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SILO PROJECT INDEPENDENT REVIEW TEAM DOCUMENTATION - OPERABLE UNIT 4 VITRIFICATION PILOT PLANT PHASE I TREATABILITY STUDY WORK PLAN

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WORK PLAN

OPERABLE UNIT 4 VITRIFICATION PILOT PLANT PHASE I TREATABILITY STUDY WORK PLAN

Revision 2
WP-25-0007

Fernald Environmental Management Project
Fernald, Ohio

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June 1996

U.S. DEPARTMENT OF ENERGY
Fernald Area Office

Fernald Environmental Management Project
Fernald, Ohio

OPERABLE UNIT 4

VITRIFICATION PILOT PLANT PHASE I

TREATABILITY STUDY WORK PLAN

Revision 2
WP-25-0007

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U. S. Department of Energy
Fernald Area Office

OU4-VPPI-WP-REV 2
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OPERABLE UNIT 4
VITRIFICATION PILOT PLANT PHASE I
TREATABILITY STUDY WORK PLAN

Revision 2
WP-25-0007

APPROVED FOR ISSUE

David Paine 6/14/96

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Vitrification Pilot Plant Project Manager

OPERABLE UNIT 4
VITRIFICATION PILOT PLANT PHASE I
TREATABILITY STUDY WORK PLAN

Revision 2
WP-25-0007

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LIST OF ACRONYMS

ACA	Amended Consent Agreement
ACOE	United States Army Corps of Engineers
ARARS	Applicable or Relevant and Appropriate Requirements
ASL	Analytical Support Level
AWWT	Advanced Wastewater Treatment
BAT	Best Available Technology
BDAT	Best Demonstrated Available Technology
BMP	Best Management Practices
CAT	Construction Acceptance Testing
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CRU4	CERCLA/RCRA Unit 4
CWID	Construction Waste Identification/Disposition
CX	Categorical Exclusion
DOE	United States Department of Energy
DOE-FN	Department of Energy Fernald Field Office
DQO	Data Quality Objective
EP	Extraction Procedure
EPA	United States Environmental Protection Agency
ERMC	Environmental Restoration Management Contractor
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FFCA	Federal Facilities Compliance Agreement
FHAR	Final Hazard Analysis Report
FRESH	Fernald Residents for Environmental Safety and Health
FRVP	Fernald Residues Vitrification Plant
FS	Feasibility Study
FSAR	Final Safety Analysis Report

HAZOP	Hazard and Operability Analysis
HEPA	High Efficiency Particulate Air
LLRW	Low Level Radioactive Waste
MEF	Material Evaluation Form
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTS	Nevada Test Site
NWP	Nationwide Permit
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
OU4	Operable Unit 4
PCT	Product Consistency Test
PNL	Pacific Northwest Laboratory
PP	Proposed Plan
PPE	Personal Protective Equipment
PSAR	Preliminary Safety Analysis Report
PWID	Project Waste Identification and Disposition
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RI/FS	Remedial Investigation/Feasibility Study
RI	Remedial Investigation
ROD	Record of Decision

RSE	Removal Site Evaluation
RTS	Radon Treatment System
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SCR	Silicon Control Rectifier
SOT	Systems Operability Testing
TBC	To Be Considered
TBD	To Be Determined
TC	Toxicity Characteristic
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
VITPP	Vitrification Pilot Plant
VOA	Volatile Organic Analyses
VSL	Vitreous State Laboratory
WBS	Work Breakdown Structure
WMCO	Westinghouse Materials Company of Ohio

LIST OF WEIGHTS AND MEASURES

cfm	cubic feet per minute
Ci	curie
cm	centimeter
d	day
ft^3	cubic feet
gpm	gallons per minute
ha	hectares
in	inch
g	gram
kg	kilogram
km	kilometer
lb	pound
Lpm	liters per minute
m^3	cubic meter
mi	mile
pCi	picocurie
ppm	parts per million
wt	weight
hr	hour
$pCi/m^2 - s$	picocuries per square meter - second

LIST OF CHEMICAL SYMBOLS

B	Boron
Ba	Barium
C	Carbon
Cr	Chromium
K	Potassium
Li	Lithium
Na	Sodium
Pb	Lead
Po	Polonium
Ra	Radium
Rn	Radon
Si	Silicon
Th	Thorium
U	Uranium

LIST OF ISOTOPES OF INTEREST OR CONCERN

Ra-226	Radium-226
Pb-210	Lead-210
Th-230	Thorium-230
Po-210	Polonium-210
U-234	Uranium-234
U-235	Uranium-235
U-236	Uranium-236
U-238	Uranium-238
Th-228	Thorium-228
Th-232	Thorium-232
Rn-222	Radon-222
Rn-220	Radon-220

1.0 PROJECT DESCRIPTION

1.1 SITE LOCATION, DESCRIPTION AND HISTORY

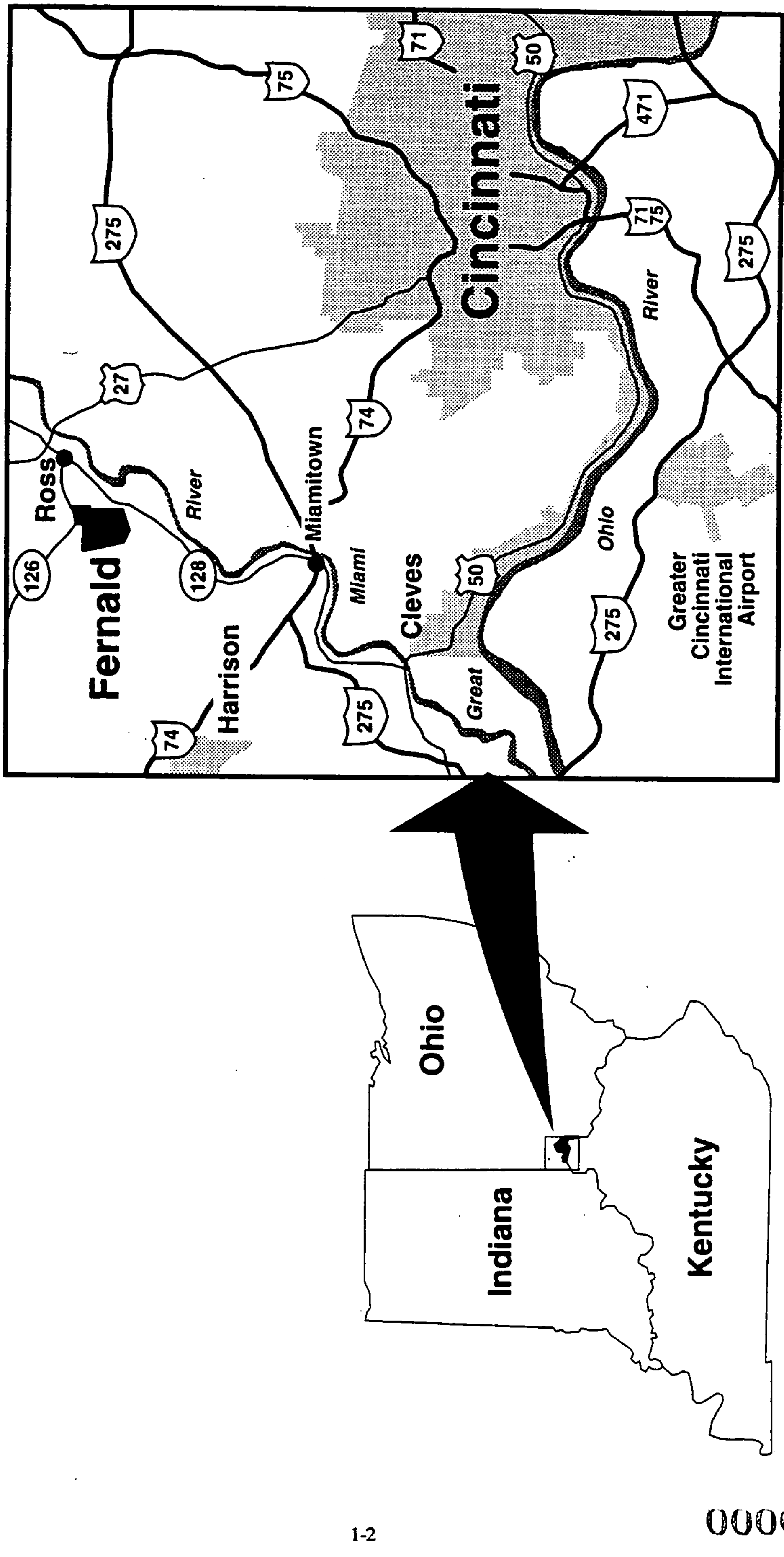
The Fernald Environmental Management Project (FEMP) site is a 425-hectare (1050-acre) facility located just north of Fernald, Ohio, a small farming community, and lies on the boundary between Hamilton and Butler Counties. Of the total site area, 345 hectares (850 acres) are in Crosby Township of Hamilton County, and 80 hectares (200 acres) are in Ross and Morgan Townships of Butler County. Other nearby communities include Shandon, New Baltimore, Ross, and Harrison (see Figure 1-1). Production operations at the facility were limited to a fenced 55-hectare (136-acre) tract of land, now known as the former Production Area, located near the center of the site. The FEMP's primary mission was to process uranium into metallic "feed" materials for other United States Department of Energy (DOE) facilities for use in the nation's defense program.

Prior to 1984, solid and slurried materials from uranium processing were stored or disposed in the on-site Waste Storage Area, which is located west of the former Production Area. Operable Unit 4, on which this phase of the FEMP remediation is focused, is situated in the southwestern portion of the Waste Storage Area, occupying an area of approximately 2 hectares (5 acres) (see Figure 1-2). Operable Unit 4 consists of two earthen-bermed, concrete silos containing K-65 residues; a decant sump tank; one silo containing cold metal oxides; one unused silo; and various quantities of contaminated soils and debris.

Briefly stated, the Operable Unit 4 site history dates back to the early 1950s, when the silos were constructed and filled with residues for storage. These residues were generated from the process of extracting uranium from high grade uranium ores and concentrates in support of national defense programs. These residues are classified as by-product materials consistent with Section 11(e)2 of the Atomic Energy Act (AEA). Facilities and equipment associated with this placement, storage, and continued maintenance of these materials include a decant sump tank, radon treatment system (RTS), various concrete pads, and miscellaneous piping and appurtenances. In 1991, a bentonite clay layer was added over the residues in Silos 1 and 2 to reduce chronic radon emanation from both silos. In addition, an Expedited Removal Action was completed in January 1992, when an out-of-service dust collector and hopper assembly were removed from the dome of Silo 3. Minor facility modifications (i.e., equipment upgrades) have also been carried out in recent years to enhance radon monitoring capabilities, stormwater runoff controls, and decant sump tank maintenance activities.

FIGURE 1-1

FERNALD AND VICINITY



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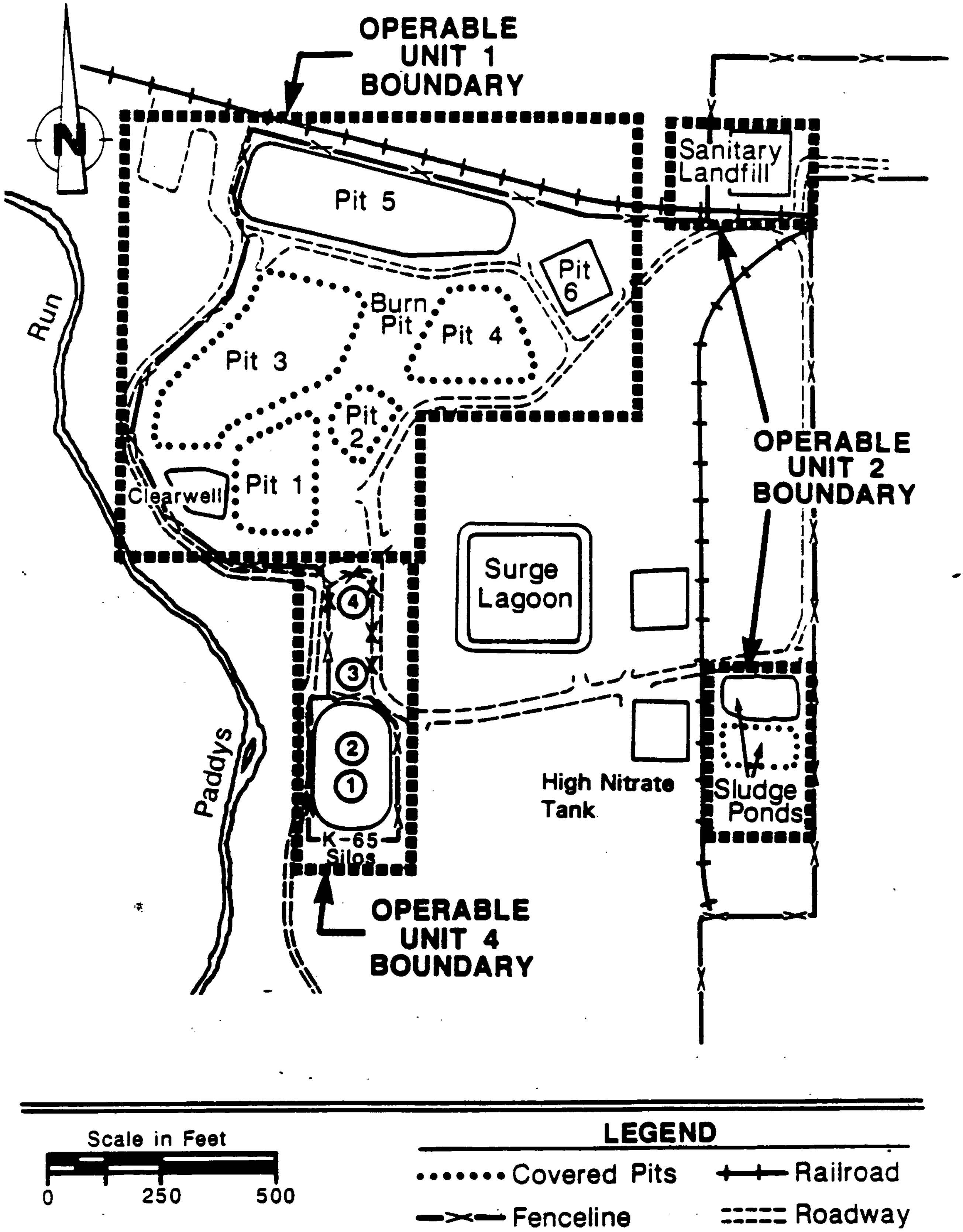

FIGURE 1-2 WASTE STORAGE AREA

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1.2 CURRENT SITE STATUS

In July 1986, the DOE and the United States Environmental Protection Agency (EPA) signed a Federal Facilities Compliance Agreement (FFCA), addressing impacts to the environment associated with federally operated sites, including the FEMP. The DOE agreed to conduct the FFCA investigation as a Remedial Investigation/Feasibility Study (RI/FS) in accordance with CERCLA guidelines. In November 1989, the FEMP site was included on the National Priorities List (NPL) of the EPA. The FFCA was later amended by the June 1990 Consent Agreement between DOE and EPA, and the Consent Agreement was further modified by amendment in September 1991.

In accordance with the Amended Consent Agreement (EPA 1991), the DOE submitted to EPA a Draft Remedial Investigation (RI) Report for Operable Unit 4 in April 1993, which was later submitted as a Draft Final and then as a Final Report in August 1993 and November 1993, respectively. (See DOE 1993c.) Final approval of the Final RI Report for Operable Unit 4 was received in August 1994. Likewise, a Draft Feasibility Study (FS) Report and Proposed Plan (PP) for Remedial Actions at Operable Unit 4 were submitted to the EPA in September 1993. Subsequent Draft Final and Final documents were submitted to the agency in December 1993 and February 1994, respectively. (See references DOE 1994a and 1994b.) Final EPA approval of the Final FS Report and PP for Operable Unit 4 was received in August 1994.

The Final Record of Decision (ROD) for Remedial Actions at Operable Unit 4 was submitted to the EPA in November 1994. The EPA approved and signed the Final ROD for Remedial Actions at Operable Unit 4 on December 7, 1994 (DOE 1994c). On February 29, 1996, the DOE awarded the first construction package for the remediation of Operable Unit 4.

Remediation of OU4 components will be accomplished as distinct elements by separate projects that address specific work scopes. The Fernald Residues Vitrification Plant (FRVP) Project will remediate the contents of Silos 1, 2, and 3 and the decant sump tank. The Facilities Decontamination and Demolition (D&D) Project will remediate all existing aboveground structures and future remedial action facilities. The Soil Remediation Project will remediate all contaminated soils and all structures at or below grade, including foundations, roadways, underground piping and underground utility systems. The Aquifer Restoration Project will remediate any contaminated water, including perched water, groundwater, the Great Miami Aquifer, and surface water. Remediation of OU4 will address all of these items as well as any contaminated soils within the OU4 geographic boundary and any contaminated perched water encountered while conducting OU4 remedial activities.

1.3 REMEDIAL ALTERNATIVE DESCRIPTION

Several remediation technologies were considered for OU4. These alternatives were fully developed, evaluated and compared in the Operable Unit 4 Feasibility Study/Proposed Plan - Environmental Impact Statement (DOE 1994b).

The following remedial alternatives for Silos 1, 2, and 3 residues were later approved as the selected remedy in the OU4 ROD (DOE 1994c).

1.3.1 Alternative 3A.1 - Removal, Stabilization and Off-Site Disposal

This alternative involves the removal of the Silos 1 and 2 contents, the stabilization of the contents by vitrification, and the off-site disposal of the stabilized wastes. The wastes would be transported to the disposal facility by truck.

1.3.2 Alternative 3B.1 - Removal, Stabilization and Off-Site Disposal

This alternative requires the removal of the Silo 3 contents, the stabilization of the contents by vitrification, and the off-site disposal of the stabilized wastes. The wastes would be transported to the disposal facility by truck.

1.3.3 Vitrification Pilot Plant Treatability Study

The EPA-approved work plan for the Operable Unit 4 Remedial Design (DOE 1995b) detailed a remedial management strategy for Operable Unit 4 which utilizes a phased approach to accomplish the remedial design and remedial action activities. One of the integral parts of the approach is the manner in which the Pilot Plant Phases I and II Treatability Study Program is integrated directly into the remedial design schedule.

Phase I of the Vitrification Pilot Plant (VITPP) program includes demonstrating the technology for the following processes:

- Feed preparation
- Vitrification of surrogate Silos 1, 2 and 3 material
- Off-gas control and treatment

This technology will then be applied to the Phase II VITPP program to demonstrate processing of actual silo material.

- Hydraulic removal of the material from Silo 2
- Pneumatic removal of the material from Silo 3
- Vitrification of the material from Silos 2 and 3
- Off-gas control and radon treatment

The vitrification technology consists of heating the residues to sufficient temperatures to induce the formation of a glass-like material. The resulting vitreous solid would have a reduced volume. The mobility (leachability) of the constituents of concern in the K-65 and Silo 3 residues would be greatly reduced, and the stabilized waste form would have a greatly reduced radon emanation rate. The vitrified material would be well suited for long-term disposal.

1.4 OVERVIEW OF THE VITRIFICATION PILOT PLANT PROGRAM

1.4.1 Purpose of the Vitrification Pilot Plant Program

The FRVP Project personnel and FEMP supporting departments are currently preparing for the third tier of the EPA-outlined approach for conducting treatability studies at a Superfund site (see Section 1.6). Although the FEMP is not using Superfund monies, this approach is applicable to the VITPP program. The third tier [Remedial Design/Remedial Action (RD/RA) Treatability] consists of the design, construction, and operation of a one metric ton (1.1 ton) per day pilot scale facility for vitrification of K-65, BentoGrout®, and Silo 3 material. This third tier of treatability testing will be conducted in phases.

Phase I of the VITPP program will process newly purchased BentoGrout® and surrogate materials in the pilot-scale facility to demonstrate vitrification technologies. Phase II, which follows Phase I, will use BentoGrout®, K-65, and Silo 3 materials which will be retrieved from the silos. A separate work plan is being developed for Phase II. Phase II also addresses the treatment of radon gas since materials bearing radon and radium will be processed. The results of this third tier treatability testing will be used to develop the design of facilities and equipment for the final remediation of Operable Unit 4.

Phase I is the proving stage for the equipment, process, and methodology in the pilot vitrification facility. Operations will initially use a benign borosilicate glass for melter startup and will then use a nonradioactive surrogate material consisting of silty sands, BentoGrout®, water, and nonradioactive additives to simulate the other major constituents of the silo residues. This includes lead, barium, sulfate, nitrate and phosphate compounds. Four campaigns are planned during Phase I testing. Starting with Campaign #2, lead, barium, sulfates, nitrates, and phosphates will be added to the surrogate material to more closely simulate K-65 material. Thickener operation will not be introduced until Campaign #4. The number and order of the campaigns may be revised based on the results of tests recently conducted at The Catholic University of America Vitreous State Laboratory (VSL) or the results of VITPP Phase I testing as it progresses. The duration of the Phase I testing is currently estimated at four to five months.

The vitrification facility is designed for a production rate of one metric ton (1.1 ton) per day of product. It is anticipated that Phase I will require approximately 87 metric tons (95 tons) of nonradioactive surrogate material to adequately demonstrate vitrification.

The following is a list of the major activities included in the scope of Phase I:

- Pilot-scale vitrification facility construction
- Loading surrogate material into the thickener or slurry tanks
- Operation of the vitrification melter with benign borosilicate glass
- Operation of the vitrification facility with surrogate materials

Phase II of pilot scale testing for vitrification will be implemented in the vitrification facility constructed for Phase I. Lessons learned during Phase I on the process, administrative and engineering control, and equipment operation will be incorporated into Phase II and the FRVP design. The Phase I design was developed for the use of actual K-65 and Silo 3 material; therefore, the facility should require at most minimal modification for Phase II operations.

In addition to the hydraulic removal of actual K-65 material and the pneumatic removal of material from Silo 3 (both to be used for Phase II vitrification), Phase II will demonstrate radon control for the Silos 1 and 2 headspace gas. Radon control and off-gas treatment for the vitrification facility will be performed by a treatment system separate from the vitrification system.

When identified in the Operable Unit 4 Vitrification Pilot Plant Phase II Test Plan (FERMCO 1995a), Silo 3 material will be mixed with K-65 material at a predetermined ratio and then vitrified. Glass formulations recently developed and optimized will be tested and further optimized (if required) during this phase of pilot-scale testing. In addition to several process sampling points, the final glass product will be sampled and tested to ensure that it meets the process acceptance criteria to be addressed in the Phase II Work Plan. The following is a list of the major activities to be included in the scope of Phase II:

- K-65 Silo Radon Treatment System (RTS) upgrade
- Vitrification facility modification (as required)
- Hydraulic retrieval of K-65 material
- Pneumatic retrieval of Silo 3 material
- Operation of the vitrification facility using actual K-65 material and Silo 3 material
- Treatment of process off-gases
- Demonstration of waste packaging for shipment and disposal at the Nevada Test Site (NTS)

Information obtained from the Phase I and II VITPP program will be used to generate quantitative performance data and to further refine the cost estimate for full-scale remediation.

1.4.2 Forecast Schedule

Figure 1-3 presents the forecast schedule for the VITPP Phase I and Phase II treatability study program. The schedule is driven by the RD/RA schedules that are incorporated in the Amended Consent Agreement (ACA). The schedule displays DOE-approved forecast dates for the VITPP program. Start dates for several activities are shown as October 2, 1995, but were actually much earlier. This is because the project was rebaselined as of October 2, 1995, and previous activities were deleted from the schedule. Actual start dates were as follows: Phase I Pilot Plant Startup/Training (June 1995), Pilot Plant Phase I Construction (July 1994), and Pilot Plant Phase I SOT Procedures (April 1994).

1.4.3 Organization of the Work Plan

This work plan describes Phase I of the VITPP program. It is organized in accordance with EPA guidance (EPA 1992). In addition to the EPA-suggested sections, a discussion of the regulatory requirements governing construction and operation of the VITPP, including a permit information summary for VITPP Phase I, is included.

This VITPP Phase I work plan describes system operability testing and the initial use of nonradioactive surrogate material as a substitute for the silo material for testing the vitrification processing equipment prior to the introduction of radioactive materials during VITPP Phase II. The VITPP Phase II work plan will address the implementation actions required for the hydraulic removal of the K-65 material from Silo 2, the pneumatic removal of the material from Silo 3, and vitrification of the actual K-65 and metal oxide material.

Activity description	Start	Finish
PILOT PLANT PHASE I		
PHASE I PILOT PLANT STARTUP/TRAINING	02OCT95	28FEB96
PILOT PLANT PHASE I CONSTRUCTION	02OCT95	24JAN96
PILOT PLANT PHASE I SOT PROCEDURES	02OCT95	25JAN96
READINESS ASSESSMENT	08FEB96	28FEB96
BAKE-OUT OF MELTER	29FEB96	20MAR96
PHASE 1 PILOT OPERATIONS	21MAR96	09JAN97
PILOT PLANT PHASE II		
PHASE II CONSTRUCTION - PART A	21NOV95*	08MAY96
PHASE II CONSTRUCTION - PART B (OFF-GAS LINE REP	06FEB96	03FEB97
PILOT PLANT PHASE II ORR PREPARATION	21MAR96	03FEB97
PHASE II TRAINING	21MAR96*	15APR97
PHASE II WORK PLAN	01OCT96*	28FEB97
PILOT PLANT PHASE II SOT PROCEDURES	01OCT96*	01APR97
MELTER HOT STANDBY	10JAN97	23JUL97
OPERATIONAL READINESS REVIEW (FERMCO)	16APR97	12MAY97
OPERATIONAL READINESS REVIEW (DOE-FN)	13MAY97	12JUN97
PHASE 2 PILOT OPERATIONS	24JUL97	21OCT97
PHASE II TEST REPORT	22OCT97	19NOV97

Timescale: FY96, FY97, FY98 (J A S O N D J F M A M J)

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Project Start	01OCT95	Early Bar	FRVP
Project Finish	24JUL06	Progress Bar	
Data Date	[illegible]5	Critical Activity	

FERNALD RESIDUES VITRIFICATION PROJ

PI[illegible]T PLANT

Sheet 1 of 1

Fernald Environmental

1.5 PREVIOUS VITRIFICATION STUDIES

The OU4 RD/RA Treatability Study for vitrification of the silo materials is being conducted based on encouraging results from previous laboratory and bench-scale testing. The following sections summarize these results.

1.5.1 Laboratory Testing by PNL in 1991

In February 1991, Westinghouse Materials Company of Ohio (WMCO) submitted the results of FEMP K-65 residue vitrification tests in the Treatability Study Report, "Characteristics of Fernald's K-65 Residue Before, During, and After Vitrification" (Chapman and Janke 1991). The following, which is extracted from that report, details the background for conducting the vitrification tests as well as several key findings and test results:

". . . Vitrification of radioactive and hazardous wastes has been under thorough investigation since the mid-1950s. During the high-level waste development program, the U.S. Department of Energy accumulated over 40 years of operating experience with the vitrification process (Chapman and McElroy, 1989). Vitrification has endured international scrutiny and is the preferred international treatment method for the most radioactive and hazardous high-level radioactive wastes (DOE/RL-90-27). Other compelling factors support the use of vitrification for treating many types of hazardous and radioactive wastes:

- *The EPA has promulgated vitrification as the treatment standard {i.e., best demonstrated available technology (BDAT)} for high-level radioactive mixed waste (Federal Register, June 1, 1991), and a BDAT for arsenic-containing hazardous wastes (Federal Register, ca. May, 1990).*

- *The glass, formed with, at most, minor chemical additions to the waste, generally tests by the Toxicity Characteristic Leachate Procedure (TCLP) or by the Extraction Procedure (EP) toxicity criteria as nonhazardous.*

- *Volume reduction for solids is typically greater than 60 percent."*

"In a vitrified matrix, the diffusion of gases with atomic radii equal to or greater than krypton (1.03 angstrom) and xenon (1.24 angstrom), such as radon (1.34 angstrom), is nil. Thus, once vitrified, release of radon from the residue will be limited to the modest amount of externally exposed surface area. It has been found that volcanic glass has the highest radon retention ability of the 59 rock samples

studied. Based upon these favorable processing and product characteristics, vitrification of the K-65 residue is an environmentally progressive and technically sound option for treating this material."

"For the work reported in February 1991, Pacific Northwest Laboratory (PNL) received approximately 15 lbs (7 kg) of the K-65 residue from Silo 1 for vitrification tests. The objectives of the tests were to determine the quantity and composition of off-gas evolved during vitrification, the radon emanation rate from both the original K-65 residue and the vitrified product, and the leachability of the vitrified material.

