DRAFT FINAL

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EVALUATION OF SILO 3 ALTERNATIVES

VOLUME 2 of 2

2504-RP-0001

Revision B

Fernald Environmental Management Project
Fernald, Ohio

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ACRONYMS AND ABBREVIATIONS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AHU	air handling unit
AIRFA	American Indian Religious Freedom Act
A/L	air lock
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ARASA	Alternative Remedial Action Subcontracting Approach
ATM	atmosphere
BMP	Best Management Practices
BOP	Balance of Plant
BTU	British Thermal Units
°C	Degrees Celsius or Centigrade
CAA	Clean Air Act of 1990
CAEM	continuous air effluent monitor
CAMU	Corrective Action Management Unit
CCTV	closed circuit television

ACRONYMS AND ABBREVIATIONS (Cont.)

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CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
Ci	curies
cm	centimeter
CMSA	consolidated metropolitan statistical area
COC	constituent of concern
CONF	conference
CWA	Clean Water Act
CWR	cooling water return
CWS	cooling water supply
DIA	diameter
D&D	decontamination and decommissioning
DOE	United States Department of Energy
DOE-FN	United States Department of Energy - Fernald Area Office
DOT	United States Department of Transportation
EE	Equipment Enclosures
E/E	emergency exit
EL	elevation
ELECT	electrical
EP	Extraction Procedure
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
°F	Degrees Fahrenheit
FDF	Fluor Daniel Fernald
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FFA	Federal Facilities Agreement
FFCA	Federal Facility Compliance Agreement

ACRONYMS AND ABBREVIATIONS (Cont.)

FMPC	Feed Materials Production Center
FPT	Feed Preparation Tanks
FR	Federal Register
FRVP	Fernald Residues Vitrification Plant
ft	feet (foot)
ft^3	cubic feet
FS	Feasibility Study
gal	gallon
gpm	gallons per minute
GTC	gem transfer containers
ha	hectare
HEPA	high efficiency particulate air
HI	Hazard Index
HP	health physics
HVAC	heating, ventilating, and air-conditioning
ILCR	incremental lifetime cancer risk
kg	kilogram
KO	knockout [drum]
L	liter
lb	pound
LDR	land disposal restrictions
LFCM	Liquid Feed Ceramic-lined Melter
LIN	linen closet
LLRW	Low Level Radioactive Waste
LOOW	Lake Ontario Ordnance Works
m	meter
m^3	cubic meters
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCW	Mallinckrodt Chemical Works

ACRONYMS AND ABBREVIATIONS (Cont.)

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MEPA	medium efficiency particulate air
MFT	Melter Feed Tank
mg/l	milligrams per liter
MOG	Melter Off-gas System
MON	monitor
mrem	millirem
mrem/yr	millirem per year
MTR	minimum technology requirements
μg/L	micrograms per liter
NAGPRA	Native American Graves Protection and Repatriation Act
NC	normally closed
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NO	normally open
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standard for Hazardous Air Pollutant
NHPA	National Historic Preservation Act
NLO	National Lead of Ohio, Inc.
NORM	naturally occurring radioactive material
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
O&M	operation and maintenance
OCS	off-gas scrub column
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^2-s	picocuries per square meter per second
PCT	product consistency test

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ACRONYMS AND ABBREVIATIONS (Cont.)

PFD	process flow diagram
PLATF	platform
PNL	Batelle-Pacific Northwest Laboratories
ppb	parts per billion
psi	pounds per square inch
PVV	Process Vessel Vent
QST	quench solution tank
Ra	radium
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RD/RA	Remedial Design/Remedial Action
REFRIG	refrigeration
RFP	request for proposal
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
Rn	radon
ROD	Record of Decision
RPCDF	Representative Permitted Commercial Disposal Facility
RTS	Radon Treatment System
SARA	Superfund Amendments and Reauthorization Act
SCR	Selective Catalytic Reaction
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office
SOP	step off pad
STOR	storage
TBC	to be considered
TBP	tributyl phosphate
TCLP	toxicity characteristic leaching procedure
Th	thorium

ACRONYMS AND ABBREVIATIONS (Cont.)

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TSDF	treatment, storage, and disposal facility
T/T	tangent to tangent
TU	temporary unit
U	uranium
UHC	underlying hazardous constituent
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978
UPRR	Union Pacific Railroad Company
UPS	uninterruptible power supply
UTS	universal treatment standards
VE	value engineering
VEST	vestibule
VITPP	Vitrification Pilot Plant
VSL	The Catholic University of America Vitreous State Laboratory
WAC	Waste Acceptance Criteria
WMB	white metal box
wt	weight
yd	yard
yd^3	cubic yard

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EXECUTIVE SUMMARY

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Introduction

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

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

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

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

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

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

Background

Silo 3 contains 3,890 m^3 (5,088 yd^3) of residues, known as cold metal oxides, which were generated at the FEMP during uranium extraction operations in the 1950s. This process involved Belgian Congo ores and uranium concentrates received from a variety of uranium mills in the United States and abroad. The residues in Silo 3 are substantially different from those in Silos 1 and 2. First, Silo 3 residues have a low moisture content resulting in a powder-like consistency, while residues in Silos 1 and 2 consist of wet slurry from which excess liquids were decanted. Second, while the radiological constituents in Silo 3 are similar to those in Silos 1 and 2, certain radionuclides, such as radium, are present in much lower concentrations. Thus, the estimated contact dose level of 10 mrem/hr and radon emanation rate of 70 pCi/m^2/sec associated with untreated Silo 3 residues is significantly lower than the estimated contact dose level of 600 mrem/hr and radon emanation rate of 7000 pCi/m^2/sec associated with untreated Silo 3 residues.

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

cadmium, chromium, and selenium are leachable from the residues exceeding maximum limits.

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

Treatability Studies

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

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

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

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

Continuous evaluation of the performance data obtained during this process as it pertains to full-scale operations is both critical and appropriate. Throughout the implementation and development of the

Vitrification Pilot Plant Phase I and II Treatability Study Programs, continued schedule delays, cost growth and technical concerns have resulted in DOE thoroughly reassessing the overall project for opportunities to accelerate schedule, reduce project costs, and optimize the RD/RA process using data obtained from these treatability study programs.

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

Evaluation of Alternatives

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

The analyses presented in this report followed a two-stage process. First, an analysis of alternatives and their uncertainties were performed on those alternatives which were retained through the *Summary Screening Evaluation of Silo 3 Alternatives*, March 1996, (Appendix B). Second, a

comparative analysis of the alternatives passing the screening analysis were conducted to develop the basis for determining the most appropriate alternative for treating the Silo 3 residues. The following is a list of the five alternatives evaluated:

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

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

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

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

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

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

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

- State acceptance; and
- Community acceptance.

Summary of Analysis

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

Overall Protection of Human Health and the Environment

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

Compliance with ARARs

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

Long-term Effectiveness and Permanence

VIT, ALT1, ALT2, and ALT3 would ensure long-term protection to human health and the

TABLE ES-1

SILO 3 ALTERNATIVES - COMPARATIVE ANALYSIS

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

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

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environment by removing the residues from the silo, treating the residues by vitrification or stabilization, and disposing of the material off-site at either the NTS or a RPCDF.

Reduction of Toxicity, Mobility or Volume Through Treatment

The toxicity characteristic is measured by the leachability of certain RCRA constituents (i.e., the ability of those constituents to percolate through solid material and potentially contaminate groundwater). By stabilizing or immobilizing the constituents through either vitrification or cementation, the leachability of the constituents can be reduced and the toxicity characteristic can be removed. Therefore, VIT, ALT1, ALT2, and ALT3 would remove the toxicity characteristic by reducing the mobility of the contaminants by either vitrification or stabilization. In addition, the vitrified form would result in a reduction in volume of treated material relative to untreated material. Stabilized material would result in a volume increase of treated material relative to untreated material as a result of adding the stabilization and/or settling agents. Table ES-2 presents a comparison of treated and disposal volumes for the Silo 3 alternatives.

TABLE ES-2

COMPARISON OF TREATED AND DISPOSAL VOLUMES FOR SILO 3 ALTERNATIVES

Alternative	Untreated Volume yd^3	Treated Volume yd^3	Disposal Volume yd^3
VIT	5,088	2,273	6,972[1]
ALT1	5,088	6,088	8,960
ALT2	5,088	6,320	6,320[2]
ALT3	5,088	5,960	5,960[2]

[1]Disposal volume increase due to volume of disposal container from blending with Silos 1 and 2 residues during vitrification.

[2]No disposal volume increase from treated volume since treated residues would be bulk disposed at the RPCDF.

Short-term Effectiveness

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

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transportaion risks associated with the Silo 3 alternatives.

