DOE PUBLIC WORKSHOP
SILO 3 PATH FORWARD

June 16, 1997

7:00 p.m.	Welcome/ Opening Remarks	Gary Stegner
7:10 p.m.	Review of Proposed Technologies to be Carried Forward for Silo 3 Remediation	Don Paine
7:20 p.m.	Education Process of Potential Technologies Available for Silo 3 Remediation	Christine Langton
8:00 p.m.	Comparative Analysis of Potential Technologies Available for Silo 3 Remediation	Terry Hagen
8:30 p.m.	Informal Question and Answer Session	
9:00 p.m.	Review of Action Items/ Closing Remarks	Gary Stegner

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PUBLIC MEETING/WORKSHOPS FOR 1997
(Some TBD)

JANUARY 7 CRO Meeting 11 Citizens Task Force 22 STCG 23 FRESH	**FEBRUARY** 4 CRO Meeting 12 IRT Availability Session 12,13 Health Effects Subcommittee 26 IRT Public Briefing	**MARCH** 4 CRO Meeting 13 CTF/FRESH & DOE/FDF 15 Citizens Task Force 18 STCG 19 CP&T
APRIL 1 CRO Meeting 3 FRESH 15 DOE Community Mtg. 22 DOE 10-Year Plan Mtg.	**MAY** 6 CRO Meeting 7 WM Subcommittee 7,8 Health Effects Subcommittee 10 Task Force 14 Silos Project Workshop 20 Joint Response 21 CP&T Mgt. 21 EM Subcommittee 22 FRESH 27 OU2/OU5 Workshop	**JUNE** 3 Silos Project Wkshp. - Nevada 3 CRO Meeting 9 WM Subcommittee 10 STCG 12 MPN/FRESH Roadshow 16 Silos Project Workshop 23 Accelerated Cleanup Plan/Budget 24 OSDF Roundtable
JULY 8 Recycling Methodology 9 Citizens Task Force 14 Public Involvement Workshop 16 CP&T 24 FRESH TBD STCG TBD Silos Project Workshop -Nevada TBD Silos Project Workshop - local Aquifer Restoration Workshop	**AUGUST** 5 CRO Meeting TBD Community Meeting 20,21 Health Effects Subcommittee	**SEPTEMBER** 2 CRO Meeting 17 CP&T 20 Citizens Task Force 25 FRESH TBD STCG TBD Natural Resources Workshop Open House
OCTOBER 7 CRO Meeting TBD OU1/ARASA TBD Soils/Water	**NOVEMBER** 4 CRO Meeting 15 Citizens Task Force 19 CP&T 20 FRESH TBD STCG TBD Community Meeting TBD Health Effects Subcommittee	**DECEMBER** 2 CRO Meeting

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For more information, please call Gary Stegner at 648-3153.

EXPERIENCES WITH CEMENT STABILIZATION

Site	Waste Stream	Treatment Method	Comments
Oak Ridge National Lab (ORNL) Hydrofracture	Liquid Waste - LLW $NaNO_3$ 0.1 - .2M	Solidification Cement Grout Underground Injection.	Successful
ORNL Hydrofracture	Suspended Sludge ILW ≤ 100 ngTRU	Solidification Cement Grout Underground Injection.	Poor QA. MTG Failures Resulted in Out-of-Spec Injections. DOE Closed Facility in 1984.
ORNL Emergency Avoidance Campaign	Liquid LLW 2M $NaNO_3$	Solidification Cement-Slag Matrix. Stored in 55 Gal Drums.	Successful
Oak Ridge K-65 Site	Sludge-Mixed Waste	Stabilization/Solidification Cement/Flyash Grout. Mixed in Batch Plant. Poured in Drums.	Major Failure Due to QA. MTG Failure.
Hanford, WA Site • Grout Program	LL Liquid Waste	Stabilization/Solidification Cement-Based Matrix Pumped Into 1.5M Gal Vault.	One Successful Campaign With Phosphate Waste. Pgm Cancelled in Favor of Vitrification.
Hanford, WA Site • 183 H Basins	Saturated Sodium Nitrate Solution. Mixed Waste.	Stabilization/Solidification Mixed in Batch Mixer With Sorbond, a Commercial Stabilizing Material of American Colloid. Mix Placed in Drums.	Drums Bulged DOE. Russ Fed Services in Negotiations With WA Dept of Ecology.
Rocky Flats • Pondcrete	Water, Sediment, LL	Solidification Neat Cement Mix Poured Into Cardboard Box.	Improper QA. Wrong Equipment, Improper Curing.
• Saltcrete	Saturated Sodium Nitrate Solution. Mixed Waste.	Solidification Placed in Wooden Boxes Refered to as "Crates" or "1/2 Crates".	Crates Expanded.
West Valley, NY	LL Mixed Sodium Nitrate Solution From HLW Processing.	Stabilization/Solidification Cement-Based Matrix.	Successful Approximately 20,000 Drums Stabilized
Los Alamos National Lab (TA-55)	Tru-Sodium Nitrate Sol.	Solidification Envirostone- Gysum Cement	Product Had Bleed Water After 6-8 Wks. Replaced With Portland Cement System. No Additional Problems.
Weldon Spring, MO Chemical Stabilization System (CSS)	Sludge From Raffimate Pits CERCLA Site.	Solidification Cement/Flyash Matrix. On-Site Disposal Cell.	Dev. Complete Pilot Plant Ops Successful. Production Facility Being Built.
Savannah River Site (Salstone)	Approximately 28 wt% Sodium Nitrate Sol of Mixed, LLW.	Stabilization/Solidification Cement/Flyash/Blast Furnace Slag Martix. Disposal In Onsite Cells.	Successful on Fullscale Test. Feed Stream Dependent on DWPF.