- *Vitrified K-65 residue (Specific Gravity = 3.1) has a volume that is 35 percent of dried, tamped K-65 residue (Specific Gravity = 1.06), a 65 percent volume reduction.*

- *The radon emanation flux from the K-65 residue was reduced by more than 33,000 times when vitrified. The flux from the original material was measured to be 1.5 million pCi/hr or 52,400 pCi/m^2-S, while glass was 48 pCi/hr or 1.56 pCi/m^2-S (an order of magnitude below the EPA limit of 20 pCi/m^2-S). We predict that during full-scale processing, the flux may be further reduced by a total factor of up to 90,000 to 2,400,000 because the test crucible had both unmelted material and a coat of glass on the crucible walls. Therefore, the actual surface area exceeded the assumed surface area by a factor of more than 3.*

- *The off-gas data indicate that for the chemicals present, 99.5 percent to 99.95 percent is retained in the glass. This is typical of results obtained during thousands of hours of melter testing with simulated high-level radioactive waste slurries.*

- *As measured by the TCLP, the vitrified K-65 residue tests as nonhazardous. The two TCLP heavy metals present in the glass were barium at 4.4 wt% and lead at 9.9 wt%. The leachate concentrations were 0.98 ppm and 0.3 ppm for barium and lead, respectively, which is well below the limits of 100 and 5 ppm for barium and lead. Results from EP toxicity tests for this (untreated) K-65 residue show a leachate concentration of 0.76 and 630 ppm for barium and lead, respectively. Thus, the vitrified product improved the leach resistance for lead by a factor of over 2000.*

- *The vitrified product is so durable that it could not be dissolved in a hot mixture of concentrated nitric and hydrofluoric acid by Controls for Environmental Pollution (CEP), Inc., during their analyses of the glass."*

The TCLP leachate results from the previous laboratory test for the vitrified K-65 waste are presented in Figure 1-4. The results are well below the established TCLP limits.

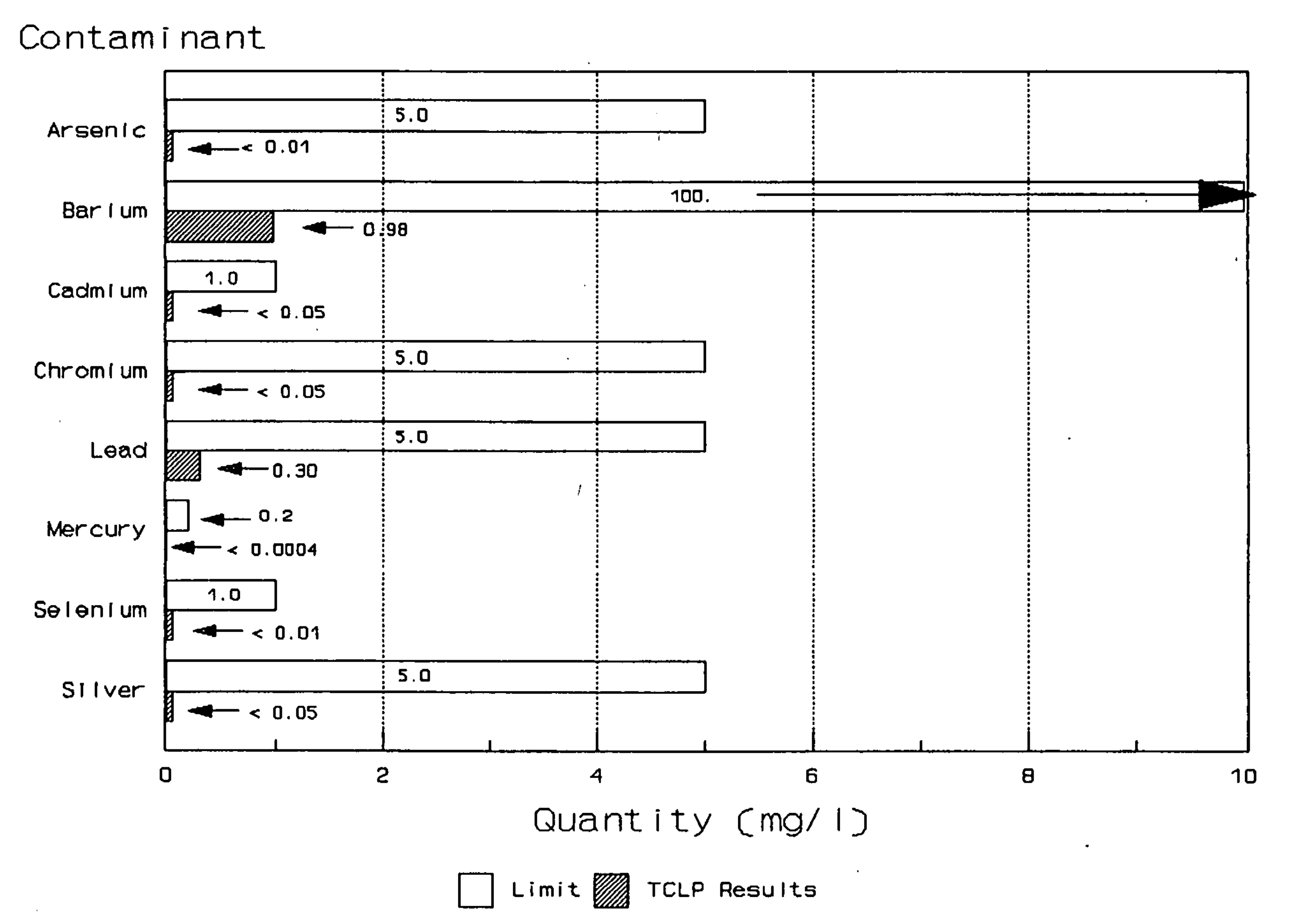


FIGURE 1-4

1991 Laboratory Vitrification Testing TCLP Leachate Results for Vitrified K-65 Material: Concentration of Metals in Leachate

1.5.2 Treatability Study for the Vitrification of Residues from Silos 1, 2, and 3

As indicated in Section 1.5.1, preliminary vitrification tests for the K-65 material yielded promising results. This supported the development of a more comprehensive vitrification treatability study program for the treatment of all OU4 silo materials. The objective of this subsequent vitrification treatability testing (bench-scale), as described in the EPA-approved (April, 1992) work plan (DOE 1992), was to provide data to allow comparison of vitrification to other remediation treatment technologies based upon the following criteria:

- Leachability of the final product
- Reduction in volume achieved through processing
- Reduction in radon emanation from the waste material

Physical and chemical characterization of the silo material was performed to evaluate vitrification performance. Initial laboratory screening melts were conducted to investigate different glass formulations. Bench-scale melts were then performed. For this, glass formulations were developed for four different mixtures of the K-65, Silo 3, and BentoGrout® material. A vitrified product was tested in duplicate for each of these mixtures. Table 1-1 presents a summary of the vitrification tests that were included in the OU4 Bench-Scale Treatability Testing program. The study results, which were reported in 1993 (DOE 1993a), included the following findings:

- *"The measured radon emanation rate from the glass is approximately equal to the emanation rate from natural building materials such as brick and concrete, even though the radium content of the waste glass is 10^3 to 10^6 times greater than that of natural building materials. A reduction in the radon emanation of about 500,000 times was obtained in the bench-scale vitrification tests."*

- *"Essentially all of the radon initially present in the sample is released during vitrification, providing an upper bound to the expected radon concentration in the off-gas from the vitrification system."*

- *"The final glass product (density from 2.7 to 2.9 g/cm^3) has a volume of about 32 percent to 50 percent of the initial waste volume, representing a volume reduction of 50 percent to 68 percent."*

- *"The PCT results show the durability of the glasses from all four sequences to be comparable to the durability of glasses developed for high-level waste. The normalized leach rates for the elements considered (K, Na, Si, Li, B, U, Th, Ra-226) ranged from 0.0002 to 0.09 g/m^2/d. Leaching of radium-226 was one to two orders of magnitude less than the leaching of the major constituents of the glass."*

TABLE 1-1

Summary of Vitrification Tests for OU4 Bench-Scale Treatability Testing

SEQUENCE	TEST*	TYPE OF MATERIAL	APPROX. AMOUNT OF MATERIAL	DESCRIPTION
0		K-65 Silo 3 BentoGrout	As required	Small melts of approx. 100 to 150 grams each to develop glass formulations for the Sequence A through D tests and to test the system and operating procedures.
A	Open	K-65	1.0 kg	K-65 material and glass forming reagents as determined in the Sequence 0 tests. Radon concentration monitored in the off-gas stream.
A	Closed	K-65	1.0 kg	Duplicate of open system test. Off-gas collected for analysis.
B	Open	K-65 BentoGrout	0.5 kg 0.5 kg	K-65 material, BentoGrout, and glass forming reagents as determined in the Sequence 0 tests. Radon concentration monitored in the off-gas stream.
B	Closed	K-65 BentoGrout	0.5 kg 0.5 kg	Duplicate of open system test. Off-gas collected for analysis.
C	Open	Silo 3	1.0 kg	Silo 3 material and glass forming reagents as determined in the Sequence 0 tests.
C	Closed	Silo 3	1.0 kg	Duplicate of open system test. Off-gas collected for analysis.
D	Open	K-65 Silo 3	0.7 kg 0.3 kg	K-65/Silo 3 material and glass forming reagents as determined in the Sequence 0 tests. Radon concentration monitored in the off-gas stream.
D	Closed	K-65 Silo 3	0.7 kg 0.3 kg	Duplicate of open system test. Off-gas collected for analysis.

*Open and closed refers to off-gas system configuration

- *"The vitrified residue from all sequences tested nonhazardous as measured by the TCLP. Previous testing found the untreated K-65 and Silo 3 materials to test hazardous for several metals (lead for K-65; arsenic, cadmium, chromium, and selenium for Silo 3). Lead concentrations in the leachate from the glass were reduced several hundred times relative to the untreated K-65 material, while for the Silo 3 material, arsenic was reduced about 100 times, and cadmium, chromium, and selenium were reduced to less than or near less than detection limits."*

- *"The fractional release of radionuclides from the glass was similar to that of the major constituents of the glass, indicating that selective leaching of radionuclides did not occur."*

Some of the report's recommendations follow:

- *"Appropriate glass formulations should be developed and acceptable limits of material variability of the waste determined."*

- *"Small-scale tests of systems for removal of radon from the off-gas stream are needed to provide data for designing a radon control system for processing operations."*

- *"Pilot-scale testing in a continuous melter should be carried out to validate the glass formulations developed in crucible melts and to provide data necessary for sizing and design of the full-scale system."*

Appropriate glass formulations have been developed under an OU4 glass development project. A radon adsorption experiment utilizing granular activated carbon was conducted at Rust Geotech Laboratory. This test indicated that the VITPP design should achieve about 85% removal of radon in the off-gas stream under the conditions studied. This VITPP program addresses the third item.

1.5.3 Glass Development Program

The scope of work for the bench-scale treatability study performed at Battelle's Pacific Northwest Laboratories for vitrification of residues from Silos 1, 2, and 3 addressed the basic glass development work. These bench-scale results were very promising; however, further development of the glass formulation was deemed necessary prior to conducting pilot-scale testing. This work has been done at the VSL. The VSL facility and staff, which are part of The Catholic University of America, provide technical support to GTS Duratek. The VSL work has been completed well in advance of the Phase I test campaigns that are discussed in Section 4.0. Optimization of glass formulations reduces risk and will improve the VITPP operational performance.

Optimization addresses formulating a glass that has acceptable leaching characteristics, durability, viscosity, electrical conductivity, and phase stability properties. The optimization studies also determined an acceptable range of additives to respond to the variability in the waste composition at the lowest practical melter temperatures. Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leachate Procedure (TCLP) results for metals are now being obtained for the optimized formulation, and processability and robustness will be the basis for defining the operating envelope for the VITPP tests.

1.5.3.1 Battelle - Pacific Northwest Laboratory Development Program

Glass formulations were developed in conjunction with glass scientists at PNL using data from the previous bench-scale melts performed as part of the treatability study testing with a reference waste composition material. This study consisted of a screening phase and a formulation optimization phase. During the screening tests, 100-gram (0.22-pound) test melts were performed with several different glass formulations. The criteria for determining the optimum formulation were based on the TCLP results of the reference glass, processability, phase stability and the ability to handle variation in the waste feed composition. The formulation chosen from these screening tests was quantitatively studied during optimization of the formulation.

Optimization of the chosen formulation was accomplished through a statistically designed series of tests over a range of credible waste stream compositions. These melts included testing with simulants and testing with the actual waste material. The correlation of TCLP for the glass product and of viscosity and electrical conductivity of the molten material to waste variations was quantitatively determined, and acceptable limits for variability in the waste stream were defined.

1.5.3.2 GTS Duratek/Vitreous State Laboratory Development Program

The PNL work was done in crucible melters. The resulting preferred formulations require melt temperatures that are on the edge or outside the range of most commercial melters that are available for this application. Translation of crucible melt data to continuous melt requirements is a large step that includes some inherent uncertainties. The VSL work for GTS Duratek bridges this gap and focuses on determining what formulation adjustments are necessary to reduce the operating temperature and to avoid other undesirable characteristics such as foaming. The VSL work includes both crucible melts and continuous melting in a minimelter whose design includes the three-chamber approach and several other design features of the GTS Duratek HT-1000 melter which was purchased for the VITPP program.

The VITPP melter is a joule-heated, continuous melter that includes a three-chamber design to attain the specified operating temperature while addressing the problem of corrosion and erosion of the melter at high temperatures. Scaleup of this design would result in a first-of-a-kind production unit. One prime objective of the VSL work was to develop operating techniques and to customize the glass formulations for operation of the VITPP melter between 1050°C and 1350°C with a target of 1250°C. Nonradioactive feed materials that simulated K-65, Silo 3, and BentoGrout® in various combinations were included in the test program. The data from this work will be used to finalize the formulations that will be tested in the VITPP test campaigns. The vitrification work has been completed, and preparation of the report was in progress as of this writing.

1.6 EPA TREATABILITY STUDY GUIDANCE

According to EPA guidance on conducting Treatability Studies, as many as three tiers of treatability testing may be required to provide critical data needed to evaluate and supplement remedial treatment technologies. The three tiers of testing are depicted graphically in Figure 1-5 and are as follows:

- Remedy Screening (Laboratory Screening)
- Remedy Selection (Bench-scale or Pilot-scale Testing)
- RD/RA (Pilot-scale or Full-scale)

Operable Unit 4 is currently preparing for the third tier, RD/RA treatability testing for vitrification. RD/RA treatability studies are conducted after the Record of Decision, which states the selected remedial action for the operable unit. The post-ROD study is intended to provide the detailed design, cost and performance data required to optimize the treatment process and the design of a full-scale treatment system. It complements the information obtained during the RI/FS phase, which in the case of OU4 is the earlier laboratory and bench-scale treatability studies (see Figure 1-6). As the figure shows, Phases I and II of the pilot-scale testing will occur after the EPA-approved ROD was issued.

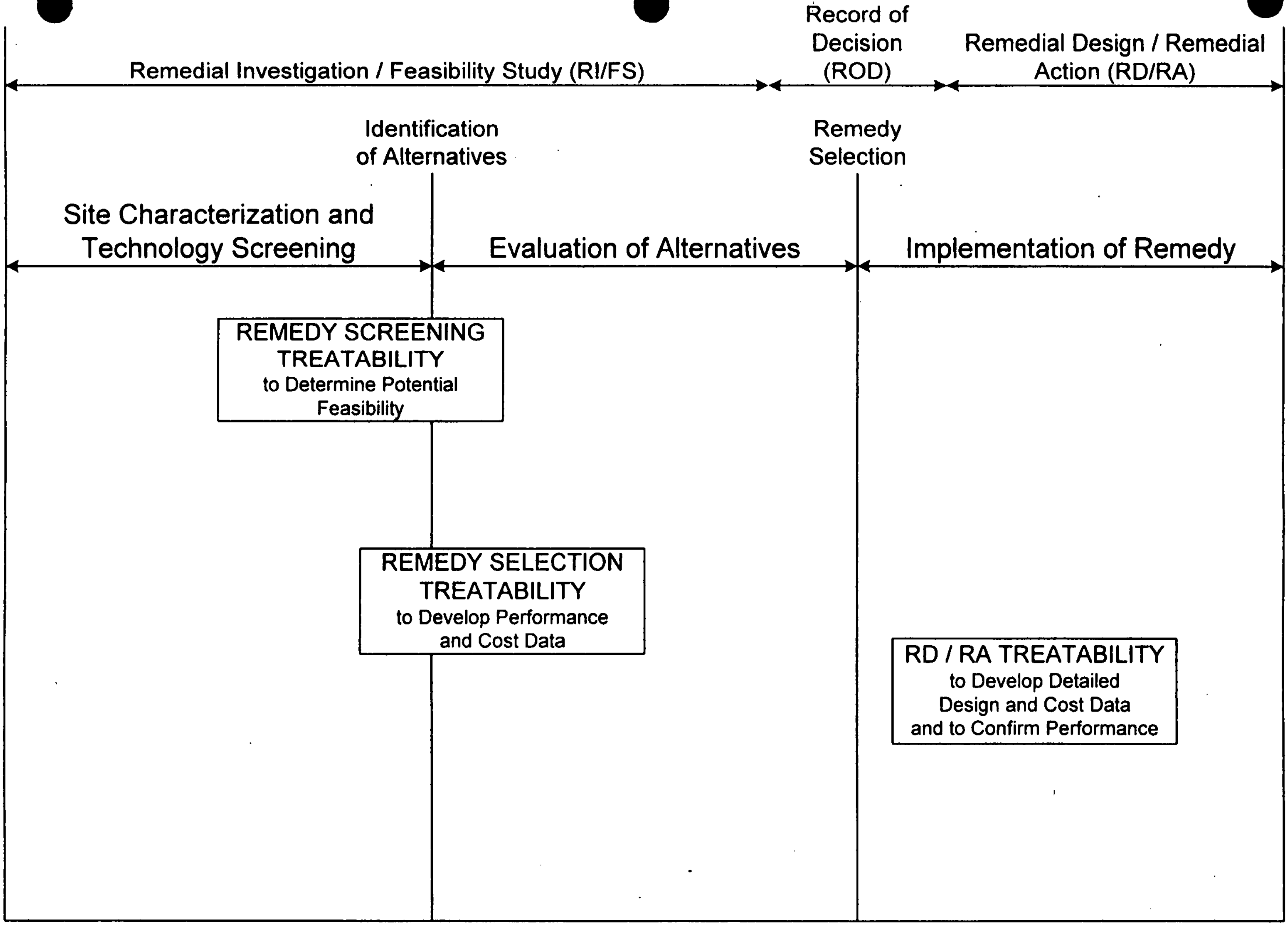


FIGURE 1-5

The Role of Treatability Studies in the RI/FS and RD/RA Process

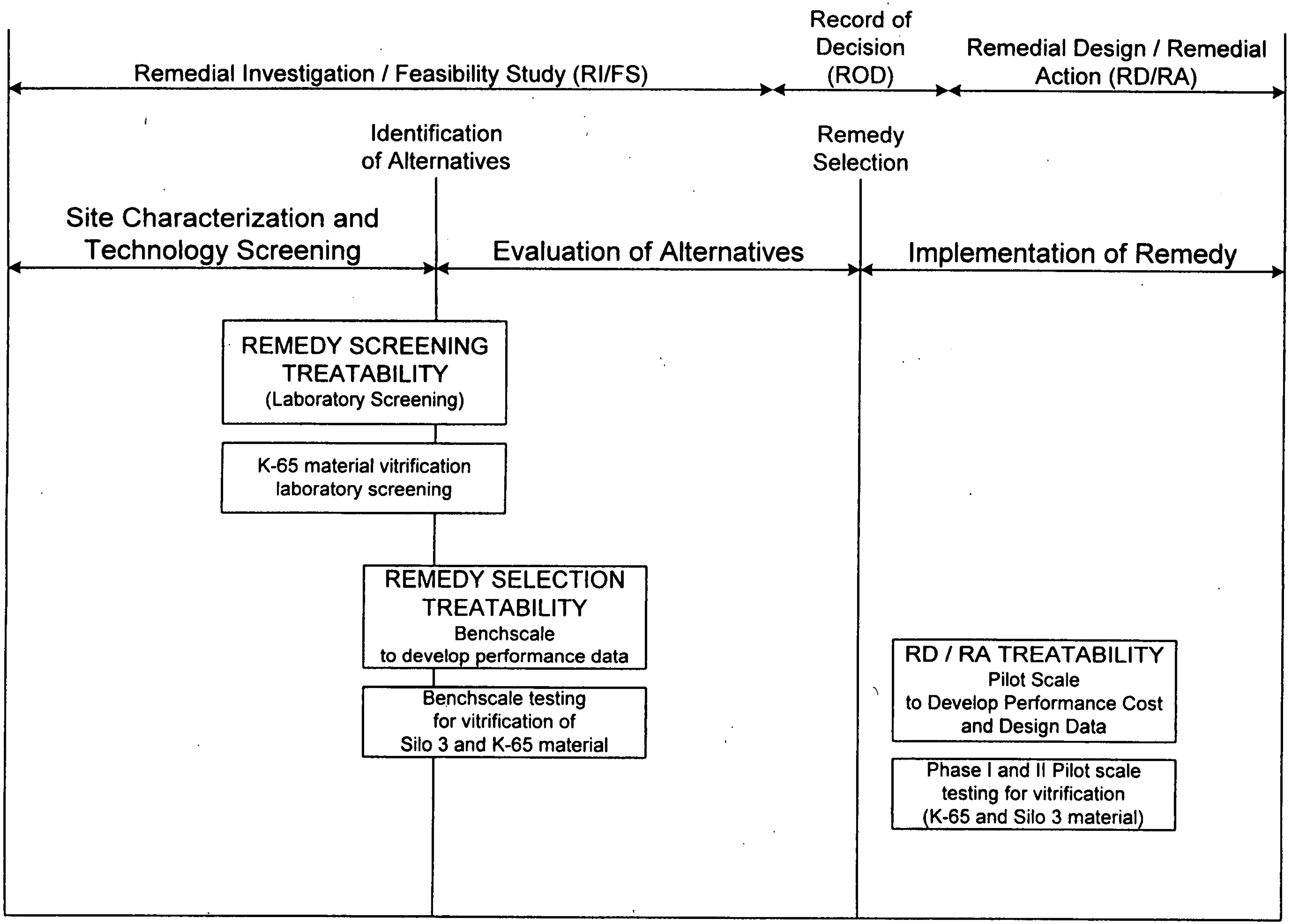


FIGURE 1-6
Relationship of the OU4 Vitrification Treatability Studies to the RI/FS and RD/RA

The EPA Guide for Conducting Treatability Studies under CERCLA (EPA 1992) lists potential reasons for performing RD/RA treatability testing, including "to support the design of treatment trains." Previous OU4 laboratory and bench-scale treatability study results indicate that vitrification of OU4 materials is a viable treatment alternative. However, the proposed vitrification process must still be proven on a continuous, pilot-scale level prior to performing a full-scale facility design. Phases I and II of the VITPP program will accomplish this by providing information on continuous operation performance, maintainability, constructability, equipment sizing, material handling, process upset and recovery, side-stream and residuals generation and treatment (e.g., wastewater, radon), energy and reagent usage (e.g., process additives), and sampling and analysis of the process and the final product.

2.0 REMEDIAL TECHNOLOGY DESCRIPTION

The pilot scale vitrification facility is located east of the K-65 Silos. The majority of the equipment for melter feed preparation, off-gas cleanup and wastewater recycle is located in the open process area outside the building on diked concrete pads. The open process area is now covered with a temporary structure for weather protection. Interim storage of the vitrified product is accommodated on a nearby covered concrete pad. The melter and product forming equipment, along with the process control system and other support functions, are housed in a pre-engineered metal building. Figure 2-1 is the civil site plan, which shows the VITPP location with respect to the existing silos.

2.1 DESIGN ACTIVITIES/DESIGN BASIS

The conceptual design of an OU4 vitrification facility was developed during the preparation of the FS. The requirements for the pilot scale facility were defined, and a document entitled "Functional Requirements Document, Vitrification Pilot Plant" (Parsons 1993) was developed to establish the basis for the VITPP design. Process and facility design to satisfy these functional requirements was conducted in compliance with criteria developed specifically for this project as documented in the "Design Criteria for the CRU-4 Pilot Plant Program" (Parsons 1994). A VITPP process flow diagram was developed, and the required equipment items were identified and specified. The process flow diagram applicable to Phase I is presented in Figure 2-2.

2.2 EQUIPMENT DESIGN FOR THE VITPP PROCESS

The key equipment item for the VITPP process is an electric, joule-heated melter capable of melting a wide range of waste materials at moderately high temperatures. It has been designed to produce a consistent, durable, stabilized glass with minimal effluent. The molten glass can be discharged as a monolith pour or it can be fed to a product forming machine. This machine produces a glass product of shape and size that can be handled easily for containerization and final packaging.

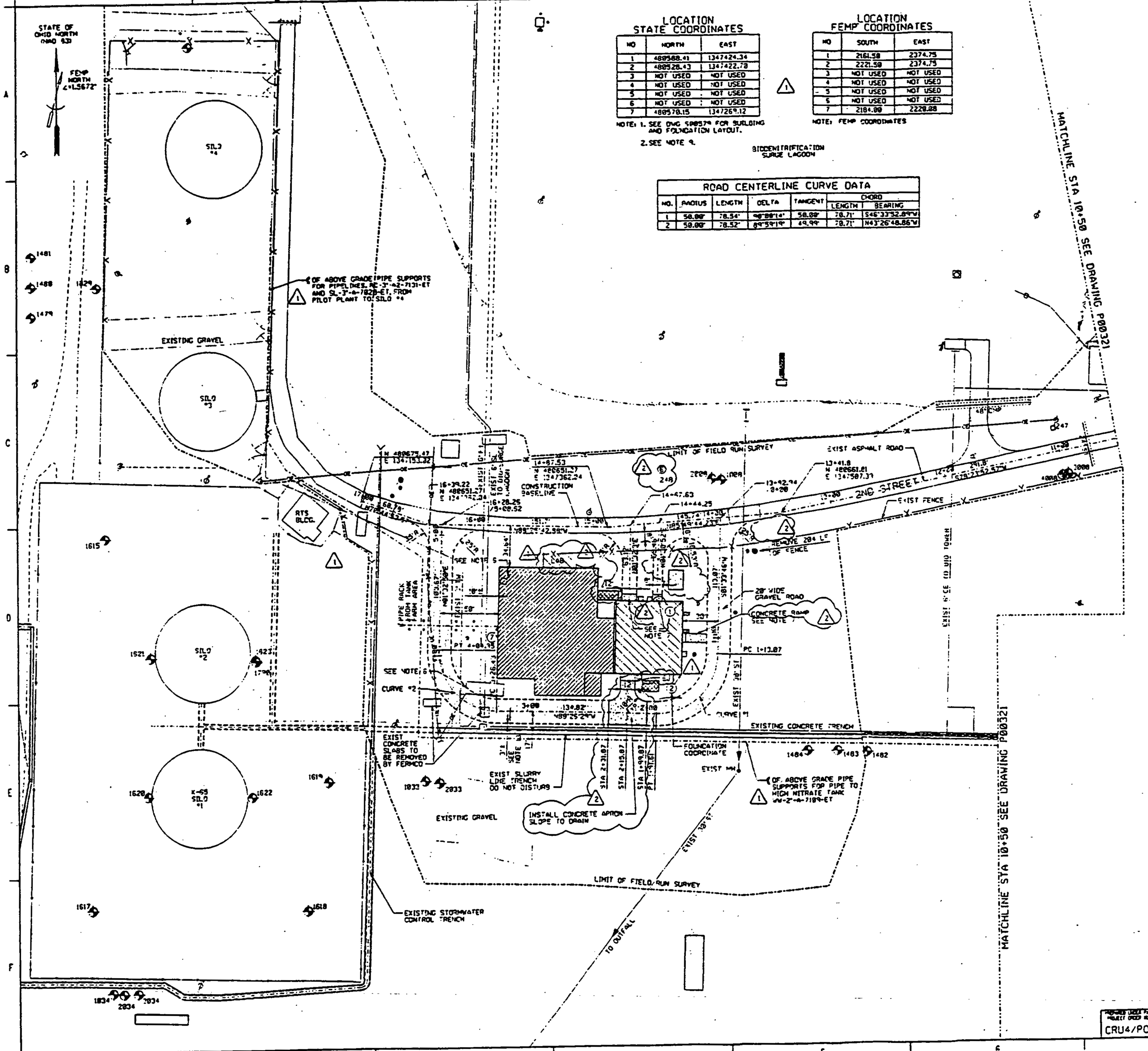
An off-gas system is included in the facility design. The system is composed of standard industry components such as a quench tower to reduce melter off-gas temperature, scrubber, desiccant tower, carbon beds (Phase II only), High Efficiency Particulate Air (HEPA) filters, and blower. The off-gas is discharged to the atmosphere through a stack. The stack is equipped with an isokinetic sampler and a radon monitoring device (Phase II).

2.2.1 Feed Preparation

The equipment for introducing additives to the feed includes a standard bag slitting and dumping station. The bag dump station has its own ventilation fan and includes filters to control fugitive dust during the dumping operation. The additives, which are introduced as dry powders, are pneumatically conveyed to a filter/receiver unit. Exhaust from the filter/receiver is vented by a vacuum blower that discharges to a HEPA filter unit prior to final discharge via the VITPP exhaust stack.

