AGENDA AND HANDOUTS FROM SILO 3 ALTERNATIVES PUBLIC WORKSHOP
HELD AUGUST 20, 1996

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AGENDA

AGENDA

SILO 3 WORKSHOP

August 20, 1996, 7:00 - 9:00 p.m.
Alpha Building

Welcome and Announcements	Gary Stegner
Meeting Statement/Introductions	Nina Akgunduz
Presentations:	
• Silo 3 Report Summary	Jeff Stone
• Stabilization/Solidification at Fernald	John Sattler
Silo 3 Path Forward	Nina Akgunduz
Q&A	Gary Stegner

Mixed Waste Stabilization Project

- The objective of the Mixed Waste Stabilization Project was to safely treat ~2,300 drums of mixed waste.
- The mixed waste consisted of grit blast residue, solidified furnace salt, sump cake and sludges, construction rubble, and miscellaneous trash.
- A treatability study (proof-of-process) was conducted on all five waste categories to assure stabilization would successfully treat the waste and to optimize the design recipe.

Mixed Waste Stabilization Project

- The waste was successfully treated by Perma-Fix utilizing a cement based stabilization/solidification process.

- The treated waste met Land Disposal Restriction (LDR) and the Nevada Test Site (NTS) Waste Acceptance Criteria and is currently being disposed at NTS as Low Level Waste.

- To meet LDR and NTS Waste Acceptance Criteria, the waste must pass a Toxicity Characteristic Leaching Procedure to assure that the hazardous constituents cannot leach out of the solidified waste.

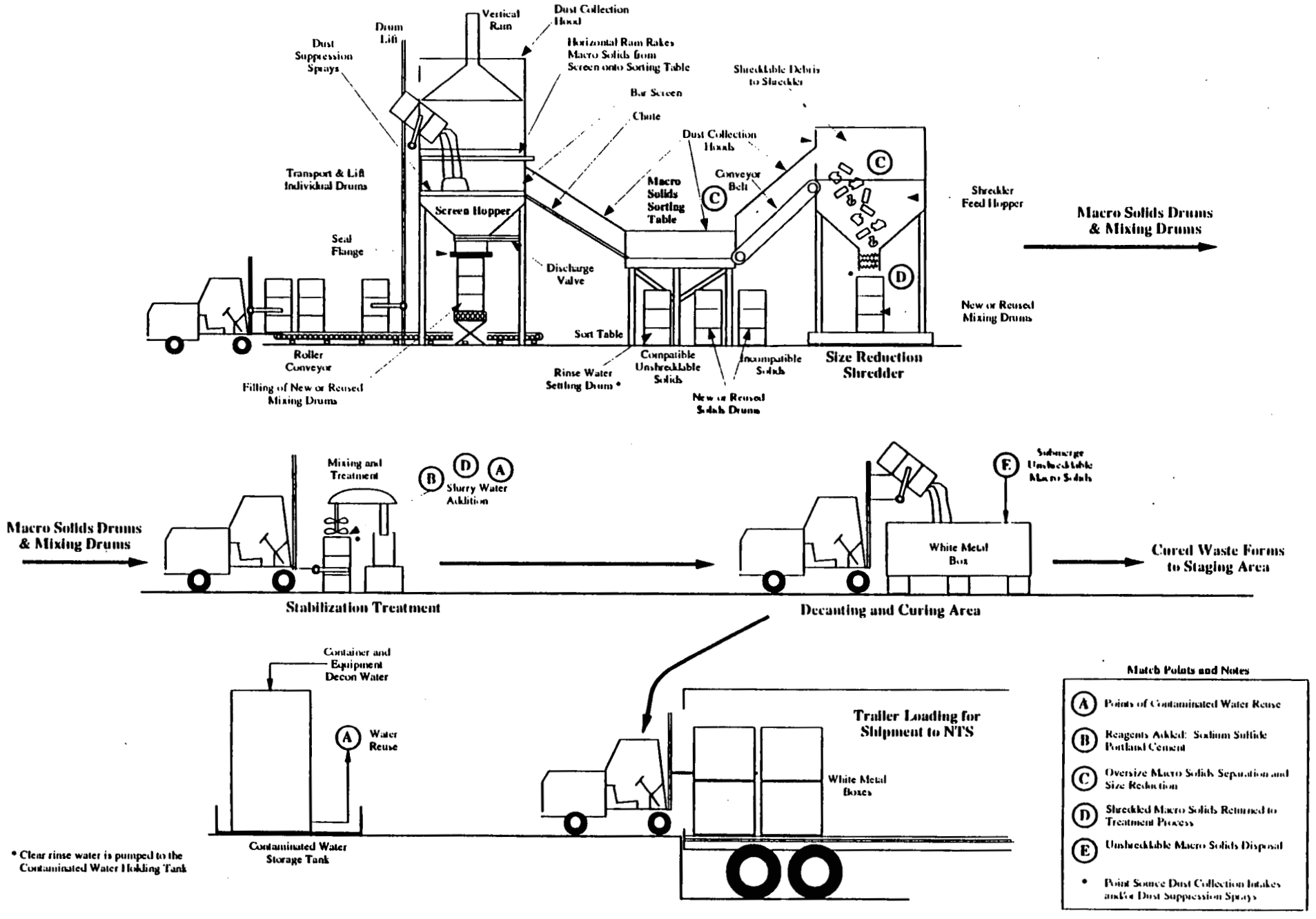

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Figure 2-3
Schematic Diagram of Treatment Process