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SILOS PROJECT

FERNALD

EPA
Remediation Technologies, Screening Matrix
Soils, Sediments, Sludges

Physical/Chemical Processes	Thermal Processes	Other Processes
1. Solidification/Stabilization Full-Scale/Conventional	1. High Temperature Thermal Desorption Full-Scale/Innovative	1. Excavation and Off-Site Disposal Full-Scale/Conventional
2. Solvent Extraction Full-Scale/Innovative	2. Vitrification Full-Scale/Innovative	
3. Chemical Reduction/Oxidation Full-Scale/Innovative		

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SILOS PROJECT

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Proposed technologies to carry forward for detailed evaluation

- Cement Stabilization/Solidification
- Polymer (Micro) Encapsulation
- Sulfur/Polymer Encapsulation
- Vitrification

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REVIEW OF WASTE STABILIZATION TECHNOLOGIES

C.A. Langton, Ph.D.
Westinghouse Savannah River Company

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OUTLINE

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- Introduction
- Waste Treatment
- Waste Forms
- Experience
- Summary

WASTE TREATMENT PROCESSES

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- Stabilization
  - Chemically react contaminants with reagents to form insoluble compounds. BDAT: Toxic Metal Waste
- Encapsulation
  - Physically isolate contaminants from environment. BDAT: Debris; ALT: Toxic Metal Waste
- Solidification
  - Convert liquid to solid
  - Convert fine powder to non-dusting solid. BDAT: N/A
- Vitrification
  - Melt mixture of waste and frit to form glass waste. BDAT: HLW

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STABILIZATION

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- **Chemically Reduce Contaminant Mobility**
  - Precipitation
  - Chemisorption
  - Ion Exchange
- **Waste Types**
  - Solids, Sludges, Liquids
- **Materials**
  - Chemicals
  - Cements
- **Tests**
  - TCLP
  - Paint Filter
  - Particle Size

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MICROENCAPSULATION

FERNALD

- Physically Isolate Contaminants
- Waste Types
  - Solids, Sludges, Liquids
- Materials
  - Dry waste: Polyethylene, Sulfur, Epoxy, Cement plus Water
  - Wet Waste: Cement
- Tests
  - TCLP
  - Paint Filter
  - Particle Size

SOLIDIFICATION

FERNALD

- Chemically or physically react with liquid or fine powder to form solid blocks
- Waste Types
  - Solids, Sludges, Liquids
- Materials
  - Dry waste: Polyethylene, Sulfur, Epoxy, Cement plus Water
  - Wet Waste: Cement, Absorbents, Evaporation
- Tests
  - Paint Filter
  - Particle Size

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INFORMATION REQUIRED FOR WASTE FORM DESIGN

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- Well Characterized
- Knowledge of cement-waste interactions
- Understanding of mechanisms for controlling performance
- Knowledge of regulatory requirements
- Experimental results
- Treatability Studies

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CEMENT-BASED MATERIAL

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Cement + Sand + H_2O	→	Mortar, Grout
Cement + Sand + Gravel + H_2O	→	Concrete
Cement + Aqueous sludge/solution	→	Waste Form
Cement + Dry Waste + H_2O	→	Waste Form

± Mineral reactive additives(Pozzolans)
± Additives for processing
± Chemicals or materials for cured property improvements

MATERIALS USED IN WASTE STABILIZATION

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- Hydraulic Cement
  - Portland
  - Slag
  - Calcium Aluminum Sulfate
  - Gypsum
  - Limes
- Pozzolans
  - Fly Ash
  - Natural
- Zeolites
  - Natural
  - Manufactured
- Clays
  - Natural
  - Processed
- Chemically reactive ingredients for specific contaminant stabilization/treatment

CEMENT WASTE FORM DESIGN

FERNALD

- Select cement, mineral additives, processing additives, and stabilization reagents to produce a material which meets production, storage, transportation and disposal requirements.