TABLE ES-3

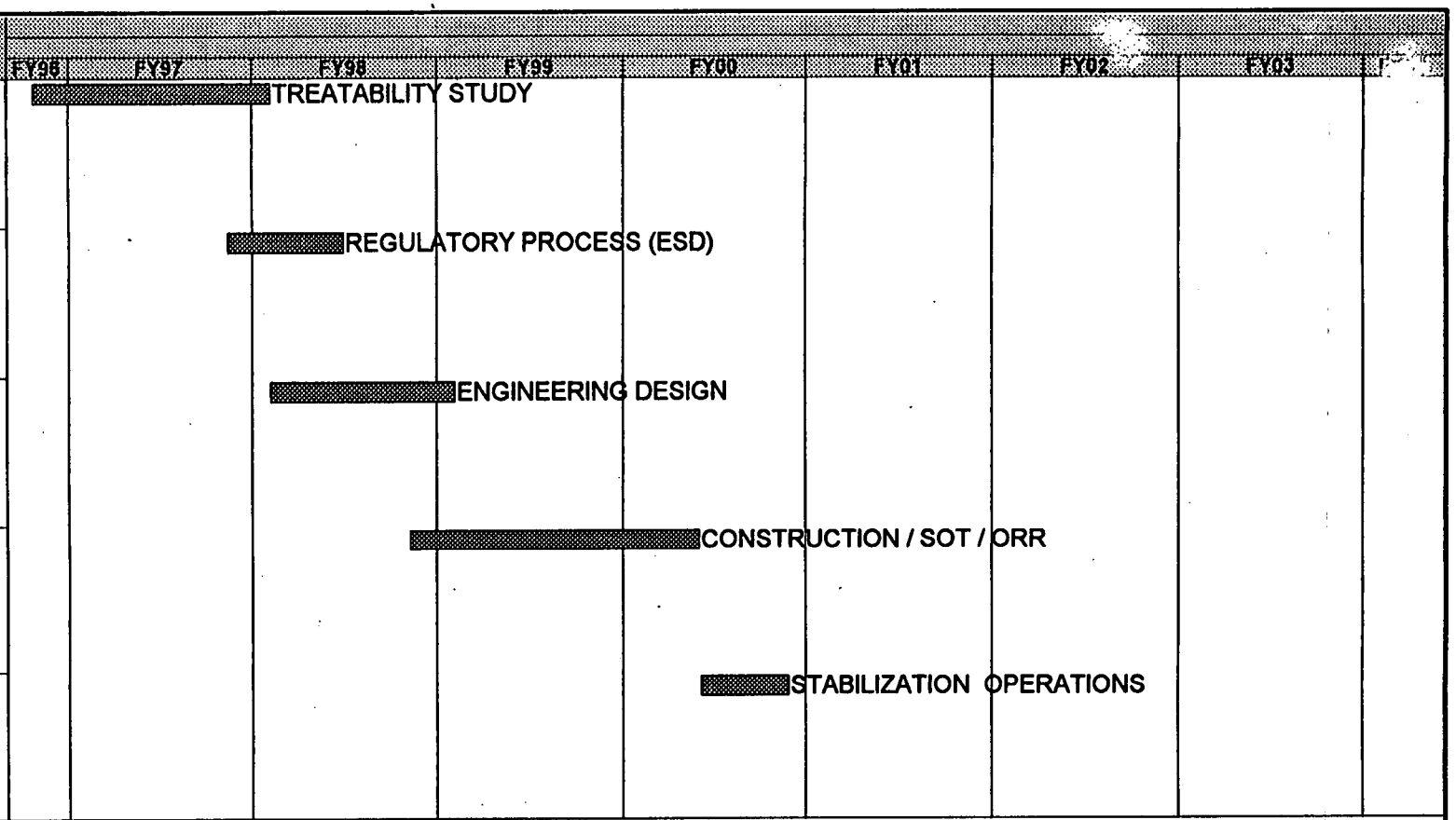
COMPARISON OF SHORT-TERM MECHANICAL AND TRANSPORTATION RISKS FOR SILO 3 ALTERNATIVES

Risk Type	VIT	ALT1	ALT2	ALT3
Worker Injury	6	1	2	1
Worker Fatality	0.09	0.02	0.02	0.02
Transportation Worker Injury	0.06	0.05	0.07	0.05
Transportation Worker Fatality	0.003	0.002	0.004	0.003
Public Transportation Injury	0.2	0.1	0.2	0.1
Public Transportation Fatality	0.02	0.01	0.02	0.02
Lifetime Cancer Risk Maximally Exposed Individual	3×10^{-10}	8×10^{-10}	8×10^{-10}	8×10^{-10}

Implementability

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

Orig Dur	Early Start	Early Finish	
327*	22JUL96*	06NOV97	TREATABILITY STUDY
157*	11AUG97*	27MAR98	REGULATORY PROCESS (ESD)
250*	07NOV97*	06NOV98	ENGINEERING DESIGN
390*	11AUG98*	03MAR00	CONSTRUCTION / SOT / ORR
122*	06MAR00*	25AUG00	STABILIZATION OPERATIONS



NOTE: ACTUAL STABILIZATION OPERATIONS DURATION WILL VARY DEPENDING ON ALTERNATIVE

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

Project Start 01OCT95
Project Finish 11JUL02
Data Date 01OCT95
Plot Date 27JUN96

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Early Bar
Progress Bar
Critical Activity

SSFS

Sheet 1 of 1

FIGURE ES-1
SILO 3 ALTERNATIVES
ACCELERATED SUMMARY SCHEDULE

Fernald Environmental
FERMCO
Restoration Management Corporation

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

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

TABLE ES-4

SILO 3 ALTERNATIVES SCHEDULE COMPARISON

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

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

Cost

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

Summary

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

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

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

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

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

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1.0 INTRODUCTION

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This report documents the reexamination of the selected remedy and considers the evaluation of alternative treatment and disposal options for the remediation of the contents of Silo 3 of Operable Unit (OU) 4 at the United States Department of Energy (DOE) Fernald Environmental Management Project (FEMP). OU4 is one of five operable units at the FEMP, and one for which a United States Environmental Protection Agency (EPA)-approved final Record of Decision (ROD) has been issued. The OU4 remedial actions, as outlined in the *Final Record of Decision for Remedial Action at Operable Unit 4, December 1994 (DOE 1994c)*, primarily consists of the removal of the contents of Silos 1, 2, and 3; stabilization by vitrification; off-site disposal of the vitrified waste at the Nevada Test Site (NTS); and the demolition, removal, and final disposition of the contaminated concrete, debris and soils within the OU4 boundary. The goal of the OU4 remedial action is to safely remediate all the OU4 components in a timely, efficient and cost- effective manner, that assures compliance with all applicable or relevant and appropriate requirements (ARARs) and that would be protective of human health and the environment.

1.1 Background

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

Continuous evaluation of the performance data obtained during this process as it pertains to full-scale operations is both critical and appropriate. Throughout the implementation and development of the Vitrification Pilot Plant Phase I and II Treatability Study Programs, respectively, continued schedule delays, growing costs and technical concerns have resulted in DOE thoroughly reassessing the overall project for opportunities to accelerate schedule, reduce project costs, and optimize the RD/RA process using data obtained from these treatability study programs.

It is the additional insight to the physical, chemical and radiological characteristics associated with the Silo 3 residues, as determined from these treatability studies, that make it a leading candidate for consideration of alternative treatment and the means by which the overall OU4 remediation project schedule could be accelerated. By performing the remediation of Silo 3 residues through an alternate method either ahead of schedule or in parallel to the vitrification of Silos 1 and 2 residues, the overall remediation schedule could possibly be shortened for OU4. However, it must first be determined whether another technically feasible treatment method could be implemented in an equally protective and cost-effective manner.

1.2 Purpose and Scope

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

The technical efforts presented in this report follow a two-stage process. First, an analysis of alternatives and their uncertainties will be performed on those alternatives which were retained through the Screening of Silo 3 Alternatives (Appendix B). Second, a comparative analysis of these final alternatives will be conducted to provide the basis for determining the most appropriate alternative for treating the Silo 3 residues. The following is a list of the five alternatives to be evaluated:

- Removal - Onsite Vitrification, Off-site Disposal at the NTS (Baseline)
- Removal - Onsite Stabilization, Off-site Disposal at the NTS
- Removal - Onsite Stabilization, Off-site Disposal at a Representative Permitted Commercial Disposal Facility
- Removal - Off-site Stabilization and Disposal at a Representative Permitted Commercial Disposal Facility
- Removal - Onsite Blending with Waste Pit 5 Material, Off-site Disposal at a Representative Permitted Commercial Disposal Facility

1.3 Operational History of OU4

In order to clarify the differences between Silos 1 and 2 residues and the Silo 3 residues and thus, understand the rationale behind potentially selecting an alternative process for the treatment of the Silo 3 residues, this section discusses the process history and origins of all the silo residues. In addition, Section 1.4 will comparatively discuss the differences between the Silos 1 and 2, and the Silo 3 residues. Together, these sections will provide the complete background information for later evaluating whether an alternative means of stabilization might have cost, schedule or technical benefits in Sections 3 and 4.

The storage silos were constructed for the transfer and storage of two basic forms of waste materials known as "hot" raffinates and "cold" metal oxides. The following discussion has been included from the final OU4 Remedial Investigation Report (DOE 1993b) to explain the origins and differences between hot raffinates and cold metal oxides and describe the processes employed at Mallinckrodt Chemical Works (MCW) and the former Feed Materials Production Center (FMPC) refinery to generate the stored residues. Also discussed are the pertinent aspects of waste handling and the function of the K-65 Drum Handling Building to show how the residues were generated and transferred to Silos 1, 2, and 3.

The FMPC refinery processed two basic classes of materials: (1) pitchblende ores as they were mined and shipped to the FMPC and (2) other uranium concentrates that had already been refined to some degree. This second class of materials included uranium concentrates that had undergone a preliminary refining process at an off-site mill and residues recovered at various stages of FMPC operations.

Uranium-bearing ores, as they are mined, contain not only uranium, but also equilibrium (activity) concentrations of uranium progeny (i.e., the isotopes of other elements formed through the sequential radioactive decay chains that begin with uranium [U]-235 and U-238). These progeny, which include radium, are removed in either a preliminary milling process or in the refining process (if the ores are not preprocessed through a mill). Thus, when the FMPC refinery processed pitchblende ores, the refinery wastes contained a high concentration of the radioactive uranium progeny. These refinery wastes were known as "hot" raffinates. The term "hot" was used to indicate that the residues contained a high concentration of the radionuclide radium (Ra)-226 and gamma-emitting progeny that result in a significant direct penetrating radiation exposure rate. When the FMPC processed uranium concentrates that had been preprocessed through a uranium mill, a significant portion of the Ra-226 and the gamma-emitting progeny had already been removed and were thus termed "cold" metal oxides. However, some of the thorium progeny of uranium (i.e., thorium [Th]-230) remained within the uranium concentrates due to the inefficiency of the mill in removing this metal, so even though the residues are called "cold," they are

radioactive.

1.3.1 History of Silo 1

Silo 1 was constructed in 1952, as one of the first facilities at the FMPC site, with the intent to store drummed residues in inventory at other United States facilities. The residues stored in Silo 1 were generated at MCW in St. Louis, Missouri, as a result of the processing to extract uranium from pitchblende ores. The pitchblende ores processed at MCW and the great majority of the pitchblende ores processed at the FMPC site came from one mine, the Shinkolobwe Mine in the Belgian Congo. These ores contained relatively high concentrations of uranium oxides (U_3O_8) in the range of 40 to 50 percent. The Shinkolobwe Mine, owned by African Metals Corporation, began operation in 1921 for the purpose of obtaining radium. The mine was reopened in 1943 for its uranium. Based on the high value of radium at the time, the agreement reached between the Atomic Energy Commission (AEC) and the African Metals Corporation stipulated that the African Metals Corporation would retain ownership of the radium within any processing residues; after the United States had processed the pitchblende to extract uranium, the residue would be returned to the African Metals Corporation. In 1984, ownership of the K-65 residue was transferred to DOE.