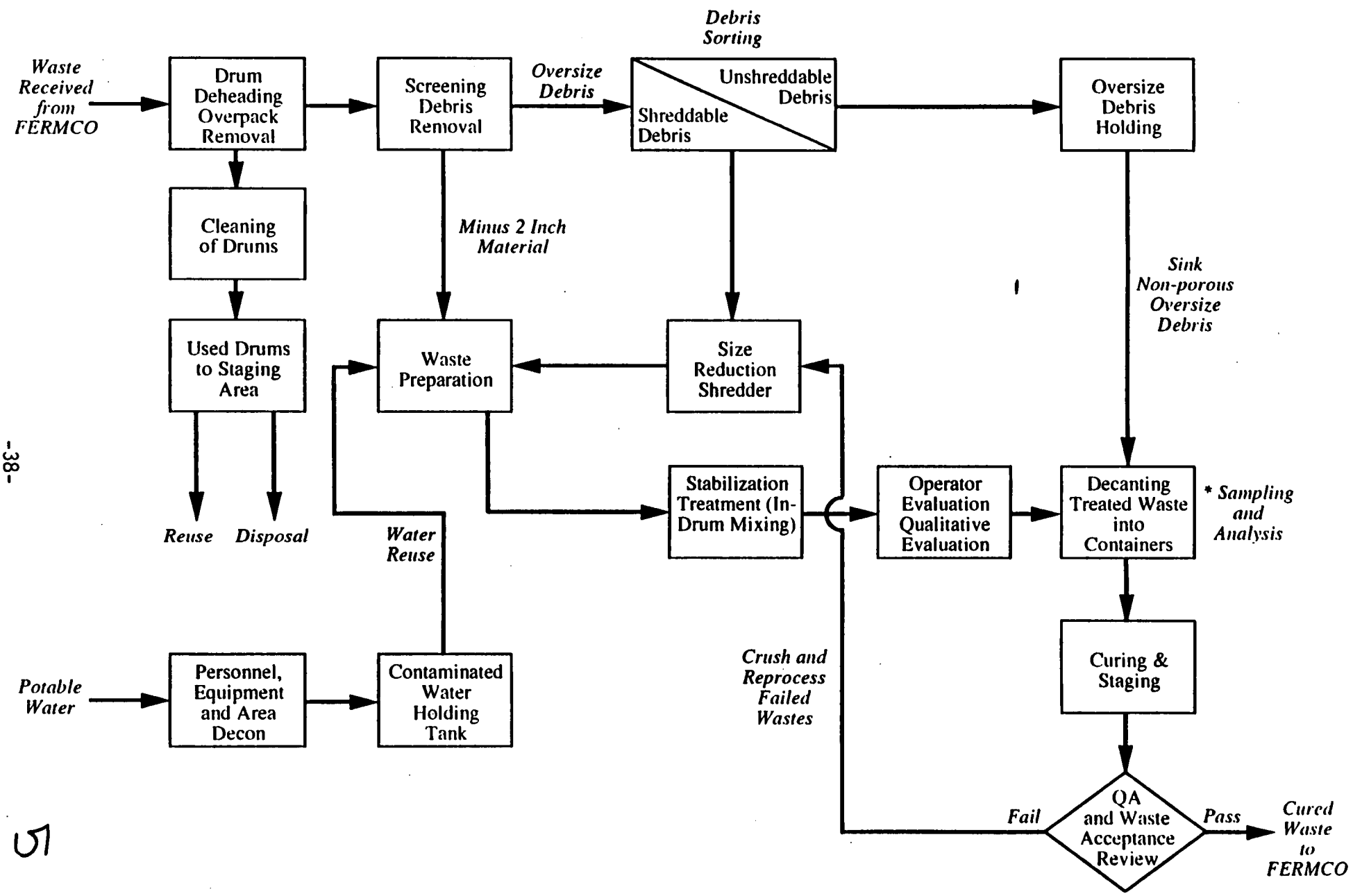
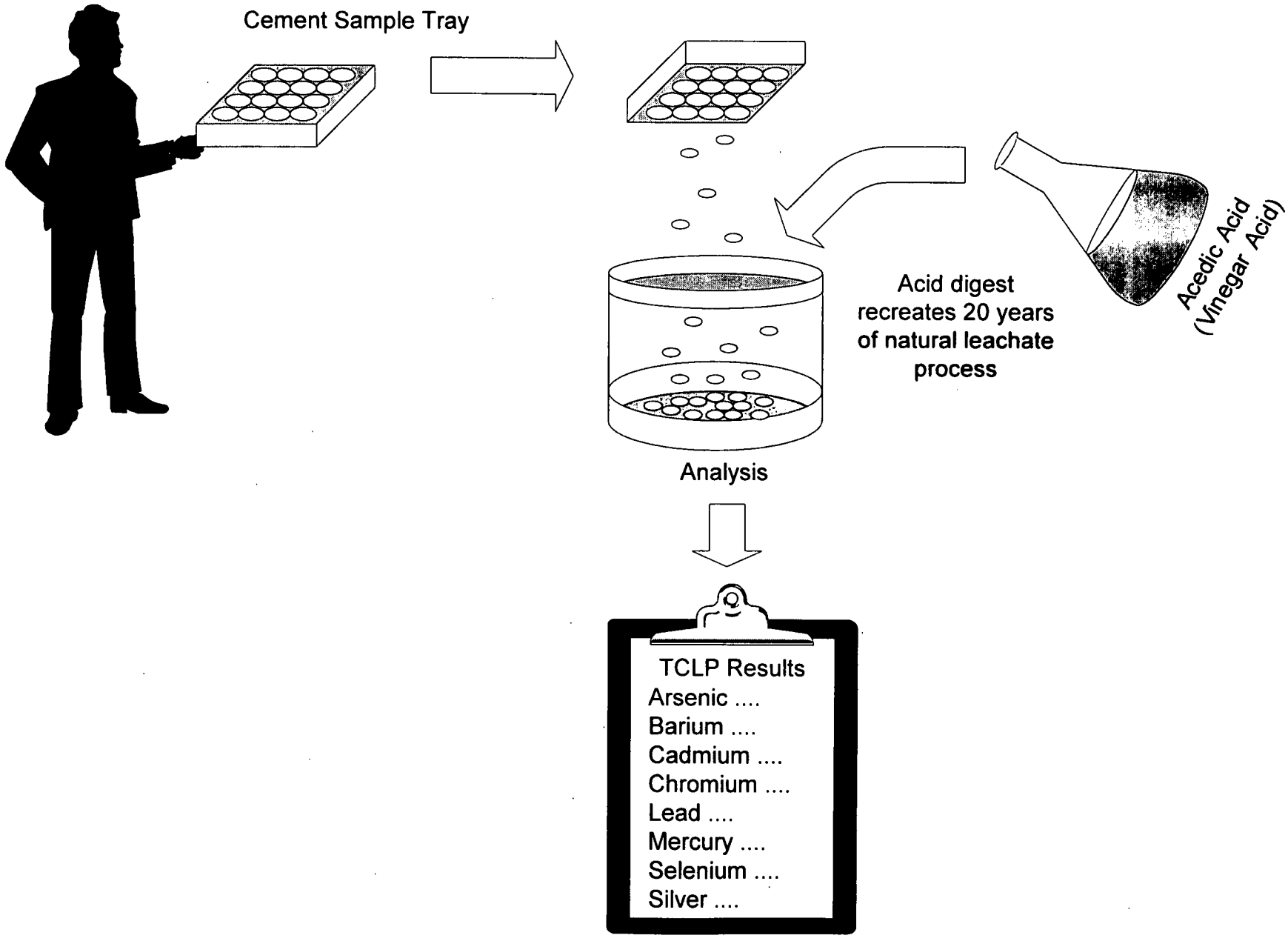


Figure 1.3
Block Flow Diagram - Mixed Waste Stabilization

Toxicity Characteristics Leaching Procedure (TCLP)



Mixed Waste Stabilization Project

Concentrations of Hazardous Constituents			
CONSTITUENTS	REGULATORY LIMITS	PRE TREATMENT CONCENTRATIONS*	POST TREATMENT CONCENTRATIONS**
Arsenic-D004	5.0 ppm	7,430 ppm	< 5.0 ppm
Barium-D005	100.0 ppm	250,000 ppm	< 100.0 ppm
Cadmium-D006	1.0 ppm	35 ppm	< 1.0 ppm
Chromium-D007	5.0 ppm	909 ppm	< 5.0 ppm
Lead-D008	5.0 ppm	7,946 ppm	< 5.0 ppm
Mercury-D009	.2 ppm	0.722 ppm	< 0.2 ppm
Selenium-D0010	1.0 ppm	124 ppm	< 1.0 ppm
Silver-D0011	5.0 ppm	138 ppm	< 5.0 ppm
Uranium		852,000 ppm	~40% Reduction

ppm = Part Per Million

*Results are the maxium concentrations of the samples taken

**Results are the average concentrations of the samples taken

Thorium Nitrate Mixed Waste Stabilization

- Over 6,000 gallons of Thorium Nitrate liquid waste from Tank T-2 at the Pilot Plant was stabilized using a cement mixture.
- Chem-Nuclear Systems, Inc. was contracted and performed the stabilization utilizing their processing experience and the FEMP work force.
- Chem-Nuclear performed treatability studies (proof-of-process) to formulate the proper chemical mixture for solidification of the Thorium Nitrate in Tank T-2.
- Stabilization was completed more than 1 year ahead of schedule and ~$500,000 under budget.
- The stabilized waste no longer exhibits hazardous characteristics for RCRA constituents and the waste is to be disposed at NTS as Low Level Waste.

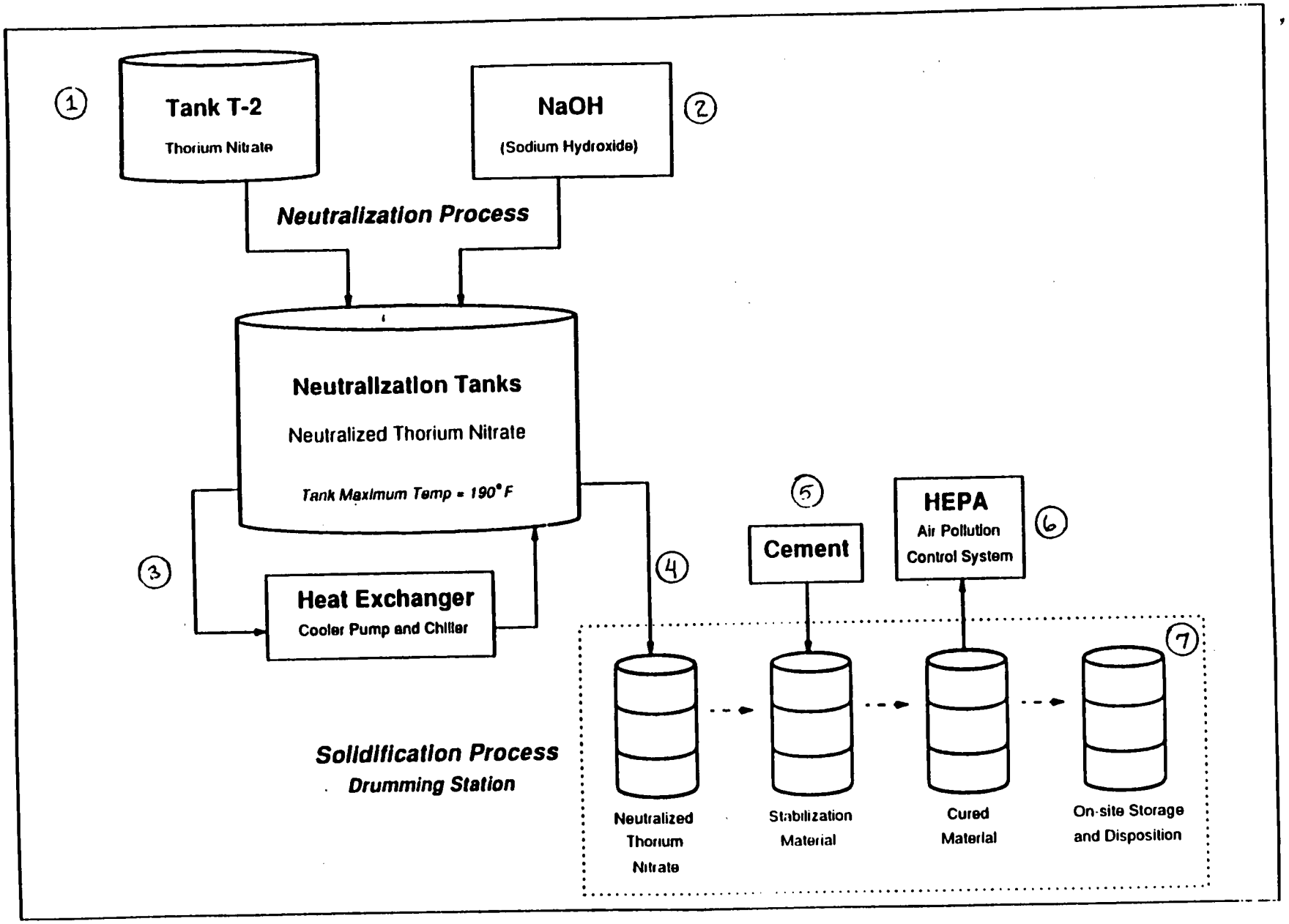


Figure 2-3 Thorium Nitrate - Neutralization and Solidification Process Schematic

Thorium Nitrate Solidification Project
Process Outline

1 Thorium nitrate was transferred from Tank T-2 to one of two neutralization tanks in 200 gallon batches. Before transferring the waste, Tank T-2 was recirculated for 30 minutes per 1,000 gallons of waste to thoroughly mix the liquid and ensure uniform composition.