Chemical additives needed for the vitrification process, such as alumina, sodium carbonate and calcium carbonate, are weighed and then fed to the slurry tanks and blended with the surrogate material. Lead, barium, sulfate, phosphate, and nitrate compounds are added to the nonradioactive surrogate material to more closely simulate the K-65 and Silo 3 materials. The evaluation of the behavior of metal oxides, phosphates, and sulfates and their effects on the glass and the melter's electrodes are important parts of the testing program.

The lead and barium can be potential problems in the melter. The lead oxide in the glass can change to elemental lead or lead sulfides under reducing conditions in the melter. These have lower melting points than other compounds in the feed and can drop to the bottom of the melter. However, the melter is run in an oxiding mode to avoid reducing conditions (i.e., air is used to agitate the melter bath). In the unlikely event that molten lead or lead sulfide were to collect in the bottom of the melter, the material could be removed by draining the contents of the melter through the existing bottom drain. Barium may not be of high enough concentration to cause crystallization. Barium crystallization has not been observed in crucible melts or the minimelter runs at VSL. In addition, the potential presence of chromium in the glass product is also a concern and must be monitored. Due to its high concentration in the melter's refractory brick lining, any corrosion or erosion of the brick lining would lead to the introduction of chromium into the glass product.



LOCATION STATE COORDINATES

NO	NORTH	EAST
1	480588.41	1347424.34
2	480528.43	1347422.78
3	NOT USED	NOT USED
4	NOT USED	NOT USED
5	NOT USED	NOT USED
6	NOT USED	NOT USED
7	480578.15	1347269.12

NOTE: 1. SEE DWG SR0579 FOR BUILDING AND FOUNDATION LAYOUT.
2. SEE NOTE 9.

LOCATION FEMP COORDINATES

NO	SOUTH	EAST
1	2161.58	2374.75
2	2221.58	2374.75
3	NOT USED	NOT USED
4	NOT USED	NOT USED
5	NOT USED	NOT USED
6	NOT USED	NOT USED
7	2184.80	2228.88

NOTE: FEMP COORDINATES

ROAD CENTERLINE CURVE DATA

NO.	RADIUS	LENGTH	DELTA	TANGENT	CHORD LENGTH	CHORD BEARING
1	50.00'	78.54'	90°00'14"	50.00'	70.71'	S46°33'52.89"W
2	50.00'	78.52'	89°59'19"	49.99'	70.71'	N43°26'48.86"W

NOTES

1. INFORMATION ON THE LOCATION AND ELEVATION OF EXISTING FEATURES SHOWN ON THIS PLAN WERE OBTAINED FROM SEVERAL DIFFERENT SOURCES INCLUDING THE GRID/GRID UTILITY PLANS, THE 1992 FLYOVER, AND THE FIELD RUN SURVEY PROVIDED BY FERMCO IN DECEMBER 1993. LIMIT OF FIELD RUN SURVEY IS NOTED ON DRAWING.
2. THE SUBCONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS AND DIMENSIONS INCLUDING ELEVATIONS BEFORE STARTING ANY CONSTRUCTION AND FABRICATION. ANY DEVIATIONS FROM INFORMATION SHOWN SHALL BE PRESENTED IN WRITING TO THE FERMCO CONSTRUCTION CONTRACTS ~~MANAGER IMMEDIATELY AND BE RESOLVED BEFORE CONTINUING~~. FEATURES SHOWN ON DRAWING ARE "AS DESIGNED." AS BUILT CONDITIONS CAN BE DIFFERENT. (2)
3. FOR DRAWING INDEX, SEE DRAWING 94X-5900-X-00353.
4. FOR LEGEND AND SYMBOLS, SEE DRAWING 94X-5900-Y-00315.
5. ALL DISTURBED SURFACES SHALL BE SEEDED AT PROJECT COMPLETION.
6. TRAILER AND ABANDONED WELL HEAD TO BE REMOVED BY FERMCO.
7. FOR CONCRETE APRON, RAMP, AND STOOP DETAILS, SEE DRAWING 94X-5900-G-00325.
8. FOR PAD LOCATIONS, SEE DRAWING 94X-5900-S-00577.
9. ALL COORDINATES GIVEN ARE IN NAD 83 STATE PLANE COORDINATE SYSTEM, AND ALL BEARINGS ARE FROM NAD 83 NORTH UNLESS NOTED OTHERWISE.
10. ALL 1600 SERIES ARE SOIL BORINGS (NOT MONITORING WELLS).
11. (2)
12. ALL EXCAVATION SHALL BE PERFORMED WITH EXTREME CARE. SUBCONTRACTOR IS RESPONSIBLE FOR IMMEDIATELY INFORMING THE FERMCO CONSTRUCTION CONTRACTS MANAGER AND REPAIRING ANY UTILITY DAMAGE TO THE SATISFACTION OF THE FERMCO CONSTRUCTION CONTRACTS MANAGER. FEATURES SHOWN ON DRAWING ARE "AS DESIGNED." AS BUILT CONDITIONS CAN BE DIFFERENT.

LEGEND

- BUILDING OR TRAILER
- OPEN PROCESS AREA (SEE NOTE 8)
- CONCRETE PAD OR PAVING
- CRUSHED AGGREGATE SURFACING
- HVAC SYSTEMS (SEE NOTE 3)
- LIMIT OF FIELD SURVEY (SEE NOTE 1)

REF DWG NO.	DRAWING TITLE
94X-5900-X-00353	DRAWING INDEX - SHEET 1 OF 4
94X-5900-Y-00315	LEGEND AND SYMBOLS
94X-5900-G-00325	SITE DETAILS - SHEET 2 OF 3 (1)
94X-5900-S-00577	TANK FARM
94X-5900-S-00579	PROCESS AREA
94X-5900-P-00321	PLAN AND PROFILE

REV NO.	ISSUE OR REVISION PURPOSE - DESCRIPTION	A-E	FERMCO	DATE
2	REMOVED GENERATOR HOLD, REVISED HVAC AND SURGE BIN PADS, MOVED ELECTRICAL ...	[illegible]	[illegible]	[illegible]
	ADDED CONCRETE APRON			
1	ADDED PIPELINE RUNS, MOVED LAB, REMOVED RTS BUILDING AND COORDINATES, AND UTILITY TANK	RAZ	RC RE	[illegible]
0	APPROVED FOR CONSTRUCTION	RAZ	RE	03/12/94

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

THIS DRAWING PREPARED BY
PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

PROJECT NAME: VITRIFICATION PILOT PLANT DESIGN
CRU4 - ONE METRIC TON

DRAWING TITLE: **FIGURE 2-1** CIVIL SITE PLAN

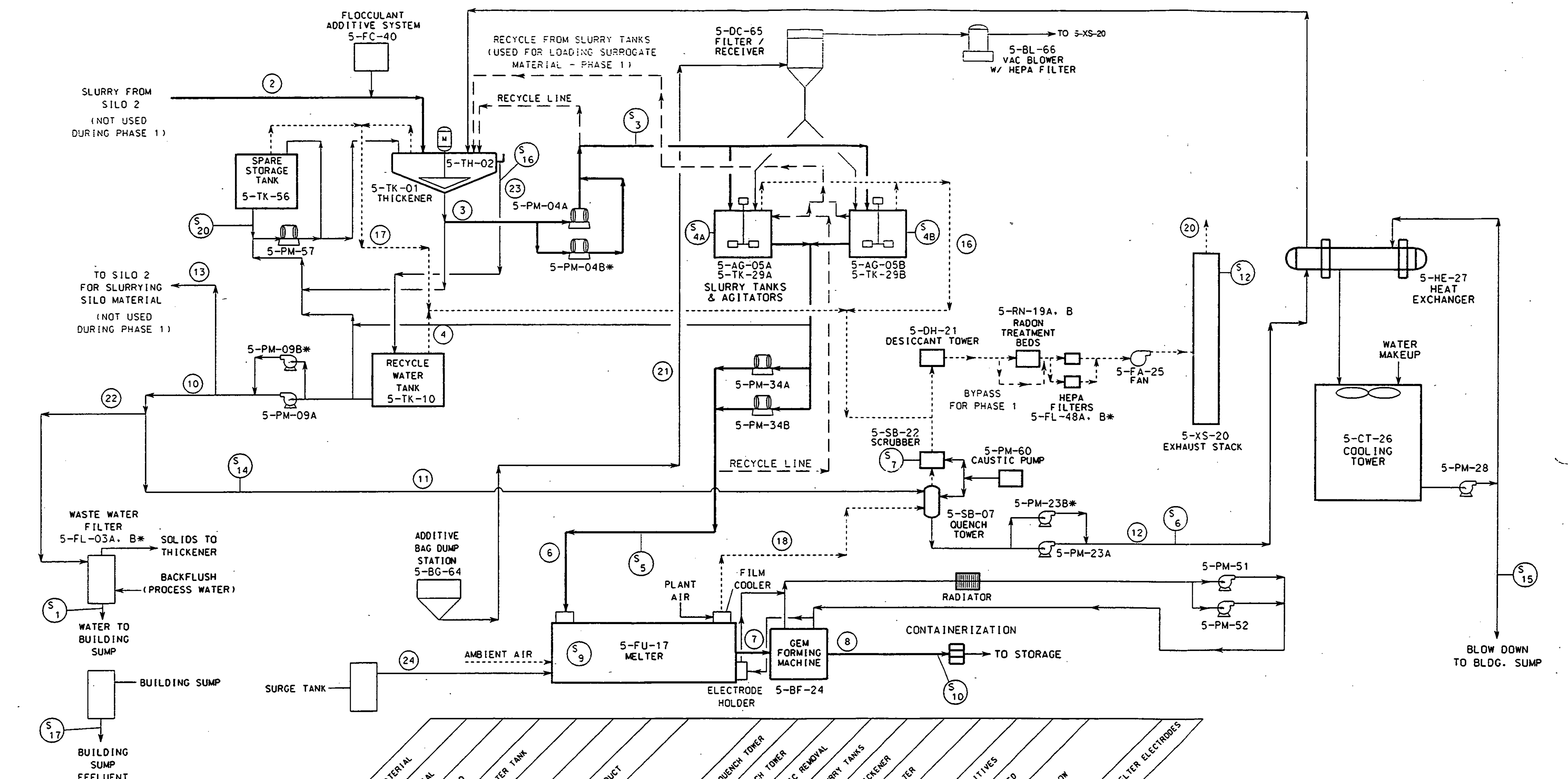
DRAWN BY: R.M. LINDGREN — DATE: [illegible] — LEAD ENGINEER: EDWARD J. KUBRIN — DATE: 03/12/94 — CHECKED BY: K. GERARD — DATE: [illegible]

SCALE: 1"=30'

SUBMITTED FOR APPROVAL: R.A. ZIEMINSKI 03/12/94 — FERMCO APPROVAL: R.C. EMERTON 03/12/94 — CERTIFIED FOR CONSTRUCTION: V. PICKLES 03/18/94

CRU4/P085 — WBS 1.1.1.1.4.3.1 00-90701 — 94X-5900-G-00317 — SHEET G0001 — REV. 2

VITRIFICATION PILOT PLANT PROCESS FLOW DIAGRAM - PHASE I



FLOW NO.	1	2	3	4	6	7	8	10		11	12	13	16	17	18	20	21	22	23		24
	K-65 SILO MATERIAL	SLURRIED MATERIAL	SLURRY TANK FEED	OFFGAS FROM WATER TANK	MELTER FEED	MELTER PRODUCT	FINAL GLASS PRODUCT	RECYCLE WATER		H2O FOR OFFGAS QUENCH TOWER	WATER FROM QUENCH TOWER	H2O FOR HYDRAULIC REMOVAL	OFF-GAS FROM SLURRY TANKS	OFF-GAS FROM THICKENER	OFF-GAS FROM MELTER	OFF-GAS TO ATM	MELTER FEED ADDITIVES	H2O TO BE TREATED	THICKENER OVERFLOW		COOLING WATER TO MELTER ELECTRODES
AIR (SCFM)				50									100	50	50	250					
SOLIDS (LBS/HR)	4450	4450	4450	0	92	92	92	0	0	0	0	0	0	0	0	0	1080	0	0	0	
WATER (LBS/HR)	1910	17800	4450	0	74	0	0	21910	20000	20000	20074	15890	0	0	74	0	0	1910	33424	20074	
OPER. TIME (HR/ DAY)	0.4	0.4	0.4	24	24	24	24	0.4	23.6	24	24	0.4	24	24	24	24	0.4	0.4	0.4	23.6	24

NOTE:
* - INSTALLED SPARE
(S XX) - SAMPLING POINTS

000040 **FIGURE 2-2**

SKETCH: CRU4-PP-SK027
REV M DATE 5/24/96

/RES2050/VITFLOW3.DGN

2.2.2 Thickener

The surrogate material for Campaign #4 will be pumped into a 24,000-gallon carbon steel thickener tank. The feed enters the center well of the thickener at 15 to 20 percent solids. Slurry flow rates and percent solids are measured by a flow indicator installed in the feed line.

Control of thickened solids in the underflow is by rake height and an adjustable, air-operated diaphragm pump that pumps the material to one of two slurry tanks. A density controller in the thickener underflow line controls the density of the solids by adjusting the diaphragm pump flow rate. The underflow is designed for 50 percent solids and will be confirmed by sampling and analysis. The thickener overflow flows by gravity to the recycle water tank where it is used to supply the quench tower. A flow transmitter in the thickener underflow line monitors thickener flow. The thickener overflow water is sampled for clarity and percent solids.

Addition of a polymeric flocculant is necessary to ensure that the settling rate of the solids is high enough for adequate solid-liquid separation in the thickener. The flocculant is added using a dedicated mixing and feeding system. Laboratory tests have shown that the presence of the BentoGrout® clay makes thickener operation more difficult, requires high levels of polymer addition and possibly requires pH adjustment. The ability to adequately thicken the BentoGrout® is crucial to the success of the Phase I program.

The thickener mechanism is supplied with protective instrumentation. A set of 30-foot diameter rakes is automatically raised and lowered as a function of torque. Torque alarm annunciation occurs on the activation of a high torque sensor, and automatic shutdown occurs on the activation of a high-high torque sensor.

2.2.3 Slurry Tanks

The two carbon steel slurry tanks, approximately 2650 liters (700 gallons) each, alternate between feed preparation and melter feed functions. While one tank feeds the melter, the other tank receives from the thickener about 810 kilograms (1780 pounds) of solids, which represents about one day's production. The complete cycle of slurry tank fill, additive addition, mixing, and verification takes 24 hours or less.

Feed material for Campaigns #1 through #3 will be loaded directly into the slurry tanks via the bag dumping station, since the formulations consist of dry feed material. The feed material for Campaign

#4 will be pumped from the thickener tank to one of the two slurry tanks by the thickener underflow pump at a rate of approximately 151 lpm (40 gpm).

Each feed batch of surrogate material is prepared by the following sequence of steps. Thickener underflow at 50 percent solids by weight is transferred to one of the slurry tanks. The slurry is sampled and analyzed for percent solids and specific metals to identify and verify the correct additive mix. The desired solids content in the final slurry is approximately 50 percent, so recycled water is added as needed to maintain the percent solids in the slurry tanks at 50 percent.

The agitator blends the surrogate material and the additives so that a homogeneous mix is fed to the melter. The slurry tank material is sampled to ascertain the agitator's effectiveness, and the slurry material density is monitored.

Crucible testing will be performed on the mixed composition. This crucible melt testing of a small sample of the slurry tank contents provides an initial indication of the behavior of that specific batch at the test temperature. Key characteristics include viscosity and electrical conductivity of the melt at various temperatures.

2.2.4 Melter

The pilot-scale joule-heated melter is refractory-lined, welded steel construction on a steel frame base. In joule heating, the electric current passes directly through the molten glass. This approach allows melting the nonradioactive surrogate materials at moderately high temperatures. The slurry is delivered continuously from the slurry tank to the melter by an air-operated diaphragm pump. The feed enters the melting chamber and is deposited onto the molten glass surface. The melter is designed to produce a consistent, durable, stabilized glass. The melter is lined with high temperature-resistant refractory bricks and is capable of operating in the range of 1050 to 1350°C (1922 to 2462°F). Melt chamber temperature is controlled by power adjustments to the heating electrodes and supplemental area heaters. Agitation is incorporated into the melter design to promote uniform glass production with a minimum retention time. Agitation is achieved by bubbling air through the molten glass. The melter plenum will normally be kept at a slightly negative pressure. This is accomplished by venting the melter into an induced draft, once-through off-gas system.

Melter operating parameters are as follows:

Discharge Rate	1.0 metric ton (2200 lb)/day
Operating Temperature	1050 - 1350°C (1922 - 2462°F)
Feed Solids	40 - 50 percent by weight
Feed Temperature	10 - 40°C (50 - 104°F)
Bath Surface Area	9 ft^2 (0.84 m^2)
Bath Volume	25 ft^3 (0.71 m^3)

It is the intent to operate the melter system on a continuous basis once testing has begun, with feed batches being prepared and run back-to-back. Except when changing melter status from idle to operating or from operating to idle, minimum melter temperature variations will be maintained. When going from a lower temperature to a higher one, the melter will be allowed to stabilize at the higher temperature before a new feed composition is introduced.

Each feed batch is sampled prior to being fed to the melter. A feed batch is defined as the quantity of feed material that is required to produce one metric ton (2200 lbs) of glass product. A feed batch, which is prepared in a slurry tank, is fed to the melter continuously over a period of approximately 24 hours. It takes approximately three melter volumes (6 tons over 6 days) to displace the previous batch and obtain a representative sample. Melter operation will be carefully monitored, and adjustments to temperature, hold time, formulation, and other variables will be made as required to ensure that an acceptable glass is produced. Operation of the melter at its lower temperature range will be tested to determine the minimum temperature required to produce an acceptable glass product. One glass product sample per batch is collected for final product acceptance testing, which includes RCRA TCLP metals analysis.

Under certain operating conditions, metallic lead or other heavy metals could form and settle to the bottom of the molten material within the melter. However, the formation of metallic lead is not anticipated because the glass formulations are designed to preclude reducing conditions in the melter. In addition, the potential presence of chromium in the glass product is also a concern and must be monitored. Due to its high concentration in the melter's refractory brick lining, any corrosion or erosion of the brick lining would lead to the introduction of chromium into the glass product.

2.2.4.1 Temperature Control

The melter is capable of operating at temperatures from 1050 to 1350°C (1922 to 2462°F). The ability to maintain a constant glass melt temperature during operations will be tested due to its importance in producing a uniform glass product that flows from the melter at a constant rate. The melter temperature and discharge temperature are closely monitored to ensure that the melter is within the desired operating range.

2.2.4.2 Foaming

Foaming occurs in a glass melter when gases are generated by the decomposition of certain feed materials at temperatures near melter operating temperature. Carbon dioxide (CO_2) is formed from carbonates and SO_x from sulfates. Because it is critical to be able to continuously operate the melter without foaming problems, the extent of foaming will be observed by remote video monitoring and the glass formulation adjusted if necessary.

The prevention of foaming can involve the following: 1) reducing the melter feed rate, 2) reducing the melter temperature, 3) increasing the melter temperature, 4) substituting non-gas producing additives (e.g., calcium oxide) for gas producing additives (e.g., calcium carbonate), 5) including reductants (such as urea or starch), or 6) reducing the content of waste in the melter feed.

2.2.4.3 Molten Material Removal

Controlling the flow of molten material from the melter is important to the subsequent product forming operation. The transfer of molten glass from the melting chamber to the discharge chamber is accomplished by using an air lift feature located in the discharge chamber. The air lift mechanism injects air into the bottom of the discharge chamber, and the rising bubbles lift and push the molten glass toward the discharge port. The rate of discharge can be controlled by the rate of air flow applied. The air lift provides flexibility in the control of the glass flow from the melter to the gem forming machine. The air lift is used to lower the glass level in the melt chamber.

2.2.5 Gem Forming Machine

While feeding is in progress, molten glass inventory will be accumulated in the melting cavity and discharged through the discharge chamber into the gem forming machine. The shape and size of the glass product facilitates containerization and the anticipated final packaging configuration. The gem forming machine consists of a mechanism to break the molten glass stream into droplets which fall onto a conveyor. The gems are air-cooled on the conveyor and fall into a drum. Samples of the glass product will be collected, visually inspected, and analyzed. The operation and mechanical reliability of the system will also be tested.

2.2.6 Off-Gas System

Sources of off-gas are the melter and the VITPP tank vents. The off-gas treatment system consists of a film cooler, quench tower, scrubber, desiccant tower, radon adsorption carbon beds, HEPA filters, blower, and stack. The carbon beds are included for radon control and will be bypassed during VITPP Phase I operation. The melter off-gas is expected to exit at a temperature near 800°C (1472°F). Partial cooling is accomplished by the introduction of compressed ambient air into the film cooler and by direct heat loss through the pipe wall to the surrounding atmosphere. The quench tower is constructed of carbon steel and is designed to receive hot gases from the film cooler and quench them using recycled water. Tower internals consist of stainless steel spray nozzles and/or baffles. The scrubber is stainless steel and removes sulfur oxides from the off-gas with a caustic solution.

During testing, the quench tower and scrubber are monitored for pressure drop, water inventory control, and water temperature rise. The scrubber reagent is sampled once per batch for total dissolved solids to determine salt content in the sump and for alkalinity to determine the reagent consumption. Both of these parameters are measured for process control.

The desiccant tower consists of a desiccant bed to reduce the water content to 15 percent relative humidity. A deliquescent material such as calcium chloride ($CaCl_2$) is used in the desiccant tower to absorb moisture from the off-gas stream. HEPA filtration is the final off-gas treatment step prior to discharge through the exhaust fan and the stack. One HEPA unit is always on-line while the other is maintained in a parallel configuration as a spare to be used when the one filter is being replaced.

During operations, the routinely monitored off-gas parameters are volumetric flow rate, temperature, humidity and pressure drop through the system. During the campaign runs that involve lead and barium, stack isokinetic filter samples will be analyzed for chromium, lead and barium to evaluate process control of the off-gas using HEPA filtration. The volumetric flow rate out the stack is continuously measured for calculation of the emission rate.

2.2.7 Wastewater Treatment System

The VITPP wastewater treatment system is a pretreatment process designed to remove suspended solids prior to discharge for final treatment in the site Advanced Wastewater Treatment (AWWT) System. The VITPP wastewater treatment system is sized to handle approximately 38 liters (10 gallons) per minute of wastewater (containing suspended solids and dissolved salts) on an intermittent basis as required. Treatment equipment consists of a multimedia deep bed pressure filtration system and a radon sparge tank. Water is removed from the process mostly through the recycle water tank and the wastewater filters, but some is also removed by the off-gas system in the form of condensed water vapor that exits the melter. For Phase I, removal of suspended solids is the only item requiring pretreatment of this water; therefore, Phase I treatment will consist only of the multimedia pressure filtration system. The radon sparge tank will be bypassed.

The ability of the filter to successfully handle the BentoGrout® clay must be determined. Two filters are included and installed in parallel so that one is available when the other is being backwashed. Backwash from the filter is directed to the thickener tank. During melter bakeout and Campaign 1, filtered water is pumped to the existing Biodenitrification Surge Lagoon by way of the lined Waste Pit Area Stormwater Trench. Beginning with Campaign 2, the filtered water is pumped to the existing High Nitrate Tank. The Advanced Wastewater Treatment System (AWWT) receives the effluent from both the Biodenitrification Surge Lagoon and the High Nitrate Tank. Process wastewater streams will be characterized prior to treatment in the AWWT System, with the treated effluent being discharged under the site National Pollutant Discharge Elimination System (NPDES) permit.

The radon stripping system consists of a sparge pipe that is housed in a heated sparge tank, a circulation pump, and a supply of compressed air. The sparge tank vents to the desiccant tower. Operation consists of introducing compressed air into the sparge pipe while operating the tank heaters and the circulation pump. The purpose of this system is to reduce the concentration of radon dissolved in the wastewater prior to discharge to the High Nitrate Tank. The ability of the radon stripping system to remove radon from the wastewater will be determined as part of Phase II testing.

2.2.8 Cooling Water Systems

Two cooling water systems are included in the design: a small capacity system to cool the melter electrode holders and the gem forming machine, and a larger recycle water system that services the quench tower and scrubber system.

The electrode holders and the gem forming machine are cooled using a closed loop system that includes a pump, a surge tank, and an air-cooled, finned-tube heat exchanger that is serviced by a fan. The system operates at a fixed flow rate that is set manually.

The main cooling water system includes two loops that circulate through a shell-and-tube heat exchanger. The heat exchanger, which has a design heat transfer rate of 2 million Btu/hr, provides cooling water to the quench tower via the tube side loop, which also includes the thickener and the recycle water tank. The shell side loop, which circulates through a galvanized steel cooling tower, includes a side stream that cools vitrification equipment components, primarily the gem forming machine. Cooling water exits the cooling tower at a design rate of 760 liters per minute (200 gallons per minute) and is pumped to the heat exchanger at a design rate of 494 liters per minute (130 gallons per minute), leaving 266 liters per minute (70 gallons per minute) for vitrification equipment cooling.

Cooling tower water will be sampled regularly to determine the buildup of soluble salts and the proper amount of treatment chemicals required. Treatment chemicals for the cooling tower water are phosphate, calcium sulfate dispersant, and biocide.

2.2.9 Distributed Control System

Process operations are controlled from the control room via the Distributed Control System (DCS).

The control system also gathers data from vitrification operations for display on screens in the control room. Likewise, the status of control devices [valves, dampers, pumps, motors, and Silicon Control Rectifiers (SCRs) for melter electrodes] is displayed.

2.3 CONSTRUCTION ACTIVITIES

Construction activities included the following construction work packages and support services.

- Grading and earthwork such as excavation and engineered fill for footings and grade beams
- Installation of site utilities
- Installation of concrete footings, equipment foundations and slabs
- Erection of building
- Installation of process equipment, piping, electrical, and instrumentation
- Construction acceptance testing
- Support of plant start-up

Construction activities were deemed complete when Construction Acceptance Testing (CAT) was completed, and the facility was then turned over for start-up testing and operations. Construction Acceptance Testing addressed the functionality of individual equipment items and components and was done in accordance with the Construction Acceptance Testing Plan (18-CP-0010).

2.4 SYSTEMS OPERABILITY TESTING

Following the completion of CAT, Systems Operability Testing (SOT) commenced. The SOT activities were conducted per an approved SOT Plan (18-SU-0002) which identified the systems and equipment that required systems operability testing and described the planning, execution, and documentation of those tests.

The SOT Plan defined an extensive list of checkout activities. The following activities are addressed in the SOT Plan and were conducted as part of SOT. All items have passed SOT and have been accepted for start-up.

A. The thickener tank was filled, and the tank level indications and alarms and the overflow to the recycle water tank were tested. The thickener rake mechanism and torque control were tested. Each residue slurry pump was tested in both the recycle and feed forward modes. The function of the density controls was verified. Water was transferred to the slurry tanks.

B. The flocculant additive tank level and flow instruments, agitator, and addition pump were tested.

C. The recycle water tank level indications and alarms were checked. Both recycle water pumps were tested.

D. Both slurry tanks were filled and the agitators tested. Level, weight, and flow instruments were checked. Both slurry diaphragm pumps were tested in both the melter feed and the recirculation mode of operation.

E. The additive system rotary air locks and diverters were tested. The vacuum blower and bag dump station were tested. Filter/receiver level instruments were tested.

F. The quench tower was tested with recycle water pumped to the spray heads, and the flow and level controls and alarms were tested. The level instruments and alarms were tested. The quench tower pumps were tested. Water was pumped through the heat exchanger and to the thickener.

G. The scrubber was filled with water and the level instruments and alarms were tested. Both scrubber recirculation pumps were tested.

H. The caustic addition pump was tested.

I. The off-gas system exhaust fan was operated, the flows were balanced, and the flow control was tested.

J. The desiccant tower level indications and alarms were tested. The desiccant condensate tank instruments and pump were tested.

K. Pressure drops across the carbon beds (Phase II) and the HEPA filters were tested. The valves for flow path selection were tested.

L. Melter SCR controls were tested to the extent possible without heating up the melter. Melter pressure control was tested. Melter level alarms were verified. Temperature alarms and controls were checked. The melter utility rack water and air instruments and controls were tested. The melter feed pump was tested and calibrated with water.

M. The gem forming machine gob cutter and gob roller speed controls were functionally tested. The startup and emergency diverters were tested. The gem forming machine air and water cooling systems were tested.

N. The gem container handling conveyor equipment and controls were tested. Motor drives were tested in forward and reverse operation.

O. The cooling tower level instruments, freeze protection, and fan operation were tested. Water was pumped through the Heat Exchanger and flow was tested.

P. Wastewater filter forward and backflush operation were tested. The wastewater filter pressure and flow controls were tested.

Q. The spare storage tank level alarms and pump operation were tested.

R. Pilot plant sump systems were tested. Pump operations and level alarms were tested.

S. Building support systems were tested. Examples of these systems include the diesel generator, air compressor, air dryer, electrical systems, HVAC systems, and the process water system.