Initially, the residues from the MCW refining operations were sent back to the African Metals Corporation. Beginning in April 1949, the residues were no longer returned to the African Metals Corporation following processing, but were stored at MCW for future disposition. As production continued, storage became a problem. As a result, the drummed K-65 residues were sent from MCW to Lake Ontario Ordnance Works (LOOW) near Niagara Falls, New York, for storage. Some of the drums that were sent to LOOW were emptied into a concrete water tower at that site. Approximately 6,000 drums were shipped from LOOW to the FMPC site for storage. Beginning in 1951, continuing production at the MCW resulted in approximately 25,000 drums being sent directly from St. Louis to the FMPC site.

MCW operated a uranium refinery for production of uranium prior to construction of the FMPC refinery. The MCW refinery used a dual-cycle ether process that was somewhat different from the tributyl phosphate (TBP)-kerosene extraction system used at the FMPC site. Another difference between the FMPC process and the MCW refinery operation was in the method used to extract radium and other impurities from the uranium. Unlike the FMPC process, the impurities were removed from K-65 residues at MCW in the ore digestion process before the uranium extraction system.

The process to remove uranium from pitchblende at MCW consisted first of milling the ores to pass a 100-mesh sieve followed by a 3-hour leach in concentrated nitric acid, which resulted in the radium precipitating as radium sulfate ($RaSO_4$). Barium sulfate ($BaSO_4$) was added during digestion to ensure coprecipitation. If insufficient sulfide was present in the ore, sulfuric acid (H_2SO_4) was added to ensure the precipitation of radium and lead. The precipitated materials were vacuum-filtered, then reslurried and digested with sodium carbonate (Na_2CO_3) and sodium formate ($NaHCO_2$). This second digestion process was to recover approximately 2 percent of the original uranium, which remained in this waste fraction. The second digestion also led to the precipitation of impurities including ferric, aluminum, and manganese hydroxides. Following the carbonate leach, the slurry was again vacuum filtered and packaged in drums as K-65 residues. Much of the thorium (most importantly Th-230), as a nitrate, remained soluble and traveled in solution with the uranyl nitrate to the extraction process area. Therefore, Th-230 is not present in secular equilibrium with Ra-226 in the K-65 residues.

Approximately 24,000 of the 31,000 drums of pitchblende ore processing residues received at the FMPC site from MCW and LOOW were transferred to Silo 1 for storage. The remaining 7,000 drums of K-65 residues received from MCW and LOOW were transferred to Silo 2. (The history of Silo 2 will be discussed in the next section.) As the drums were received by railroad car at the FMPC site, the drums were temporarily staged in an area to the east of Silos 3 and 4. The drummed material was transferred to Silo 1 from July 1952 until November 1953 through the use of a specially constructed Drum Handling Building.

The K-65 Drum Handling Building was used for receipt of drummed waste from MCW and LOOW locations and the transfer of that waste into Silos 1 and 2. A block diagram of this process is presented in Figure 1.3-1.

Wet solids were delivered to the K-65 Drum Handling Building in 55-gallon drums, each containing approximately 230 kg (500 lb) of material. The material had a bulk density of approximately 1.44 grams/cubic centimeter (g/cm^3) (90 lb/ft^3) and contained approximately 40 percent moisture by weight. One drum of waste was handled at a time.

Each drum was placed on a slat conveyor and moved inside the building. There it was placed on a skip hoist and raised to a point above the slurry tank, where it was inverted. The contents of the drum were dumped into the slurry tank by vibration, aided by a high-velocity water jet. The water jet also washed the drum, which was eventually returned to the conveyor and removed from the building. Approximately

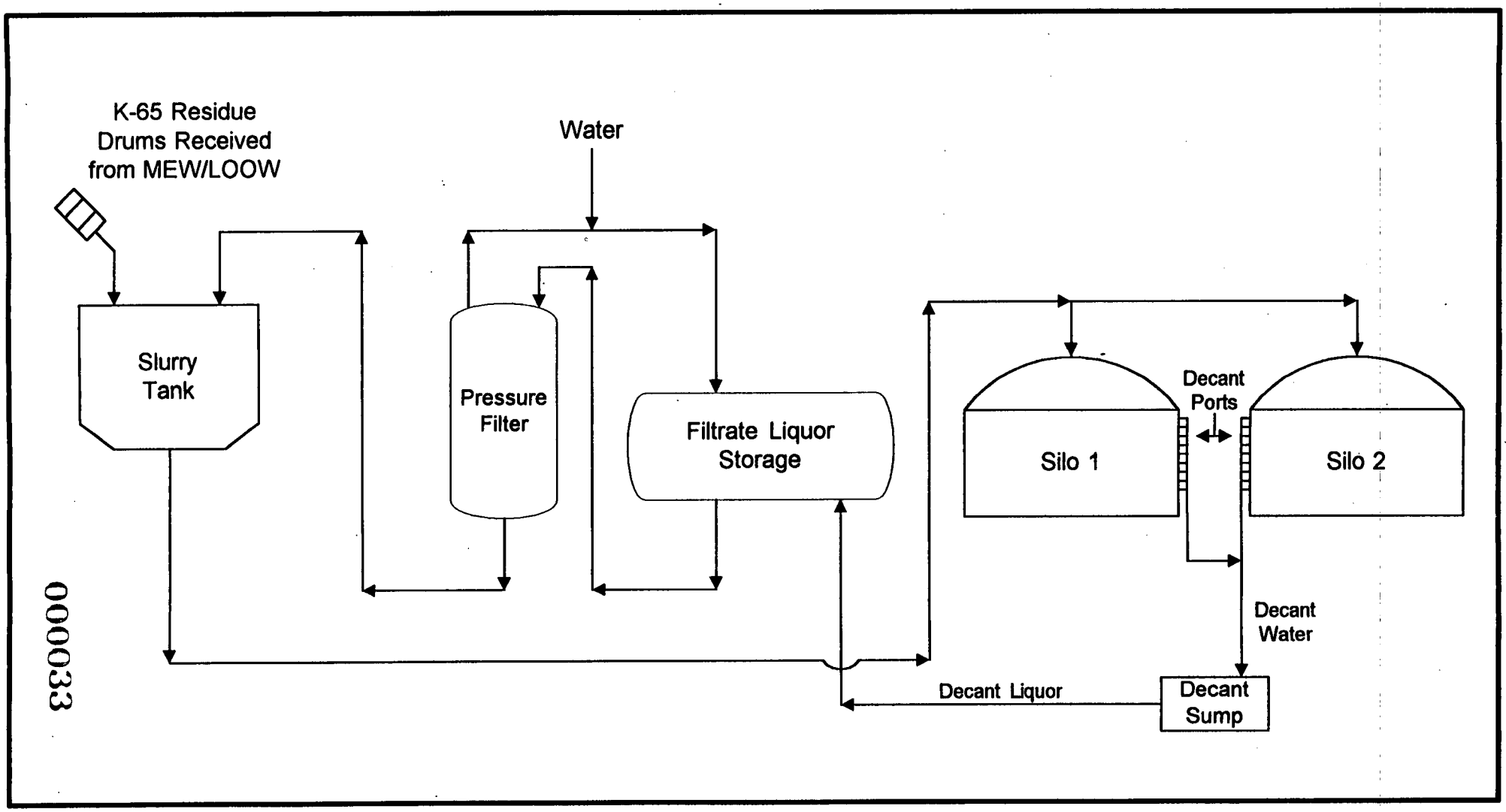

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Figure 1.3-1 Hot Raffinate from K-65 Drummed Waste Handling Facility

280 liters (L) (75 gallons) of slurrying liquor, which was fresh water during initial operations, was consumed in removing the solids from one drum. The resulting slurry, which had a consistency of approximately 4 pounds of wet solids per gallon of slurry, was continuously agitated in the slurry tank.

When approximately 7,570 L (2,000 gallons) of slurry had been produced, the contents of the slurry tank were pumped to storage in Silo 1. This slurry pumping was followed by a 6,250-L (1,650-gallon) clear liquor wash, which was passed through the slurry tank, slurry pump, transfer line, and into the storage silo.

The slurries pumped into storage Silo 1 were allowed to settle into two layers. The slurry liquor, which consisted of either water or a metal nitrate solution, formed the top layer over a bed of the settled, wet solids. This layer of clear liquid was decanted from the silos through the decant ports and collected in the decant sump tank. From here, the decanted liquid was periodically pumped back to the Drum Handling Building where it passed through a pressure filter, and was stored in a filtrate storage tank. The filtrate storage tank was located within the Drum Handling Building on the concrete pad, forming the floor of the structure. The filtered liquid was then used for slurry preparation in the K-65 Drum Handling Building. Excess liquids were transported back to the FMPC Plant 8 for treatment, then to the General Sump for final treatment before discharge to the Great Miami River. The K-65 Drum Handling Building was demolished in 1983 to allow for the installation of the earthen berm.

Although MCW processed the pitchblende ores by batch runs on the incoming ores from the Shinkolobwe Mine, no conscious attempt was made at Fernald to transfer the residues to the silos by the original MCW batch or lot number. Therefore, the residues within Silo 1 represent a range of processing runs at MCW, displaying the variations present in the natural ores and the generating production process.

1.3.2 History of Silo 2

While Silo 1 was completely filled by the transfer of drummed residues from MCW and LOOW, Silo 2 is a mixture of MCW K-65 residues and FMPC-generated K-65 residues. As previously stated, 7,000 drums of K-65 residues transferred from MCW and LOOW to Fernald were emptied into Silo 2. The transfer of the drummed residues received from off-site into Silo 2 occurred between late 1953 and January 1956. The generating process and the methodology to transfer the MCW/LOOW residues to Silo 2 is similar to those used in Silo 1, as discussed in the previous section.

Additionally, Silo 2 received residues generated at the FMPC site resulting from the processing of pitchblende ores shipped directly from the Shinkolobwe Mine and a small quantity of Australian ores from two mines, the Rum Jungle Mine and the Radium Hill Mine. The processing completed at the FMPC site was performed to extract the uranium from these very rich pitchblende ores. Belgian Congo ores were processed from May 1954 until August 1958. Australian ores were processed following the Belgian ores from May 1957 until March 1958. The last K-65 slurry was added to Silo 2 in January 1959. The Australian ore residues constitute less than 180,000 kg (200 tons) of the estimated 4.4 million kg (4,900 tons) in Silo 2. The term K-65 was used to describe the processing of both the Belgian Congo and the Australian ores.