2 68 gallons of water and 95 gallons sodium hydroxide were added to neutralize the waste to a pH of approximately 2. This quantity was verified every ten batches by performing a process control test.

3 A cooling unit was available to keep heat of reaction in the neutralization tanks below 110 deg. F. This was necessary to prevent the generation of nitrous oxide gas. Maximum temperature encountered during actual processing was 99 deg. F.

4 35 gallons of neutralized solution were transferred to a drum through the a fillhead. The drumming station was located in a containment tent.

5 With the mixer running, 170 - 190 lbs of cement/fly ash were added to each drum through the fillhead and mixed with the neutralized waste. Total filling and mixing time per drum was approximately 30-45 minutes.

6 The entire drum filling and mixing operation were conducted inside a ventilated containment tent. The containment tent and drum fillhead were vented through a HEPA filter.

7 After mixing was completed, the fillhead was removed and replaced with a vented lid for curing. The drum was then moved out of the tent and staged for 2-3 days to cure. After this initial curing, the drum was inspected, the final shipping lid installed, and the drum was moved to Plant 1 Pad for storage.

Thorium Nitrate Solidification

Concentrations of Hazardous Constituents			
CONSTITUENTS	REGULATORY LIMITS	PRE TREATMENT CONCENTRATIONS*	POST TREATMENT CONCENTRATIONS**
Cadmium-D006	1.0 ppm	1.42 ppm	0.015 ppm
Chromium-D007	5.0 ppm	3.77 ppm	0.115 ppm
Thorium		408,000 ppm	< 5.0 ppm
Dose		35 mREM on Contact with Tank T-2	8-10 mREM on Contact with Drum

ppm = Part Per Million

*Results are the maxium concentrations of the samples taken

**Results are the average concentrations of the samples taken

SLIDE FORMAT

1. Picture of OU4/Silo 3/VITPP
2. Brief History
3. Why Change the Path Now?
4. Why Stabilize/Solidify the Silo 3 Residues?
5. Approach to Silo 3 Alternatives Report
6. Comparison of Silo 3 Alternatives with OU4 Selected Remedy
7. Summary of Silo 3 Alternatives Report
8. Schedule Comparison
9. Silo 3 Residues Path Forward

SILOS PROJECT

FEMP

BRIEF HISTORY

- Announcement of VITPP 17-Month Schedule Delay (Nov - 95)
- Direct Impacts to the OU4 Remedial Design Management Strategy
- DOE Sponsored Value Engineering Study (Jan 96)

  Recommendations:

  - Vitrification Upgrade Analysis
  - Alternative Treatment Silo 3 Residues

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SILOS PROJECT

FEMP

Why Change the Path Now?

- Project Must Adjust to Current Situations
  - New knowledge from post-ROD laboratory testing
  - VITPP experience
- Need for Schedule Improvements
- Smarter Spending of Limited Federal Funds
- No Adverse Safety, Health, Environmental or Cost Affects

SILOS PROJECT

FEMP

Why Stabilize/Solidify the Silo 3 Residues?

- Protective of Human Health and the Environment
- Accelerate Schedule - Parallel Remediation
- Low Direct Radiation Allows Contact Handling of Treated Silo 3 Waste Product
- Reduces Technical Complexity of Treatment Process
- Minimizes Packaging Requirements/Reduces Costs
- Simplifies Off-gas Treatment Requirements
- Separates and Simplifies Material Handling Concerns

APPROACH TO SILO 3 ALTERNATIVES REPORT

- Considered Low-Risk Alternatives
- Variations of the OU4 FS Cementation Alternative
- Followed Traditional FS Format and EPA Guidance
- Compared Silo 3 Alternatives to Vitrification (Baseline)

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SILOS PROJECT

FEMP

COMPARISON of SILO 3 ALTERNATIVES to OU4 SELECTED REMEDY (OU4 Record of Decision)

Silo 3 Alternatives	Selected Remedy
Remove Residues	Remove Residues
Onsite/Offsite Treatment	Onsite Treatment
Stabilization/Solidification	Vitrification
Offsite Disposal at NTS/RPCDF	Offsite Disposal at the NTS

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SUMMARY OF SILO 3 ALTERNATIVES REPORT

- Analysis and Results Consistent with Operable Unit 4 Feasibility Study and Operable Unit 4 Record of Decision
- Silo 3 Residues Could be Stabilized/Solidified in a Manner Protective of Human Health and the Environment
- Offered Opportunity to Complete the Silo 3 Remediation Schedule Before Silos 1 and 2 Remediation is Complete
- Cost Was Not a Decisive Factor

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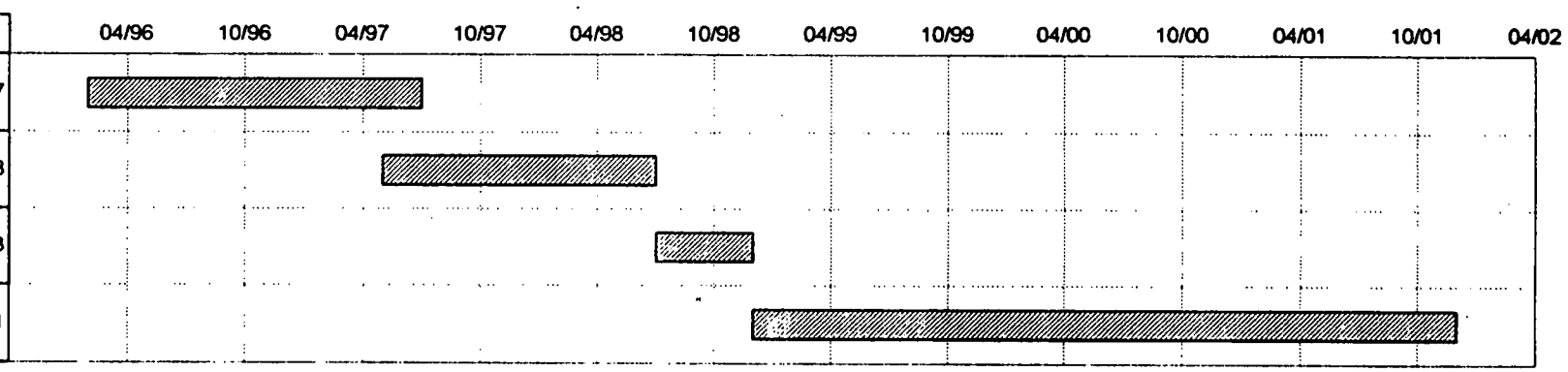
OU4 Remedial Design Work Plan Schedule Comparison with Silo 3 Residues Project Schedule

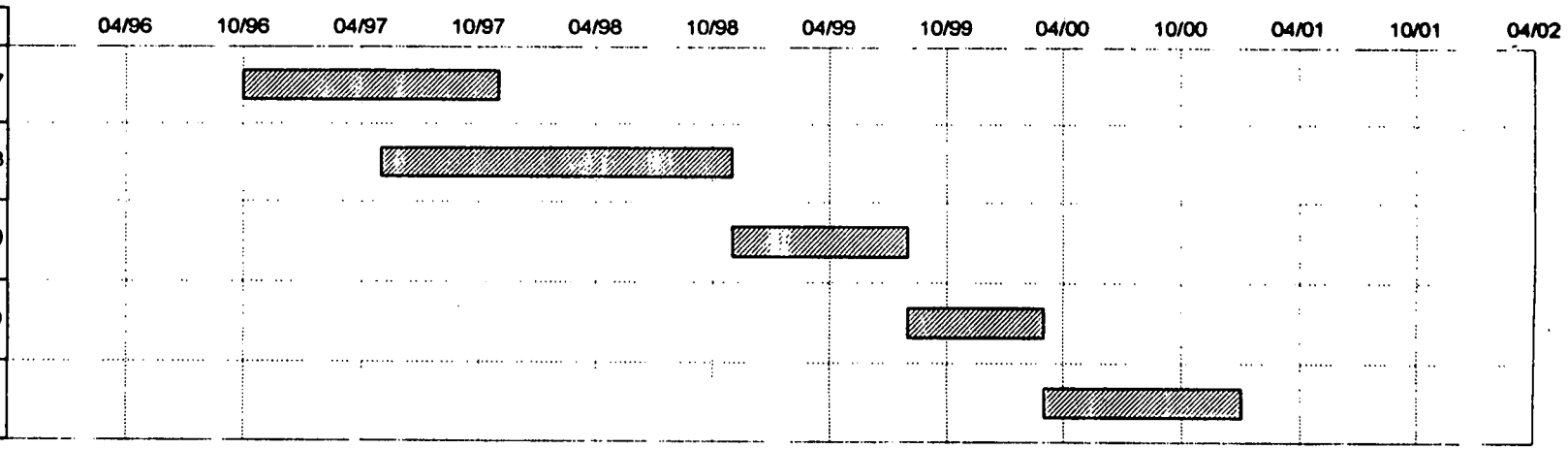
Remedial Design Work Plan Schedule

FRVP	Start	End
Design FRVP	Feb 96	July 97
Construction FRVP	May 97	July 98
Startup FRVP	July 98	Dec 98
Operations FRVP (Silos 1,2,3)	Dec 98	Dec 01