T. During the checkout operations, the distributed control system was monitored for correct indications of measured variables, control action, and status of motors and valves.

U. Safety alarms were checked and emergency shutoffs were tested for proper settings and function.

V. All support system components such as pumps, valves, filters, and instruments that were not tested as part of Items A through U of this list were checked and/or tested for proper operation.

On successful completion of the SOT, the facility and systems were ready to commence melter bakeout. The melter went through a bakeout cycle sufficient to condition the refractory brick in the melter. The melter was then charged with benign borosilicate glass frit and heated sufficiently to melt the frit to seal the refractory.

3.0 PERFORMANCE AND DATA QUALITY OBJECTIVES

3.1 OVERALL VITRIFICATION PILOT PLANT PHASE I OBJECTIVE

The overall program objective for Phase I of the VITPP project is to demonstrate the vitrification process and its support systems prior to treatment of radioactive materials in VITPP Phase II. VITPP Phase I, and ultimately Phase II, will provide data to support the technologies and methodologies proposed for the remediation of the K-65 and Silo 3 residues and the design of the FRVP.

Section 3.3 of this work plan identifies the VITPP Phase I Data Quality Objectives (DQOs) for sampling activities, including soil, water, geotechnical sampling for facility siting and design, and operation of the VITPP equipment using surrogate materials. The DQOs discussed in Section 3.3 were developed using program requirements from the EPA-approved FEMP Sitewide CERCLA Quality Assurance Project Plan (SCQ) (DOE 1993b) and other EPA treatability guidance. Optimum process parameters for the treatability of K-65 and Silo 3 material will be identified in VITPP Phase II. As required by the SCQ, the engineering design and environmental program DQOs for this project are identified in this work plan. Data will be documented in the appropriate regulatory report or engineering design document.

3.2 PERFORMANCE OBJECTIVES

This section addresses the performance objectives that have been established in order to evaluate the effectiveness and operability of the vitrification process. The objectives have been developed to obtain the information necessary for successful VITPP Phase II testing and ultimately for the design and construction of a final remediation facility operating at a production rate of approximately 25 metric tons (28 tons) per day.

Both general and equipment-specific objectives will be addressed. The performance objectives for the key equipment items are shown in Table 3-1. Note that the only objective that is really a cleanup criterion is for the glass product to pass RCRA TCLP metals limits.

The specific tests that will be conducted during VITPP Phase I to verify performance are addressed in the VITPP Phase I Test Plan (FERMCO 1996c).

TABLE 3-1
PERFORMANCE OBJECTIVES

TEST COMPONENT	PERFORMANCE OBJECTIVE
Thickener	Underflow: approximately 40-50 wt% solids Overflow: $\leq$1 wt% total suspended solids
Slurry Tanks	approximately 50 wt% solids
Melter	Bath temperature control 1050-1350°C (1922-2462°F) $\pm$50°C. 1.0 metric tons/day (average); determine maximum rate
Product Forming Machine	1-3 metric ton/day
Glass Product	Pass RCRA TCLP metals limits Approximately $\geq$50% volume reduction
Quench Tower	Reduce off-gas temperature to $\leq$46°C (115°F)
Desiccant Tower	$\leq$15% relative humidity at 130°F

3.2.1 General

1. Verify VITPP process operability on nonradioactive surrogate feed materials. This will provide the level of confidence required to operate the VITPP in Phase II and will also serve as a proving ground for developing test personnel operating experience.

2. Perform test activities in a safe manner such that the results will provide the data necessary to support VITPP Phase II testing and the design of the final remedial facility for OU4.

3. Perform a series of test campaigns that process and treat K-65 surrogate and Silo 3 surrogate formulas which simulate the formulas projected for Phase II testing. The use during Phase I of nonradioactive surrogates which are chemically similar to the materials that will be processed in VITPP Phase II will improve the probability of success during Phase II operation.

3.2.2 Pilot Plant

1. Determine process parameters for VITPP Phase II testing while processing surrogate material during VITPP Phase I. By using nonradioactive surrogate materials, the process parameters should be applicable to VITPP Phase II operation.

2. Validate the performance and integration of the Standard Operating Procedures during the operation of the VITPP and the execution of the Test Plan. This will enhance the stable operation of the VITPP in preparation for VITPP Phase II testing.

3.2.3 Feed Preparation and Transfer

1. Target 40 to 50 weight percent solids content, with K-65 surrogate and BentoGrout®, in the thickener underflow using a flocculant additive as necessary. (A decrease of solids content to less than 40 weight percent will result in an increased off-gas volume from the excess water and a reduced glass output, both of which are undesirable from an efficiency standpoint.)

2. Achieve sufficiently low total suspended solids content ($\leq$ 1 weight percent), with K-65 surrogate and BentoGrout®, in the thickener overflow for satisfactory reuse at the thickener, quench tower, and heat exchanger. The performance of the thickener and flocculant system is critical to the recycled water system for off-gas cooling, batch blending, and mining.

3. Demonstrate consistent transfer of the thickened solids slurry to the two slurry tanks.

4. Demonstrate pneumatic transfer of actual additive materials to the two slurry tanks.

5. Demonstrate successful slurry mixing and formula matching in the two slurry tanks.

6. Successfully recirculate slurry in the slurry tank.

7. Successfully regulate the transfer of blended slurry to the melter for vitrification.

3.2.4 Melter

1. Ensure that melter operation is controlled, monitored and documented as required in order to evaluate the following related items:

   a. Redox state in the melter.
   b. Melter retention time for each formula campaign.
   c. Glass resistivity/conductivity.
   d. Glass behavior during glass forming operation.
   e. Electrode consumption rate and cause of any erosion.
   f. Document the melter performance at a production rate of 1 metric ton per day.
   g. Document the melter maximum glassmaking capacity. Document limiting factors of systems or components as they relate to melter performance.

These items will be revisited during Phase II testing. Therefore, Phase I testing results will provide a basis for the control of the melter in Phase II.

2. Validate the optimum glass formulation for surrogate material loading developed during bench scale testing at the VSL, i.e., lowest possible temperature with workable viscosity and electrical conductivity, and maximum surrogate material loading. This will provide relative waste loading information for the Phase II operation with respect to the glass formulation.

3. Demonstrate control of melter operation, including temperature control, electrode current/voltage/cooling control, slurry feed control, glass level control, glass air lift control, and off-gas control.

4. Demonstrate melter ability to produce 1 metric ton of glass per 24-hour day for a continuous 36-hour period. This is required to satisfy the melter acceptance test that is specified in the procurement documents.

5. Demonstrate the ability of the melter to control, balance, and maintain the flow of molten glass from the melter.

3.2.5 Gem Forming Machine

1. Demonstrate the operation of the gem forming machine in the ability to continuously produce glass gems for an 8-hour period at the rate of 1 metric ton of glass per 24-hour day. Demonstrate the conveying of the gems to storage containers. These are required to satisfy the gem forming machine acceptance test that is specified in the procurement documents.

2. Demonstrate the operation of the gem forming machine discharge chute diverter while molten glass is being produced by the melter. These chutes are required to be operated in the event that the gem cutter rollers are to be bypassed for maintenance or for monolith pours.

3. Demonstrate the operation logic functions for the gem forming machine.

3.2.6 Off-gas System

1. Obtain design performance data of the off-gas system and maintain air flow balance.

2. Achieve off-gas temperature less than 46°C (115°F) in the quench tower exit line and for the quench tower bottom discharge to the heat exchanger during slurry feed to the melter.

3. Maintain a caustic concentration of 5 to 10 weight percent for scrubber operation using caustic solution and the caustic metering system. Ensure that the net pressure drop for the off-gas through the scrubber is within design limits.

Note: A standard caustic scrubber can routinely remove acid gases such as SO_x at around 99 percent efficiency and is considered to be the best available technology (BAT) for this purpose. HEPA filtration routinely removes 99.97 percent of particulates that are larger than 0.3 micron in diameter and is considered BAT for removal of particulates. While these efficiencies are not considered performance objectives for Phase I testing, the operation and effectiveness of the scrubber and HEPA units will be evaluated during both Phase I and Phase II operations.

3.2.7 Recycle Water System

1. Demonstrate wastewater filter operation, to include filtration of discharge water, transfer of water to the building sump, transfer of water to the AWWT, wastewater filter backflush operation, and reseating of wastewater filter filtration material. Ensure during this operation that melter glass production is not interrupted.

2. Demonstrate a balance of recycle water system operation as a function of thickener water overflow, quench tower water supply, and slurry line flushing operations.

3. Collect data to document and anticipate the buildup rates of dissolved solids in the recycle water system during melter operation.

3.2.8 Cooling Water Systems

1. Demonstrate proper operation of the main cooling water system, including cooling tower heat dissipation and heat exchanger heat transfer.

2. Demonstrate proper operation of the air-cooled cooling water system, including heat dissipation by the fan, finned-tube heat exchanger heat transfer, electrode holder heat removal, and gem machine cooler heat removal.

3.2.9 Building Sump System

1. Demonstrate the operation of the plant sump tank and pumps, especially during periods of heavy rainfall.

2. Demonstrate via SOT the operation of the spare storage tank and pump in the ability to support the VITPP processes during melter production.

3.2.10 Process Sampling

1. Demonstrate test sampling and monitoring of exhaust stack equipment during melter slurry feed.

2. Validate the performance and integration of the Project Specific Plan (PSP) for process sampling with the VITPP operation. Ensure that minimum sample result turnaround time is achieved. This will enhance the stable operation of the VITPP in preparation for VITPP Phase II testing.

3. Verify that the Sampling Procedures used in VITPP Phase I for gathering support data are appropriate for obtaining samples during VITPP Phase II testing. This will aid in the identification of any possible problem areas that could potentially impact gathering samples during VITPP Phase II testing.

4. Demonstrate successful sample retrieval from all sample points. (NOTE: There is one exception; the line between Silo 2 and the thickener will not be used during Phase I and the sample port may be relocated prior to use.)

3.2.11 Data Acquisition

1. Demonstrate automatic and manual data collection to obtain predetermined data points for evaluation, correlation, and trend reporting.

3.3 DATA QUALITY OBJECTIVES

Environmental and process control sampling and analysis identified in the DQOs will be implemented consistent with document 2504-SU-0011, "Project Specific Plan for Operable Unit 4 Vitrification Pilot Plant Phase I Process Sampling," Rev.1 (FERMCO 1995d). Sampling and laboratory analysis will be performed in accordance with applicable sections of the SCQ, DQO TS-023, laboratory procedures, and standard operating procedure 11-C-276.

Preconstruction activities required geotechnical sampling to determine soil data such as soil classification, moisture content, specific gravity, grain size analysis, Atterberg Limits, consolidation, California Bearing Ratio, and maximum density. Data from this sampling and testing activity were reported with an Analytical Support Level of A (ASL A).

Start-up and operational objectives include sampling of the process flows (except glass) for percent solid analyses to determine achievable and expected ranges of percent solids of the slurry; total dissolved solids (TDS) and total suspended solids (TSS) testing of the recycle water and cooling tower blowdown to determine the expected solids accumulation; compression testing, TCLP metals testing, and visual inspection of the final glass product to determine the optimum operating parameters of the melter; and process off-gas sampling utilizing an isokinetic sampler to quantify heavy metal particulate emissions during operation.

DQO TS-023 has been developed for VITPP Phase I environmental sampling and analysis of wastewater, off-gas, and glass product. The wastewater sampling will be used to confirm adequate pretreatment of the wastewater as necessary to ensure the site Advanced Wastewater Treatment (AWWT) system can further treat the stream to meet FEMP NPDES permit discharge limits. Wastewater analysis will be used to determine the means of treatment to be applied at the AWWT and includes measurements of metals, nitrates, pH, total suspended solids, and particle size distribution. Analytical results for the metals and nitrates will be reported in an ASL B data package, and the determinations of pH and total suspended solids will be reported within a data package with an ASL A.

Per DQO TS-023 for treated off-gas, off-gas is sampled for total metal particulate (lead, barium and chromium) prior to discharge to the atmosphere. Off-gas sampling during Phase I testing is not a regulatory requirement; however, an isokinetic sampler will be used to collect process data. The isokinetic filters will be sampled and analyzed for total metals at ASL B.

Per DQO TS-023 for glass product, glass samples will be taken from collection drums after the glass product has cooled. Sampling of the glass product will be based on operating intervals. Operating intervals include both steady and transitional states during (and between) glass formulas, melter operating temperatures, and glass production rates. The glass produced during each operating interval will be considered a separate glass population. Glass product analysis includes total metals, density, and TCLP for lead, barium and chromium. Significant concentrations of lead, barium (both added to surrogate glass) and chromium (from refractory corrosion/erosion) metals may make the glass subject to RCRA regulations. To meet waste acceptance criteria for disposal, the glass leachate must pass the RCRA TC regulatory limits (lead and chromium, 5 milligrams per liter, and barium, 100 milligrams per liter). (It is anticipated that the Phase I glass will contain all the lead and barium put into the surrogate feed. Since the intent is to dispose of the Phase I glass product as nonhazardous waste, it must pass TCLP metals testing to confirm that it does not exhibit a hazardous characteristic.) During gem form sampling, size and weight of the gems will be measured and recorded.

4.0 EXPERIMENTAL DESIGN

The objective of the first operational phase of the VITPP is to achieve design rates on a continuous basis and to determine steady state and optimum parameters. The majority of the VITPP Phase I testing will simply entail equipment operation, observation, and subsequent process correction. During some of the VITPP Phase I testing campaigns, lead, barium, phosphates, nitrates, and sulfates will be added to the surrogate material prior to being fed to the melter to more closely simulate the OU4 silo materials.

The bulk constituents in the waste are the primary determinants of the chemistry of the molten glass within the melter. The silo wastes were sent to Battelle Pacific Northwest Laboratory (PNL) in Richland, Washington, for elemental analysis. Concentrations of the elements were reported as oxides, which is a common convention in the glassmaking industry. The makeup of nonradioactive surrogates for the silo material is based on these analyses. Those constituents that had concentrations at or above 1/2 weight percent (oxide basis) were incorporated into the makeup of the nonradioactive surrogates. The minor constituents, below 1/2 weight percent, were considered to be below the concentration that would have significant impact on the glass chemistry. The minor constituents compose between 3 and 4 weight percent of the total weight of the silo wastes. Table 4-1 shows a comparison of the actual material and the nonradioactive surrogate mixes for each of the silos. These nonradioactive surrogates will be mixed in the appropriate proportions for each of the campaigns scheduled for Phase I testing of the VITPP.

These nonradioactive surrogates are expected to closely resemble the silo wastes with respect to the elemental makeup, melting points and glassmaking characteristics. The materials in the nonradioactive surrogates are the same as those in the silos where feasible and are very similar otherwise. For example, Table 4-1 shows that for both the actual Silo 1 and 2 material and the nonradioactive surrogate, content of silicon dioxide (SiO_2, sand) is approximately 60 weight percent. Lead oxide (PbO) content in the Silo 1 material and its nonradioactive surrogate is about 14 weight percent and in Silo 2 is about 7 weight percent. Content of barium oxide (BaO) in the silo material is about 7 weight percent for Silos 1 and 3 and 5 weight percent for Silo 2. Barium carbonate ($BaCO_3$) and barium sulfate ($BaSO_4$) are used in the nonradioactive surrogate to provide not only the barium but also needed quantities of CO_2 and SO_3. Also, barium is used as a nonradioactive surrogate for the small quantities of radium (about 4.5 kilograms) in Silos 1 and 2. The chemical behavior of barium is very similar to that of radium, as barium is the next heaviest element after radium in the same group on the periodic table. For Silo 3 material, silicon dioxide is used as in Silos 1 and 2 nonradioactive surrogates. Needed SO_3 is provided in the nonradioactive surrogate by sulfates of calcium, magnesium and sodium ($CaSO_4$, $MgSO_4$ and Na_2SO_4).

P_2O_5 is provided by magnesium phosphate, $Mg_3(PO_4)_2$. The magnesium in the magnesium oxide, MgO, is emulated with the aforementioned magnesium sulfate and magnesium phosphate.

Details of the VITPP Phase I operational testing are provided in the VITPP Phase I Test Plan (FERMCO 1996c). An overview summary of the planned test campaigns and their objectives is provided in Table 4-2. The initial nonradioactive surrogate recipes will be based on the results of the GTS Duratek-contracted work at VSL. The VITPP Phase I nonradioactive surrogate campaigns are structured so that the necessary data can be captured and evaluated for processing the actual K-65 and metal oxide materials scheduled for VITPP Phase II testing. To ensure that the characteristics of the extrapolated glass formulas (e.g., viscosity, conductance, and consistency) are within the capabilities of the pilot-scale melter, the empirical glass formulas have been verified with crucible melts and subsequent mini-melter runs. Glass formulas were adjusted during the glassmaking runs to minimize foaming, phase separation and other problems. These optimized formulas will be used in the VITPP Phase I campaigns.

Initial VITPP Phase I testing will process a benign glass to establish system and subsystem control of the process. Once process stability is achieved and VITPP start-up personnel are comfortable with controlling the processes, nonradioactive surrogate material will be introduced for the remaining VITPP Phase I campaigns. A detailed elaboration of the information in Table 4-2 follows.

4.1 CAMPAIGNS

The following are the currently planned campaigns that would establish glass formulations, operating base, and process control assurance prior to proceeding with Phase II testing and processing of actual radioactive materials. Also, these campaigns are designed to obtain scaleup data to support FRVP design.

Comparison of Actual Silo Materials and Surrogates

Table 4-1

	Silo 1		Silo 2		Silo 3	
Compound	Actual wt %	Surrogate wt %	Actual wt %	Surrogate wt %	Actual wt %	Surrogate wt %
Al2O3	3.00	3.15	3.99	4.15	6.03	6.29
BaO	7.27		3.52			
BaCO3		4.44				
BaSO4		6.35		5.58		
CO2	3.69		3.99		2.16	
CaO			2.93	0.63	5.34	
CaCO3				4.13		
CaSO4				0.28		13.55
Fe2O3					9.10	8.13
Fe2(SO4)3	2.88	3.02	7.16	7.45		3.43
K2O	0.78		0.80		2.05	
K2CO3		1.21		1.22		
KNO3						4.59
Li2O					0.53	
Li2CO3						1.38
MgO	1.38		2.00		11.37	
MgCO3		1.70		2.86		
MgSO4						7.36
Mg3(PO4)2		1.39		1.54		20.45
MnO2					0.76	0.80
N2O5			0.73		6.94	
Na2O	2.08		1.03		6.71	
Na2SO4						5.12
Na2CO3		3.72		1.10		3.45
NaNO3				1.19		7.54
NiO					0.59	0.62
P2O5	0.72		0.80		10.58	
PbO	13.85	14.52	7.28	7.57		
SO3	2.08		2.00		17.06	
SiO2	57.69	60.50	59.86	62.30	15.92	16.62
TiO2						
V2O5					0.63	0.66
Others, ea. < 0.5	4.58	–	3.91	–	4.24	–
	100.00	100.00	100.00	100.00	100.00	100.00

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TABLE 4-2

PHASE I TEST CAMPAIGN OVERVIEW

Campaign #	Run	Objective, Rationale, and Justification
1	1	Run benign slurry through melter and establish melter control (temperature, current, voltage, or power). The preferred control method is automatic adjustment of power in response to the in-bath thermocouple. It will be necessary to (1) determine the temperature profile through melter and the accuracy of the measurements, (2) establish alternate methods of melter control if the in-bath thermocouple is lost, (3) determine delayed temperature response during feed and idle conditions, and (4) determine response to mass flow rates of material into and out of the melter.
	2	It will be necessary to coordinate operation of the gem forming machine with that of the melter, to (1) confirm that good quality gems can consistently be made at various viscosities and glass flow rates, and (2) balance the auxiliary systems with the melter operation.
	3	Determine the melter's maximum capacity by slowly ramping up the slurry feed rate and power. Limiting conditions include (1) the melter electrode current or voltage becoming saturated, (2) cold cap size cannot be properly controlled, (3) the quality of the glass degrading, or (4) failure of the off-gas system to support the melter throughput.
2	1	This campaign includes the melter and gem forming machine acceptance test as required by the procurement specification. Continuous operation of the melter with a prescribed slurry for 36 hours is required. The acceptance test will be performed using Series D glass formula, including lead and barium.
	2	The Series D formula is designed to simulate a realistic, average blend of all the silos' constituents, including BentoGrout©. The glass recipe will be formulated for temperature as specified by VSL bench-scale testiing. The target melter temperature for this part of the campaign may be varied for data collection or correction of a variant condition (i.e., if glass is becoming too thick, foaming occurs, or precipitates start to form in glass).
3	1	This campaign includes the Series C formula that is designed to simulate the vitrification of Silo 3 residues. The glass will be formulated and the melter will be operated at temperatures as specified by VSL bench-scale testing. The main issues to be addressed include (1) a high sulfate and phosphate feed material, (2) glass devitrification, (3) acid scrubbing of the off-gas, (4) glass product quality, (5) feed rate (melter capacity), and (6) waste loading (percentage). The results of this test will be key inputs to FRVP melter design.

Campaign #	Run	Objective, Rationale, and Justification
4	1	The main issues to be addressed include (1) high concentrations of lead and barium in the feed, (2) control of the redox state of the melter, (3) performance of the thickener and the flocculant addition equipment, and (4) settling rate as a function of BentoGrout® concentration. The Series A formula part of this campaign is intended to simulate the vitrification of K-65 composition waste. Tests will be performed in the thickener to determine the thickening performance of the surrogate sand. Flocculant addition equipment will be tested and the settling rate for BentoGrout® as a function of flocculant addition will also be determined near the end of this campaign. The Series B formula part of this campaign is designed to simulate the vitrification of a blend of K-65 material and BentoGrout® (up to 50 wt%). The glass will be formulated and the melter will be operated at temperatures as specified by VSL bench-scale testing. The main issues to be addressed include (1) the high concentration of alumina in the BentoGrout®, which tends to increase the melting point and viscosity of the glass product, (2) glass product quality, (3) feed rate (melter capacity), and (4) waste loading (percentage). The results of this test will be key inputs to FRVP melter design.

4.1.1 Campaign 1 - Benign Glass

Campaign 1 will test the melter and gem forming machine with a nonhazardous batch mix or benign glass immediately following refractory bakeout. Adjustments, correlations, calibrations, and corrections can be made without the hindrances and hazards involved with the surrogate waste glasses. The benign glass formula(s) do not contain hazardous substances in the feed (lead and barium) and will not produce hazardous acid gases (e.g., SO_x and NO_x) like the succeeding nonradioactive surrogate campaigns. There is some potential for the glass to contain chromium from erosion or corrosion of the chromium-containing refractory brick used to line the melter; this will be monitored through sampling and analysis of the glass product.

The objective of this campaign is divided into three parts:

4.1.1.1 Establish Melter Control

During Run 1 of Campaign 1, the melter and glass melt parameters that can be measured and used as a means of control will be determined. The preferred parameter to measure and control is the viscosity of the molten glass in the melter (or molten bath). The next preferred parameter is the temperature of the molten bath. Such measurements will require the placement of thermocouples directly in the bath of the melt. However, this may not be possible after the benign glass run(s) because the melt may be too erosive for the thermocouples to survive. Therefore, indirect temperature measurements may be the best measurements possible for melter control. Transients or pulses will be introduced to determine how well and how quickly transients can be detected and process corrections can be made by the control system to bring the system back to normal conditions. This part of the campaign will determine the best means of control, establish thermocouple calibration, and establish temperature profiles as a function of power setting.

This campaign provides the opportunity to establish the relationship of actual bath temperature and indirect temperature measurements. Since higher temperatures are required to vitrify the surrogates in subsequent campaigns, the thermocouples may erode and dissolve into the glass before an accurate reading can be obtained. The correlation and understanding of in-bath temperatures as they relate to indirect temperatures taken within the melter walls are absolutely necessary to confirm that control of the melter can be maintained.

4.1.1.2 Synchronize Operation of the Melter and Gem Forming Machine.

Run 2 of Campaign 1 will establish and demonstrate that feed preparation, sampling, analysis, melter operation, and gem forming can be coordinated and sustained at the minimum production rate of 1 metric ton per day of glass output.

Synchronization of the melter with all the peripheral systems is required early in Phase I testing for Test Coordinators to understand what is required to stabilize operations and operate the facility as a complete system. Synchronization steps will be checked against operating procedures as a method to finalize procedures. Step-by-step actions will continuously be revised as needed throughout VITPP testing. However, initial controls of the process need to be as fully understood as practicable, and the best method to do this is by hands-on experience with the operation.

4.1.1.3 Ramp Operations Up To 3 Metric Tons/Day Glass Output.

A determination of the maximum operating capacity of the melter is extremely important information for FRVP design. Ramp-up will be Run 3 of Campaign 1. This information will be used as input to determine the fullscale remedial melter(s) size and design.

The melter capacity test will be run with a benign glass formula so that no hazardous gases are produced. The test is to be run so that vacuum is maintained on the melter. As with all other melter operations, the off-gas system will be used to minimize release of particulates.

To achieve steady state equilibrium, the melter needs to be sustained at this rate for a few days. This is due to the fact that it may take days for the new temperature profiles to stabilize throughout the melter (because of the melter's large mass and insulation). Restrictions that may impact determining the true melter capacity are analytical turnaround times and off-gas system capacity. The slurry mix tanks only hold enough feed to produce approximately one metric ton of glass. Therefore, VITPP Operations and Analytical Support Services must be capable of preparing and analyzing three batches of feed per day (one per shift) to support this run. The thickener tank will not be used during this campaign. The surrogate and additives will be pneumatically transported to the filter/receiver, which discharges directly into the slurry tanks.

In order for Campaign 1 to be successfully completed, the capabilities of the melter and gem forming machine must be known and the overall vitrification process kept under control.

4.1.2 Campaign 2 - Series D Glass Formula

4.1.2.1 Equipment Acceptance Testing

During Campaign 2 the melter and gem forming machine acceptance test will be performed. This testing will be performed according to the FERMCO-approved Acceptance Test Plan per the melter and the gem forming machine procurement specifications and the contracts with GTS Duratek. The formulation prescribed is for Series D glass as determined by results from VSL bench-scale testing. Campaign #1 will demonstrate that the melter and gem forming machine can melt glass at the prescribed rate. However, it does not demonstrate that the melter can vitrify simulated or actual silo materials. This campaign will demonstrate that the melter is capable of vitrifying this Series D formula feed material, which contains lead and barium compounds. The specification requires 36 hours of continuous operation of the melter to complete the test and 8 hours of continuous operation of the gem forming machine. It will take approximately three melter volumes to flush the melter bath before the melter actually contains the surrogate waste and the 36-hour test can begin. To help ensure compliance with the test specifications and the prescribed glass formula, the thickener tank will not be used during this campaign. To run this test and the following campaigns, the off-gas system has to be fully functional, with the exception of the radon removal system.

There is a potential for sulfate salts to form a layer on top of the melter bath. However, neither this campaign nor any other Phase I campaign includes testing of the sulfate drain to demonstrate a functional solution to an accumulation of molten sulfate salts. In the event that a full sulfate layer forms and causes process problems, the VITPP Phase I Test Plan provides recommendations for addressing this off-normal condition.

4.1.2.2 Melter Efficiency Test

Following the completion of the melter and gem machine Acceptance Test, Campaign 2 will further process the Series D glass formulation to test the melter efficiency under normal operating conditions.

4.1.3 Campaign 3 - Series C Glass Formula

The purpose of Campaign 3 is to collect the data and to establish the operating conditions necessary to control a feed high in sulfate, nitrate and phosphate content. This campaign will demonstrate several items related to feed composition.

- The effects of sulfate, nitrate and phosphate on the melter and glass formula
- SO_x and NO_x handling capabilities of the off-gas system
- Devitrification potentials of the glass formula and glass product

Feed preparation will not include the operation of the thickener tank. Ingredients will be transferred pneumatically to the slurry tank as dry feed via the additive transportation system. Water will be added to the batch to form a slurry (approximately 50 weight percent solids) that can be pumped to the melter.

Campaign 3 will also collect the data and establish the operating conditions to control the high sulfate, nitrate, and phosphate content of feed. The major concern with this part of the campaign is that destruction of sulfates at lower temperatures may not be possible. However, if the sulfates are destroyed and the electrodes remain intact (little or no erosion), a low-temperature melter design may be possible at reduced capital and operating cost. Also, easier scaleup and fewer melters may be possible, with further reductions in capital costs. To help ensure compliance with the test requirements and the prescribed glass formula, the thickener tank will not be used during this campaign.

4.1.4 Campaign 4 - Series A/Series B Glass Formula

The purpose of Campaign 4 is to collect data and establish the operating conditions that are required to control feed high in lead and barium content (both with and without BentoGrout® additions)and to demonstrate operation of the thickener (both with and without BentoGrout® additions). Campaign #4 is the only campaign in which the thickener will be used.

The focus of the Series A formula portion of Campaign 4 is to collect the data and to establish the operating conditions that are required to control high lead and barium content feed. Operation of the thickener will be initiated with Series A glass formula prior to the addition of BentoGrout® during the Series B portion of this campaign.