Fernald-generated residues in Silo 2 are a byproduct of refinery operations conducted in Plant 2/3 and supporting structures at the facility. Pitchblende ores were received at Plant 1 of the FMPC site where the ores were thawed (if necessary), milled, and assayed for their uranium content. Milling took place in a Williams mill, where the ores were ground until they would pass a 100-mesh sieve. Milling was performed to facilitate the digestion process. The milled ores, following assay, were conveyed to the Plant 1 ore silos for storage until they were processed in the refinery (Plant 2/3). At the refinery, the milled ores were transferred to digester tanks by batch. Each batch varied from 1,820 kg (4,000 lb) to 2,270 kg (5,000 lb) of uranium and 2,270 kg (5,000 lb) to 4,550 kg (10,000 lb) of net feed. Nitric acid and water were added to the ores in the digesters to yield a final slurry concentration of 200 grams of uranium per liter and 3 Normal excess nitric acid. Following a typical 3-hour digestion, the digest slurry was transferred to a feed holding tank in the extraction area of the refinery.

The uranium extraction system at the FMPC site, at the time of K-65 processing, employed a series of three perforated plate pulse columns, including an extraction column, a scrub column, and a reextraction column. The aqueous feed slurry from the hold tank was introduced into the top of the extraction column. An organic extractant, 33.5 percent by volume TBP in an inert purified kerosene diluent, was introduced into the bottom of the same extraction column. The combined liquid phases were pulsed through the stationary perforated plates, with the aqueous feed solution passing down and the organic phase moving up through the column. The organic extractant flow rate and the feed stream flow rate were controlled to maintain a constant uranium saturation level in the organic product stream. The uranyl nitrate solution was removed from the aqueous slurry of the organic extractant. Extraction of the uranium from the ores was essentially completed when the organic product stream left the top of the extraction column.

The remaining metals and other impurities in the pitchblende ores left the bottom of the extraction column. This byproduct stream was known as K-65 raffinates. The K-65 raffinates were freed of the organic phase in a disengagement chamber at the base of the extraction column. Despite this disengagement process, considerable quantities of entrained TBP remained in the raffinate leaving the column. To recover these reusable concentrations of TBP, the raffinates were transferred to a single stage mixer settler where the raffinates were contacted with continuously recycled kerosene to recover the remaining TBP.

While the TBP extraction system was relatively specific toward uranyl nitrate, other nitrate compounds, such as thorium nitrate, present in the feed slurry were physically entrained in the organic product phase leaving the extraction column. To remove these impurities from the feed stream, a second purification step was performed in the scrub column to achieve product quality standards. In the scrub column, the organic product stream from the extraction column entered the bottom while deionized water entered the top of the column. During the continuous flow through the scrub column, essentially all of the remaining metallic impurities were transferred to the aqueous phase, together with a small quantity of uranium. The aqueous phase was directed back to the extraction column to recover the remaining uranyl nitrate. The pure organic phase continued through the final re-extraction column where the TBP-kerosene was separated from the uranyl nitrate. The operation of the re-extraction column is not relevant to the generation of the K-65 residues and is, therefore, not presented. The impurities residing in the aqueous phase from the scrub column were transferred to the K-65 raffinates leaving the extraction column.

The kerosene-washed K-65 raffinates were filtered through a precoated rotary vacuum filter to remove suspended solids (Figure 1.3-2). Most of the gamma-emitting uranium progeny, and radium, were filtered out in this step. Filtrate was passed on to the cold metal oxide process, which will be described in the following section on Silo 3. The filter cake from the rotary filter contained the gamma-emitting uranium progeny, and thus were termed hot raffinates. This filter cake was reslurried and then neutralized with lime ($Ca[OH]_2$). The resulting slurry had a consistency of about 0.5 kg of wet solids per liter of slurry (4 lb of wet solids per gallon of slurry). Once each day during refinery operation, the hot raffinate slurry was pumped into Silo 2 through a 7.6-cm (3-inch), Schedule 80 transfer line located in a concrete trench that extended from the refinery to the silos. This slurry transfer was followed by a 4,500- to 5,500-L (1,200- to 1,500-gallon) process water wash to clean the transfer line.

Following completion of K-65 processing operations at the FMPC site, approximately 150 drums of radium-contaminated material, consisting of soils from the MCW/LOOW drum staging area, cleanup

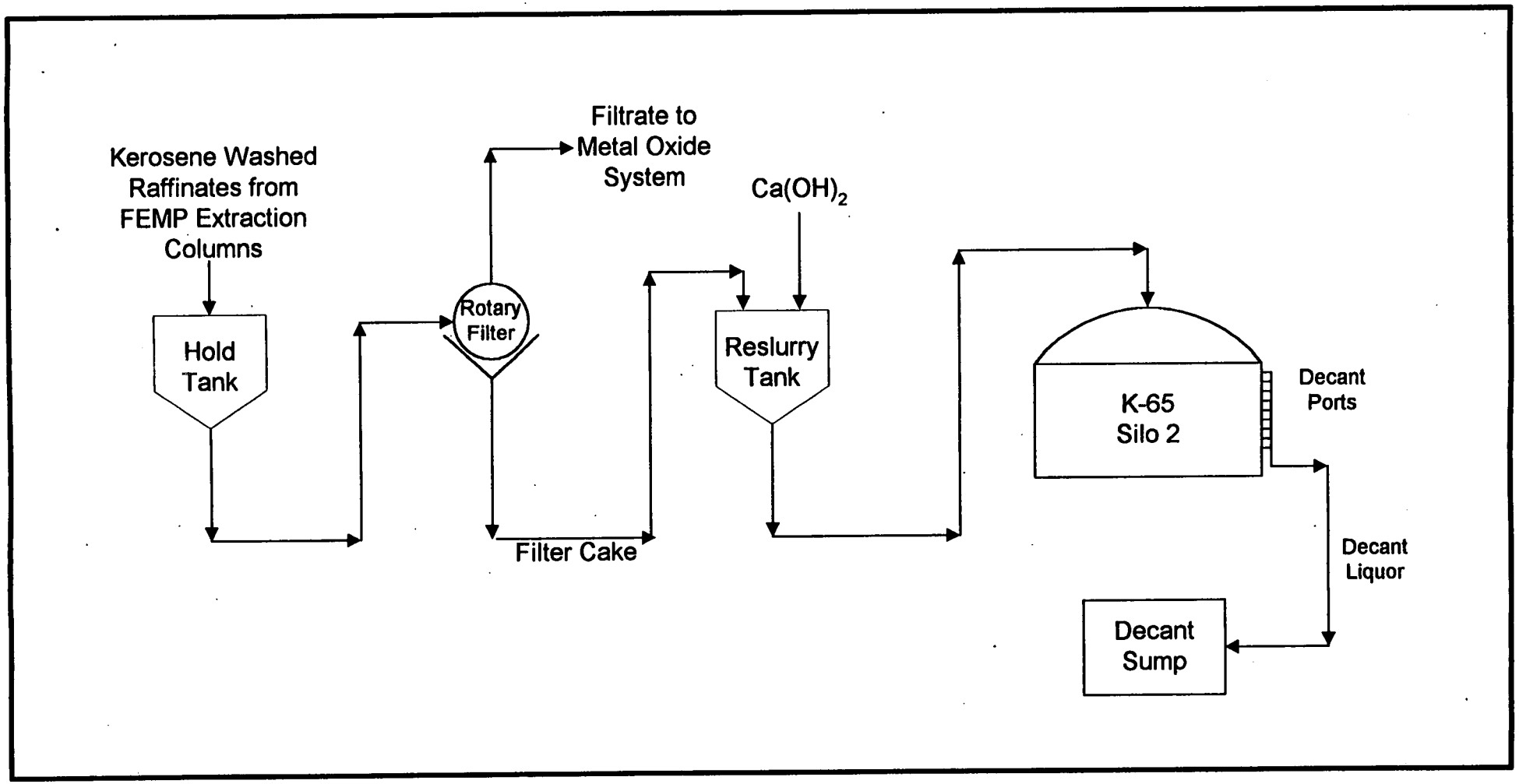

Figure 1.3-2 Hot Raffinate Flow to Silo 2

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materials, and excess K-65 samples, were placed into Silo 2 in June 1960. In 1979, in response to concerns on the part of the FMPC Operating Contractor, National Lead of Ohio (NLO), Inc., relative to the chronic radon emissions from the silos, all vents, manways, and other penetrations through the domes of Silos 1 and 2 were sealed. No materials (with the exception of decant liquid and samples) have been removed from Silos 1 or 2 since final filling.

1.3.3 History of Silos 3 and 4

Silos 3 and 4 were constructed in 1952 for the storage of byproduct metal oxides generated through the operation of the FMPC refinery. Unlike Silos 1 and 2, which received byproducts from the processing of ores from only three mines, Silo 3 received metal oxides generated consequential to all FMPC refinery operations from May 1954 until late 1957. During this time period, the FMPC refinery processed the previously mentioned pitchblende ores and uranium ore concentrates received from a number of foreign and domestic uranium mills. In the previous section, the FMPC refinery operations that generated the K-65 residues and the metal oxide stream were discussed. As previously stated, following a kerosene wash, raffinates from the refinery extraction column were passed through a precoated rotary vacuum filter to separate the solid phase from the aqueous phase.

In the case of pitchblende ore processing, the filter cake was transferred to Silo 2 to hold the radium and other precious metals present in this byproduct fraction for the planned eventual return to the Belgian Congo. The filtrate from the vacuum filter was subjected to further waste processing and eventually was transferred to Silo 3. In the FMPC processing of uranium concentrates, the major fraction of metal impurities, including radium, had been previously removed from the concentrates by the uranium mills prior to transfer to the FMPC site. Significant activity concentrations of other radionuclides in the uranium decay series, including thorium, remained in the concentrates due to the variations in the efficiency of the removal at the mill.