Silo 3 Residues Project Summary Schedule

Silo 3 Project	Start	End
Predesign	Oct 96	Nov 97
Design	Nov 97	Nov 98
Procurement/ Construction	Nov 98	Aug 99
Start-up/ORR	Aug 98	Mar 00
Operations	Mar 00	Jan 01



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SILOS PROJECT

FEMP

SILO 3 RESIDUES PATH FORWARD

- Silo 3 Report - Stakeholder/Agency Comments by September 9, 1996
- Request for Extension of - Deliverables/Milestones
- Modification of Operable Unit 4 Record of Decision

  - Explanation of Significant Differences (ESD)
- Procurement Strategy

EVALUATION OF SILO 3 ALTERNATIVES PUBLIC WORKSHOP

August 20, 1996

Evaluation Survey

Thank you for attending the workshop to discuss an alternative remediation for Silo 3. Please take a few minutes to answer the questions below:

1. Was the Silo 3 fact sheet mailed to you? If no, please print your address to make sure you are on our mailing list.

2. If you received and read the fact sheet, did you understand the five alternatives being evaluated for the remediation of the Silo 3 contents?

3. Was the presentation on the Silo 3 Report Summary adequate and understandable?

4. Did the presentation on stabilization illustrate that this alternative method is effective and protective?

5. Do you have questions concerning the Explanation of Significant Differences (ESD)?

6. How satisfied were you with responses to questions asked this evening?

7. Do you have any other constructive comment/criticism about tonight's meeting?

Optional:

Name_____ Phone_____

Definitions of Acronyms used in the Presentations

ARAR: Applicable or relevant and appropriate requirements, cleanup standards. standards of control, and other substantive environmental protection requirements used to guide the selection of cleanup activity at a particular site, and which must be attained at completion of remedial actions.

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act (also known as Superfund), the federal law that provides the organizational structure and procedures for preparing and responding to releases of hazardous substances, pollutants, and contaminants.

DOE: U.S. Department of Energy

ESD: Explanation of Significant Differences, used to modify an EPA-approved Record of Decision, when changes do not fundamentally alter the selected remedy.

FEMP: Fernald Environmental Management Project, the name given Fernald when its mission was transferred from weapons production to environmental restoration.

FERMCO: Fernald Environmental Restoration Management Corporation, the contractor selected in August 1992 to clean up Fernald.

FRVP: Fernald Residues Vitrification Plant, the name given to the full-scale OU4 vitrification facility.

NTS: Nevada Test Site, a DOE repository for radioactive wastes located near Las Vegas.

OEPA: Ohio Environmental Protection Agency

ORR: Operational Readiness Review, a disciplined review of a project's safety and quality assurance program conducted by DOE and FERMCO prior to the issuing of written authorization to start of operations.

OU: Operable Unit, an area of study that contains similar characteristics or problems. There are five operable units at Fernald. Silo 3 is a part of OU4.

PEIC: Public Environmental Information Center, 10845 Hamilton-Cleves Highway, Harrison, Ohio 45030, which houses the administrative record and the public reading room. The phone number is 513-738-0165.

RCRA: Resource Conservation and Recovery Act, the federal environmental law designed to account for and ensure proper management of hazardous wastes, from cradle to grave.

RD/RA Remedial Design/Remedial Action, the next phase of cleanup following the RI/FS. Remedial design includes development of engineering drawings and specifications for site cleanup. Remedial Action is the actual construction and implementation phase of site cleanup under CERCLA.

RI/FS: Remedial Investigation and Feasibility Study, two distinct, but related studies. Together they characterize environmental problems and outline remedial actions to solve those problems.

ROD: Record of Decision, a written decision that identifies the selected remedy for long-term cleanup of contamination at a site under CERCLA.

RPCDF: Representative Permitted Commercial Disposal Facility, i.e., Envirocare located in Clive, Utah.

TCLP: Toxicity Characteristic Leaching Procedure, a laboratory procedure used to simulate and determine the concentration of hazardous constituents which may leach from waste when buried in the ground.

U.S. EPA: United States Environmental Protection Agency

VITPP: Vitrification (a method of treating waste that produces a glass-like solid that immobilizes radioactive and hazardous materials in the glass matrix) Pilot Plant.

WAC Waste acceptance criteria, criteria established by disposal facilities to control waste entering the facility as well as to comply with environmental requirements.

Figure 1-3 Tank T-2 (on right) Inside Secondary Containment

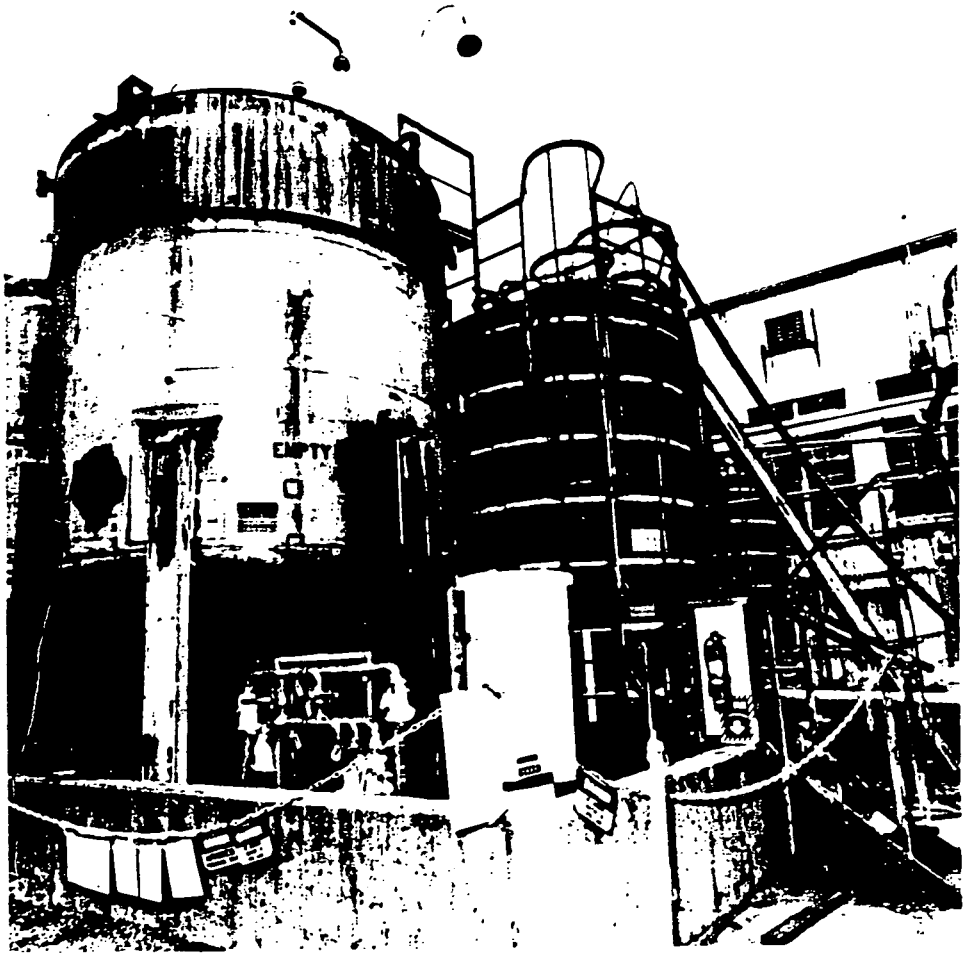

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Figure 2-1
Thorium Nitrate
Solidification
Project Area