While the Series A nonradioactive surrogate will be placed in the thickener tank, the lead, barium, and water-soluble constituents will be introduced into the slurry mix tank(s). Powdered sand (silica) will be purchased to approximate the particle size of the silo waste. The surrogate will then be pumped from the underflow of the thickener tank to the slurry tank as a 40 - 50 weight percent solids slurry. Additives will be introduced at the slurry tank to adjust the batch to the predetermined composition prior to feeding to the melter for vitrification.

During the Series B portion of Campaign 4, BentoGrout® will be added to ramp up the BentoGrout® mix in the thickener tank from an initial 10 percent to approximately 25 percent BentoGrout® by weight. BentoGrout® is considered to be the most difficult constituent of the silo wastes for the thickener tank to handle. The purpose of this part of the campaign is to collect the data and to establish the operating conditions that are required to control the BentoGrout® that is included in the feed.

Settling of the BentoGrout® during thickener operation will be aided by a flocculant that is added to the thickener slurry. The surrogate will be pumped from the underflow of the thickener tank to the slurry mix tank as a 40-50 weight percent solids slurry. The BentoGrout® contains alumina, which drives up the melting point and viscosity of the glass melt. Additives and fluxes (sodium carbonate and calcium carbonate) will be added to the glass formulation to adjust the batch to the predetermined composition and to lower the melting point and viscosity of the glass melt to acceptable levels. Adjustments for conductivity may need to be made to be compatible with the melter.

As with Campaign 3, the major concern with the high sulfate content of the feed is that destruction of sulfates at lower temperatures may not be possible; therefore, the status of the sulfates will be closely monitored during the campaign. If the sulfates are destroyed and the electrodes survive with little or no erosion or deterioration, then a low temperature melter may be considered for the FRVP, allowing for easier scaleup with fewer melters for a considerable savings in capital and operating costs.

Table 4-3 provides a campaign summary.

TABLE 4-3
PHASE I CAMPAIGN SUMMARY

CAMPAIGN	SILO WASTE SURROGATE
0. Melter Bakeout	N/A
1. Benign Glass Part 1: Establish Melter Control Part 2: Synchronize Operation of the Melter and Gem Forming Machine Part 3: Ramp Operations up to 3 Tonnes/Day Glass Output	N/A
2. Series D Glass Formula* Part 1: Vendor Acceptance Test Part 2: Melter Efficiency Test	Simulated Silo 1, Silo 2 and Silo 3 material with 10% BentoGrout®
3. Series C Glass Formula*	Simulated Silo 3 material
4. Series A Glass Formula* Series B Glass Formula*	Simulated Silo 1 and Silo 2 material Simulated Silo 1 and Silo 2 material with varying amounts of BentoGrout®

* The Series A, B, C,and D glass formulas represent the optimized formulation based on VSL bench-scale testing at Catholic University. Melter operating temperatures will be as specified by VSL for each series glass formulation.

5.0 EQUIPMENT AND MATERIALS

5.1 MAJOR EQUIPMENT ITEMS

Table 5-1 provides a list of the major equipment items that have been installed to support the VITPP Phase I testing.

TABLE 5-1

VITRIFICATION PILOT PLANT PHASE I EQUIPMENT LIST

EQUIP NO.	DESCRIPTION	QTY	DESIGN CAPACITY
5-TK-01	THICKENER TANK	1	24,000 GAL
5-TH-02	THICKENER MECHANISM & RAKES	1	30 FT DIA
5-FL-03A,B	WASTEWATER FILTER	2	10 GPM
5-PM-04A,B	RESIDUE SLURRY PUMPS - THICKENER	2	40 GPM
5-AG-05A,B	SLURRY TANK AGITATORS	2	
5-SB-07/22	QUENCH TOWER AND SCRUBBER SYSTEM	1	120 SCFM
5-PM-09A,B	RECYCLE WATER PUMPS	2	130 GPM
5-TK-10	RECYCLE WATER TANK	1	5800 GAL
5-FU-17	MELTER	1	1-3 MTON/DAY
5-VL-18	DIVERTER VALVE - ADDITIVES	1	6000 LB/HR
5-DH-21	DESICCANT TOWER	1	250-500 SCFM
5-PM-23A,B	QUENCH TOWER PUMPS	2	60 GPM
5-BF-24	PRODUCT FORMING MACHINE	1	1-3 MTON/DAY
5-FA-25	EXHAUST FAN (VIT. OFF-GAS)	1	250-400 SCFM
5-CT-26	COOLING TOWER	1	200 GPM
5-HE-27	HEAT EXCHANGER	1	2E6 BTU/HR
5-PM-28	COOLING TOWER PUMP	1	220 GPM
5-TK-29A,B	SLURRY TANKS (VITRIFICATION)	2	700 GAL
5-TF-30	UNIT SUBSTATION-TRANSFORMER	1	2000 KVA
5-SG-31	HIGH VOLTAGE SWITCHGEAR	1	600 AMP
5-SG-32	LOW VOLTAGE SWITCHGEAR	1	3200 AMP
5-MC-33A,B	MOTOR CONTROL CENTER	2	600 AMP

TABLE 5-1 (Cont.)

VITRIFICATION PILOT PLANT PHASE I EQUIPMENT LIST			
EQUIP NO.	DESCRIPTION	QTY	DESIGN CAPACITY
5-PM-34A,B	SLURRY TANK PUMPS	2	40 GPM
5-FL-37	EMERGENCY OFF-GAS HEPA	1	615 CFM
5-FC-40	FLOCCULANT ADDITIVE SYSTEM	1	0-5 GPM
5-CN-41	MELTER ROOM MONORAIL	1	2 TON
5-GE-43	EMERGENCY GENERATOR	1	150 KW
5-CM-44	AIR COMPRESSORS	2	220 AND 500 SCFM @ 100PSI
5-BH-46	CONTAINERIZING EQUIP. (DRUMS)	1	1-3 MTON/DAY
5-CS-47	DATA ACQUISITION & CONTROL	1	1200 PTS
5-FL-48A,B	HEPA FILTERS - (VIT. OFF-GAS)	2	250-500 SCFM
5-PM-50A,B	BUILDING SUMP PUMPS	2	30 GPM
5-TK-56	SPARE STORAGE TANK	1	24,000 GAL
5-PM-57	SPARE STORAGE TANK PUMP	1	90 GPM
5-PM-58	SPARE STORAGE CONTAIN. PUMP	1	100 GPM
5-BG-64	BAG DUMP STATION - ADDITIVES	1	6000 LB/HR
5-DC-65	FILTER/RECEIVER - ADDITIVES	1	6000 LB/HR
5-BL-66	VACUUM BLOWER SYSTEM	1	350 CFM
5-PO-69	U.P.S. (DACS)	1	12.5 KVA
5-RV-71	ROTARY AIRLOCK - ADDITIVES	1	6000 LB/HR
5-SC-72	PLATFORM SCALE - ADDITIVES	1	330 LB
5-SU-74	BUILDING SUMP TANK	1	700 GAL
5-FL-85A,B	BUILDING HVAC HEPAS	2	6000 CFM
N/A	FILM COOLER	1	120 SCFM

N/A - Not Applicable

5.2 FEED MATERIALS

VITPP Start-up will use a benign glass for the initial melter operation. This will be followed by introduction of nonradioactive surrogate feed materials. The surrogate feeds will be formulated from the chemical compounds listed in Table 5-2. The table includes both the chemical formula and the common name for most of the listed compounds. Actual BentoGrout® will be used during Phase I.

TABLE 5-2

SURROGATE FEED CONSTITUENTS	
CHEMICAL FORMULA	**COMMON NAME**
Al_2O_3	Alumina
H_3BO_3	Boric Acid
$BaSO_4$	Barium Sulfate
$CaCO_3$	Calcium Carbonate
$CaSO_4$	Calcium Sulfate
Fe_2O_3	Iron Oxide
$Fe_2(SO_4)_3$	Iron Sulfate III
KNO_3	Potassium Nitrate
$MgSO_4$	Magnesium Sulfate
$Mg_3(PO_4)_2$	Magnesium Phosphate
MnO_2	Manganese Dioxide
$Na_2B_4O_7$	Borax
Na_2SO_4	Sodium Sulfate
Na_2CO_3	Sodium Carbonate
$NaNO_3$	Sodium Nitrate
NiO	Nickel Oxide
PbO	Lead Oxide
SiO_2	Silica Sand, 200+ Mesh
SiO_2	Silica Sand, 120-140 Mesh
SiO_2, Al_2O_3, MgO, Fe_2O_3, Na_2O, CaO, K_2O	BentoGrout® (commercial clay compound containing constituents shown here as oxides)
V_2O_5	Vanadium Pentoxide
ZrO_2	Zirconium Oxide
Co_2O_3	Cobalt Oxide
$(C_6H_{10}O_5)_n$	Potato Starch

6.0 SAMPLING AND ANALYSIS

6.1 PRECONSTRUCTION SAMPLING AND ANALYSIS

Geotechnical sampling was performed in the proposed construction location to determine soil characteristics. The geotechnical data were used to define foundation and construction requirements for the vitrification facility. Analyses performed for this activity included soil classification, moisture content, specific gravity, grain size analysis, Atterberg Limits, consolidation, California Bearing Ratio and maximum density. Results indicated the designated site is suitable for the planned building and construction activities. In addition, data from soil samples and borings taken from the areas around the silos over the last ten years were reviewed by a subcontracted geotechnical firm. Recommendations for bearing capacity, excavation slopes, lateral earth pressures, and settlements for design of the superstructure's foundations were made. This information is contained in a subcontractor-issued report (ATEC Associates, Inc. 22-03-92-00024).

Preconstruction soil sampling was performed in accordance with an approved site Sampling Plan (EM&S-SMPLN-93-278) to establish RCRA waste characteristics and radiological contamination of the soil in the area of the VITPP footprint located east of the K-65 Silos. Soil samples were taken at the surface and at depths of one foot and five feet. The soil was analyzed for TCLP metals, TCLP Volatile Organic Analytes (VOAs), TCLP semi-VOAs, and the following radiological constituents:

Total uranium	Total thorium
U-234	Th-228
U-235	Th-230
U-236	Th-232
U-238	Ra-226

The soil was characterized based on a statistical analysis of the data from the analyses of the samples identified in site media sampling plan 93-278. Also, the historical data from soil borings in the vicinity of the utility tie-in area were retrieved from site data sources. The data were analyzed, and a characterization summary was issued as an internal memorandum [M:ESH:(EP):94-0049]. Only one nonradiological constituent was detected in the sample population, that being methyl ethyl ketone (MEK) at a statistical mean of 0.11 parts per million. All detection limits for nonradiological analytes were well below the regulatory levels. Activity levels for radioactive isotopes were reported at 2.8 picocuries per gram or lower (statistical mean).

The following excerpts of text from the Process Knowledge File Narrative for this project concluded:

> *"Soils generated from project activities will come from a relatively large area which includes the pilot plant location itself, the immediate ground around the access road leading to the silos, and the utility tie-in locations in the vicinity of the intersection of "A" and "2nd" streets. Facilities in the vicinity of these locations did not historically work with materials or processes which would have caused surrounding soils to contain listed wastes through spills or other application to the ground. A review of existing spill report data for the areas in question showed no reason to suspect the presence of hazardous substances in the soil. The only surface unit in the vicinity of the project area is the Bio-Surge Lagoon. Material from the Bio-Surge Lagoon has been characterized under MEF 1532.* ...... and .....
>
> *All waste material projected to be generated from the project operations is determined to be RCRA non-hazardous. The projected waste streams for this project match the material and regulatory profiles documented in the Material Evaluation Forms (MEFs) contained in the project file. ...."*

However, since the revelation of preconstruction unknowns is always possible, the following caveat from the Sampling and Analysis Narrative text concluded:

> *"Radiological sampling and/or survey may be required at the time of shipment to a disposal facility at the discretion of Radiological Assessment."*

6.2 START-UP AND OPERATIONAL SAMPLING AND ANALYSIS

Samples will be collected during start-up and Phase I operation of the VITPP to generate physical and analytical data for four purposes: process control of the VITPP, support design of the FRVP, evaluate effectiveness of environmental controls, and the development of reports. Specific sampling points, media, rationale, and frequencies planned for Phase I of VITPP operations are listed in Table 6-1 and discussed in detail in the project specific plan (FERMCO 1995d).

The most common sampling and analysis activity during VITPP Phase I Start-up and Operations will be for percent solids. Each process stream will be sampled for percent solids during start-up, and then at least once per shift during operation and at higher frequencies as needed to identify optimum operating parameters.

The glass product will be sampled at least once per batch and more frequently during early operations. The product will be visually inspected for a "glassy" well-vitrified appearance and for evidence of phase separation. Visual examination of fractured specimens will provide clues as to the uniformity of the glass product. In addition, TCLP analysis will be conducted to evaluate leachability of lead, barium, and chromium.

To provide data for process control components of the off-gas system, calibrated in-line continuous-monitoring devices have been installed. Temperature (at the Quench Tower) and humidity (at the Desiccant Tower) of the off-gas are monitored both in the VITPP control room and routinely in the field. The in-line monitoring devices are regularly calibrated by experienced, knowledgeable specialists, and regular maintenance activities are scheduled to support operations activities. The information generated by the continuous, in-line monitoring is reviewed in combination with analytical data to determine the effectiveness of the off-gas treatment system.

Sampling and analytical data on the pH, alkalinity, and sulfate and nitrate concentration of the spent scrubber liquor will provide project scientists and engineers the analytical data required to determine the efficiency of the scrubber. Adjustments to the system will be made based on calculations and recommendations of project personnel.

TABLE 6-1

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I

SAMPLE PORT	SAMPLING MEDIA	ANALYSIS	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S1	Wastewater Filter Effluent	Metals - Ba, Pb, Cr	Provide information to AWWT	1/week	B^c	μg/l
		pH	Provide data for FRVP design	1/week	A	pH
		Nitrates		1/week	B	mg/l
		Total Suspended Solids and Size Distribution	Possible recycle of water Provide data for FRVP design	1/week	A	wt % solids & % passing
S3	Slurry in the Thickener Underflow Line to the Slurry Tanks	Percent Total Solids	Measure Thickener Performance	1 to 10/batch	A	wt % solids
		Percent Suspended Solids		1 to 10/batch	A	wt % solids
		Size of Largest 5% of Particles	Provide data for FRVP design	1 to 10/batch	A	mm
		Density of Largest 5% of Particles		1 to 10/batch	A	g/ml
		Density		1 to 10/batch	A	g/ml

000078

TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I						
SAMPLE PORT	**SAMPLING MEDIA**	**ANALYSIS**	**RATIONALE / OBJECTIVE**	**FREQUENCY**	**ASL**	**UNITS**
S4A/B	Slurry in the Slurry Tanks	Carbonates	Determine type and amount of additives required	2/batch	A	wt % solids
		Sulfur	Verify the batch makeup	2/batch	A	wt % solids
		Total Metals		2/batch	B[c]	wt % solids & mg/l
		Wet Density	Verify 50% solids	2/batch	A	g/ml
		Nitrates		1/batch	A	mg/l
		Percent Total Solids	Provide data for FRVP design	2/batch	A	wt % solids
		Viscosity	Verify glass characteristics with crucible tests	1/batch	A	poise
		Conductivity		1/batch	A	siemens/cm
		Liquidus Temperature	Provide data for FRVP design	1/batch	A	°F
		Glass Density		1/batch	A	g/ml

TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I

SAMPLE PORT	SAMPLING MEDIA	ANALYSIS	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S5	Slurry in the Melter Feed Line	Density	Verify percent solids present within the slurry	1 or 2/batch	A	mg/l
		Percent Total Solids	Provide data for FRVP design	1 or 2/batch	A	wt % solids
		Particle Size Distribution		1 or 2/batch	A	% passing
		Density of Largest 5% of Particles		1 or 2/batch	A	mg/l
S6	Quench Tower Discharge Water	Total Suspended Solids	Determine suspended solids	6/week	A	mg/l
		pH	Field determination of pH	1/Shift	A	pH
		Total Dissolved Solids	Measure buildup of soluble salts in the recycle loop	6/week	A	mg/l
		Soluble Sulfates	Monitor the buildup of sulfates and nitrates in the recycle water	1/batch	A	mg/l
		Insoluble sulfates		1/batch	A	mg/l
		Nitrates		1/batch	A	mg/l
		Total Metals	Determine metals for material balance	6/week	B[c]	µg/l

TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I						
SAMPLE PORT	SAMPLING MEDIA	ANALYSIS	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S7	Scrubber Reagent	Alkalinity/pH	Control of scrubbing operation	3/day	A	mg/l & pH
		Density	Determine salt content for process control.	3/day	A	mg/ml
		Soluble Sulfates	Provide data for FRVP design	3/day	A	mg/l
		Insoluble Sulfates	Monitor buildup of sulfates and nitrates in recycle water	3/day	A	mg/l
		Nitrates		3/day	A	mg/l
		Total Metals		3/day	A	mg/l

000081

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TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I

SAMPLE PORT	SAMPLING MEDIA	ANALYSIS	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S10	Glass Gems and Monolith	TCLP Metals - Ba, Pb, Cr	Leachability for RCRA	1/batch or glass population	C[c]	mg/l
		Total Metals	Material balance Process control Provide data for FRVP design	1/batch	A	wt% solids
		Bulk Density		1/batch	A	g/ml
		Glass output		as produced	A	lbs
		Gem Characteristics (dimensions, weight)		1/batch	A	mm, g
		Specific Gravity of Gems		1/batch	A	None
S12	Exhaust Stack Emissions	Isokinetic Monitoring (Ba, Pb, Cr)	Quantify and identify particulates released in the off-gas.	2/Month of Operation	B[c,d]	mg/l
S14	Recycle Water	pH	Control water chemistry	3/day	A	pH
		Percent Suspended Solids, and Size Distribution	Determine thickener effectiveness	3/day	A	%wt solids mg/l %passing
		Total Dissolved Solids	Measure buildup of soluble salts in the recycle loop	3/day	A	mg/l

TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I						
SAMPLE PORT	SAMPLING MEDIA	ANALYSIS	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S14 (Cont.)		Soluble Sulfates	Provide data for FRVP design	1/batch	A	mg/l
		Insoluble sulfates		1/batch	A	mg/l
		Nitrates		1/batch	A	mg/l
		Total Metals	Material balance	6/week	B[c]	mg/l
S15	Cooling Tower Water	Total Dissolved Solids	To determine buildup of soluble salts in the recycle loop	1/week	A	mg/l
		Water Chemistry	Adjust water chemistry	1/week	A	mg/l
		pH		1/week	A	pH
		Total Suspended Solids	To determine buildup of insoluble solids in the cooling water	1/week	A	mg/l
S16	Thickener Overflow	Percent Suspended Solids	To measure thickener effectiveness	3/day	A	%wt solids
		Percent Dissolved Solids	To determine the buildup of soluble salts in the recycle loop	3/day	A	wt% solids
		pH	Control water chemistry	3/day	A	pH
		Particle Size Distribution	To measure thickener effectiveness	3/day	A	% passing

TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I

SAMPLE PORT	SAMPLING MEDIA	ANALYSIS	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S17	Building Sump Effluent	Metals - Ba, Pb, Cr	Provide information to AWWT	1/week	B[c]	mg/l
		Nitrate		1/week	B[c]	mg/l
		pH		1/week	A	pH
		Total Dissolved Solids		1/week	A	mg/l
		Total Suspended Solids		1/week	A	mg/l
S20	Spare Storage Tank	Total Metals	Determine usage or disposition of material in tank. (Analyses may be selected as appropriate for actual tank usage.)	As necessary	B	mg/l
		Nitrate			B	mg/l
		pH			A	pH
		Total Solids			A	wt% Solids
		Phosphate			A	mg/l
		Sulfate			A	mg/l
		Total Suspended Solids			A	wt% Solids

TABLE 6-1 (Cont.)

SAMPLING AND ANALYSIS DURING VITRIFICATION PILOT PLANT PHASE I

SAMPLE PORT	SAMPLING MEDIA	ANALYSIS[a]	RATIONALE / OBJECTIVE	FREQUENCY	ASL	UNITS
S21	Electrode Holder Cooling Fluid	Alkalinity	Maintain quality of the electrode holder cooling fluid.	1/week	A	mg/l
		Total Dissolved Solids		1/week	A	mg/l
		Total Suspended Solids		1/week	A	mg/l
		Hardness		1/week	A	mg/l
		pH		1/week	A	pH
		Iron		1/week	A	mg/l
		Oils/Grease		1/week	A	mg/l

a - A crucible test includes measuring the electrical conductivity, viscosity, and liquidus temperature of the molten glass.
b - TBD - to be determined
c - A field duplicate sample will be collected for every ten samples.
d - A field blank and matrix spike will be prepared every second round of sampling.

Isokinetic sampling will be used to collect particulate samples from off-gas in the stack. The sample will be continuously drawn through a filter to collect particulate matter for analysis, and total metals will be determined. Although no radionuclide particulates will be present during VITPP Phase I, the isokinetic sampler will be calibrated and tested under Phase I operating conditions in preparation for VITPP Phase II operation. Because metals that fall under the jurisdiction of RCRA (lead and barium) are present in the feed material and chromium is present in the melter's refractory lining, particulates from the isokinetic sampler will be analyzed for these constituents.

The cooling tower blowdown will be regularly sampled and analyzed for total dissolved solids. Dissolved solids will be maintained, via the amount of blowdown, at a low enough level to minimize fouling of heat exchanger surfaces.

6.3 SAMPLING METHODOLOGY

The PSP has been developed to support the Operable Unit 4 VITPP Phase I Treatability Study. The PSP outlines the sampling and analysis of nonradiological surrogate material (consisting of silica, BentoGrout®, and additives to simulate the nonradiological components of the silo residues), recycle water, off-gas filters, and the glass to be produced in the VITPP during Phase I Operations. The PSP identifies analytical parameters and associated sample volumes, container types, preservatives, quality control samples, ASL requirements, and hold times. Sampling will be conducted at a minimum of 15 sample port and monitoring locations in the process. Sampling procedures will identify and address safety hazards associated with each sampling location. All field activities shall be driven by field level procedures which will identify the appropriate personal protective equipment (PPE) and other safety requirements. The sample port locations are shown in Figure 2-2.

The sampling and analysis activities specified in the PSP support the VITPP Phase I Treatability Study by providing analytical results to support the demonstration of the pilot plant equipment as well as the vitrification technologies and methodologies being proposed for the remediation of the K-65 and Silo 3 residues. In addition to the samples that are taken to support VITPP process control and the FRVP design, samples will be taken to determine effectiveness of environmental controls. Environmental sampling and analysis will be performed on the glass product, the wastewater, and the off-gas.

The regulatory drivers for sampling are listed below:

- Resource Conservation and Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- National Pollutant Discharge Elimination System (NPDES) Permit
- Ohio Administrative Code (OAC) 3745-1-07, 3745-31-05(A)3
- Ohio Revised Code (ORC) 3704.01-.05
- Occupation Safety and Health Act (OSHA)
- Hazardous Materials Transportation Act (HMTA)
- EPA "Guide for Conducting Treatability Studies under CERCLA," Final (EPA/540/R-92/071a, October 1992, and OSWER Directive No. 9380.2-10, November 1992)

Sample collection procedures and sample quantities will be in accordance with Appendix K of the SCQ (DOE 1993b), as necessary. Samples collected and analyzed for process control and not for regulatory reporting do not require the conditions specified in the SCQ to be satisfied for the data users. Sample collection procedures shall also address health and safety hazards associated with each sample port. For safety reasons, plastic sample containers shall be used exclusively.

6.4 ANALYTICAL METHODS

To the extent possible, analytical methods from the SCQ will be utilized. Additional process and analytical procedures have been developed in a joint effort between VITPP engineers and FERMCO laboratory personnel to meet the specific needs of the project. These procedures have been reviewed and approved, as required by the SCQ-Quality Assurance, prior to their implementation. The level of confidence in the analytical methods used for the VITPP program meets the needs of the end users and is comparable to confidence levels in SCQ methods. Analytical methods that will be used for samples from the VITPP are shown in Table 6-2.

TABLE 6-2

ANALYTICAL METHODS

PARAMETER	ANALYTICAL METHOD
Aluminum	AA/ICP Method SW 846-6010A
Barium	AA/ICP Method SW 846-6010A
Boron	AA/ICP Method SW 846-6010A
Calcium	AA/ICP Method SW 846-6010A
Chromium	AA/ICP Method SW 846-6010A
Iron	AA/ICP Method SW 846-6010A
Lead	GFAA Method SW 846-7421
Lithium	AA/ICP Method SW 846-6010A
Magnesium	AA/ICP Method SW 846-6010A
Manganese	AA/ICP Method SW 846-6010A
Nickel	AA/ICP Method SW 846-6010A
Phosphorous	AA/ICP Method SW 846-6010A
Potassium	AA/ICP Method 9043
Silicon	AA/ICP Method 256-S-0003
Sodium	AA/ICP Method 9043
Vanadium	AA/ICP Method SW 846-6010A
Zirconium	AA/ICP Method SW 846-6010A

TABLE 6-2

ANALYTICAL METHODS
(Cont.)

Nitrate	EPA standard methods 353.1 and 353.2
Total Suspended Solids	EPA standard method 160.2 or 254D
Sieve Test/Particle Size Distribution	Site Procedure Method No. 9158
Density	Weight, volume SCQ Appendix G
Percent Suspended Solids	EPA standard method 160.2 or 2540B
Total Solids	EPA Standard Method 160.3
Carbonate	Titration EPA Standard Method 310.1 or 2320B
Soluble Sulfate	Site Method 43M-1027
Viscosity	Site Procedures 25-PR-0002 and 25-PR-0005
Conductivity	Site Procedures 25-PR-0002 and 25-PR-0006
Liquidus Temperature	Site Procedures 25-PR-0002 and 25-PR-0008
Total Dissolved Solids	EPA Standard Method 160.1 or 2540
Insoluble Sulfates	Site Procedure 25-PR-0015
Alkalinity	Titration EPA Standard Method 310.1 or 2320B
TCLP Metals	EPA Standard Method 1311, Prep. Method 1250
Phosphate	EPA Standard Methods 300.00 and 375.2
Hardness	EPA Standard Method 2340C
Iron	SW 846-3010 or 7760
Oils/Grease	SW 846-9070

6.5 DATA QUALITY OBJECTIVES AND ANALYTICAL SUPPORT LEVELS

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required to support decision making. The end use of the data to be collected requires different levels of data quality documentation. Three levels of data quality documentation have been specified for the VITPP Phase I sampling and analysis program: Analytical Support Level (ASL) A, ASL B, and ASL C, in order of increasing quality level documentation. Data packages with ASL A are generated for real time (short turnaround time) results to support plant operations and for similar purposes. Data packages with ASL B range from having a few more quality control checks than packages with ASL A to having nearly as much QA/QC as data packages with ASL C. Data packages with ASL B can be released with short turnaround times with documented QA checks and QC protocols. Data packages with ASL C include data with full QA checks and QC protocols such as for TCLP metals. For data packages with ASL C, laboratories are required to maintain raw instrument data in a project file for validation purposes.

Based on the requirements of Section 3.0 and Section 4.0, a Data Quality Objectives (DQO) document has been developed for sampling, analysis, and data management for environmental sampling and analysis performed in association with this Work Plan. After reviewing the SCQ and consulting QA personnel, VITPP project personnel selected the ASL required for each type of data package based on the planned use of the resulting data. As indicated by DQO TS-023, the analytical data associated with wastewater and off-gas will be reported with ASL B packages. The supporting field sampling documentation will be provided to project scientists and engineers along with the analytical data. DQO TS-023 also indicates that the TCLP metal analytical data will be reported with an ASL C data package. FERMCO Data Validation will review the analytical data package and the field data package, as will project personnel. End use data will be presented according to the SCQ qualitative and quantitative statements for data quality. Data validation process requirements for review and qualification of the analytical data are presented in Section 11.0, as well as appropriate sections of Appendix D of the SCQ (DOE 1993b).

6.6 QUALITY ASSURANCE REQUIREMENTS

Quality Assurance for the Phase I program will be in accordance with quality program elements identified in FERMCO RM-0012, "Quality Assurance Program Description," for the management of the program. The SCQ will be used for quality program elements for sampling, analysis, and data reporting activities covered by this Work Plan. For TCLP metals testing, quality assurance shall be guided by 40 CFR Part 261, Appendix II.

Project-specific quality elements are addressed in the Quality Assurance Job Specific Plan (QAJSP), 25-WP-0016 (FERMCO 1995e). This plan addresses the Program Criteria of RM-0012 and Quality Assurance (QA) Performance to support this Work Plan.

QA personnel are assigned field positions and will be involved with the continuous operation of the VITPP. QA personnel will review field sampling documentation and will be involved in the approval process for variances to the sampling and analysis program. Analytical data reported with ASL C packages will be reviewed by the FERMCO Data Validation group.