The entire kerosene-washed raffinate stream from the extraction column during ore concentrate processing, and the filtrate from the rotary vacuum filter during operation involving pitchblende ores, were processed in a similar fashion to produce the cold metal oxides present in Silo 3 (Figure 1.3-3). These waste streams were transferred to a series of agitated holding tanks in the refinery area. These surge tanks fed a set of evaporators where approximately 90 percent of the liquids were evaporated and the remaining 10 percent concentrates were withdrawn for further processing. Evaporator temperatures ranged from 90°C (200°F) to 120°C (250°F). The concentrates from the evaporator were transferred to one of two processing operations depending on when they were transferred. From plant start-up

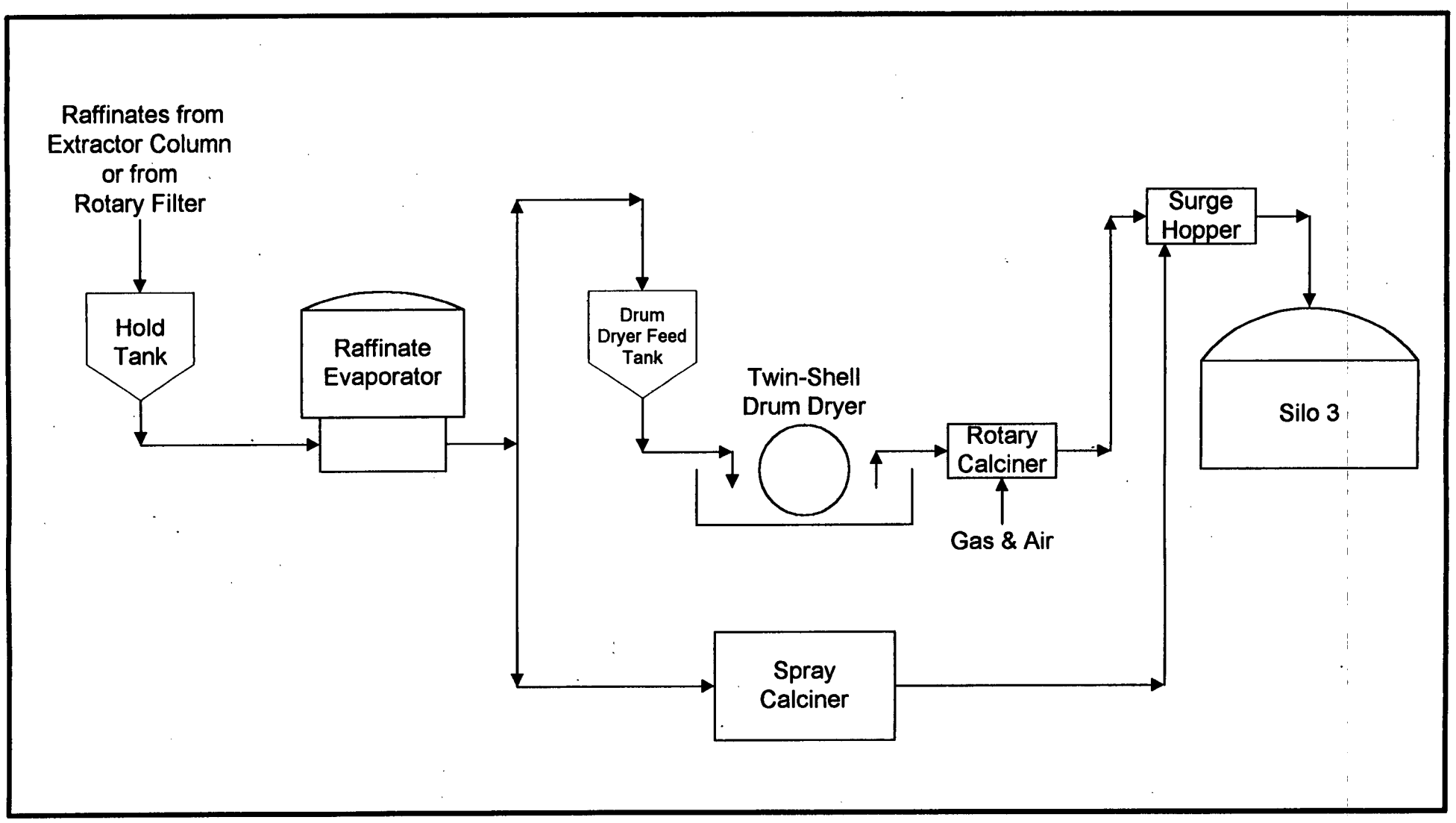

Figure 1.3-3 Metal Oxide Transfer to Silo 3

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through the mid-1950's, the concentrates were transferred to a spray calciner. The spray calciner operated at a temperature of 510°C (950°F) to remove the remaining liquids and convert the metal nitrates present in the concentrates into oxides.

Due to operational difficulties experienced with the spray calciners, a second process was installed to complete the drying of the concentrates. In this process, the concentrates from the evaporators were transferred to a drum dryer where the materials were spread in a rotating dryer. In the dryer, liquids were removed from the concentrates by centrifugal force. The drum-dried concentrates were then transferred to a rotary calciner to remove the remaining liquids and to complete conversion of the metal nitrates into oxides. The concentrates were retained in the furnace zone at 650°C (1,200°F) to 820°C (1,500°F) for approximately 10 minutes.

The finely-powdered, dried metal oxides were transferred to a surge hopper. From this hopper, the residues were pneumatically conveyed to Silo 3 through a pipeline in the concrete trench to Silo 3. At the Drum Handling Building, the Silo 3 transfer line ran above grade on a pipe rack to the top of Silo 3. A dust collector, which was used to control discharges to the atmosphere resulting from the discharge of the powdered residues into Silo 3, was located at the top of the silo. Silo 3 was filled to its present level using this rotary calcining system. No residues, except samples, have been removed from Silo 3 since filling in 1957.

Following a programmatic decision in early 1957 to use raffinate surface impoundments, the spray calcining and rotary calcining systems were eventually abandoned. As a result, Silo 4 was never employed for the storage of cold metal oxides and remains empty. Inspections completed on Silo 4 during the OU4 RI-related site investigations confirmed that no waste materials were present within the silo.

1.4 Comparison of Differences Between Silo 3 Residues and K-65 Residues

The Silo 3 residues and K-65 residues are dissimilar in many respects. Their primary similarity is that, due to geographic location, both are included within the OU4 boundary. Beyond this and the fact that a significant portion of Silo 3 residues came from the processing of uranium-bearing Belgian Congo ore (as did K-65 residues) and the fact that they have both radioactive and hazardous components, they are not similar in any other meaningful way. It is the purpose of this section to highlight the dissimilarities in the areas that have and will contribute to an overall evaluation of the most appropriate method of

remediation for the Silo 3 residues and the potential for treating the K-65 residues and Silo 3 residues differently.

1.4.1. Physical Differences

There are two main physical differences between the Silo 3 residues and the K-65 residues: particle size and moisture content. The difference in particle size is the result of the two waste streams being removed by separate processing steps in residue handling following extraction of the uranium. The Silo 3 portion was calcined to dryness and as a result is uniformly of a smaller size than K-65 residues. The K-65 residues retain a significant portion of large sized particles since the primary size reduction action on this material was in the initial milling of the ore. A better appreciation of this difference in particle sizes of the two waste streams can be seen in Figure 1.4-1.

The other main difference between Silo 3 residues and K-65 residues is the physical state in which their water content allows them to exist. The dryness of the Silo 3 residues, along with its smaller particle size, causes it to be very dispersible. The K-65 residues, in contrast, having been placed in the silos in a slurry form and retaining more than 30 percent of this original moisture, is in a state of much more close and strong adherence of particles. As a result, unless the K-65 residues are dried, they would not be in an easily dispersible state. This difference is a primary and significant difference between the two waste streams.

The dispersibility of the Silo 3 residues (considering its thorium-230 content) causes it to be a potentially serious respiratory hazard to the remedial worker (the radiological differences between the two waste streams will be discussed in Section 1.4.3) In contrast, the K-65 residues, although in a dry and dispersible state on the surface of the residue (prior to installation of the bentonite layer), is moist beneath this layer and is less of a respiratory hazard.

This difference dictates the retrieval method(s) selected for the two residues. The K-65 residues will be hydraulically removed in a slurry form where Silo 3 residues will be removed pneumatically as identified in the OU4 ROD. Due to a concern with the results in the analyses of particle size performed for the OU4 Remedial Investigation Report, subsequent analysis of particle size for Silo 3 residues was performed in support of the remedial design activities. The resolution of the percentage of particles less than 1 micron was important and directly relates to the design of the residues handling systems prior to treatment.