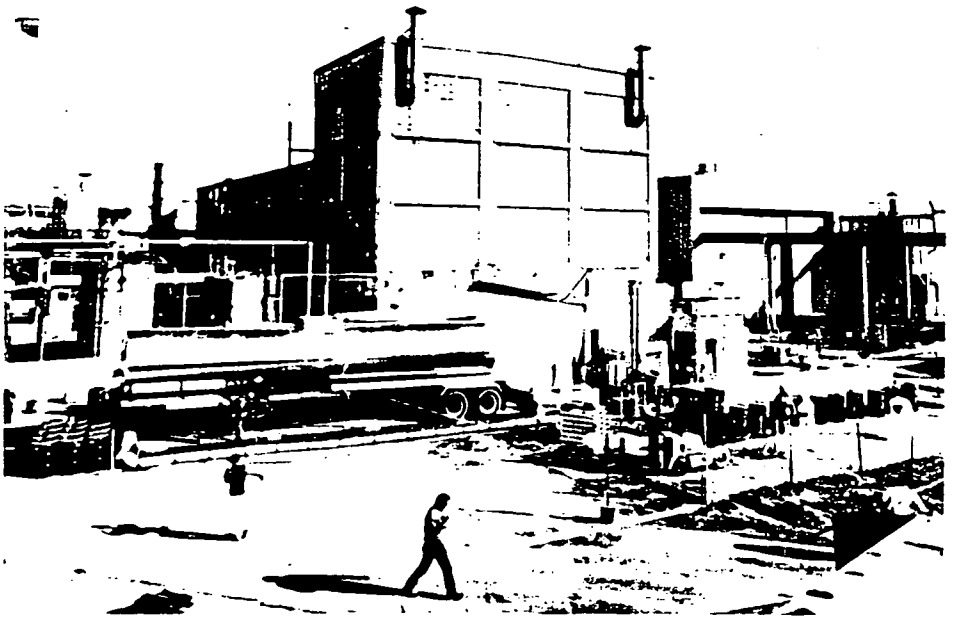

Figure 2-2
TNSP Neutralization
Tanks and Associated
Equipment

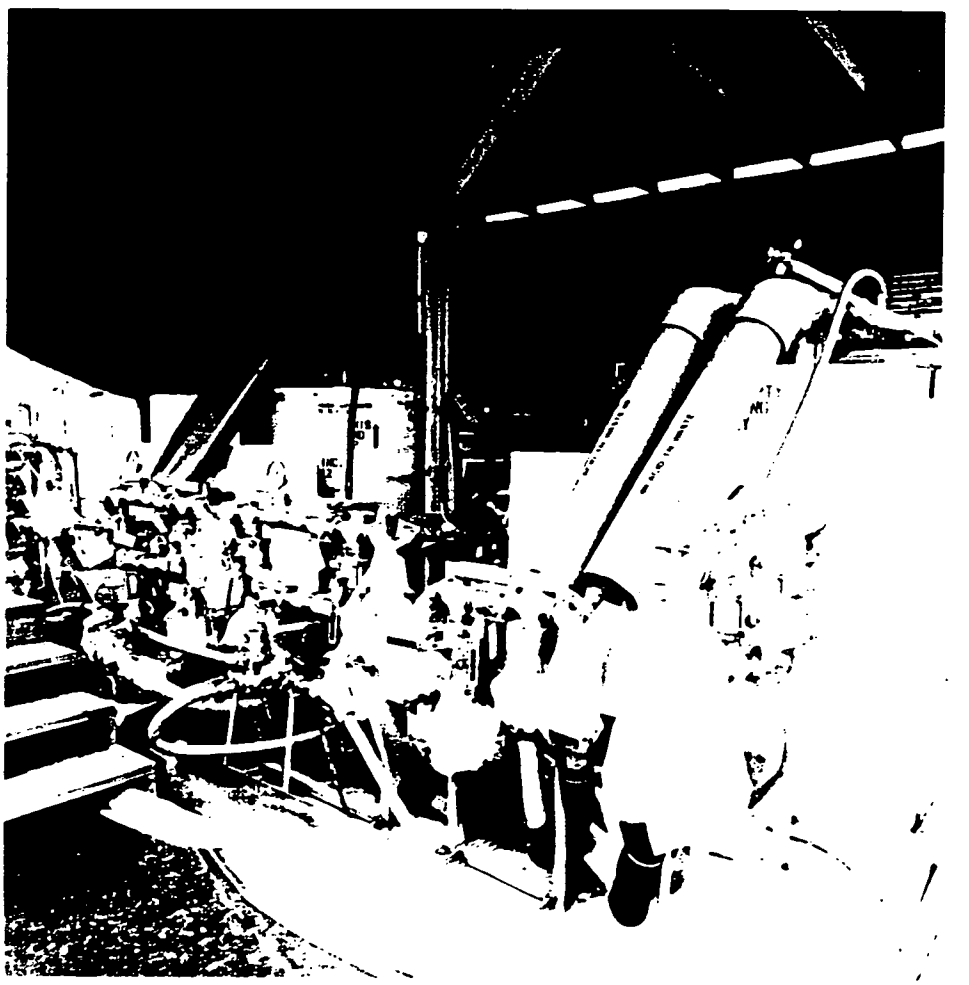

Figure 2-3 Inspecting the Cured Waste

Operable Unit 4

Silos Project

July 1996

Introduction

Operable Unit 4 is one of five well-defined areas undergoing remediation at the U.S. Department of Energy's (DOE) Fernald Environmental Management Project. The operable units were defined, based on their locations or the potential for similar technologies.

Located at the western periphery of the Fernald site, Operable Unit 4 includes Silos 1 and 2 (K-65 Silos), Silo 3 (metal oxide silo), unused Silo 4, and ancillary structures. Operable Unit 4 remediation will address each of these structures, as well as any contaminated soils within the geographic boundary, and any contaminated perched water encountered during Operable Unit 4 remedial activities.

For each operable unit, the U.S. Environmental Protection Agency (EPA) issues a record of decision (ROD). The selected remedial action for an operable unit, as well as the basis for the selection, are formally presented in the ROD.

Background

On Dec. 7, 1994, U.S. EPA signed the Record of Decision for Remedial Action at Operable Unit 4, in which the selected remedial action and the basis for selecting that remedial action, are presented.

Silos 1 and 2, commonly called the "K-65 Silos," contain radium-bearing, low-level radioactive wastes dating back to the 1950s. In 1964, the two silos were reinforced with an earthen berm, which was upgraded in 1983.

Other improvements include a 30-foot cap on top of the silo domes, installed for added protection, and a polyurethane foam coating applied over the domes for weather protection. A silo headspace radon treatment system was also constructed, and radon monitors were installed around the Fernald site boundary and in the immediate vicinity of Silos 1 and 2.

Silo 3 contains dried uranium-bearing wastes. Silo 4 is empty.

Operable Unit 4 Selected Remedy

A restructuring of all Fernald project and support organizations has been completed to strategically align the existing project organizations to permit more efficient performance of remedial design and remedial action activities. The selected remedy for Operable Unit 4 will be performed by the following project organizations.

Silos Project

-- Removal of the contents of Silos 1, 2 and 3 (K-65 residues and cold metal oxides) and the decant sump tank sludge.

-- Vitrification (glassification) to stabilize the residues and sludges removed from the silos and decant sump tank.

-- Shipment of the vitrified contents of Silos 1, 2, and 3, and the decant sump tank for disposal at the Nevada Test Site (NTS).

Facilities D&D Project

-- Demolition of Silos 1, 2, 3 and 4, and decontamination -- to the extent practicable.

-- Of concrete rubble, piping and other construction debris generated.

-- Demolition of the vitrification treatment unit and associated facilities after use and decontamination or recycling of debris prior to disposition.

Soil Remediation Project

-- Segregation of non-contaminated soils.

-- Removal of the earthen berms and excavation of contaminated soils within the Operable Unit 4 boundary to achieve proposed remediation levels. Placement of clean backfill following excavation.

-- On-property interim storage of excavated contaminated soils and remaining contaminated debris in a manner consistent with the approved *Work Plan for Improved Storage of Soil and Debris* (Removal Action 17).

-- Pumping and treatment of any contaminated perched water encountered during remedial activities.

Remedial Design, Remedial Action

The overall objective of Operable Unit 4 remedial actions is to safely remove a known source of contamination, which will reduce the potential for release of hazardous substances, including radionuclides, to the environment, thereby alleviating a potential risk to human health. Substantial risk reduction will be achieved by removing the sources of contamination, treating the material for which exposures result in the highest risk, shipping the treated residues off site for disposal, and managing remaining contaminated soils and debris consistent with a sitewide strategy.

Operable Unit 4 remedial actions entail removing the materials from Silos 1, 2, and 3 and treating them in a vitrification facility to be constructed at the Fernald site. Sludge from the decant sump tank, which collects liquids from in and around the silos, will also be removed and treated in the vitrification facility. Following treatment, the vitrified residues will be containerized and transported and disposed at NTS. The Operable Unit 4 scope includes successful completion of these actions.

After the residues are removed from the silos, the concrete structures, radon treatment system and other structures within Operable Unit 4 will be demolished. After treatment, the vitrification facility will be disassembled.

Vitrification (glassification) will reduce the mobility of hazardous constituents and will reduce the volume of materials requiring disposal.

Standard decontamination technologies will be applied, to the extent practical, to minimize the volume of waste requiring disposal. Opportunities for recycling materials will be explored.