CEMENT WASTE FORMS

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- **ADVANTAGES**
  - Tailor properties
  - Ambient temperature
  - No off gas
  - Rework
  - Broad experience
  - Materials available
  - Vendors
  - One step processing liquids/sludges
- **DISADVANTAGES**
  - Cement hydration (solidification) sensitive to waste composition
  - QA issues for multiple component systems
  - Dust control required
  - Potential bleed water
  - Exothermic reaction
  - High density of cement additives
  - Container corrosion

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SULFUR POLYMER MATERIAL

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- Developed in 1970s as an acid resistant construction material in an effort to find uses for sulfur generated as by-product waste in the petroleum industry

Elemental Sulfur 95% + Additives 5% —Melt, 130-150°→ Molten Sulfur —Cool→ Modified sulfur polymer

- Adapted to waste encapsulation by DOE

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SULFUR POLYMER

FERNALD

- **ADVANTAGES**
  - Solidification assured
  - Compatible with many wastes
  - Rapid hardening
  - Resistant to many chemicals
  - No gas generation due to radiation
  - No free liquid
  - Low leaching
  - Rework
- **DISADVANTAGES**
  - Requires drying (<1% water)
  - Pre-heat waste
  - Off gas
  - SP deforms > 90°C
  - Limited waste processing experience

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POLYETHYLENE MATERIAL

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- Polyethylene developed in 1930s
- Organic Polymer - Low density used for waste encapsulation

Polyethylene Pellets + Dry Waste —Melt 150°C / Extrusion Press < 200 psi→ Polyethylene Encapsulated Waste

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POLYETHYLENE MICROENCAPSULATION

FERNALD

- **ADVANTAGES**
  - Insensitive to waste chemistry
  - Broad range of molecular weights
  - No chemical reaction for solidification
  - Rework

- **DISADVANTAGES**
  - Pre-dry waste (< 2% H_2O)
  - Foaming potential
  - Vent gases
  - Processing hazards > 350°C
  - No production scale experience
  - No stabilization

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TREATMENT - PRODUCT COMPARISON

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WASTE PROCESS	CEMENT	SULFUR	POLYETHYLENE
Stabilization (Metals)	Y	Y	-
Microencapsulation (Metals)	Y	Y	Y
Solidification (Powder)	Y	Y	Y
Solidification (Liquid)	Y	Pre-Evap	Pre-Evap

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ISSUES

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	CEMENT	SULFUR	POLYETHYLENE
• **Volume Increase**			
Dry Waste	≤ 20%	≤ 20%	≤ 20%
Wet Waste	≤ 50% (water)	?	?
• **Long Term Protection**			
Mechanism	Chemical stabilization physical entrapment	Chemical stabilization physical entrapment	Physical entrapment
• **Contaminants**	Many	Metal sulfides	Many
• **Cost**	Vendors competitive bid	?	?

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CONCLUSIONS

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- All 3 waste forms can be designed to meet disposal requirements for many waste streams including Fernald Silo 3
- All 3 waste treatments can be poorly designed and result in processing, storage and disposal failure

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CERCLA "NINE CRITERIA"

TRESHHOLD CRITERIA

Overall Protection of Human Health and the Environment
Compliance with ARARs

BALANCING CRITERIA

Long-Term Effectiveness and Permanence
Reduction of Toxicity, Mobility, or Volume through Treatment
Implementability
Short-Term Effectiveness
Cost

MODIFYING CRITERIA

State Acceptance
Community Acceptance

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THRESHOLD CRITERIA

OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

- All four alternatives are protective of human health and the environment
  - Transportation risk addressed through a combination of treatment and containerization
  - Long-term risks addressed through combination of treatment and arid, impacted disposal environment

COMPLIANCE WITH APPLICABLE OR RELEVENT AND APPROPRIATE REQUIREMENTS (ARARs)

- All four alternatives can comply with identified ARARs

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BALANCING CRITERIA

LONG-TERM EFFECTIVENESS AND PERMANENCE

- The treatment technologies combined with disposal in an arid environment provide approximately equal long-term effectiveness and permanence

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SHORT-TERM EFFECTIVENESS

- Work risks are higher for vitrification, and encapsulation technologies because of higher operating temperatures
- Transportation risks for all alternatives are significantly below U.S. EPA guidelines
- Transportation risks are lowest for vitrification due to smaller number of waste shipments
- Offgas issues more significant for vitrification and encapsulation technologies
- Time to protectiveness (cleanup time) is judged to be most certain for cement stabilization as the most developed tecnology

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REDUCTIONS OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Mobility:
- All technologies reduce RCRA metals mobility to below regulatory limits

Volume:
- Vitrification will realize a reduction of the treated waste
  - Must consider secondary wastes
- Cement stabilization will realize a volume increase (approximately 20%) in the treated waste
- Sulfur/Polymer Encapsulation and Polymer Encapsulation are expected to perform similar to cement stabilization relative to volume increase

Toxicity:
- None of the treatment technologies achieve a significant reduction in waste toxicity

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COST

Vitrification: $61.1M (Total Present Worth)

Cement Stabilization: $25M (Total Present Worth)

Sulfur/Polymer Encapsulation: Comparable to Cement Stabilization*

Polymer Encapsulation: Comparable to Cement Stabilization*

*Based on U.S. EPA Reference Material

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IMPLEMENTABILITY

Administrative Implementability:

- All alternatives judged to be equally implementable from an administrative perspective (i.e., ability to meet offsite waste acceptance criteria)

Technical Implementability:

- Based on commercial availabilty and industry experience, cement stabilization implementability is judged to be most certain
- Greater uncertainty exists for encapsulation technologies due to lack of commercial development
- High waste sulfate content significantly increases uncertainty for vitrification implementability

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