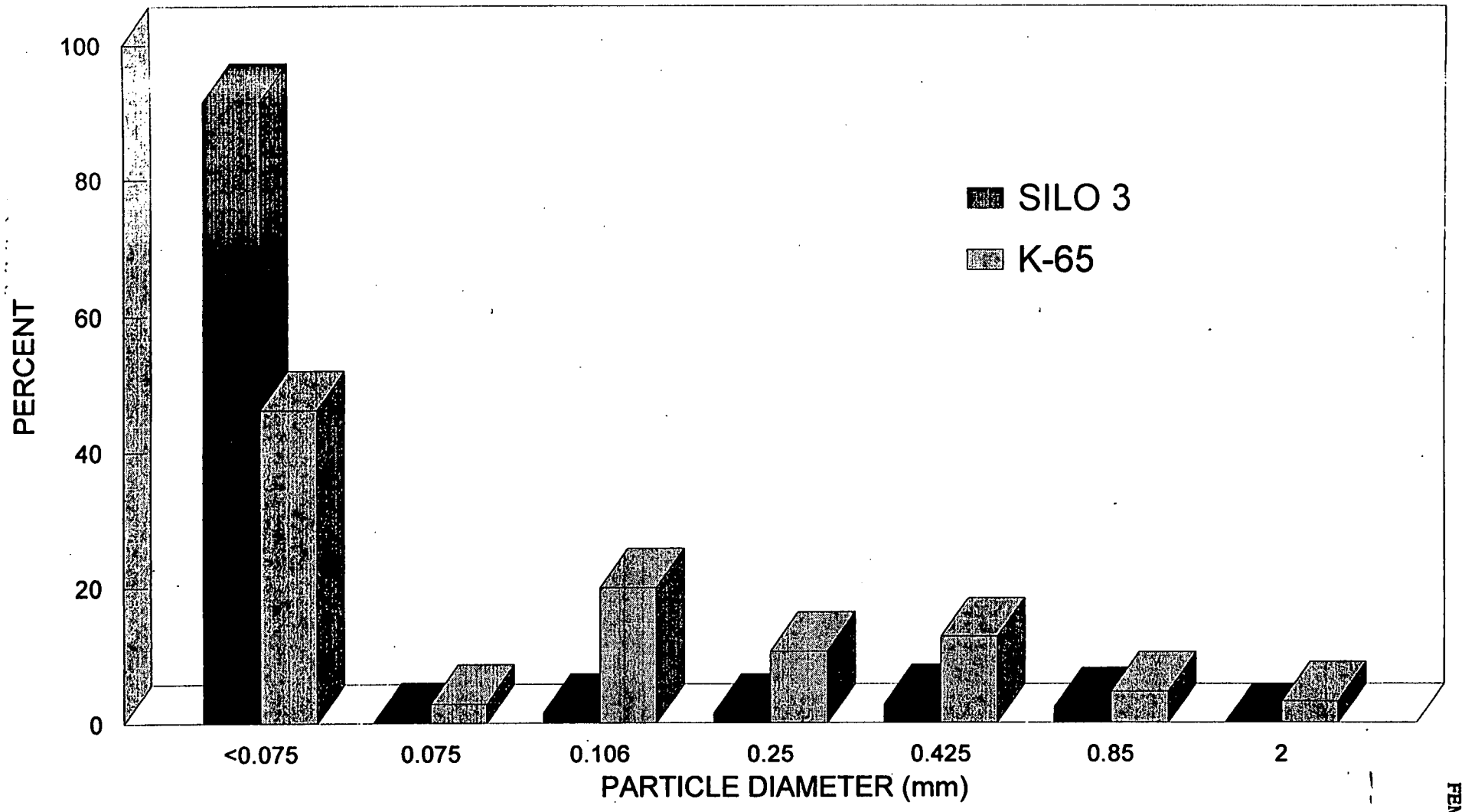

FIGURE 1.4-1 COMPARISON OF PARTICLE SIZES

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1.4.2 Chemical Differences

The Silo 3 residues and K-65 residues are chemically different as a result of being derived from different portions of the waste stream remaining from the uranium-bearing ore and ore concentrates. The chemical differences are listed in an abbreviated form based on some key parameters essential to the vitrification technology. Both the OU4 Remedial Investigation (DOE 1993b) data and Battelle-Pacific Northwest Laboratory (PNL) data are presented in Tables 1.4-1 and 1.4-2 respectively, to show the parts per million (mg/kg) of the constituents and the percentage of the constituents in the residues. However, the amount of constituents reported in Table 1.4-1 should not be interpreted as the actual amounts contained in the residues, but rather the amount extracted using the Hazardous Substance List (HSL) extraction procedure (required in the RI/FS process). As a result, the relative ratio of the constituents is the relevant data for this comparison, since it is this relationship that allows for good melting conditions or not.

There are major differences in the data between the two tables. This can be explained by looking at the objectives of the two analyses. The OU4 RI data were gathered to determine the amounts of RCRA controlled materials that were contained in the residues. These materials are typically small percentages, thus the test methodology and the ppm (mg/kg) units were selected accordingly. This type of analysis can miss the bulk constituents like silicon by an order of magnitude or more. The PNL data, on the other hand, were gathered to determine the qualities of the residues as glass-formers. The emphasis here was placed on the compounds important to glass-making like silica (SiO_2), so that the accuracy of the measurements for these constituents is much better. The PNL data are also presented as oxides, which is typically done by glass chemists for ease of calculations; however, only elemental analyses were performed and the oxides shown will not exist until after the residues are vitrified. A compound analysis has not been performed to determine what compounds exist in the residues, e.g., whether the sulfate is present as barium sulfate ($BaSO_4$), lead sulfate ($PbSO_4$), magnesium sulfate ($MgSO_4$), etc.

When the components of K-65 and Silo 3 residues are compared, the viewpoint which has been held by PNL and, until recently by FERMCO, is that the K-65 residue is easily vitrified, while the Silo 3 residues do not possess the basic constituents (i.e., relative difference of silicon [Si] levels between the Silo 3 to K-65 material) to allow vitrification to occur with the same ease (DOE 1993a and PNL 1994). This is because of the presence of high levels of sulfates and phosphates which can hinder vitrification and a less than desirable level of silicon in the Silo 3 residues. Therefore, in order to vitrify the Silo 3 residues (either alone or in a blend with K-65 residues) a greater degree of reliance upon the feed additives would be necessary in order to prevent foaming and to encourage the destruction of sulfates, at the desired production rates.

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TABLE 1.4-1

SUMMARY OF CHEMICAL ANALYSES FOR SILOS 1, 2, AND 3 RESIDUES

Analyte	Arithmetic Mean (mg/kg)	Upper 95% CI on A Mean (mg/kg)	Range of Detection (mg/kg)
SILO 1[1]			
Aluminum	1050	1320	450-2460
Silicon	723	853	359-1290
Iron	14700	21100	4280-75100
Lead	81700	95500	17400-133000
Phosphorus	1130	3290	0.4-3290
Sulfate	1300	3460	444-3460
Calcium	2960	3650	799-5700
Barium	11600	14200	1970-22100
Nitrate	2930	4764	2216-4764
Sodium	8670	10700	360-16700
SILO 2[1]			
Aluminum	845	1110	363-2250
Silicon	851	1148	507-1780
Iron	1650	28900	4010-40000
Lead	48200	299000	153-299000
Phosphorus	1130	1400	623-1400
Sulfate	8610	19300	2590-19300
Calcium	33300	301000	64-301000
Barium	6970	19900	89.2-19900
Nitrate	5430	8900	3490-8900
Sodium	2430	3200	226-4940

TABLE 1.4-1 (Cont'd)

SUMMARY OF CHEMICAL ANALYSES FOR SILOS 1, 2, AND 3 RESIDUES

Analyte	Arithmetic Mean (mg/kg)	Upper 95% CI on A Mean (mg/kg)	Range of Detection (mg/kg)
SILO 3[2]			
Aluminum	17200	19800	10800-23700
Iron	37800	52200	13900-67600
Lead	1730	2380	646-4430
Barium	217	278	118-332
Calcium	29400	33400	21300-39900
Sodium	36100	40800	22900-51700
Arsenic	1950	3170	532-6380
Chromium	288	395	139-560
Cadmium	60	94	21.5-204
Selenium	174	229	101-349

[1]Silos 1 and 2 data taken from Table 4-4 of the "Remedial Investigation Report for Operable Unit 4," (DOE 1993b).
[2]Silo 3 data taken from Table 4-20 of the Remedial Investigation Report for Operable Unit 4," (DOE 1993b).

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TABLE 1.4-2

INORGANIC COMPOSITION OF SAMPLES (Dry Weight %)

Component in Waste	Zone A	Zone B	Zone C	Composite	Average A, B, C	Range A, B, C
SILO 1[1]						
SiO_2	52	48	48	49	50	48-52
PbO	10	13	13	13	12	10-13
BaO	6.0	6.1	6.8	6.3	6.3	6.0-6.8
Al_2O_3	2.6	2.7	2.6	2.6	2.6	2.6-2.7
Fe_2O_3	2.7	2.3	2.4	2.6	2.5	2.3-2.7
SO_3	1.9	1.8	1.6	NA[4]	1.8	1.7-1.9
Na_2O	1.0	2.2	2.2	1.8	1.8	1.0-2.2
MgO	1.2	1.2	1.1	1.2	1.2	1.1-1.2
P_2O_5	0.93	0.46	0.48	0.65	0.62	0.46-.93
CaO	0.62	0.28	0.22	0.45	0.37	0.22-.62
SILO 2[2]						
SiO_2	49	57	46	58	51	46-57
PbO	4.9	7.2	6.4	6.6	6.2	4.9-7.2
Fe_2O_3	8.4	3.4	6.4	5.8	6.1	3.4-8.4
Al_2O_3	3.7	3.2	3.2	3.4	3.4	3.2-3.7
BaO	1.5	3.7	3.8	3.1	3.0	1.5-3.8
CaO	3.1	2.2	2.2	2.7	2.5	2.2-3.1
MgO	2.3	1.1	1.6	1.7	1.7	1.1-2.3
SO_3	1.4	0.87	2.7	NA[4]	1.7	0.87-2.8
Na_2O	0.61	0.98	1.0	0.93	0.88	0.61-1.0
P_2O_5	0.70	0.73	0.61	0.68	0.68	0.61-0.73

TABLE 1.4-2 (Cont'd)

INORGANIC COMPOSITION OF SAMPLES (Dry Weight %)

Component in Waste	Zone A	Zone B	Zone C	Composite	Average A, B, C	Range A, B, C
SILO 3[3]						
SO_3	15	15	15	15	15	15
SiO_2	14	13	13	16	14	13-16
MgO	11	9.6	9.9	10	10	9.6-11
P_2O_5	10	8.4	9.5	9.2	9.3	8.4-10
Fe_2O_3	8.0	8.1	7.5	8.6	8.0	7.5-8.6
N_2O_5	6.0	6.1	6.3	6.1	6.1	6.0-6.3
Na_2O	NA[4]	5.9	5.7	6.2	5.9	5.7-6.2
CaO	5.2	4.1	5.0	4.5	4.7	4.1-5.2
Al_2O_3	4.3	5.8	4.6	6.4	5.3	4.4-6.4
CO_2	1.9	1.9	1.9	1.9	1.9	NA[4]

[1]Silo 1 data taken from Table 4.4 of the "Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3," (DOE 1993a).
[2]Silo 2 data taken from Table 4.5 of the "Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3," (DOE 1993a).
[3]Silo 3 data taken from Table 4.6 of the "Operable unit 4 Treatability Study Report for the Vitrification fo Residues from Silos 1, 2, and 3," (DOE 1993a).
[4]"NA" signifies "not analyzed."
[5]Only one composite sample was given to PNL. This one sample was split and analyzed four times, except for SO_3 and CO_2.

To date, there is limited test data supporting the ability to maintain process control using additives with formulas involving Silo 3 residues on a continuous basis. The K-65 residues are also high in silica, which is good for vitrification, but are also high in lead which may hinder vitrification under reductant conditions. The Silo 3 residues are lower in silica, but high in magnesium, calcium, and iron which are good fluxing and glass-forming agents. Recently, as the result of attempts to refine process control in laboratory tests performed at the Catholic University of America, Vitreous State Laboratory (VSL), the view has developed that Silo 3 residues may effectively enhance the vitrification process (VSL 1996). This view is based on the importance of specific chemical species in the vitrification process (described in Section 1.4.2.1).

