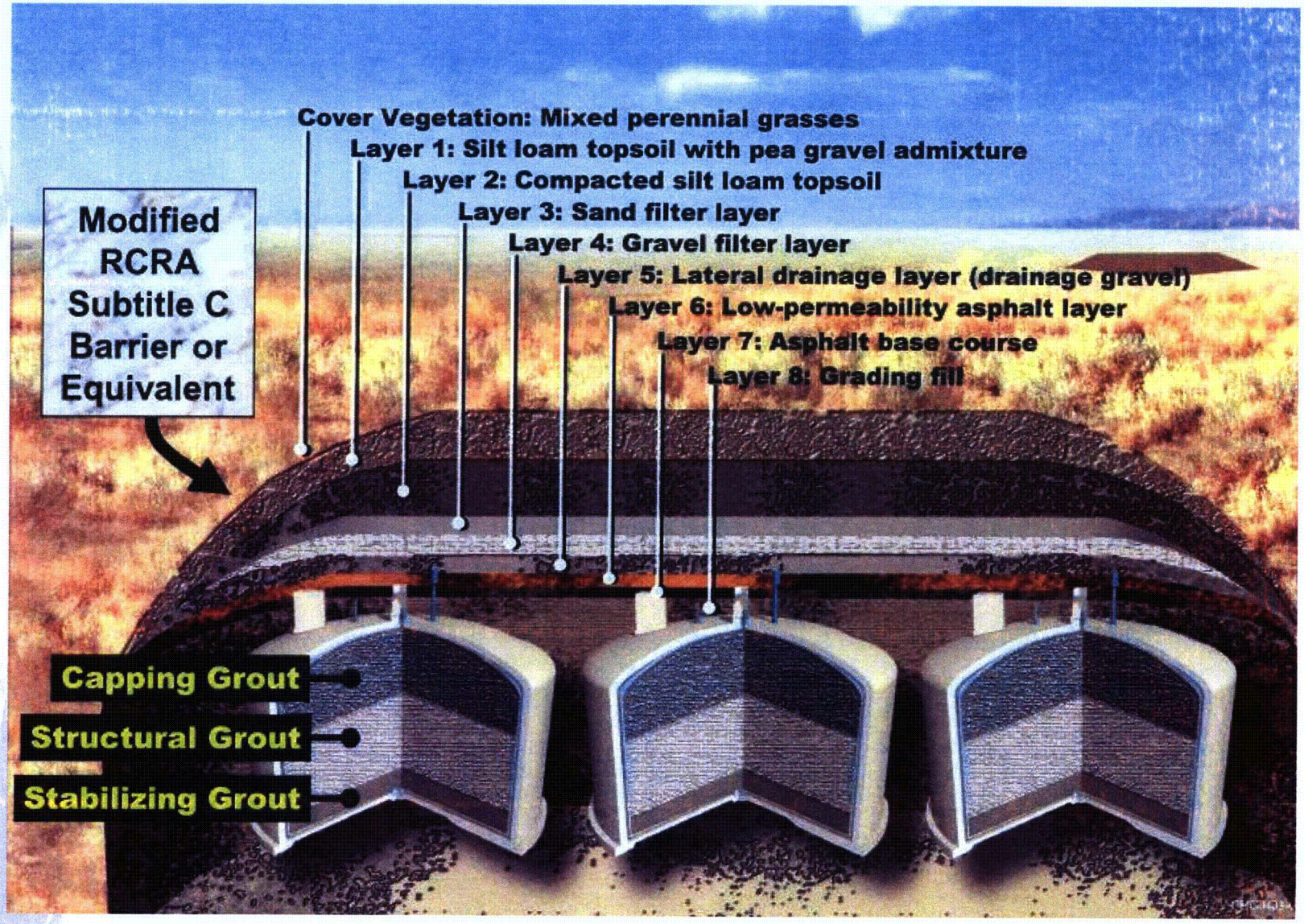
Conceptual Defense-in-Depth Closure Concept



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