6.7 DATA REDUCTION, VERIFICATION AND QUANTIFICATION

Data reduction, verification, and quantification will be conducted according to Sections 7.0 and 8.0 of this Work Plan and Appendix D of the SCQ. Field sampling and monitoring information will be reviewed regularly by independent reviewers and project personnel. The project testing and data management organization will file, track, and report developing trends to the project scientists and engineers.

6.8 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of the activities covered by this Work Plan will be performed in accordance with Section 12.0 of the SCQ and FERMCO RM-0012. Per the Quality Assurance Job Specific Plan (QAJSP) for the VITPP project (FERMCO 1995e), self-assessment in the form of surveillances will be scheduled and performed by the VITPP organization, and independent audits will be scheduled and performed by FERMCO QA. The QAJSP also allows for independent audits by either DOE, EPA or both.

6.9 CALCULATIONS OF DATA QUALITY INDICATORS

Equations to calculate data quality indicators and results determining instrument linearity, ongoing instrument calibration compliance, precision, and accuracy will be performed in accordance with the requirements of Section 14.0 of the SCQ. VITPP project instrument mechanics and engineers will document all calibrations, operability testing, and maintenance activities performed on facility instrumentation.

6.10 CORRECTIVE ACTION

Corrective actions will be performed in accordance with the requirements of Section 15.0 of the SCQ and FERMCO Quality Assurance Programs and Procedures. VITPP operations personnel, in coordination with Project QA personnel, will log, track, and document all deviations from the project work plan, test plan, and project specific plan in accordance with the governing QA documents.

6.11 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Section 16.0 of the SCQ will be used to direct activities for requirements of quality reports to management. As indicated in subsection 16.2 of the SCQ, VITPP project QA personnel shall notify VITPP project management of field audit and surveillance results, performance of measurement systems, data quality, results of QA activities, and significant QA problems. This notification will be in the form of routine distribution of surveillance and audit reports, deviation reports, corrective action reports, and weekly and monthly activity reports. Records of QA activities in support of the VITPP project shall become part of the VITPP project files.

7.0 DATA MANAGEMENT

Data and records generated during Phase I will be used to support Phase I Operations, Phase II Operational Planning, and full scale vitrification plant design. Data will be managed in accordance with Section 4.4 of the FEMP Records and Document Control Administration procedures (as applicable), applicable sections of Appendix F of the SCQ (DOE 1993b), and with applicable project documents. Field and laboratory data collected as part of Phase I will be maintained and recorded in accordance with applicable SCQ requirements. Phase I process operational tests and engineering design data will be managed in accordance with FEMP and Project Records Management requirements.

When so designated, field and laboratory records will be maintained in logbooks or on SCQ forms that are reviewed, signed and dated by the responsible persons. Currently identified reviews include Quality Control reviews of field-generated records, laboratory reviews of analysis records generated, and data validation records generated on data required to be validated by this project plan. Where necessary, the project will generate records using forms that will identify Phase I operational testing requirements; equipment calibration and preventive maintenance; verification of numerical results; checks for data entries, transcriptions and calculations; and records of training performed.

VITPP project personnel and FERMCO computer programming personnel have developed a database which will be utilized to track and report field- and laboratory-generated data. The VITPP project Testing and Data Management Group is prepared to transfer field data from logbooks, round sheets, and shift turnover logs. The data will be verified for accuracy and reviewed for trends. Reports will be generated to provide operations and design personnel with necessary information. The report-system design for the VITPP database can easily produce reports trending any single or related data points for the VITPP.

The project-specific data management program has been verified and validated. Data will be backed up on disks, and printouts of processed data will be filed in appropriately labeled binders or notebooks as required by the SCQ. Based on the requirements of Sections 12.0 and 14.0 of the SCQ, quality records generated for this project will be identified, and information on corrective actions taken will be provided in final reports, if applicable. These records will be managed in accordance with SCQ and Document Control program requirements.

8.0 DATA ANALYSIS AND INTERPRETATION

Preconstruction data generated for engineering designs were reviewed by engineering personnel for use in design work and required no further analysis and interpretation. Preconstruction sampling and analysis data generated to provide characterization for RCRA and radiological programs were validated according to the requirements of the FEMP Data Validation Program. Field sampling documents were reviewed by the FEMP Quality Control organization to verify completeness and intercomparability of information.

VITPP operating personnel will receive the process control data generated from physical and chemical analyses of samples collected for process control during VITPP Start-up and Operations. Laboratory personnel will provide the data to VITPP personnel in a timely manner to support continuous operation of the process equipment. For example, key parameters of the feed stream (elemental makeup, density, etc.) will be determined through analysis. VITPP engineers will then use these data to determine both the amount of additives necessary to make glass of the required formulation and the operating parameters (feed rate, melter voltage and amperage, etc.) for the system. These determinations will be assisted by computer spreadsheets developed by the VITPP engineers that model the operation of the system. Data required for process control will be reported in ASL A or ASL B data packages, which are sufficient for the use of these data. Process data that are not needed to support environmental regulatory requirements will not undergo rigorous QA/QC validation.

Environmental Compliance and VITPP program personnel will receive copies of the results of the analyses of environmental samples collected during VITPP Phase I Start-up and Operations. With the exception of metals analyses on the glass, the data will be reported in ASL B data packages. TCLP metals analysis for the glass product will be reported in ASL C data packages. Data validation personnel will validate ASL C data packages. These data will be used to provide evidence that the glass product meets waste acceptance criteria at the disposal facility.

Personnel who are responsible for the design of the FRVP will also receive copies of the physical and chemical data generated from samples collected during VITPP Phase I Start-up and Operations. VITPP and FRVP engineers will evaluate the data to determine performance and key parameters with their appropriate values. Expected values have been theoretically determined for most of the key parameters and incorporated into data mapping and evaluation documentation. The theoretical values will be compared against empirical values, and adjustments to the modeling and calculations will be made as necessary so values can be accurately predicted and provide a firm design basis for the full-scale facility. The majority of the analytical data will be reported in ASL A and ASL B packages.

Sampling and analysis data from Phase I Start-up and Operations will be analyzed based on performance and the data quality objectives identified in Section 3.0. As stated in the SCQ (DOE 1993b), data generated by the activities defined in this work plan under ASL A and ASL B to support design and Phase I operation will not require validation.

9.0 HEALTH AND SAFETY

Per DOE Orders, a series of documents was prepared to govern the health and safety aspects of the VITPP project. An OU4 General Health and Safety Plan (FERMCO 1994a) was developed that governs all generic OU4 activities. A Project Specific Health and Safety Plan was developed for each VITPP Phase I construction subcontract. An Auditable Safety Record (FERMCO 1996a) was developed for VITPP Phase I operations. In addition, all project specific health and safety requirements will be included in SOPs and standing orders as well as a health and safety matrix for VITPP Phase I.

Per DOE Order 5480.23, the VITPP project requires a formal safety analysis and review. A "Preliminary Safety Analysis Report for Operable Unit 4" (FERMCO 1994b) was approved by DOE. The Preliminary Safety Analysis Report (PSAR) provided the safety basis for the construction of the VITPP. The safety basis included the design objectives and those measures necessary to ensure that the facilities was constructed and will be operated in a safe manner and in compliance with applicable laws, regulations, and DOE orders. Based on the analysis contained in the PSAR, the risks associated with construction and Phase I operation of the VITPP are within the limits defined in the applicable regulations, DOE orders, and proposed standard DOE-DP-STD-3005-93, "DOE Standard, Definitions and Criteria for Accident Analysis," March 8, 1993.

The Auditable Safety Record or ASR (FERMCO 1996a) addresses health and safety hazards routinely encountered in the VITPP. The ASR includes a detailed hazard analysis, in which hazards and their causes are identified, consequences are analyzed, and corrective actions and mitigating factors are described.

As a result of the hazard analysis in the ASR, the VITPP, under Phase I configuration and operation, is categorized as an Industrial Facility in accordance with DOE-STD-5502-94. No radiological materials are involved in Phase I and there is little potential to exceed guidelines in the event of a chemical release. All hazards associated with Phase I are considered standard industrial hazards. The high temperatures and electrical power supply of the melter are the primary hazards. The engineered and administrative controls implemented to protect workers from these and other facility hazards are discussed in the ASR. Operational readiness has been addressed by a Readiness Assessment (RA). No major findings were identified during the RA. Observations were corrected satisfactorily before the start of melter bakeout. None of the silos or other facilities located in OU4 are involved in Phase I activities.

Existing OU4 facilities and the VITPP are isolated from the balance of the FEMP site both geographically and operationally. The site/facility interactions are access control, emergency response, laboratory support, and transportation activities. There are no facility interactions identified that pose a potential safety hazard in another facility in OU4 or the FEMP site.

10.0 RESIDUALS MANAGEMENT

10.1 WASTE CHARACTERIZATION

This section describes the management of residual materials resulting from VITPP construction and Phase I operations. Sampling locations and parameters are identified in Section 6.0. Regulatory applicable or relevant and appropriate requirements (ARARs) for management of residuals are described in Section 11.0 and listed in Appendix B.

Waste characterization will be performed in accordance with existing site procedures to determine the type of waste management that is required. Generally, it is desirable that project waste be identified and characterized prior to its actual generation. Characterization of waste generated during construction projects, including soils, is currently performed according to FERMCO Environmental Restoration and Waste Management Procedure EW-0006, "Management of Excess Soil, Debris and Waste from a Project." The Project initiated this process by completing the Construction Waste Identification/Disposition (CWID) form, which identified the types of waste and approximate quantities that were expected to be generated during the construction phase of the Project. Characterization of all waste generated at the FEMP is documented on a Material Evaluation Form (MEF). The MEF and its associated documentation fully identify the waste, including any restrictions and regulatory requirements that apply to each waste stream. Information contained in the MEF is used to identify the required container type, labels and markings, storage restrictions, and ultimately the management/disposal method(s) that will be applied to the waste.

The completed CWID was forwarded to the FERMCO Waste Characterization group, where the waste identified on the form was matched to currently characterized waste streams documented in MEFs. This process may involve the use of any of the following techniques to verify that the waste to be generated during a project will match the waste stream profiles documented in MEFs.

- Review of existing process knowledge, documentation and project files
- Review of historical sampling data which pertains to the project area or waste material
- Sampling and analysis of materials within the project area

Frequent contact between project personnel and the Waste Characterization group is required to ensure that the necessary information, forms, and work assignments are communicated clearly and expeditiously. In the event that a waste material does not match an existing MEF profile, the Project is required to initiate a new MEF. This process is conducted per FERMCO procedure EW-0001, "Initiating Waste Characterization Activities Using the MEF." When all waste materials identified on the CWID have been assigned to completed MEFs, the Waste Characterization group issues a summary letter, which identifies the final characterization and specific MEF assigned to each. In the event that SSOPs, forms, group names, or responsibilities referenced above are changed, then waste generated through this project will be characterized according to the most recent approved procedures.

The following construction activities performed during Phase I generated waste requiring characterization via procedure EW-0006.

- Trenching, earth moving and grading
- Vitrification facility construction
- Equipment installation

Waste streams generated during the activities listed above included those listed below.

- Soil
- Rubble (concrete, blocks, refactory brick, etc.)
- Scrap metal
- Miscellaneous liquids (excess solvents, paints, thinners, etc.)
- Scrap wood
- Miscellaneous trash (paper, plastic, PPE, drywall, tile, etc.)
- Conduit/wiring
- Oil solvents and sweeping compounds

The following streams are expected to be generated during operation of the VITPP during Phase I and will require characterization via procedure EW-0001.

- Vitrified surrogate material
- Nonvitrified surrogate material (bentonite, silica, water, etc.)
- HEPA filter cartridges
- Wastewater filter media
- Laboratory waste
- Miscellaneous trash (PPE, paper)

Liquid waste streams which will be generated during Phase I and will combine in the Building Sump Tank prior to discharge for final treatment at the AWWT include those below.

- Pretreated process wastewater
- Cooling tower blowdown
- Used desiccant
- Sink drainage
- Scrubber purge
- Stormwater

This combined waste stream will be routinely characterized as described in Section 6.0, Sampling and Analysis.

10.2 WASTE DISPOSITION

Waste disposition is dictated by characterization of the identified waste stream as described in Section 10.1. Therefore, final disposition of the waste cannot be specified until characterization is complete. Listed below are potential categories of characterized waste with corresponding disposal options. Management and disposition of all wastes will be in accordance with the OU4 ROD and associated ARARs and TBCs. Management and disposal of soil and debris will be in accordance with the OU5 and OU3 RODs, respectively, the Removal Action 17 Work Plan (DOE 1995), site procedures, and OU4 ARARs.

- Process wastewater - pumped to the FEMP Advanced Wastewater Treatment (AWWT) System.

- Accumulated stormwater - pumped to the FEMP AWWT System or (for Phase I, Campaign 1 only) to the waste pit area stormwater runoff collection system.

- Soil and debris - all soil and debris will be collected and managed in accordance with the requirements specified by EW-0006 and the Removal Action 17 Work Plan (as revised), and OU3 and OU5 RODs as appropriate.

- Low level radioactive waste (if any) - disposed at NTS or properly stored on-site until alternate, appropriate disposal methods or facilities are identified.

- Nonhazardous, nonradioactive waste - recycled or properly stored on-site until appropriate disposal methods or facilities are identified.

- Hazardous, nonradioactive waste - properly managed on-site in accordance with RCRA requirements until appropriate disposal methods or facilities are identified.

- Mixed waste (if any) - properly managed on-site in accordance with RCRA requirements until appropriate disposal methods or facilities are identified.

Preconstruction waste was characterized based on a statistical analysis of the data gathered from the execution of site media sampling plan 93-278. The characterization summary was issued as an internal FERMCO memorandum, M:ESH:(EP):94-0049. The FERMCO Waste Management group then issued a memorandum to the project that discussed the waste characterization results and their implications, together with the required handling and disposition of the individual waste streams, M:(RSO):(WM):94-0413. Attached to the memorandum was a copy of the Project Waste Identification and Disposition (PWID) form (PWID file 94-001) that is used to document this information. Construction waste disposal was accomplished per the requirements stipulated therein.

10.3 WASTE MINIMIZATION

Since the FEMP is a CERCLA site undergoing remediation, efforts are being made to reduce the generation of waste that requires special handling. By minimizing waste generation, the cost, risk, and burden on available waste management facilities are also reduced. Several aspects of VITPP construction and operation provide opportunities to facilitate waste minimization practices.

Dumpsters were used to collect uncontaminated (i.e., nonradioactive) and nonhazardous scrap for disposal at a commercial sanitary landfill. This avoided the disposal cost of managing the material at NTS as Low level radioactive waste (LLRW). Means were provided to segregate the material to avoid contamination as it was accumulated.

Process water will be recycled in a closed loop system. This approach substantially reduces the quantity of wastewater requiring treatment, thus reducing costs related to transfer of the water to the site treatment system, wastewater treatment, and management of wastewater sludge generated in the water treatment system.

The goal of Phase I of the project is to test the system's ability to successfully support the vitrification of silo residues. The use of nonradioactive materials as surrogate for the silo residues during VITPP Phase I testing will reduce or eliminate the generation of radioactive waste from the vitrification process.

Additional waste minimization efforts may be identified as the project progresses and will be evaluated at that time. The minimization efforts referenced above may also be modified as the need arises.

11.0 REGULATORY COMPLIANCE

Regulatory requirements governing construction and operation of the VITPP Phase I are discussed in this section. The pilot vitrification facility is designed to produce a consistent stabilized glass with minimal effluent. During VITPP Phase I operations, the systems will be tested using surrogate material. Some campaigns will include lead and barium compounds to more closely simulate the actual silo material.

The overall project will include VITPP construction, operation of the vitrification facility, and the disposition of construction rubble and other debris under existing site procedures.

11.1 REMOVAL SITE EVALUATION (RSE) GUIDANCE

Construction during this project required excavation of soils and generated construction rubble and debris. Pursuant to the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) under 40 CFR 300.410, a Removal Site Evaluation (RSE) must normally be conducted to assess the potential for an activity to release hazardous substances to the environment. The purpose of this requirement is to determine whether a removal action should be conducted prior to remediation of an unknown or previously uncharacterized area. The activities proposed by this work plan are to be conducted in an area where there has been previous investigation and data collection under the RI for OU4. Based on analysis of these data, process knowledge of operations conducted in the area, and current knowledge of "hot spots," no removal action was warranted for activities conducted in this area prior to the remedial activities, including construction and operation of the pilot plant systems.

The activities proposed in this work plan will be conducted in support of the remediation of OU4 under CERCLA Section 104. Since treatability studies are part of the response action planned for OU4, a formal RSE is not required. A letter from the DOE, dated April 16, 1993 (see Appendix A), supports this position. Documentation of existing data and information, along with engineering controls and procedures described in this work plan, will meet the substantive requirements of an RSE as outlined in 40 CFR 300.410. The completed construction activities described in this work plan complied with the requirements of site procedure EW-0006, "Management of Excess Soil, Debris, and Waste from a Project." If at any time during this phase of operation it is determined that a potential exists for release of hazardous substances to the environment, an RSE will be conducted to determine whether a removal action is warranted.

11.2 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) COMPLIANCE

The National Environmental Policy Act (NEPA) requires assessment of environmental impacts due to proposed DOE projects. The determination of the appropriate class of NEPA documentation must be made by DOE in accordance with DOE Order 5440.1D (NEPA Compliance Program) and the NEPA Document Process (EP-0001). A request package containing the "Request for NEPA Services" and "Environmental Compliance Questionnaire" for a NEPA determination on Phase I, along with a project schedule and scope of work, was transmitted to the on-site NEPA work group for document preparation. On March 30, 1993, a determination was made by DOE-FN that Phase I was categorically excluded from requirements to conduct further environmental impact assessments under NEPA. This determination is documented as Categorical Exclusion 412 (CX 412).

11.3 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) COMPLIANCE

Project construction results in the generation of soils or debris (e.g., concrete) that require characterization. If the waste determination indicates the material contains hazardous waste constituents, the material would be subject to the substantive RCRA requirements for the generation, handling, management and storage of RCRA hazardous waste.

The residues in Silos 1, 2 and 3 are excluded from regulation under RCRA by 40 CFR 261.4. Under this exclusion, source, by-product and special nuclear materials are excluded from regulation under RCRA. Residues in the silos are by-product material resulting from the production of uranium metal from source material such as pitchblende ores. Therefore, the waste materials meet the exclusion, and the RCRA regulations are not applicable as ARARs. However, the materials stored in the silos contain elevated levels of natural metals such as lead and are, therefore, similar to RCRA hazardous waste (due to characteristic metals). Due to the hazard associated with the toxicity of the metals, the substantive requirements of RCRA are included as relevant and appropriate for protectiveness during this activity.

Surrogate material utilized during Phase I operations will contain compounds of lead and barium which will be added to the feed material to determine the impacts on the vitrification process. Because both lead- and barium-bearing wastes are considered hazardous waste when they exceed their respective toxicity characteristic (TC) leach limits (5 milligrams per liter for lead and 100 milligrams per liter for barium), there is a potential to generate hazardous waste during Phase I operations. Vitrified material produced during Phase I operations, as well as other residues generated during any campaign using lead and barium in the feed formula, will be characterized to determine if the waste is hazardous due to the presence of lead or barium. Residues that exhibit a RCRA characteristic will either undergo reprocessing in the melter or be managed as a hazardous waste in accordance with the RCRA regulations identified as ARARs in Appendix B of this document.

11.4 PERMITTING ISSUES

CERCLA Section 121(e)(1) states that no Federal, State or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with Section 121.

As a treatability study preceding CERCLA removal/remedial actions, this VITPP project is not required to obtain any Federal, State or local permits. However, the project must be conducted in accordance with the terms and conditions of those permits that otherwise would have been required.

Section XIII.B of the Amended Consent Agreement (ACA) requires the DOE to identify those permits that would otherwise be required, along with the standards, requirements, criteria or limitations that would have to have been met to obtain each permit. The DOE must report these findings to the EPA, along with an explanation of how the response action will meet these standards, requirements, criteria, or limitations.

The following summarizes the permits, permit requirements and plans to meet those requirements for Phase I.

11.4.1 Air Permits

Construction and Phase I operations of the VITPP generated nuisance dust during construction, and will generate off-gases from operating the vitrification melter to melt the surrogate and waste materials. Releases of dust and particulates were controlled during construction and will be controlled during operation by approved site standard operating procedures and best available technology, including off-gas control equipment.

11.4.1.1 Identification of Air Permits That Would Otherwise be Required - State Permits

PERMIT TO INSTALL - OAC 3745-31-02 (A): Unless exempted by OAC 3745-31-03, no person shall cause, permit or allow the installation of a new source of air pollutants or cause, permit, or allow the modification of an air contaminant source without first obtaining a Permit to Install. Under ordinary circumstances, an air Permit to Install would have to be obtained for the VITPP.

PERMITS TO OPERATE - OAC 3745-35-02 (A): Except as otherwise provided in paragraph H (Conditional Permits to Operate) of rule OAC 3745-35-02 and in OAC rules 3745-35-03 (variances) and 3745-35-05 (permit exemptions and registration status), no person may cause, permit, or allow the operation or other use of any air contaminant source without first applying for and obtaining a Permit to Operate. Under ordinary circumstances, Permits to Operate would have to be obtained for the VITPP.

11.4.1.2 Identification of the Standards, Requirements, Criteria, or Limitations That Would Have To Be Met to Obtain the Above Permits/Notifications - State Requirements

PERMIT TO INSTALL - OAC 3745-31-05 (A): Installation of the proposed VITPP facility must not prevent or interfere with the attainment or maintenance of applicable ambient air quality standards; must not result in a violation of any applicable laws; and must employ the Best Available Technology (BAT) to control emissions.

PERMITS TO OPERATE - OAC 3745-35-02 (C): The proposed VITPP facility must be operated in compliance with applicable air pollution control law; must be constructed, located or installed in compliance with the terms and conditions of a Permit to Install; and must not violate National Emission Standards for Hazardous Air Pollutants (NESHAPs) adopted by the Administrator of the U.S. EPA.

11.4.1.3 Explanation of How the Response Action Will Meet the Standards, Requirements, Criteria, or Limitations Identified in Section 11.4.1.2 Above

The VITPP emission control systems will employ BAT to meet State air quality standards. The emission control systems will include an off-gas scrubber for treatment of acidic gas emissions followed by HEPA filters for removal of particulates, including lead and barium.

11.4.2 Wastewater Permits

This project will result in the generation of wastewater which will be discharged to the FEMP AWWT System for further treatment. During Phase I operations, process wastewater will be routed to the AWWT System either directly via the High Nitrate Tank, or via the Biodenitrification Surge Lagoon (Campaign 1 only). Accumulations of stormwater associated with operations will also be managed through the AWWT System. Process wastewater streams will be characterized prior to treatment in the site AWWT System, with the treated effluent being discharged under the site NPDES permit.

Also, under the Clean Water Act, permits are required for activities that discharge material into U.S. waters (including wetlands). Although the VITPP was not constructed in a wetland area, some wetland areas were impacted by the installation of utility lines to serve the VITPP.

11.4.2.1 Identification of Wastewater Permits That Would Otherwise Be Required

Federal Permits

CLEAN WATER ACT - SECTION 404: Pursuant to Section 404 of the Clean Water Act, a permit from the U.S. Army Corps of Engineers (ACOE) would be required to discharge materials into the wetland areas.

State Permits

PERMITS TO INSTALL - OAC 3745-31-02 (A): Unless exempted by OAC 3745-31-03, no person shall cause, permit or allow the installation of a new disposal system, or cause, permit or allow the modification of a disposal system without first obtaining a Permit to Install. Under ordinary circumstances, a wastewater Permit to Install would have to be obtained for the VITPP.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) - OAC 3745-33-02 (A): No person may discharge any pollutant or cause, permit, or allow a discharge of any pollutant without applying for and obtaining an Ohio NPDES permit. The FEMP currently operates under an approved Ohio NPDES permit.

SECTION 401 WATER QUALITY CERTIFICATIONS - OAC 3745-32-02(A)(2): A Section 401 State Water Quality Certification is required to obtain a Section 404 permit from the ACOE.

11.4.2.2 Identification of the Standards, Requirements, Criteria, or Limitations That Would Have To Be Met to Obtain the Above Permits/Notifications

Federal Requirements

CLEAN WATER ACT - SECTION 404: The temporary sidecasting (up to three months) of excavated material into wetlands during construction of utility lines is authorized under Nationwide Permit (NWP) 12 as codified in Appendix B to 33 CFR Part 330, provided the following permit conditions are met.

- *Navigation.* The activity must not cause more than a minimal effect on navigation.

- *Proper Maintenance.* Fill authorized by the NWP must be properly maintained, including maintenance to ensure public safety.

- *Erosion and Siltation Controls.* Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills must be permanently stabilized at the earliest possible date. Standards and specifications for design of erosion and sedimentation control devices can be found in the USDA-SCS Water Management and Sediment Control for Urbanizing Areas Manual.

- *Aquatic Life Movements.* The activity must not disrupt the movement of those species of aquatic life indigenous to the body of water (wetland) where the activity is being conducted.

- *Equipment.* Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.

- *Wild and Scenic Rivers.* The activity can not occur in a component of the National Wild and Scenic River System.

- *Tribal Indian Rights.* The activity must not impair reserved tribal rights including but not limited to reserved water rights and treaty fishing and hunting rights.

- *Water Quality Certification.* A State Water Quality Certification or waiver thereof is required.

- *Endangered Species.* The activity must not jeopardize the continued existence of any threatened or endangered species or adversely affect their habitats in any manner.

- *Historic Properties.* The activity must not affect historic properties listed or eligible for listing in the National Register of Historic Places.

- *Water Supply Intakes.* The discharge of excavated material must not occur in close proximity to a public water supply intake.

- *Shellfish Production.* No discharge of material is allowed in an area of concentrated shellfish production.

- *Suitable Material.* The discharged material must be free of unsuitable materials (trash, debris, etc.) and toxic pollution in toxic amounts as per Section 307 of the Clean Water Act.

- *Mitigation.* The discharge of material must be minimized or avoided to the maximum extent practicable at the project site.

- *Spawning Areas.* Discharges in spawning areas during spawning season must be limited to the maximum extent practicable.

- *Obstruction of High Flows.* To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows or cause relocation of the water.

- *Waterfowl Breeding Areas.* Discharge into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

- *Removal of Temporary Fills.* Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting contours.

State Requirements

PERMITS TO INSTALL - OAC 3745-31-05 (A): Installation of the VITPP facility must not prevent or interfere with the attainment or maintenance of applicable ambient water quality standards; must not result in a violation of any applicable laws; and must employ the best available technology.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) - OAC 3745-33-02 (A): All discharges authorized under the NPDES permit shall be consistent with the terms and conditions of the permit. Facility expansions, production increases, or process modifications which result in new, different or increased discharges of pollutants must be reported.

SECTION 401 WATER QUALITY CERTIFICATIONS - OAC 3745-32-02(A)(2): The Ohio Environmental Protection Agency (OEPA) granted Section 401 State Water Quality Certification for NWP 12 on January 17, 1992. Work conducted under NWP 12 need only comply with the following conditions of the Water Quality Certification to be authorized.

- *Bank Stabilization.* All necessary steps shall be taken, upon completion of the project, to ensure bank stability.

- *Damages to Immediate Environment.* All damage by equipment needed for construction or hauling shall be repaired immediately.

- *Water Quality.* Care must be employed throughout the course of the project to avoid the creation of unnecessary turbidity which may degrade water quality or adversely affect aquatic life.

- *Forested Wetlands.* NWP 12 can not be used to authorize utility lines greater than 1000 feet in length in forested wetlands.

11.4.2.3 Explanation of How the Response Action Will Meet the Standards, Requirements, Criteria, or Limitations Identified in Section 11.4.2.2 Above

Federal Requirements

The proposed project has been and will be conducted in compliance with the conditions of NWP 12 as follows.

- *Navigation*. The proposed project will not affect navigation.

- *Proper Maintenance*. Any fill discharged as a result of the project will be maintained and stabilized as soon as practicable upon completion of the project.

- *Erosion and Siltation Controls*. Appropriate erosion and siltation controls were used and maintained in effective operating condition during construction, and all exposed soil and other fills were permanently stabilized at the earliest possible date after completion of construction.

- *Aquatic Life Movements*. Construction did not disrupt the movement of any indigenous aquatic species.

- *Equipment*. When heavy equipment must be used to conduct work within the wetland, mats or other measures will be utilized to minimize disturbance within the wetland area.

- *Wild and Scenic Rivers*. The wetland in which work will be conducted is not part of the National Wild and Scenic River System.

- *Tribal Indian Rights*. The project will not impair reserved tribal Indian rights in any manner.

- *Water Quality Certification*. OEPA granted State Water Quality Certification for NWP 12 on January 17, 1992.

- *Endangered Species*. No known threatened or endangered species inhabit the area in which work will be conducted.

- *Historic Properties.* The project will not affect any historic properties which are listed or eligible for listing in the National Register of Historic Places.

- *Water Supply Intakes.* There are no public water supply intakes in close proximity to the proposed project location.

- *Shellfish Production.* The project will not be conducted in an area of concentrated shellfish production.