Contaminated soils within Operable Unit 4 will be excavated; it is anticipated that a minimum depth of 6 inches will be removed from the Operable Unit 4 area. Clean fill will be placed in excavated areas, which will then be seeded. Contaminated Operable Unit 4 soil and debris will be placed in an on-site storage facility. As required, the storage facility will be maintained and monitored.

Operable Unit 4 contaminated soil and debris will be disposed consistent with the selected remedial actions for Operable Units 3 and 5 and will be accomplished via the Soils Remediation Project.

On Oct. 6, 1995, DOE submitted the *Work Plan for Operable Unit 4 Remedial Action -- Phase I* to U.S. EPA. On Nov. 20, 1995, DOE received conditional approval, with comments from U.S. EPA. This document identifies the implementation strategy and schedule for completing all Operable Unit 4 remedial activities.

On Jan. 9, 1996, U.S. EPA approved the *Work Plan for Operable Unit 4 Remedial Action -- Phase I.* Phase I of the Operable Unit 4 remedial action work plan focuses on implementation of the initial remedial action in support of the construction of the Fernald residues vitrification plant: site preparation/underground utilities; silo superstructure construction; new radon treatment system construction (Silos 1 and 2).

Phase II of the remedial action work plan will be submitted following integration of test data from the pilot-scale vitrification plant.

Construction of Fernald's pilot-scale vitrification plant began July 17, 1994, and was completed in May 1996. Pilot-scale Phase I testing operations began in June 1996. Operation of this facility supports development of final vitrification processes and design of the full-scale vitrification facility.

Several of the Fernald Residues Vitrification Plant remedial design packages have already been submitted to the U.S. EPA and Ohio EPA. These include the pre-final site preparation/underground utilities design, on Aug. 31, 1995. On May 1, 1996, the silo superstructures design package was submitted to U.S. EPA and Ohio EPA.

The site preparation/underground utilities design has since been approved by U.S. EPA, and a construction subcontract was awarded Feb. 27, 1996. Construction is currently in progress.

Operable Unit 4 Vitrification Pilot Plant Treatability Study

A two-phase treatability study will be conducted to demonstrate integration of equipment and operation of the vitrification pilot plant, including the melter off-gas and radon absorption systems. Other treatability study objectives include: verifying formulations developed from the previous bench-scale studies and glass-development program, producing a satisfactory glass product during full-scale operation, and ensuring compliance with acceptance criteria required for disposal at NTS.

Phase I operations will verify the adequacy of the equipment and process. Bentonite and nonradioactive surrogate materials will be utilized in the vitrification facility to perform integrated system operability testing prior to operating with actual silo residues. The surrogate materials are composed of chemicals, including silica, borax and alumina, to closely duplicate the actual silo materials.

Phase I testing with nonradioactive, surrogate materials began June 19, 1996, and will take approximately eight months to complete. Production of approximately 90 metric tons of glass is expected to be required to adequately demonstrate vitrification.

During Phase II, radioactive materials from Silos 2 and 3 will be utilized. Also radon control for the Silos 1 or 2 headspace and off-gas treatment for the vitrification facility will be demonstrated. Silo 2 materials will be removed by a manually operated slurry pumping device suspended from a mobile crane. The device will be deployed through an existing manway. A glovebag will maintain a seal and prevent radon escape. Silo 3 materials will be removed pneumatically.

For More Information

Contact the Public Environmental Information Center (PEIC), 10845 Hamilton-Cleves Highway, Harrison, Ohio, 45030 (phone: 513-738-0164).

For specific questions regarding Operable Unit 4, contact: Acting Team Leader Nina Akgunduz, DOE Fernald Area Office, 513-648-3110.

DRAFT FINAL

EVALUATION OF SILO 3 ALTERNATIVES

Fernald Environmental Management Project
Fernald, Ohio

Fernald Environmental
FERMCO
Restoration Management Corporation

June 1996

prepared for the
U.S. Department of Energy
Fernald Area Office

EXECUTIVE SUMMARY

Introduction

This report documents the reexamination of the selected remedy and considers the evaluation of specified alternative treatment and disposal options for the remediation of the contents of Silo 3 of Operable Unit (OU) 4 at the United States Department of Energy (DOE) Fernald Environmental Management Project (FEMP). The FEMP, formerly known as the Feed Materials Production Center (FMPC), is a DOE facility that operated from 1952 to 1989. The facility's primary function was to provide high purity uranium metal products to support United States defense programs. Production operations were suspended in 1989 to focus on environmental restoration and waste management activities at the facility.

To promote a more structured and expeditious cleanup of the FEMP property, complex environmental issues associated with the FEMP were divided into five operable units under the Amended Consent Agreement. The term "operable unit" is used to identify a logical grouping of environmental issues that comprise an incremental step toward comprehensively addressing site problems. OU4 consists of the following FEMP facilities and associated environmental media:

- Silos 1 and 2 and their contents (also termed K-65 silos);
- Silo 3 and its contents (also termed cold metal oxide silo);
- Silo 4 (empty);
- K-65 decant sump tank for Silos 1 and 2, its contents, and associated piping;
- A radon treatment system (RTS);
- The portion of a concrete pipe trench within the boundaries of OU4, and other concrete structures;
- An earthen berm surrounding Silos 1 and 2;
- Soils beneath and immediately surrounding Silos 1, 2, 3, and 4; and
- Perched groundwater in the vicinity of the silos that may be encountered during the implementation of cleanup activities.

OU4 is one of several operable units at the FEMP, for which a United States Environmental Protection Agency (EPA)- approved final Record of Decision (ROD) has been issued. The OU4

remedial actions outlined in the *Final Record of Decision for Remedial Action at Operable Unit 4, December 1994 (DOE 1994c)*, primarily consists of the removal of the contents of Silos 1, 2, and 3; stabilization by vitrification; off-site disposal of the vitrified waste at the Nevada Test Site (NTS); and the demolition removal, and final disposition of the contaminated concrete, debris and soils within the OU4 boundary.

The purpose of this effort is to reexamine and determine whether any specific alternatives would simplify the implementation of the technical requirements for the remediation of the Silo 3 residues, accelerate the project schedule, and/or reduce remediation costs while providing an equivalent or improved level of protection for human health and the environment. The analyses of available and new information will support the pursuit of the most appropriate treatment alternative for the contents of OU4, Silo 3, at the DOE, FEMP, Fernald, Ohio. In addition, any technical or programmatic impacts to the remediation of Silos 1 and 2 must be considered and factored into the final decision for Silo 3 residues.

Background

Silo 3 contains 3,890 m^3 (5,088 yd^3) of residues, known as cold metal oxides, which were generated at the FEMP during uranium extraction operations in the 1950s. This process involved Belgian Congo ores and uranium concentrates received from a variety of uranium mills in the United States and abroad. The residues in Silo 3 are substantially different from those in Silos 1 and 2. First, Silo 3 residues have a low moisture content resulting in a powder-like consistency, while residues in Silos 1 and 2 consist of wet slurry from which excess liquids were decanted. Second, while the radiological constituents in Silo 3 are similar to those in Silos 1 and 2, certain radionuclides, such as radium, are present in much lower concentrations. Thus, Silo 3 exhibits a significantly lower direct radiation field and radon emanation rate than Silos 1 and 2 by two orders magnitude for each.

Residue samples collected from Silo 3 identified the presence of significant activity and concentrations of the radionuclides within the uranium decay series, confirming prior process knowledge. The predominant constituent identified within Silo 3 was thorium-230 (Th-230), a radionuclide produced from the natural radioactive decay of uranium-238 (U-238). Approximately 450 curies (Ci) of Th-230 are distributed within the Silo 3 residues. Tests performed on samples of the Silo 3 residues indicate that the following Resource Conservation and Recovery Act (RCRA) metals: arsenic, cadmium, chromium, and selenium are leachable from the residues exceeding maximum limits.

To achieve its remedial goals for OU4, the DOE has adopted a remedial management strategy that not only satisfies its remedial design/remedial action (RD/RA) obligations pursuant to Section XVII of the Consent Agreement, as amended under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) Sections 120 and 106(a), Docket Number V-W-90-C-057 (1991), but expedites to the extent practical the RD/RA process. Consistent with its strategy outlined by the OU4 Remedial Design Work Plan (DOE 1995a), the DOE initiated several advanced pilot-scale RD treatability studies both onsite and in partnership with the academic community. The Vitrification Pilot Plant (VITPP) Phases I and II Treatability Study Programs have been integrated directly into the OU4 RD/RA program in order to collect quantitative performance data to support the full-scale application of the vitrification technology to the remediation of the Silos 1, 2, and 3 residues.

Treatability Studies

Advanced vitrification treatability studies were performed in partnership with The Catholic University of America, Vitreous State Laboratory to develop techniques and customize the glass recipes for processing in the OU4 VITPP Melter between 1,150°C and 1,350°C for the following waste loading scenarios, termed "Series":

- Series A - Silos 1 and 2;
- Series B - Silos 1 and 2 with varying amounts of bentonite clay;
- Series C - Silo 3; and
- Series D - Blend of Silos 1 and 2 with Silo 3 and varying amounts of bentonite clay.