1.4.2.1 Sulfate Decomposition Related to Chemical Speciation

When the residue surrogates were being formulated for crucible and minimelter tests it was assumed that a "sulfate is a sulfate," since most chemical compounds thermally breakdown in the molten glass. Therefore, most (if not all) of the sulfate surrogates used by PNL and VSL were calcium sulfate ($CaSO_4$).

Early laboratory crucible melts using actual K-65 residues resulted in molten salt layers on the surface of the glass. This sulfate layer was presumed to be predominantly sodium sulfate (Na_2SO_4) because of the sodium flux added to the feed mix. Increased temperatures ($\geq$ 1,350°C) and/or elemental carbon added to the glass melt resulted in significant reductions of the sulfate layer. These techniques resulted in the sulfates being reduced to the metal oxides, which are easily dissolved in the glass, and SO_x gases, which leave in the off-gas. Elemental carbon is a strong reducing agent and produced some metallic lead or lead sulfide (PbS) nodules in the glass, which are not desirable.

It has been recently assumed that the salt-layer may actually have been barium sulfate ($BaSO_4$) in the K-65 residue. Barium was used to remove radium by precipitating radium sulfate ($RaSO_4$) in the uranium extraction process, from which the K-65 residues are derived. If this is so, the sulfates in Silos 1 and 2 may actually be more stubborn to handle and destroy than simulated in the minimelter runs.

Since the most common metal constituent in Silo 3 is magnesium, the predominant sulfate compound may be magnesium sulfate ($MgSO_4$). Magnesium sulfate thermally decomposes at 1,124°C (see Table 1.4-3), whereas, calcium sulfate ($CaSO_4$) decomposes about 1,400°C and barium sulfate ($BaSO_4$) decomposes

at 1,580°C. Th anomaly may explain the enigma discussed in the PNL report[1], and summarized in this ex t below:

> *"Initially, sulfate was thought to be an issue only with the Silo 3 material (with 15 wt% SO_3 in the waste material); however, during the treatability test it was found that the glass formulation for the Silo 3 material readily promoted the decomposition of sulfate in the Silo 3 waste without added reductant. A separate phase was not observed in the Silo 3 melts despite the very high initial sulfate concentration. On the other hand, melts with the K-65 material were found to form significant salt layer on the surface of the glass, even though the concentration in the waste was much lower (about 3 wt%)."*

Because magnesium sulfate's ($MgSO_4$) decomposition temperature is much lower than the melter's operating temperature, it will rapidly decompose due to the temperature, then dissolve in the glass. Since barium sulfate ($BaSO_4$) will not thermally decompose at these temperatures, its dissolution rate into the glass is much slower (limited by the solubility of sulfate), thus creating the observed salt-layer. The addition of approximately 26 percent Silo 3 residues to the feed mixture could actually increase the overall dissolution rate by providing a more dilute glass mixture for the K-65 residues to dissolve into. Increasing the dissolution rate would increase the production rate of the melter.

TABLE 1.4-3

DECOMPOSITION TEMPERATURES OF SULFATES[1,2]

Compound	Melting Point, °C	Decomposition Temperature, °C	Behavior
$Al_2(SO_4)_3$	–	770	Low temperature decomposition.
$BaSO_4$	1580	>1580	Melts without decomposition.
$CaSO_4$	1450	Graduated	Some decomposition before melting, but slow.
$Fe_2(SO_4)_3$	–	480	Low temperature decomposition.
Li_2SO_4	860	~860	Decomposition is not far above melting temperature.
$MgSO_4$	–	<1124	Decomposes before melting.
Na_2SO_4	884	Graduated	Volatilization and decomposition both take place, however, both are slow at lower molten glass temperatures. Increases with temperature.
$PbSO_4$	1170	<1170	Decomposes noticeably below the melting point.

[1]The Chemical Rubber Company (CRC) Handbook of Chemistry and Physics, 51st Edition.

[2]High Temperature Properties and Decomposition of Inorganic Salts, "Part 1. Sulfates," October 1, 1966, K. H. Stern and E. L. Weise, Institute for Basic Standards, National Bureau of Standards, Washington, D.C.

[1]Final Report of Vitrification Development for Fernald CRU4 Silo Wastes, Battelle - Pacific Northwest Laboratory, April 1994.

The sulfate scenarios described in this document are pre-VITPP Phase I Campaign 1 and 2 explanations that describe the behavior noticed in crucible and minimelter runs with respect to sulfates. Laboratory analysis of the silo residues and experiments are being performed to validate these assumptions.

The resolution of processing issues and the critical basis for vitrification process control have been resolved by the VITPP tests. The recent VSL tests are not conclusive to the point that a definite statement can be made regarding resolution of processing issues or of processing rates. This can be best determined in VITPP tests first in surrogate campaigns and definitively in the processing of actual K-65 and Silo 3 residues. A complete understanding of questions and issues regarding Silo 3 residues must be held in abeyance until these VITPP tests are completed. In the interim other issues are expected to be refined, such as enhanced sampling, to support the ultimate process/formulational approach.

1.4.3 Radiological Differences

The K-65 and Silo 3 residues are also different in their radiological content both in terms of constituents and gross activity. Recalling that the K-65 and Silo 3 residues were obtained from different portions of the waste stream, it is predictable that a certain separation of constituents will occur. Most of the difference between the two residues originates from the significant presence of Radium-226 which the K-65 residues contain, compared to a much lesser content in the Silo 3 residues. This is the result of Radium-226 being removed with the K-65 residues and, therefore, not being present in a large quantity when the remainder of the residue was processed to become Silo 3 residues. This was a purposeful removal step, since the AEC was contractually bound to return to the African Metals Corporation the Radium-226 which remained after the extraction of uranium. Radium-226 radiologically decays to become Radon-222 and Radon-222 daughter products, most of which have relatively short half-lives (Lead-210 having the longest half-life of these). Therefore, the K-65 residues have much more significant levels of Radon-222 emanating from them than do the Silo 3 residues. In addition, K-65 residues have a significant gamma component, due to the presence of Bismuth-214 and Lead-214. A 55-gallon drum of untreated K-65 residues has a radiation level that measures in the area of 550-600 mrem/h, a drum of Silo 3 residues would be on the order of < 10 mrem/h.

This data is supplemented by radiological data measured at Battelle-PNL (DOE 1993a) to illustrate the variation between zones and also relationships of Radium-226 to Radon-222 daughter products (Tables 1.4-4 through 1.4-6). To understand the specific differences between K-65 and Silo 3 residues, the radiological constituents are listed below from the OU4 RI data in Tables 1.4-7 and 1.4-8 (DOE 1993a). It should be remembered that the upper 95 percent confidence interval value is the most accurate of the

data presented due to the inclusion of some abnormally low concentrations measured during the 1989 sampling of the K-65 Silos.

Beyond the significant Radon-222 producing characteristics of the K-65 residues there is also a significant physical difference between K-65 and Silo 3 residues. As previously mentioned, the Silo 3 residues are very dry and dispersible, while K-65 residues are in a moist condition, which unless dried to some degree is not as easily dispersible.

This dispersibility becomes quite important in understanding treatment needs for the Silo 3 residues, the importance due to the Th-230 content of the residues, and the percentage of the Silo 3 residues which exists as very small particles. The net result is a potential respiratory hazard which must be contained during the removal, treatment, and disposal of the residues and which, if one treatment method could minimize significantly over others, could be the deciding factor of treatment method selection. This respiratory hazard is the primary hazard associated with Silo 3 residues, since there is very little gamma exposure resulting from the residues.

TABLE 1.4-4

RADIOLOGICAL CONSTITUENTS
ISOTOPIC CONTENT OF SILO 1 MATERIAL[1] $(nCi/g)_{PNL}$

Isotope	Zone A	Zone B	Zone C	Average	Composite
Bi-214	368	414	441	408	439
Pb-214	368	414	438	407	437
Ra-226	368	414	441	408	439
Pb-210	212	327	316	285	292
Th-230	45	69	ND[2]	38	54
Pb-211	18	14	19	17	19
Ra-223	15	16	16	15	14
Rn-219	14	12	15	14	15

[1]Silo 1 data taken from Table 4.7 of the "Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3," (DOE 1993a).
[2]"ND" signifies the isotope was not detected.

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TABLE 1.4-5

RADIOLOGICAL CONSTITUENTS ISOTOPIC CONTENT OF SILO 2 MATERIAL $(nCi/g)_{PNL}$[1]

Isotope	Zone A	Zone B	Zone C	Average	Composite
Bi-214	176	259	242	226	230
Ra-226	176	259	242	226	230
Pb-214	178	253	246	226	229
Pb-210	182	236	247	222	233
Th-230	184	25	35	81	32
Ra-223	7	10	8	8	8
Rn-219	5	9	8	7	7
Pb-211	Unresolved[2]	8	8	8	7

[1]Silo 2 data taken from Table 4.8 of the "Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3," (DOE 1993a).
[2]"Unresolved" indicates the isotope was present, but could not be resolved due to interferences.