- *Suitable Material.* All material discharged during the course of the project will be free of unsuitable materials (trash, debris, etc.) and toxic pollution in toxic amounts as per Section 307 of the Clean Water Act.

- *Mitigation.* Impacts to the wetland area will be minimized to the maximum extent practicable during construction. Disturbances will be allowed only in those areas in which they are absolutely required.

- *Spawning Areas.* The project is not being conducted in a spawning area.

- *Obstruction of High Flows.* The project will not result in the permanent restriction or impediment of flows within the wetland. All fill discharged into the wetland was removed within three months.

- *Waterfowl Breeding Areas.* The project area is not known to be a breeding area for migratory waterfowl.

- *Removal of Temporary Fills.* All fill material was removed from the wetland area immediately upon completion of construction, and the affected wetland areas were returned to their preexisting contour elevations. In addition, any exposed areas were stabilized as soon as practicable.

State Requirements

This project will not interfere with the attainment or maintenance of any water quality standards, nor will it result in a violation of any applicable laws. Wastewater streams generated by the vitrification process will not significantly alter the character of the plant effluent streams. Best available technology will be satisfied with the installation of a filter used for the removal of suspended solids. Effluent from the filter will be discharged to existing systems for the treatment necessary to meet current NPDES effluent limitations.

The project will comply with all conditions of the Section 401 State Water Quality Certification for NWP 12 as shown below.

- *Bank Stabilization.* All necessary steps will be taken, upon completion of the project, to ensure bank stability.

- *Damages to Immediate Environment.* All damage caused by equipment needed for construction or hauling will be repaired immediately, upon completion of construction.

- *Water Quality.* Care will be taken to avoid the creation of unnecessary turbidity which may degrade water quality or adversely affect aquatic life.

- *Forested Wetlands.* The proposed project does not involve work within a forested wetland.

11.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Activities of the VITPP program include the potential for generation of wastewater streams, emission of radionuclides (Phase II only), off-gas emissions, and the generation of RCRA hazardous waste, or waste sufficiently similar to RCRA waste to require regulation under RCRA, as discussed in Section 11.3. In addition, there is the potential for the generation of dust particulates and other emissions as the result of construction and operation of the vitrification facility and for generation of additional waste streams needing characterization.

Applicable or relevant and appropriate requirements (ARARs) and To Be Considered (TBC) criteria, which pertain to the types of contaminants that may be generated or the location of activities associated with the VITPP, have been identified. Appendix B presents the regulatory requirements for this project and the compliance strategies associated with each requirement. Since the list of requirements was developed for both phases of the VITPP project, ARARs that govern design for VITPP Phase II operation must be considered during VITPP Phase I. No attempt was made to distinguish between ARARs pertaining to Phase I and Phase II of VITPP operation, and one comprehensive list is presented. Therefore, ARARs or TBCs that govern radionuclides or chemical substances not present in the Phase I surrogate may not specifically relate to Phase I of the VITPP project.

12.0 COMMUNITY RELATIONS

Treatability studies and community information and involvement activities are required in the CERCLA process. Community relations activities will be conducted to explain the role of the treatability studies that will take place during the VITPP Phase I operations. This will confirm confidence in the final remediation for OU4.

In accordance with CERCLA and the NCP, information regarding this document and the vitrification technology will be provided to individuals via Fernald site publications; briefings at community, township and Fernald Residents for Environment, Safety, and Health (FRESH) meetings; and public participation activities.

In addition to attending community meetings and participating in Fernald-related activities, individuals can also obtain information by examining the Administrative Record, which contains documents relevant to the RI/FS for the site, including OU4. The Administrative Record is located in the Public Environmental Information Center, 10845 Hamilton-Cleves Highway, just south of the Fernald site.

Public Environmental Information Center Hours

Phone: 513-738-0164
Monday, 7:30 a.m. to 7:00 p.m.
Tuesday, Wednesday and Thursday, 7:30 a.m. to 5:00 p.m.
Friday, 7:30 a.m. to 4:30 p.m.

Although the law does not require a formal public comment period on treatability study work plans, individuals will have opportunities to provide input regarding the VITPP and other OU4 projects through public participation activities that will be conducted to promote communications between the FEMP and the community.

For more information about this document or the Fernald site, individuals may contact:

Mr. Gary Stegner
Public Information Director
DOE Field Office, Fernald
P.O. Box 538705
Cincinnati, OH 45253-8705
Phone: 513-648-3153

13.0 REPORTS

13.1 BIMONTHLY REPORTS

During VITPP Phase I operations, interim reports will be issued on a bimonthly basis. Each interim report will briefly summarize the progress made in meeting VITPP Phase I milestones and present any technical issues which developed during the course of work. These reports will be prepared by the VITPP Project Manager and will be submitted to DOE-FN by the tenth day of the month following the end of two-month reporting period. The first report will be due on the tenth day of the month that follows the approval of this Work Plan.

13.2 BIWEEKLY STATUS MEETINGS

A biweekly status meeting is held with DOE-FN to summarize the progress made in the VITPP Phase I construction, start-up and operation and to discuss any relevant issues that may develop during the course of work. During the course of the project, the lead reporting responsibilities are as listed below.

- Reporting of design and engineering aspects is the responsibility of the VITPP Engineering Manager
- Reporting of construction aspects is the responsibility of the VITPP Construction Manager
- Reporting of start-up and operational aspects is the responsibility of the VITPP Operations Manager

13.3 FINAL REPORT

An interim report will be prepared following completion of Phase I of the VITPP. A final report will be prepared following completion of Phase II of the VITPP. The final report will include a description of all of the work performed in VITPP Phases I and II, data from both laboratory and site operations, technical discussion, results, and conclusions.

Preparation of these reports is the responsibility of the VITPP Project Manager. Submittal of the interim report to DOE-FN is scheduled to occur within sixty days after completion of Phase I. Submittal of the final report to the DOE will be scheduled to occur within ninety days after completion of Phase II. A suggested format for the final report is outlined in Table 13-1. This format is based on EPA guidance for treatability study reports that are conducted as CERCLA activities.

TABLE 13-1

Suggested Organization of Phase I Treatability Study Final Report

1.0 Introduction
- 1.1 Site description
  - 1.1.1 Site name and location
  - 1.1.2 History of operations
  - 1.1.3 Prior removal and remediation activities
- 1.2 Waste stream description
  - 1.2.1 Waste matrices
  - 1.2.2 Pollutants/chemicals
- 1.3 Treatment technology description
  - 1.3.1 Treatment process and scale
  - 1.3.2 Operating features
- 1.4 Previous treatability studies at the site

2.0 Conclusions and Recommendations
- 2.1 Conclusions
- 2.2 Recommendations for future work

3.0 Treatability Study Approach
- 3.1 Test objectives and rationale
- 3.2 Experimental design and procedures
- 3.3 Equipment and materials
- 3.4 Sampling and analysis
  - 3.4.1 Waste stream
  - 3.4.2 Treatment process
- 3.5 Data management
- 3.6 Deviations from the Work Plan

4.0 Results and Discussion
- 4.1 Data analysis and interpretation
  - 4.1.1 Analysis of waste stream characteristics
  - 4.1.2 Analysis of treatability study data
  - 4.1.3 Comparison to test objectives
- 4.2 Quality assurance/quality control
- 4.3 Costs/schedule for performing the treatability study
- 4.4 Key contacts

References

Appendices
- A. Data summaries
- B. Standard operating procedures

14.0 MANAGEMENT AND STAFFING

This treatability study program supports the remediation of OU4 at the FEMP. As such, the governing document is the Amended Consent Agreement between the DOE and the EPA Region V which was signed in September, 1991. Thus, ultimate project management responsibility lies with these two agencies as defined by this agreement. In addition, OEPA has been granted regulatory authority over certain RCRA activities and has jurisdiction over those aspects. Within each agency, various organizations and offices have been delegated specific program responsibilities.

Each agency has engaged contractors to perform identified scopes of work related to their prime areas of responsibility for site remediation. The DOE Office of Environmental Restoration will implement this program via its Fernald Field Office (DOE-FN). The DOE has retained FERMCO as the Environmental Restoration Management Contractor (ERMC) for FEMP remediation. Within FERMCO, the FEMP site remediation will be accomplished by project organizations. The VITPP program supports the FRVP Project which will remediate the contents of Silos 1, 2 and 3 and the decant sump. Figure 14-1 shows this responsibility matrix, and Figure 14-2 identifies the lead personnel.

The VITPP program will be implemented as the third tier of an EPA RD/RA Treatability Study as described in Section 1.0. The project will be conducted in accordance with EPA guidance to the extent practicable for CERCLA activities with site operations being conducted in compliance with DOE Orders.

14.1 PROJECT MANAGEMENT

Project management responsibilities within the FRVP Project organization are as follows. The FRVP Project Manager is responsible for managing all aspects of the program to vitrify the OU4 silo waste residues. This includes facility design, construction, operation, and all supporting activities. The VITPP Project supports the FRVP Project, and as such, the VITPP Project Manager reports to the FRVP Project Manager. The VITPP Project Manager has lead responsibility for implementing the VITPP program.

The VITPP Project is being conducted in accordance with the Project Execution Plan (FERMCO 1996b) that was developed for this project.

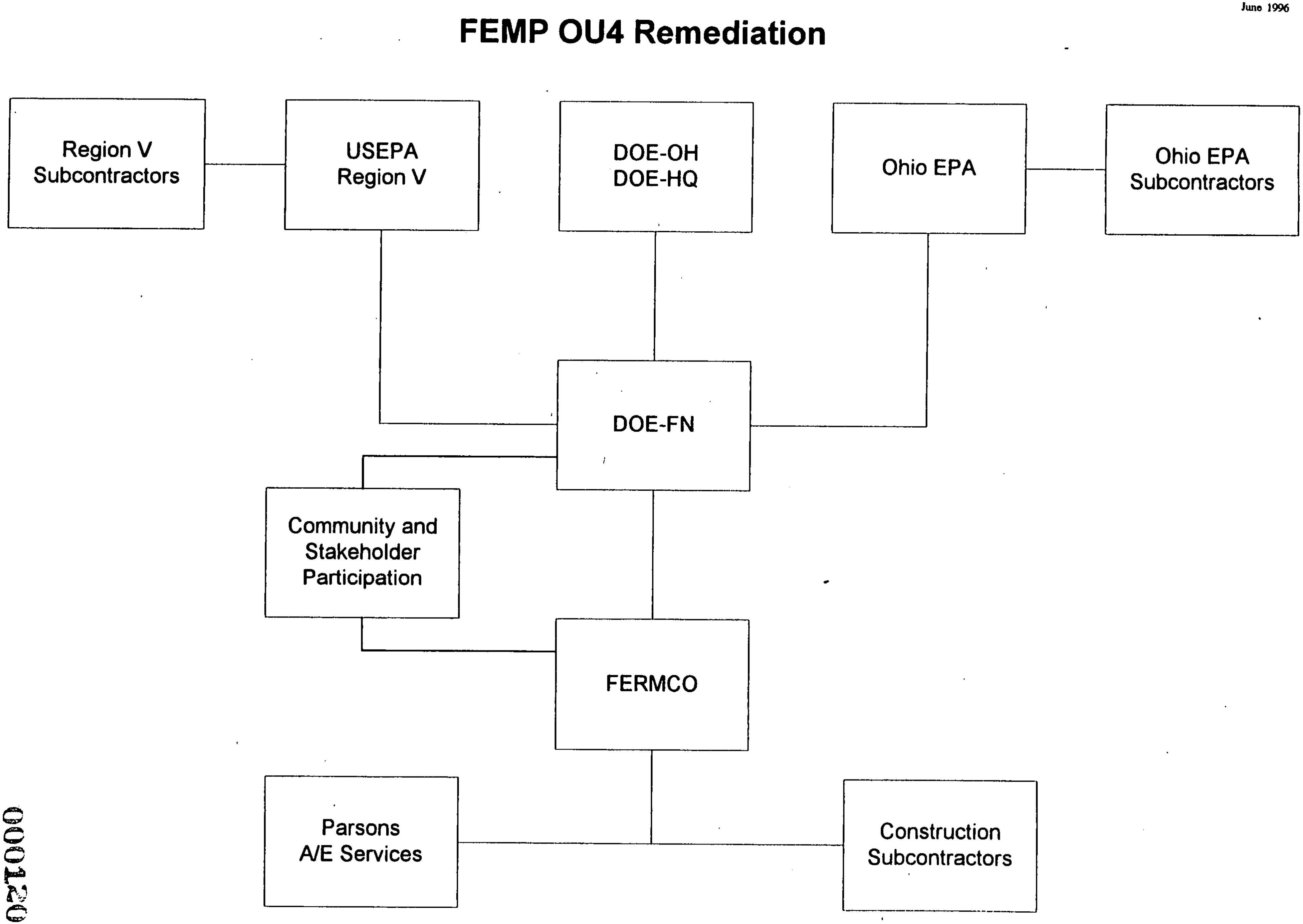

Figure 14-1 Administrative Relationships

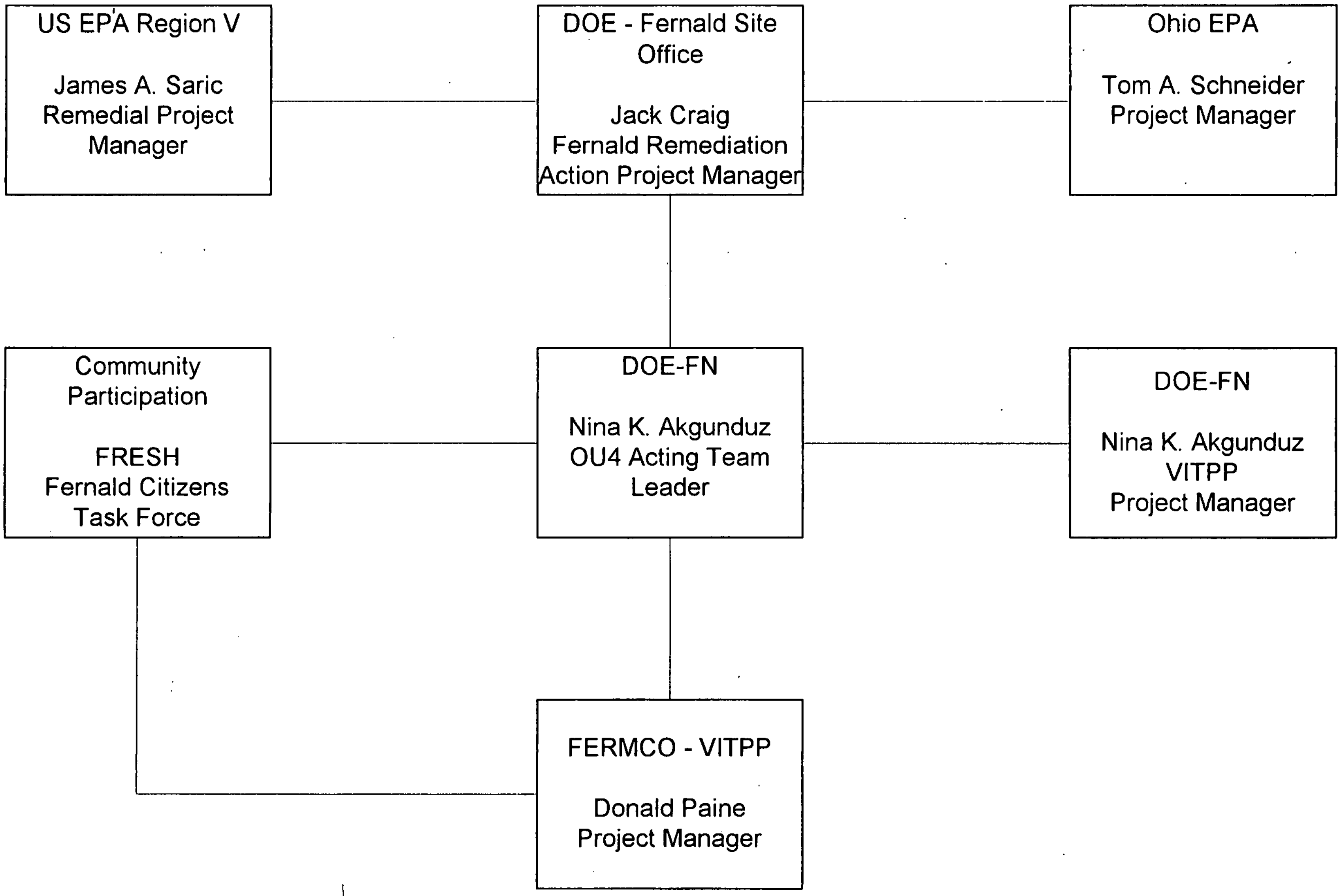

Figure 14-2 Operable Unit 4 Remediation

Within the FRVP project organization, operations are conducted in accordance with "Site Procedures Functional Area #17 CRU Operating Procedures" (FERMCO 1995f), which became effective on February 3, 1995. These division procedures address the twelve major areas of operations for which the project manager is responsible. These procedures define responsibilities, interactions within the project organization, and relationships with the home divisions for matrixed personnel.

Figures 14-3 and 14-4 are organization charts that depict the functional responsibilities for the VITPP Phase I program activities.

14.2 STAFFING

FERMCO will implement the VITPP program using its own work force and subcontractors. The Architectural/Engineering firm, Parsons, is under contract to FERMCO to perform engineering design services for remediation. When required, other subcontractors and FERMCO home office support from teaming partners are utilized to accomplish specialized tasks or unique scopes of work.

The FERMCO organization consists of project organizations (such as the VITPP and the FRVP for OU4 remediation), support divisions (such as Engineering), and service departments (such as Analytical Services). The support divisions supply full-time personnel to projects on a matrix basis. This may range from a single point of contact (such as a procurement representative) to a full department (such as Engineering or Construction). Service organizations such as Analytical Services provide support on a request-for-services basis from a document that is generated for each specific work request.

FIGURE 14-3
VITPP ORGANIZATIONAL CHART

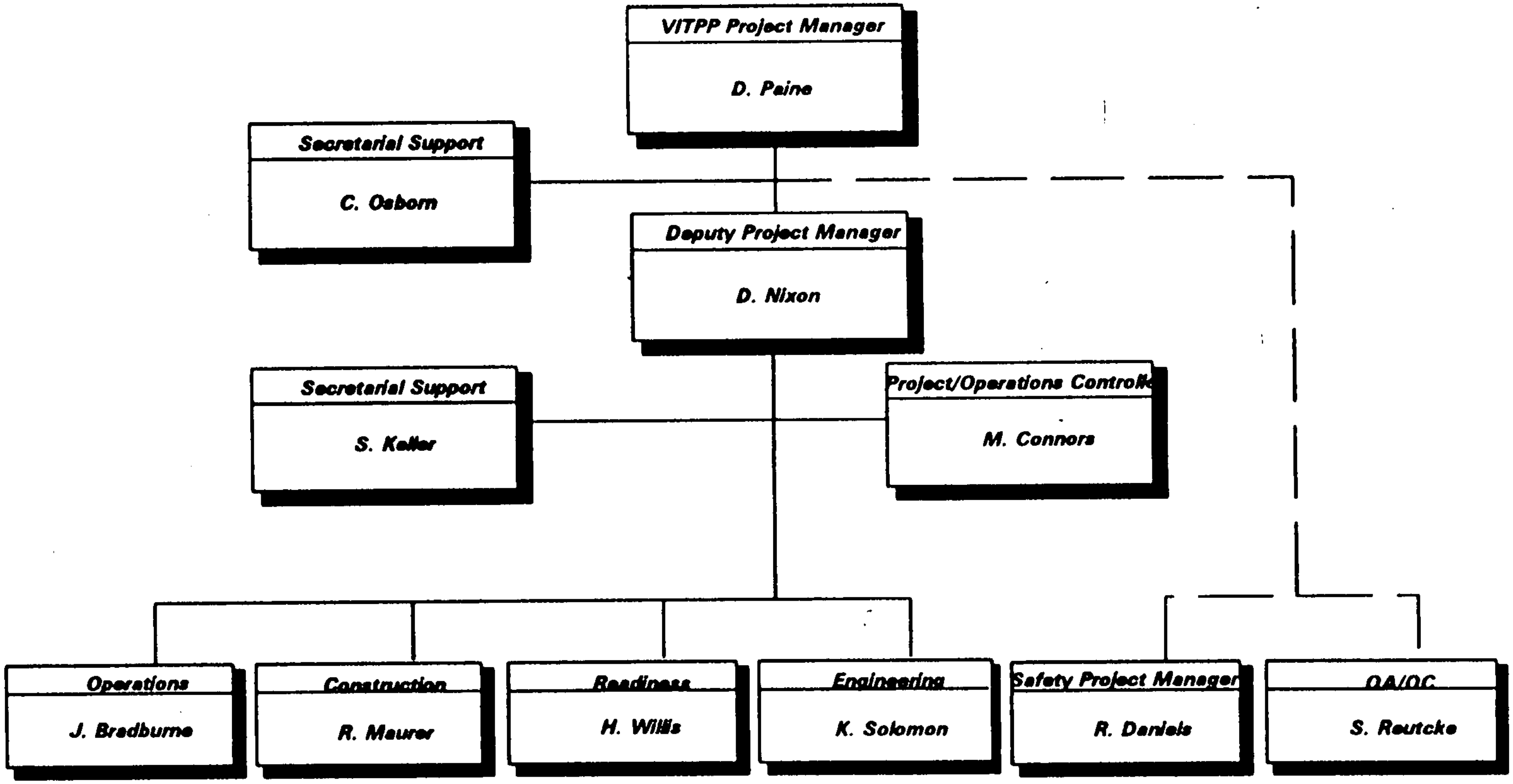

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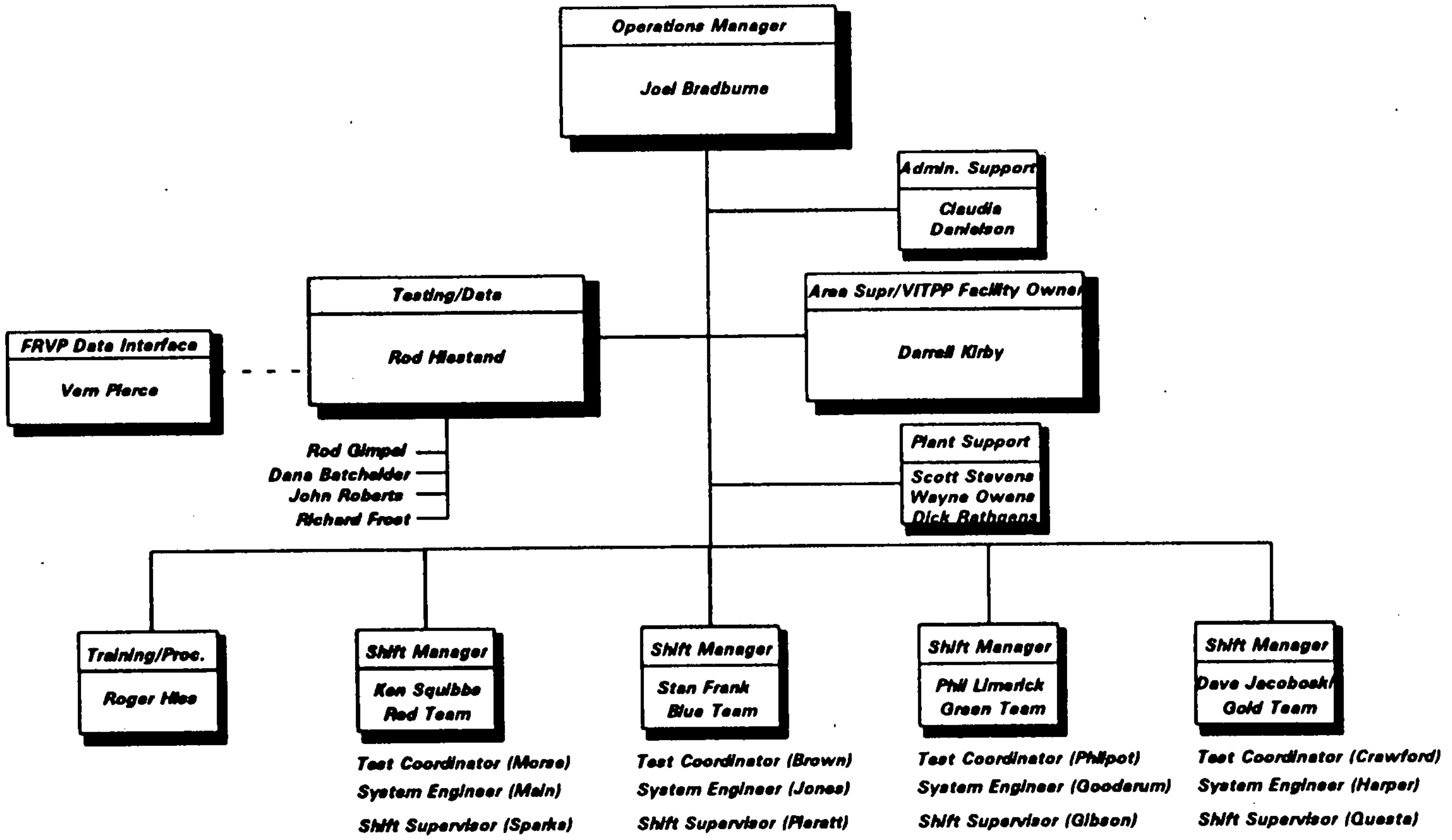
FIGURE 14-4
VITPP OPERATIONS ORGANIZATION



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APPENDIX A

DOE Letter (DOE-0817-93), April 16,1993, T.J. Rowland to N.C. Kaufman, **REMOVAL SITE EVALUATION, APPLICABILITY TO OPERABLE UNIT 4 PILOT PLANT**

Department of Energy
Fernald Environmental Management Project
P.O. Box 398705
Cincinnati, Ohio 45239-8705
(513) 738-6357

APR 1 6 1993

DOE-0817-93

Mr. N. C. Kaufman, President
Fernald Environmental Restoration
Management Corporation
P. O. Box 398704
Cincinnati, OH 45239-8704

Dear Mr. Kaufman:

REMOVAL SITE EVALUATION, APPLICABILITY TO OPERABLE UNIT 4 PILOT PLANT

The Department of Energy, Fernald Field Office concurs with the enclosed Fernald Environmental Restoration Management Corporation position which states that a Removal Site Evaluation is not required for the Operable Unit 4 pilot plant project.

If you or your staff have any questions, please contact Randi Allen at FTS/Commercial 513-748-6158.

Sincerely,

Ray Hansen
for Thomas J. Rowland
Acting Manager

FN:Allen

Enclosure: As Stated

cc w/enc.:

W. Pickles, FERMCO/52-4
R. Frost, FERMCO/52-4

Fernald Environmental
FERMCO
Restoration Management Corporation P.O. Box 398704 Cincinnati, Ohio 45239-8704 (513) 738-6200

December 22, 1992

U. S. Department of Energy
Fernald Environmental Management Project
Letter No. C:OP:92-067

Mr. James J. Fiore, Acting Manager
DOE Field Office, Fernald
P. O. Box 398705
Cincinnati, Ohio 45239-8705

Dear Mr. Fiore:

CONTRACT DE-AC05-920R21972, RSE APPLICABILITY TO CRU4 PILOT PLANT ACTIVITIES

As part of final remediation for Silos 1, 2, and 3, CRU4 is constructing a Pilot Plant for demonstration of vitrification capability for Silo 3 and K-65 type material. Existing site Regulatory Compliance Guide (RCG) M-1, dated November 7, 1990, requires the preparation of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Removal Site Evaluation (RSE) for all site excavation activities that involve over 1 yd^3 of soil in areas with above background concentrations of hazardous substances, including radionuclides.

The purpose of this letter is to transmit for your concurrence the CRU4 position regarding the applicability of this guidance to planned Pilot Plant construction activities. Since the Pilot Plant will not be constructed over an abandoned site, but will be a part of the RI/FS treatability studies to support final remediation of the Silo contents, CRU4 does not believe an RSE is warranted or required to meet the intent of the National Contingency Plan. CRU4 desires to proceed with the Pilot Plant project as scheduled, while minimizing the procedural and regulatory complexity and paperwork associated with site requirements of limited or outdated applicability. CRU4 intends to comply with all legal requirements applicable to CRU4, and meet the ARARs and substantive requirements of 40 CFR 300.410 for an RSE using existing, approved site procedures. This approach will be outlined in the project workplan.

The Pilot Plant will be used initially to demonstrate the technology and process on an iner material (sand) and then be modified to perform treatability studies on the K-65 material CRU4 is proceeding on the basis that an RSE is not required for the initial phase, but wi probably be required for the second phase testing.

Our construction schedule requires site preparation activities to begin no later than Marc: 1993. Since preparation and approval of an RSE, if required, takes several weeks t complete, it is critical to receive the concurrence of DOE-FN on our proposed direction no late than the first week in January. Please let me know if we need to meet to further discuss thi approach. Our point of contact is Robert Frost (X 8941).