Glass produced from the above series were evaluated to formulate a glass that could pass the EPA's RCRA toxicity characteristic leaching procedure (TCLP) and provide the best combination of the following:

- High residue loading to minimize disposal volumes;
- Versatile and robust formulation to allow for residue variability; and
- Low operating temperature to minimize melter corrosion.

Continuous evaluation of the performance data obtained during this process as it pertains to full-scale operations is both critical and appropriate. Throughout the implementation and development of the Vitrification Pilot Plant Phase I and II Treatability Study Programs, continued schedule delays, cost growth and technical concerns have resulted in DOE thoroughly reassessing the overall project for

opportunities to accelerate schedule, reduce project costs, and optimize the RD/RA process using data obtained from these treatability study programs.

The physical, chemical and radiological differences between the Silo 3 residues and the Silos 1 and 2 residues, that make it a leading candidate for consideration of alternative treatment and the means by which the overall OU4 remediation project schedule could be accelerated. By performing the remediation of Silo 3 residues through an alternate method either ahead of schedule or in parallel to the vitrification of Silos 1 and 2 residues, the overall remediation schedule could possibly be shortened and the remediation costs reduced for OU4. However, it must be determined whether another technically feasible treatment method could be implemented in an equally protective and cost-effective manner.

Evaluation of Alternatives

In January 1996, the DOE sponsored an independent value engineering (VE) study that was broadly scoped to include the identification and evaluation of engineering opportunities that offered the potential for technical simplification, cost savings, and overall schedule improvements in the remediation of OU4 Silos 1, 2, and 3. One of the recommendations of the Value Engineering Study Report (DOE 1996) stated that alternative methods for the treatment and disposal of the Silo 3 residues should be considered as a means for potentially simplifying the OU4 remediation, shortening the remediation schedule and reducing remediation costs. This recommendation not only reaffirmed the merit of preliminary efforts initiated by DOE/FERMCO to investigate alternative treatment methods for Silo 3 residues, but also served as a vehicle to redirect resources and to accelerate this technical effort. In order to formally address this recommendation in a more structured forum, a joint multidisciplinary DOE/FERMCO team was assembled to objectively evaluate alternative Silo 3 residues remediation options. The Silo 3 Alternatives Evaluation Team focused on considering specific alternatives that were not only technically feasible (using conventional and proven treatment methods) and cost-effective, but offered improvement to the OU4 remediation schedule and were likely to be received favorably by the stakeholders.

The analyses presented in this report followed a two-stage process. First, an analysis of alternatives and their uncertainties were performed on those alternatives which were retained through the *Summary Screening Evaluation of Silo 3 Alternatives*, March 1996, (Appendix B). Second, a comparative analysis of the alternatives passing the screening analysis were conducted to develop the basis for determining the most appropriate alternative for treating the Silo 3 residues. The following

is a list of the five alternatives evaluated:

- VIT - Removal, Onsite Vitrification (with Silos 1 and 2), Off-site Disposal at the Nevada Test Site (NTS) (Baseline);
- ALT1 - Removal, Onsite Stabilization, Off-site Disposal at the NTS;
- ALT2 - Removal, Onsite Stabilization, Off-site Disposal at a Representative Permitted Commercial Disposal Facility (RPCDF);
- ALT3 - Removal, Off-site Stabilization and Disposal at a RPCDF; and
- ALT4 - Removal, Onsite Blending with OU1 Waste Pit 5 Material, Off-site Disposal at a RPCDF.

The detailed analysis of alternatives was performed on those alternatives which were retained through the initial screening study. The detailed and comparative analyses consisted of the analysis and presentation of the relevant information needed to allow decision makers to select the most appropriate remedial alternative. The objectives of the detailed/comparative analysis were: (1) to further define the reasonable alternatives that have been carried forward from the alternative screening phase of the CERCLA process; (2) to individually evaluate each alternative against the evaluation criteria as specified in EPA "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA 1988); and (3) to compare alternatives with each other to assess the relative performance of each alternative with respect to each evaluation criterion.

Nine evaluation criteria have been developed in the EPA guidance documents to address the CERCLA requirements as stated in the National Oil and Hazardous Substances Pollution Contingency Plan. Assessments against two of the criteria relate directly to evaluation against regulatory requirements and are categorized as threshold criteria. These two criteria are:

- Overall protection of human health and the environment; and
- Compliance with applicable or relevant and appropriate requirements (ARARs).

The following five criteria are grouped together because they represent the primary balancing criteria upon which the detailed analysis is based:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;

- Short-term effectiveness;
- Implementability; and
- Cost.

The final two criteria will not be evaluated until the regulatory process following the public comment period, because formal state and public comments will not be received until after this evaluation report has been issued for review. These modifying criteria are as follows:

- State acceptance; and
- Community acceptance.

Summary of Analysis

Table ES-1 presents a summary of the comparative analysis for the Silo 3 alternatives.

Overall Protection of Human Health and the Environment

All alternatives evaluated would meet the objective of providing overall protection of human health and the environment. With the exception of ALT4, all alternatives would be able to comply with all applicable or relevant and appropriate requirements (ARARs) and criteria to be considered.

Compliance with ARARs

Although Silo 3 residues are classified as Atomic Energy Act, Section 11(e)(2) byproduct material and are exempt from regulation under RCRA, RCRA requirements are identified as "relevant and appropriate" because Silo 3 residues exhibit the toxicity characteristic for RCRA metals. The relevance and appropriateness of RCRA requirements to the Silo 3 residues preclude the use of blending under ALT4 as a treatment option since RCRA does not recognize blending as a substitute for adequate treatment. In addition, implementation of ALT4 would not be consistent with CERCLA's preference for permanent and significant reduction of volume, toxicity, or mobility of the hazardous substances or contaminated materials. As a result, ALT4 was dropped from consideration as a viable remedial alternative.

Long-term Effectiveness and Permanence

VIT, ALT1, ALT2, and ALT3 would ensure long-term protection to human health and the environment by removing the residues from the silo, treating the residues by vitrification or stabilization, and disposing of the material off-site at either the NTS or a RPCDF.

TABLE ES-1

SILO 3 ALTERNATIVES - COMPARATIVE ANALYSIS

Alternative	Overall Protection of Human Health and Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Total Capital Cost (Millions)	Present Worth Cost (Millions)
VIT-Removal, Onsite Vitrification, Off-site Disposal at the NTS	Protective	Complies with all ARARs	Effective and most reliable	Reduces toxicity mobility and volume	Medium	Innovative Technology Moderately Difficult	$1.6[1]	$20.4[1]
ALT1-Removal, Onsite Stabilization, Off-site Disposal at the NTS	Protective	Complies with all ARARs	Effective and reliable	Reduces toxicity and mobility	Medium	Reliable Technology Easy[3]	$6.7	$18.8
ALT2-Removal, Onsite Stabilization, Off-site Disposal at a RPCDF	Protective	Complies with all ARARs	Effective and reliable	Reduces toxicity and mobility	Medium	Reliable Technology Moderately Easy[3]	$6.8	$17.1
ALT3-Removal, Off-site Stabilization and Disposal at a RPCDF	Protective	Complies with all ARARs	Effective and reliable	Reduces toxicity and mobility[2]	Medium	Reliable Technology Slightly Difficult[3]	$6.7	$19.5
ALT4-Removal, Onsite Blending with OU1 Waste Pit 5 Material, Off-site Disposal at a RPCDF	Protective	Does not meet all ARARs	NA[4]	NA[4]	NA[4]	NA[4]	NA[4]	NA[4]

[1]This cost represents the incremental cost of vitrifying the Silo 3 residues in addition to the Silos 1 and 2 residues by the Fernald Residues Vitrification Plant.
[2]ALT3 would reduce toxicity by treating Silo 3 residues at the RPCDF prior to final disposal.
[3]ALT1, ALT2, and ALT3 offer a significant schedule acceleration for the remediation of Silo 3 residues.
[4]"NA" means not analayzed.

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Reduction of Toxicity, Mobility or Volume Through Treatment

The toxicity characteristic is measured by the leachability of certain RCRA constituents (i.e., the ability of those constituents to percolate through solid material and potentially contaminate groundwater). By stabilizing or immobilizing the constituents through either vitrification or cementation, the leachability of the constituents can be reduced and the toxicity characteristic can be removed. Therefore, VIT, ALT1, ALT2, and ALT3 would remove the toxicity characteristic, reduce the toxicity associated with the material by reducing the mobility of the contaminants by either vitrification or stabilization. The vitrified form would be expected to have much greater durability over time than the stabilized form. In addition, the vitrified form would result in a reduction in volume of treated material relative to untreated material. Stabilized material would result in a volume increase of treated material relative to untreated material as a result of adding the stabilization and/or settling agents.

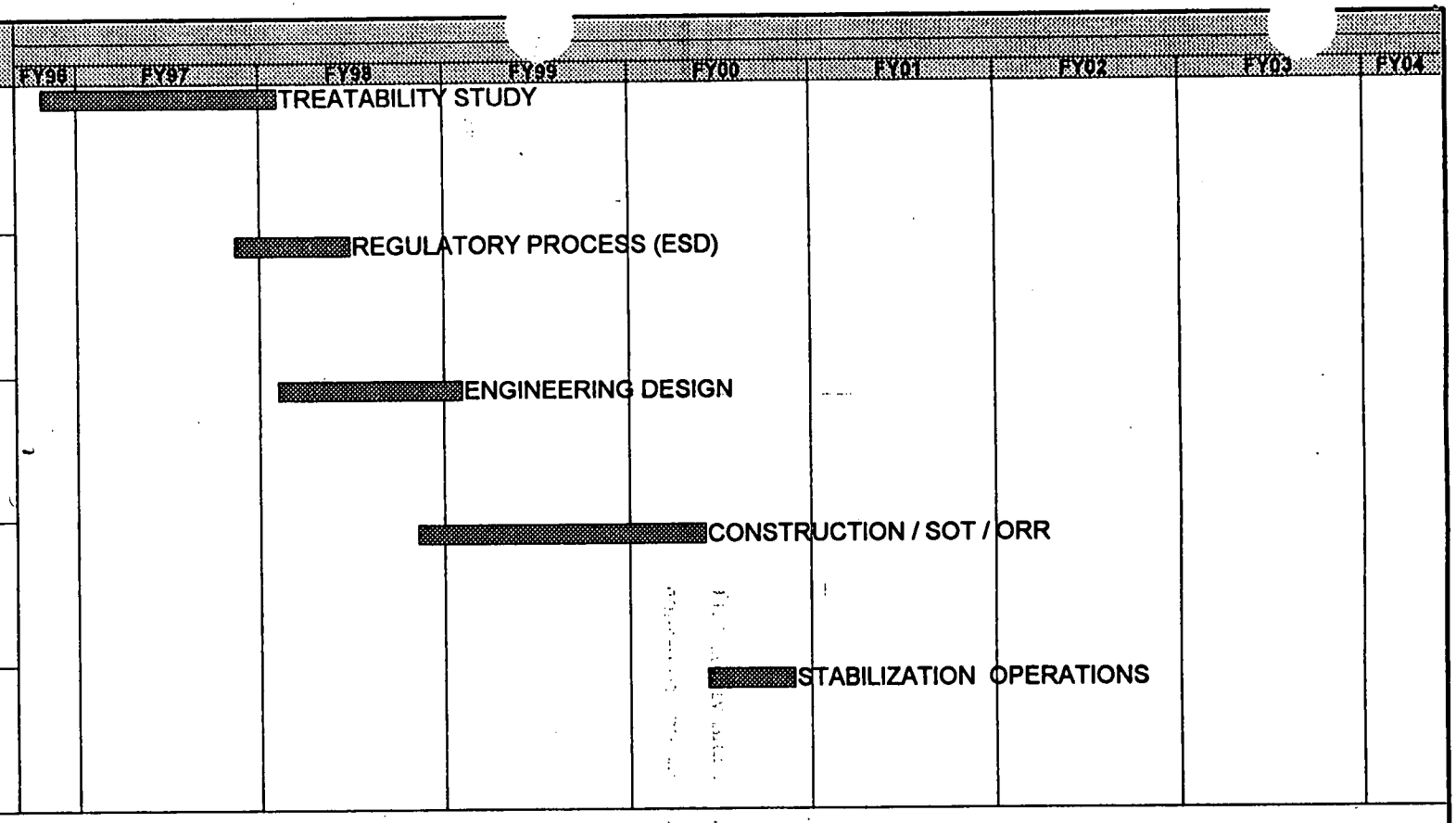
Short-term Effectiveness

ALT1, ALT2, and ALT3 provide more short-term impacts than VIT due to the increased volume of material that must be shipped, and in the case of ALT2 and ALT3, the more dispersible nature of the granular material being transported. ALT3 would have higher short-term risk due to transporting the more dispersible form of the Silo 3 residues; however, all alternatives would be within the accepted risk range under CERCLA.

Implementability

Two generic template schedules for the Silo 3 alternatives (ALT1, ALT2, ALT3) were evaluated in order to assess whether the proposed alternatives could be implemented on or before the vitrification operations baseline for the Silo 3 residues, potentially offering the ability to improve the OU4 remediation schedule. The more "traditional schedule" offered a "low-risk" approach to the implementation of the Silo 3 alternatives with nearly all activities having a sequential finish-to-start relationship with each other; however, the goal to improve the OU4 remedial operations baseline could only be marginally achieved under this approach. An "accelerated schedule" was also developed using the same activities and durations, but with several activities being performed in parallel. Under this scenario, the opportunity to achieve significant schedule improvements could readily be achieved on a more accelerated basis (see Figure ES-1).

Orig Dur	Early Start	Early Finish
327*	22JUL96*	06NOV97
157*	11AUG97*	27MAR98
250*	07NOV97*	06NOV98
390*	11AUG98*	03MAR00
122*	06MAR00*	25AUG00



NOTE: ACTUAL STABILIZATION OPERATIONS DURATION WILL VARY DEPENDING ON ALTERNATIVE

ALTERNATIVE	OPERATIONS DURATION (WORKDAYS)
ALT 1	90
ALT 2	208
ALT 3	122

Project Start	01OCT95	Early Bar	
Project Finish	11JUL02	Progress Bar	
Data Date	01OCT95	Critical Activity	
Plot Date	27JUN96		

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FIGURE ES-1
SILO 3 ALTERNATIVES
ACCELERATED SUMMARY SCHEDULE

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Each alternative (ALT1, ALT2, and ALT3) adjusted the activity durations of the "accelerated schedule" as appropriate, to form its own project-specific schedule.

The ALT1, ALT2, or ALT3 treatment alternatives could begin processing approximately 2 years prior to the current baseline schedule of VIT and complete operations approximately 3-1/2 years sooner. In addition, the vitrification process for Silos 1 and 2 would complete its mission approximately 9 months earlier without the Silo 3 residues. A schedule comparison is shown in Table ES-2.

TABLE ES-2

SILO 3 ALTERNATIVES SCHEDULE COMPARISON

Alternative	Start Design	Start Construction	Start Operations	Complete Operations
VIT without Silo 3	12/97	9/99	3/02	6/04
VIT with Silo 3	12/97	9/99	3/02	3/05
ALT1	11/97	2/99	3/00	7/00
ALT2	11/97	2/99	3/00	1/01
ALT3	11/97	2/99	3/00	8/00

Further acceleration of the Silo 3 remediation schedule may be possible through the application of innovative procurement strategies, but currently it remains unquantifiable due to the preliminary development of details.

Cost

Present worth costs associated with the three alternatives are less than VIT; however, due to the relative uncertainty of the cost estimate ($\pm$ 40 percent), no alternative offers a significant economic advantage over another. Because ALT1, ALT2, and ALT3 each require the design and construction of an additional facility (a vitrification plant will be built anyway to process Silos 1 and 2 residues) the initial capital costs would be approximately $5 million higher.

Summary

In summary, the results of the comparative analysis indicate that there is a significant margin of difference between the implementability of the alternatives evaluated compared to VIT. It appears that any of the stabilization/disposal alternatives ALT1, ALT2, or ALT3 would perform in a relatively equivalent manner to that of VIT. The significant conclusion that can be reasonably drawn from this evaluation is that there is an appreciable schedule advantage to be gained through the implementation of either alternative ALT1, ALT2, and ALT3, and create an overwhelming case to be readily chosen to supplant vitrification as the selected remedy for the Silo 3 residues. The stabilization alternatives evaluated in this study should be pursued as viable treatment and disposal alternatives to vitrification.

To date, there is limited test data supporting the ability to maintain vitrification process control, with formulas involving Silo 3 residues on a continuous basis. However, the VITPP Phase I and II Treatability Study Programs will eventually provide significant data in this area through the use of nonradioactive surrogates and actual Silo 3 residues, respectively. These testing campaigns will provide vital insight into the technical feasibility and economical viability of continuously processing (vitrifying) the Silo 3 residues. This information would definitively direct the path forward and if unsuccessful may in fact, provide additional technical justification in the future for modifying the selected remedy for the Silo 3 residues.

In order to support the parallel efforts (e.g., programmatic, technical, and administrative) to formally document the evaluation of the stabilization alternatives and to be in a proactive position to pursue the implementation process, the following specific actions are planned:

- Obtain regulatory, agency and stakeholder input to the draft final report;
- Initiate preparation of a draft ESD for regulatory approval;
- Continue with the VITPP Phase I and II treatability study testing program as currently scoped;
- Develop a procurement strategy for the Silo 3 alternatives;
- Retrieve additional residues from Silo 3 to support future vendor treatability study efforts; and
- Conduct a treatability study to verify the responsive low bidder's stabilization process.

Proceeding with this remedial management strategy would assure that stakeholder interests and concerns would continued to be factored into the final decision for selection of the path forward for the remediation of Silo 3 residues. Although this approach would ultimately result in some data which will not be used in actual processing, the systematic development of this data would enhance the ability to achieve the objective of an accelerated remediation schedule.