Very truly yours,

N. C. Kaufman
President

NCK:RHF:slk

Attachment

cc: R. B. Allen, DOE-FN
J. R. Craig, DOE-FN
D. P. Dubois
R. Mendelsohn, DOE Contract Specialist
D. Paine
W. S. Pickles
W. Quaider, DOE-FN
M. J. Strimbu
J. W. Theising

Central Files
DW:92-0477.1

APPENDIX B

ARARS AND TBC CRITERIA FOR THE PHASE I AND II OU4 PILOT PLANT PROGRAM

APPENDIX B

Applicable or Relevant and Appropriate Requirements (ARARs), and To Be Considered (TBC) Criteria for the Phase I and II OU4 Pilot Plant Program

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Ohio Water Quality Standards	3745-1-07 Use Designations and Criteria All pollutants or combinations of pollutants shall not exceed, outside the mixing zone, the Numerical and Narrative Criteria for Aquatic Life Habitat and Water Supply Use Designations listed in Tables 7-1 through 7-15 of this rule. The following constituents of concern (COCs) for Operable Unit 4 have warm water habitat maximum concentration levels outside the mixing zone as follows: (see constituent table below)	Applicable	Paddys Run and the stream segment of the Great Miami River adjacent to the FEMP are designated as warm water aquatic life habitats with use designations of agricultural and industrial water supply, and primary contact recreation. OAC 3745-1-21 establishes the classification of the receiving waters for the FEMP. Wastewater generated at the Pilot Plant will be pretreated (if required) and discharged to the existing FEMP wastewater treatment system and Advanced Wastewater Treatment System (AWWT) prior to discharge to the Great Miami River. Treatment will be in accordance with FEMP NPDES permit limits and conditions or applicable Water Quality Standards. Stormwater discharges associated with the construction and operation of the Pilot Plant will be managed in accordance with 40 CFR 122.26 and OAC 3745-38. Existing site protocols and procedures related to stormwater management will be extended to the construction and operation of this facility.

Constituent	Criteria conc.[a] (μg/L)	30-day average conc. (μg/L)
Antimony	650	190
Arsenic	360	190
Beryllium	Tab. 7-10[b]	Tab. 7-11[c]
Cadmium	Tab. 7-10	Tab. 7-11
Chromium	Tab. 7-10	Tab. 7-11
Copper	Tab. 7-10	Tab. 7-11
Cyanide	46	12
Lead	Tab. 7-10	Tab. 7-11
Mercury	1.1	0.20
Nickel	Tab. 7-10	Tab. 7-11
Selenium	20	5.0
Silver	Tab. 7-10	1.3
Thallium	71	16
Zinc	Tab. 7-10	Tab. 7-11
2-Butanone	160,000	7,100
4-Nitrophenol	790	35
Acetone	550,000	78,000
Aldrin	----	0.01
Bis(2-ethylhexyl)phthalate	1,100	8.4
Carbon tetrachloride	1,800	280

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Chemical, Location, or Action	Requirement			ARAR/TBC	Strategy for Compliance
Ohio Water Quality Standards (cont.)	DDT	----	0.001		
	Dieldrin	----	0.005		
	Di-n-butylphthalate	350	190		
	Diethylphthalate	2,600	120		
	Dimethylphthalate	1,700	73		
	Endosulfan[d]	----	0.003		
	Endrin	----	0.002		
	Fluoranthene	200	8.9		
	Methylene chloride	9,700	430		
	PCBs	----	0.001		
	Phenol	5,300	370		
	Tetrachloroethene	540	73		
	Toluene	2,400	1,700		

[a] Criteria concentration shall be met outside mixing zone.

[b] Criteria concentration based on hardness of water. See Table 7-10 for calculation to determine maximum concentration outside the mixing zone.

[c] 30-day average criteria based on hardness of water. See Table 7-11 for calculation to determine allowable 30-day average concentration outside the mixing zone.

[d] No designation was made as to whether endosulfan referred to endosulfan I or endosulfan II or the sum total of both.

The remaining COCs for OU4 will have criteria concentration levels based on calculated acute aquatic criteria (AAC) or chronic aquatic criteria (CAC).

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Radionuclide Emissions (Except Airborne Radon-222)	40 CFR 61, Subpart H Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that will cause any member of the public to receive in any year an effective dose equivalent of 10 mrem per year. Monitoring is required at all release points which have a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent in excess of 1% (0.1 mrem/yr) of the standard .	Applicable	The pollution control equipment for the silos and vitrification off-gas emissions will be designed to limit the discharge of radionuclides to acceptable levels. The facility design will include HEPA filters to minimize particulate emissions. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through good construction practices. Monitoring of radionuclide emissions will be conducted in accordance with the methods referenced in 40 CFR 61.93 with compliance being demonstrated using an EPA approved computer code.
Radon-222 Emissions	40 CFR 61, Subpart Q No source at a DOE facility shall emit more than 20 pCi/m^2-s of radon-222 as an average for the entire source during periods of storage and disposal.	Applicable	While this requirement is neither applicable nor relevant and appropriate to treatment operations, it is applicable to storage of waste material in Silos 1 and 2 prior to treatment, and storage of vitrified product following treatment. Design of the waste removal system, along with appropriate procedures, controls, and monitoring, will minimize radon releases during the material removal phase. Design and operation of the vitrified product storage area will address this requirement, along with appropriate controls, procedures and monitoring systems.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Discharge of Storm Water Runoff	40 CFR 122.26 and OAC 3745-38 Storm water discharge associated with construction sites and industrial activities must be monitored and controlled. A Stormwater Pollution Prevention Plan (SWPPP) is required for construction activities which result in a total land disturbance of 5 or more acres.	Applicable	Industrial stormwater discharges associated with the Pilot Plant are covered by the FEMP NPDES Permit 1IO00004*ED, effective November 1, 1995. Site stormwater controls are described in the sitewide Stormwater Pollution Prevention Plan (SWPPP) submitted to the OEPA on May 1, 1996, in accordance with Part IV of the NPDES permit. Construction associated with the Pilot Plant will utilize appropriate controls to ensure contamination of stormwater is minimized. Outside pads (not under roof) will have berms or curbs to contain runoff, and to prevent run on. Collected stormwater will be discharged through the existing site wastewater treatment system.
Discharge of Treatment System Effluent	40 CFR 125.100 <u>Best Management Practices</u> Develop and implement a Best Management Practices (BMP) program to prevent the release of toxic or hazardous constituents to waters of the U.S. Development and implementation of a sitewide BMP program is also required as a condition of the FEMP NPDES Permit. 40 CFR 125.104 The BMP program must perform the following functions. • Establish specific procedures for the control of toxic and hazardous pollutant spills and runoff. • Include a prediction of direction, rate of flow, and total quantity of toxic and hazardous pollutants where experience indicates a reasonable potential for equipment failure.	Relevant and Appropriate	The proposed action has the potential for releases and runoff from this operable unit. The requirement will be met by following the conditions of the sitewide Best Management Practices (BMP) program, as described in the approved BMP Plan. The design and operating procedures will be modified as necessary to ensure controls are in place that prevent contamination of receiving waters and that provide treatment of wastewaters prior to discharge.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Ohio Water Quality Standard	OAC 3745-1-04 The following general water quality criteria apply to both discharges to surface waters as a result of remediation and on-site surface waters potentially affected by project activities. All surface waters of the state shall be free from the following materials. • Objectionable suspended solids • Floating debris, oil and scum • Materials that create a nuisance • Toxic, harmful or lethal substances • Nutrients that create nuisance growth	Relevant and Appropriate	Wastewater produced at the Pilot Plant will be pretreated, if necessary, and discharged to the FEMP wastewater treatment system to comply with these aquatic quality criteria. Compliance with stormwater requirements, BMPs, and contingency plan will ensure compliance with this requirement.
Compliance with Floodplain/Wetlands Environmental Review Requirements	10 CFR 1022 (Executive Order 11990) DOE actions in a floodplain or wetland must first evaluate the potential adverse effects those actions might have on the floodplain or wetland, and consider the natural and beneficial values served by the wetlands.	Applicable	The proposed action has the potential to destroy or modify site wetland areas. Potential impacts are identified during preparation of NEPA documentation for this activity. NEPA documentation will also specify public notice requirements, wetland assessments, and any mitigative measures that may be required.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Radiation Protection of the Public and the Environment	DOE Order 5400.5 Chap. III Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following. (For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.)	To Be Considered	Operation of the OU4 Pilot Plant has the potential to release radionuclides that are contained in the waste materials. The facility design will include HEPA filtration to control radionuclide and particulate emissions where appropriate. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through established construction practices. Monitoring of radionuclide emissions will be conducted in accordance with the methods referenced in 40 CFR 61.93 with compliance being demonstrated using an EPA approved computer code.

Derived Concentration Guide[a]
(μCi/mL)

Isotope	D	W	Y
Actinium-227	2×10^{-15}	7×10^{-15}	1×10^{-14}
Lead-210	9×10^{-13}	------[b]	------
Polonium-210	1×10^{-12}	1×10^{-12}	------
Protactinium-231	------	9×10^{-15}	1×10^{-14}
Radium-224	------	4×10^{-12}	------
Radium-226	------	1×10^{-12}	------
Radium-228	------	3×10^{-12}	------
Technetium-99	1×10^{-8}	2×10^{-9}	------
Strontium-90[c]	5×10^{-11}	------	9×10^{-12}
Thorium-228	------	5×10^{-14}	4×10^{-14}
Thorium-230	------	4×10^{-14}	5×10^{-14}
Thorium-232	------	7×10^{-15}	1×10^{-14}
Uranium-234	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-235	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-236	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-238	5×10^{-12}	2×10^{-12}	1×10^{-14}

[a] D, W, and Y (Days, Weeks, and Years) represent lung retention classes; removal halftimes assigned to the compounds with classes D, W, and Y are 0.5, 50, and 500 days, respectively. Exposure conditions assume an inhalation rate of 8,400 m^3 of air per year (based on an exposure over 24 hours per day, 365 days per year).

[b] A hyphen means no limit has been established.

[c] The value shown for daily DCG is for strontium radionuclides with a f_1 value of 3×10^{-1}. The value shown for yearly DCG is for strontium radionuclides for a f_1 value of 1×10^{-2}.

0001[illegible]

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Radiation Protection of the Public and the Environment	DOE Order 5400.5 Chapter III Residual concentrations of radionuclides in water that may be ingested are listed below. These derived concentration guides (DCGs) for the COCs are based on a committed effective dose equivalent (CEDE) of 100 mrem/yr, assuming ingestion of 2 liters/day. Note that these DCGs apply <u>only if</u> ingestion is the single pathway of exposure. Isotope — Ingested Water (μCi/mL) Actinium-227 — 1×10^{-8} Lead-210 — 3×10^{-8} Polonium-210 — 8×10^{-8} Protactinium-231 — 1×10^{-8} Radium-224 — 4×10^{-7} Radium-226 — 1×10^{-7} Radium-228 — 1×10^{-7} Technetium-99 — 1×10^{-4} Strontium-90[c] — 1×10^{-6} Thorium-228 — 4×10^{-7} Thorium-230 — 3×10^{-7} Thorium-232 — 5×10^{-8} Uranium-234 — 5×10^{-7} Uranium-235 — 6×10^{-7} Uranium-236 — 5×10^{-7} Uranium-238 — 6×10^{-7}	To Be Considered	Remediation of OU4 waste has the potential to release radionuclides that are contained in the waste materials to environmental media. Although activities anticipated by this project will take place over the Great Miami aquifer, which is used as a source of drinking water, no release of radionuclides to soil or groundwater is expected to occur as a result of Pilot Plant activities. Wastewater generated at the Pilot Plant will be pretreated and discharged to the existing FEMP wastewater treatment system. Treatment will ensure that the discharges do not violate FEMP NPDES permit limits and conditions or applicable Water Quality Standards.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Residual Radioactive Material	DOE Order 5400.5 Chap. IV, 6.b Interim Storage: The above-background concentration of radon-222 in air above an interim storage facility must not exceed 100 pCi/L at any point, an annual average of 30 pCi/L over the facility, or an annual average of 3 pCi/L at or above any location outside the site.	To Be Considered	Management of radium bearing waste might result in the release of radon gas to the environment. Removal of radium bearing waste and storage prior to vitrification will include controls designed to prevent untreated release of radon. During operation of the Pilot Plant, the facility off-gas system design (activated carbon beds followed by HEPA filters) will provide adequate radon controls. These requirements will be met for interim storage of the vitrified product due to the low surface release rate of radon gas. Radon monitoring will be conducted outside the storage area to demonstrate compliance with these release limits.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Hazardous Waste Determinations	40 CFR 262.11 OAC 3745-52-11 Any generator, who treats, stores, or disposes of solid wastes, must determine whether or not the waste is hazardous. The procedures to be followed by any generator include those listed below. • Identify whether a particular material of concern is a "solid waste." • Identify whether a particular exclusion applies to the material eliminating it from definition as a "solid waste." • Identify whether a particular solid waste might be classified as a hazardous waste. • Determine if a material otherwise classified as a "hazardous waste" might be excluded from RCRA regulation.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes).	These procedures are established to determine whether wastes are subject to the requirements of RCRA. The residues in Silos 1, 2, and 3 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate to determine whether OU4 wastes, whether excluded or not, are similar to hazardous wastes based on the TCLP results. To ensure protectiveness, wastes sufficiently similar to hazardous waste will be treated, stored, and disposed in accordance with RCRA requirements. Other wastes, such as those generated during construction and operation of the Pilot Plant, will also require testing or process knowledge to determine proper management and disposal requirements. Characterization of waste generated during construction projects, including soil, will be performed in accordance with site procedure EW-0006. All other waste characterization will be performed in accordance with site procedure EW-0001.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Empty Containers	40 CFR 261.7 OAC 3745-51-07 Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if the following conditions are met. • No more than 2.5 cm (1 inch) of residue remains on bottom of inner liner; or • The remaining residue is less than 3% by weight of the total capacity, for containers whose total capacity is less than or equal to 110 gallons; or • The remaining residue is less than 0.3% by weight of the total capacity, for containers whose total capacity is greater than 110 gallons.	Relevant and Appropriate	Containers and tanks used to store waste or the treated contents of Silos 1, 2, and 3 might contain residues that exhibit hazardous waste characteristics which must be removed before the container might be reused or disposed. Removed material, if sufficiently similar to hazardous waste, will be managed in accordance with appropriate regulatory requirements.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Treatment, Storage, or Disposal Facility Standards	40 CFR 264, Subpart B, General Standards OAC 3745-54-13 through 16 1) Waste Analysis (OAC 3745-54-13)-Operators of a facility must obtain a detailed chemical and physical analysis of a representative sample of each hazardous waste to be treated, stored, or disposed of at the facility <u>prior</u> to treatment, storage, or disposal. 2) Security (OAC 3745-54-14)-Operators of a facility must prevent the unknowing or unauthorized entry of persons or livestock into the active portions of the facility, maintain a 24-hour surveillance system, or surround the facility with a controlled access barrier and maintain appropriate warning signs at facility approaches. 3) Inspections (OAC 3745-54-15)-Operators of a facility must develop a schedule and regularly inspect monitoring equipment, safety and emergency equipment, security devices and operating and structural equipment that are important to preventing, detecting or responding to environmental or human health hazards, promptly or immediately or immediately remedy defects, and maintain an inspection log. 4) Training (OAC 3745-54-16)-Operators must train personnel within 6 months of their assumption of duties at a facility in hazardous waste management procedures relevant to their position including emergency response training.	Relevant and Appropriate	Areas and activities of this project which could contain or generate hazardous waste or waste sufficiently similar to RCRA hazardous waste must comply with these RCRA requirements. 1) An OU4 Pilot Plant sampling and analysis plan will be developed. Compliance will be met by following site procedures EW-0006 (construction debris and soils) and EW-0001(other wastes). Silo waste material has already been characterized in accordance with this requirement. 2) Existing site security measures and physical barriers around the silos and the FEMP complex are sufficient to satisfy these requirements. 3) Scheduling for inspection and monitoring of safety and emergency equipment specifically related to the Pilot Plant will be presented in the SOPs that are generated for operation of the facility. 4) All operations personnel will be trained in accordance with existing FEMP requirements. Additional training will be required for the specific job related requirements associated with CRU4 Pilot Plant operations.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Treatment, Storage, or Disposal Facility Preparedness and Prevention	40 CFR 264, Subpart C OAC 3745-54-31 TSD operators must design, construct, maintain and operate facilities to minimize the possibility of a fire, explosion or any unplanned sudden or non-sudden release of hazardous waste to air, soil, or surface water which could threaten human health or the environment. OAC 3745-54-32 All facilities must be equipped with an internal communication or alarm system, a telephone, or a two-way radio for calling outside emergency assistance, fire control, spill control and decontamination equipment and water at an adequate volume and pressure to supply water hose streams, foam producing equipment, automatic sprinklers or water spray systems. OAC 3745-54-33 All fire and spill-control and decontamination equipment must be tested and maintained as necessary to assure proper emergency operation. OAC 3745-54-34 All personnel must have immediate access to emergency communication or alarm systems whenever hazardous waste is being handled at the facility. OAC 3745-54-35 Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment. OAC 3745-54-37 Operators must attempt to make arrangements, appropriate to the waste handled, for emergency response by local and state fire, police and medical personnel.	Relevant and Appropriate	The existing site-wide internal communications/alarm system will be modified as necessary to accomodate operation of the Pilot Plant facility. A fire sprinkler system will be included as part of the design of the Pilot Plant. In addition, portable fire extinguishers and spill control and decontamination equipment will be placed at accessible locations to assist in emergency response. The facility will be designed to include adequate aisle space. The site's Emergency Response Team will be available, with assistance from local and state personnel, for responding to emergency situations related to the Pilot Plant. In addition, site Emergency Response Team personnel will be trained to adequately respond to emergencies specifically related to the Pilot Plant.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Treatment, Storage, or Disposal Facility Contingency Plan and Emergency Procedures	40 CFR 264, Subpart D 40 CFR 264.51 OAC 3745-54-51 Each facility operator must have a contingency plan designed to minimize hazards to human health or the environment due to fires, explosions, or any unplanned releases of hazardous waste constituents to the air, soil, or surface/groundwater. 40 CFR 264.52 OAC 3745-54-52 Contingency plans should address procedures to implement a response to hazardous waste incidents, and provide internal and external communications, arrangements with local emergency authorities, an emergency coordinator list, a facility emergency equipment list indicating equipment descriptions and locations, and a facility personnel evacuation plan. A copy must be maintained at the site as well as submitted to appropriate emergency agencies. 40 CFR 264.55 and .56 OAC 3745-54-55 & 56 Each facility must have an emergency coordinator who has responsibility for coordinating all emergency response measures, is on the premises or on call at all times, is thoroughly familiar with all aspects of the contingency plan, facility operations, location and characteristics of waste handled, location of pertinent records, and facility layout, and who has the authority to commit the resources necessary to implement the contingency plan in the event of an emergency.	Relevant and Appropriate	Specific procedures to respond to emergencies and unplanned events or releases associated with the Pilot Plant will be addressed in the project specific Health and Safety Plan. Existing site procedures, such as the FEMP Emergency Plan (PL-3020), Emergency Response Team Procedures Manual (ERT-001), Spill Incident Reporting and Cleanup (EP-0004), and Event Notification and Reporting (EM-0010) will be implemented as is appropriate for spills, fires, or other emergencies.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Container Storage	40 CFR 264.171 - 178 Subpart I OAC 3745-55-71 through 78 Containers of RCRA hazardous waste must meet the following conditions. • Maintained in good condition • Compatible with hazardous waste to be stored • Closed during storage (except to add or remove waste) • Managed in a manner that will not cause the container to rupture or leak Storage areas must be inspected weekly for leaking and deteriorated containers and containment systems. At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all containers, liners, bases, and contaminated soils.	Relevant and Appropriate	Compliance with this requirement will be as follows: 1) Closed containers of vitrified product will be stored on-site in an approved storage facility. The containers will be compatible with the waste products. 2) Since the vitrified product will not contain free liquids, the storage area will be designed only to prevent run-on. Since the stored product will pose a significant radiation hazard, the frequency of inspection will be kept to a minimum in accordance with an SOP that addresses waste storage. The waste product storage area will be shielded to minimize the radiation hazard. 3) Closure of the storage area will not be included in the scope of this project. Closure of the area will be part of final remediation of the OU in which the storage facility is located. Vitrified waste product will no longer be "sufficiently similar" to hazardous waste since it will no longer exhibit a RCRA characteristic. Containers of other solid waste awaiting characterization, or material characterized as hazardous waste will be managed in accordance with Management of Soil, Debris, and Waste from a Project (EW-0006) and the FEMP Waste Management Plan.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Tank Systems	40 CFR 264, Subpart J (Tanks) OAC 3745-55-91 through 96; and 3745-55-97(A) Design, operating, and inspection standards for tank units within which hazardous waste is stored or treated include the following. • Tank design must be compatible with the material being stored. • Tank must be designed and have sufficient strength to store or treat waste to ensure it will not rupture or collapse. • Tank must have secondary containment that is capable of detecting and collecting releases to prevent migration of wastes or accumulated liquid to the environment. • At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all tanks, liners, bases, and contaminated soils.	Relevant and Appropriate	All process tanks will be constructed with durable material that is compatible with the waste and treatment process for which the tank is designed. The facility design will include secondary containment capable of collecting releases. Approved inspection and maintenance procedures, which include scheduled visual inspections of all tanks, will be established prior to initiation of Pilot Plant operations. Closure at the end of the useful life of the tanks will be included in the final remediation of OU4.
Miscellaneous Units	40 CFR 264 Subpart X OAC 3745-57-91 and 92 Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined by 40 CFR 260.10. 40 CFR 264.601 OAC 3745-57-91 Locate, design, construct, operate, close, and maintain to protect human health and the environment and prevent releases to groundwater, subsurface water, surface water, wetlands, soil, and air. Permit terms shall use Subpart I through O, Part 270, and Part 146 requirements as appropriate. 40 CFR 264.602 OAC 3745-57-92 Monitoring, testing, analytical data, inspections, response, and reporting procedures must ensure compliance with 40 CFR 264.601, 264.15 (general inspection requirements), 264.33 (testing and maintenance of emergency equipment), and 264.77 (reports of releases, fires, explosions, and closures).	Relevant and Appropriate	A vitrification unit could be considered a miscellaneous unit. Although no permit is required for this activity, the design, construction, operation, and maintenance of the unit will be in accordance with other ARARs, DOE orders, and accepted construction standards and practices, as appropriate. Included in the design will be secondary containment and emission controls to ensure that releases to air or water are prevented, or meet stipulated requirements or limits. Monitoring and inspection activities will be conducted to ensure compliance with these requirements. Closure of this unit will be conducted under final remediation of the OU4 area.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Containment Buildings	40 CFR 264, Subpart DD Hazardous waste and debris may be placed in units known as containment buildings, as defined in 40 CFR 260.10, for the purpose of interim storage or treatment. 40 CFR 264.1101 Containment buildings must be fully enclosed to prevent exposure to the elements and ensure containment of managed wastes. Floor and containment walls must be designed and constructed of materials of sufficient strength and thickness to support themselves, the waste contents, and any personnel and heavy equipment that operate within the unit. All surfaces coming in contact with hazardous waste must be chemically compatible with waste. Primary barriers must be constructed to prevent migration of hazardous constituents into barrier. Secondary containment systems including secondary barrier and leak detection system must also be constructed for containment buildings used to manage wastes containing free liquids. Controls must be implemented to ensure: the primary barrier is free of significant cracks, corrosion, or other deterioration that may allow release of hazardous waste; the level of hazardous waste does not exceed height of containment walls and is otherwise maintained within containment walls; tracking of waste out of unit by personnel or equipment used in handling waste is prevented; and fugitive dust emissions are controlled at level of no visible emissions.	Relevant and Appropriate	Containment buildings, as defined, are not land disposal units, so they can be used to store prohibited waste prior to treatment or disposal. During the operation of the Pilot Plant, waste materials might require temporary management for the purpose of staging or treating the material. Some of the waste material may be sufficiently similar to hazardous waste to make this requirement relevant and appropriate. Design, construction, operation, and maintenance of the buildings will be in accordance with this requirement, and other ARARs, DOE orders, and accepted construction standards and practices, as appropriate. Included in the design will be secondary containment devices (if free liquids are present) and emission controls to control releases, as appropriate.
Ohio Water Well Standards	OAC 3745-9-10 Upon completion of testing, a test hole or well shall be either completely filled with grout or such material as will prevent contaminants from entering groundwater.	Applicable	Test borings and/or wells might be installed or utilized as part of the project activities. Abandonment of any borings or wells during the duration of this project will comply with established site procedures that address this requirement.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Corrective Action for SWMUs (Solid Waste Management Units)	40 CFR Subpart S 40 CFR 264.552 and 553 Corrective Action Management Units (CAMUs) might be designated at the site as areas where remediation wastes (solid, hazardous, or contaminated media and debris) might be placed during the process of remediation. Temporary units (TUs) consisting of tanks and container storage units might be used to store and treat hazardous waste during the process of corrective action.	Relevant & Appropriate	During this treatability study, materials could be managed in containment buildings, TUs, stockpiles or other land-based units for the purpose of staging, treating, or disposing the material without triggering the land disposal restrictions (LDRs).
Radiation Dose Limit (All Pathways)	DOE Order 5400.5, Chapter II, Section 1.a The exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways.	To Be Considered	Operation of the OU4 Pilot Plant could result in release of radiation sources that could contribute to the total dose to members of the public. The facility design will include HEPA filtration to control radionuclide and particulate emissions where appropriate. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through good construction practices. Monitoring of air emissions will be conducted in accordance with the methods referenced in 40 CFR 61.93 with compliance being demonstrated using an EPA approved computer code. Releases to water will be controlled by design and operation of secondary containment features and treatment in the FEMP WWTS.
Control of Visible Particulate Emissions	OAC 3745-17-07 Particulate emissions from a stack shall not exceed specified opacity limits.	Applicable	The facility design will include HEPA filtration to limit and control particulate emissions.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Control of Fugitive Dust	OAC 3745-17-08 Requires the minimization or elimination of visible emissions of fugitive dust generated during grading, loading, or construction operations and other practices which emit fugitive dust.	Relevant and Appropriate	Excavations, excavated soil and other sources of fugitive dust emissions during construction will be controlled, as appropriate, through established FEMP construction practices.
Restriction on Particulate Emissions from Industrial Processes	OAC 3745-17-11 Any source (operation, process, or activity) shall be operated so that particulate emissions do not exceed allowable emission rates specified in this regulation (based on processing weights (Table 1) or uncontrolled mass rate of emissions (Figure II)). A source complies with Table 1 requirements if its rate of particulate emission is always equal to or less than the allowable rate of particulate emission based on the maximum capacity of the source: Process Rate at Maximum Capacity (lb/hr) — Allowable Rate of Particulate Emission (lb/hr)[1] 100 — 0.551 200 — 0.877 400 — 1.40 600 — 1.83 800 — 2.22 1000 — 2.58 [1] Excerpted from Table 1 of OAC 3745-17-1	Applicable	The facility design will include HEPA filtration to minimize particulate emissions to less than these maximum emission rates.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Prevention of Air Pollution Nuisance	ORC 3704.01-.05 OAC 3745-15-07 Measures shall be taken to adopt and maintain a program for the prevention, control, and abatement of air pollution in order to protect and enhance the quality of the state's air resource so as to promote the public health, welfare, and economic vitality of the people of the state. The emission or escape into open air from any source whatsoever of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors, and combinations of the above in such a manner or in such amounts as to endanger the health, safety, or welfare of the public or to cause unreasonable injury or damage to property shall be declared a public nuisance and is prohibited.	Applicable	Where appropriate, the facility design will include HEPA filters to control particulate emissions and an off-gas scrubber for treatment of acidic gas emissions. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through established FEMP construction practices.
Permit to Install	OAC 3745-31-05(A)(3) The installation of new sources or modification of existing sources requires the use of best available technology to control emissions.	Relevant and Appropriate	Though a permit to install is not required for the Pilot Plant (permits are administrative requirements which are excluded under CERCLA), the substantive requirements must be met by employing BAT for treating particulate and off-gas emissions from the Pilot Plant vitrification unit. This requirement will be met by using an off-gas scrubber for treatment of acidic gas emissions followed by HEPA filters for particulate removal.

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Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Nationwide Permit Program	33 CFR 330 The discharge of dredged or fill material into wetlands or waters of the U.S. must be conducted in compliance with the terms and conditions of the U.S. Army Corps of Engineers' (ACOE) Nationwide Permits (NWPs) as promulgated in 33 CFR 330 Appendix A.	Applicable	Construction of Pilot Plant access roads and utility lines will result in minor wetland disturbances. All dredge and fill activities related to construction of these access roads and utility lines will be conducted in accordance with the substantive terms and conditions of Nationwide Permit 12 - Utility Line Backfill and Bedding. The OEPA has been granted Section 401 State Water Quality Certification for NWP 12.
NEPA Compliance	10 CFR 1021.2 DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality regulations in 40 CFR 1500-1508.	Applicable	This requirement is applicable because FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities. NEPA documentation will be prepared for this project in accordance with established site procedures.