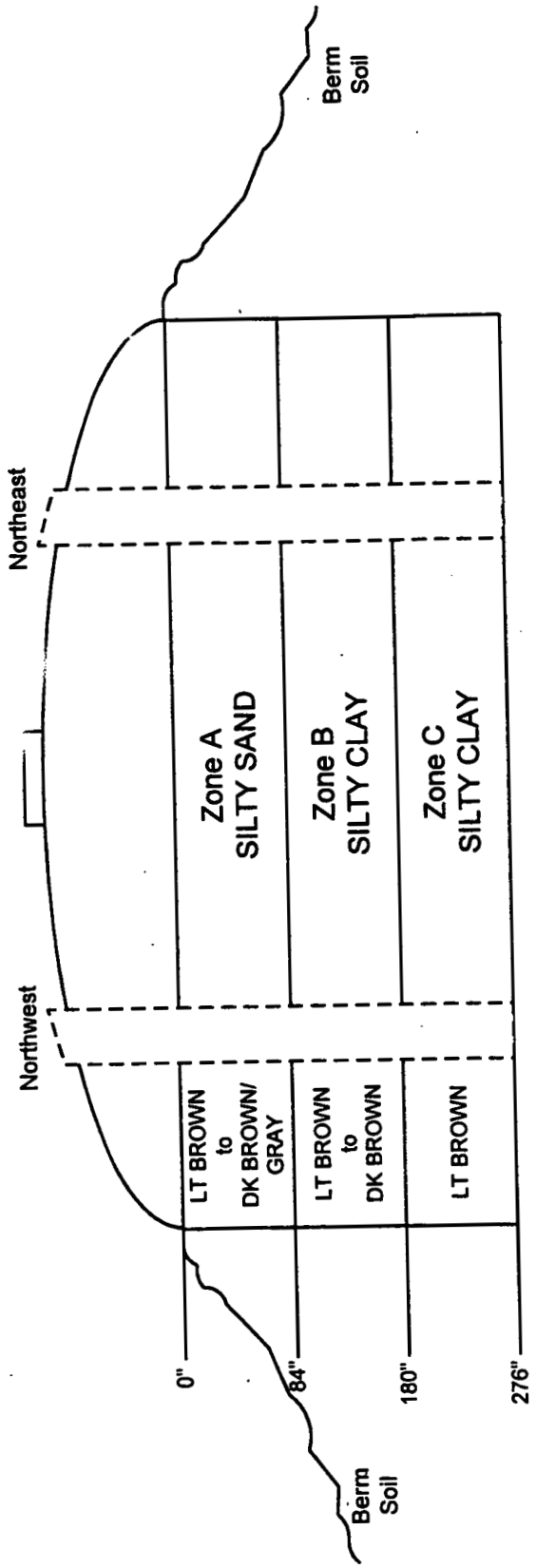

Figure 1.4-2 Generalized Visual Description for Silo 1 Contents

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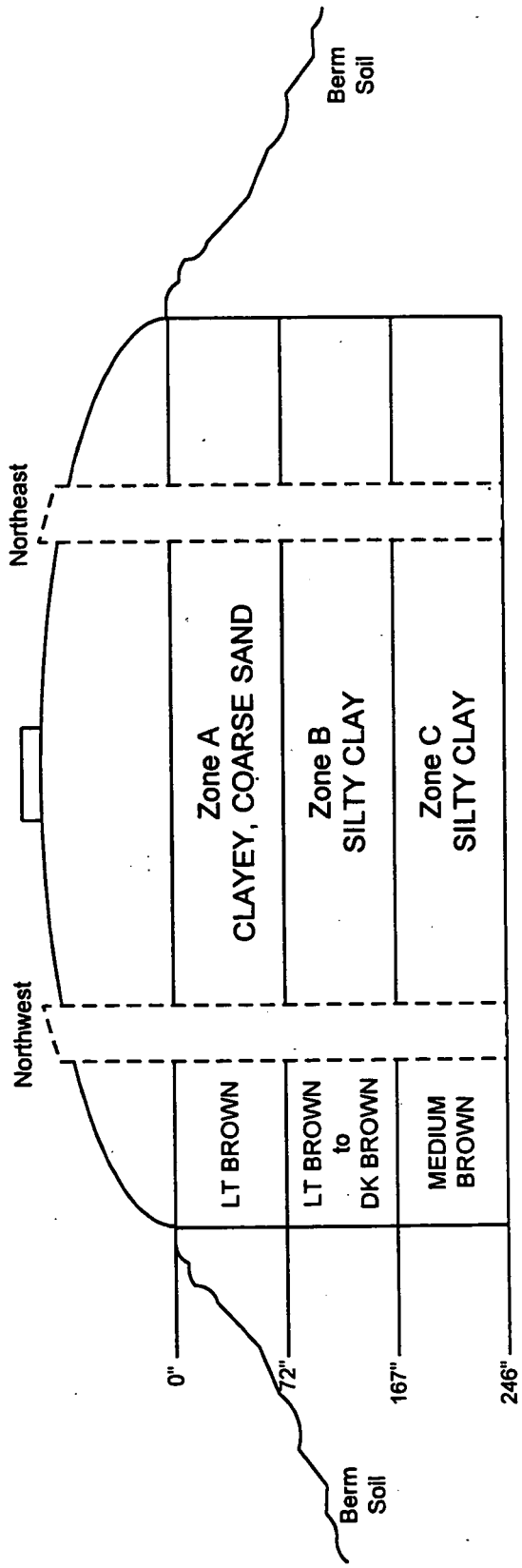

Figure 1.4-3 Generalized Visual Description for Silo 2 Contents

TABLE 1.4-6

RADIOLOGICAL CONSTITUENTS ISOTOPIC CONTENT OF SILO 3 MATERIAL $(nCi/g)_{PNL}$[1]

Isotope	Sample #1	Sample #2	Sample #3	Sample #4
Th-230	51.0	64.5	51.3	142.0
U-238	2.7	1.3	2.3	ND[3]
Pb-210	1.8	3.0	2.1	9.8
Pb-214	1.0	1.1	1.1	4.6
Ra-226	0.8	0.8	0.9	4.7
Bi-214	0.8	0.8	0.9	4.7
Pb-211	0.6	0.6	Unresolved[2]	ND[3]
Ra-223	0.5	0.7	0.4	Unresolved[2]
Pa-231	0.5	1.0	0.7	ND[3]
Ra-224	0.4	0.3	0.4	0.4
Th-232	0.3	0.3	0.3	0.3
Rn-219	ND[3]	ND[3]	ND[3]	0.7
U-235	Unresolved[2]	Unresolved[2]	Unresolved[2]	Unresolved[2]

[1]Silo 3 data taken from Table 4.9 of the "Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3," (DOE 1993a).
[2]"Unresolved" indicates the isotope was present, but could not be resolved due to interferences.
[3]"ND" signifies the isotope was not detected.

TABLE 1.4-7

SUMMARY OF RADIONUCLIDE ANALYSES FOR SILOS 1 AND 2 RESIDUES[1] — 8050

Analyte	Arithmetic Mean (pCi/g)	Upper 95% CI on A-Mean (pCi/g)	Range of Detects (pCi/g)
SILO 1			
Actinium-227	5960	7670	4320 - 17390
Lead-210	165000	202000	48980 - 381400
Polonium-210	242000	281000	144000 - 434000
Radium-226	391000	477000	89290 - 890700
Thorium-228	422	2280	835 - 2280
Thorium-230	60000	68900	10569 - 105372
Thorium-232	424	1110	661 - 1106
Uranium-234	800	932	326 - 1548
Uranium-235/236	38	54	19.1 - 105
Uranium-238	642	693	387 - 920
SILO 2			
Actinium-227	5100	6640	2905 - 10450
Protactinium-231	2350	4040	4041 - 4041
Lead-210	145000	190000	58160 - 399200
Polonium-210	139000	231000	55300 - 241000
Radium-226	195000	263000	657 - 481000
Thorium-228	645	7360	411 - 7360
Thorium-230	48400	76200	8365 - 132800
Thorium-232	402	985	851 - 985
Uranium-234	961	1160	121 - 1465
Uranium-235/236	73	94	35.6 - 172
Uranium-238	912	1120	46 - 1925

[1]Data taken from Table 4-2 of the Remedial Investigation Report for Operable unit 4, (DOE 1993b).

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TABLE 1.4-8

SUMMARY OF RADIONUCLIDE ANALYSES FOR SILO 3[1]

Analyte	Arithmetic Mean (pCi/g)	Upper 95% CI on A-Mean (pCi/g)	Range of Detects (pCi/g)
SILO 3			
Actinium-227	618	925	234 - 1363
Lead-210	2620	3480	454 - 6427
Protactinium-231	487	627	266 - 931
Radium-224	290	367	64 - 453
Radium-226	2970	3870	467 - 6435
Radium-228	297	406	82 - 559
Thorium-228	590	747	459 - 996
Thorium-230	51200	60200	21010 - 71650
Thorium-232	656	842	411 - 1451
Uranium-234	1480	1730	348 - 1935
Uranium-235/236	93.6	117	42 - 158
Uranium-238	1500	1780	320 - 2043

[1]Data taken from Table 4-19 of the Remedial Investigation Report for Operable unit 4, (DOE 1993b).

2.0 SCREENING OF ALTERNATIVES SUMMARY

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2.1 Introduction

The methodical identification, screening, and evaluation of potentially applicable technologies and process options were key steps in the development and analysis of remedial alternatives for Silo 3 residues in the OU4 Feasibility Study process. However, the reexamination of the selected remedy for the Silo 3 residues follows a more focused, streamlined screening approach. This section presents the summary of the Screening Evaluation of Silo 3 Alternatives Report, which is included as Appendix B of this report.

2.2 Background

In January 1996, the DOE sponsored an independent value engineering (VE) study that was broadly scoped to include the identification and evaluation of engineering opportunities that offered the potential for technical simplification, cost savings, and overall schedule improvements in the remediation of OU4 Silos 1, 2, and 3. VE is a problem-solving methodology in which a project or process is examined to determine pertinent functions, governing criteria, and associated costs. This is followed by the development of the best areas for improvement using alternative methods that fully meet the necessary requirements at a lower cost, accelerated schedule, or with an increase in the long-term values. The alternatives are presented in a report format and proposed for adoption by the parties responsible for the project studied.

One of the recommendations from the Value Engineering Study Report (DOE 1996) stated that alternative methods for the treatment and disposal of the Silo 3 residues should be considered as a means for potentially simplifying the OU4 remediation, shortening the remediation schedule and reducing remediation costs. This recommendation not only reaffirmed the merit of preliminary efforts initiated by DOE/FERMCO to investigate alternative treatment methods for Silo 3 residues, but also served as a vehicle to redirect resources and to accelerate this technical effort. In order to formally address this recommendation in a more structured forum, a joint multidisciplinary DOE/FERMCO team was assembled to objectively evaluate alternative Silo 3 residues remediation options.

2.3 Screening Approach

The Silo 3 Alternatives Evaluation Team focused on considering only those alternatives that were not only technically feasible (using conventional and proven treatment methods) and cost-effective, but offered improvement to the OU4 remediation schedule and were likely to be received favorably by the stakeholders. Consistent with this objective, four viable treatment alternatives to vitrification were

initially identified by the Silo 3 Alternatives Evaluation Team as follows:

- Direct Disposal with Off-site Treatment;
- Cementation (Stabilization);
- Vacuum Extrusion (Including Stabilization); and
- Blending with Material from the OU1 Waste Pits.

This approach effectively minimized and built-in a relatively low-level of technical and programmatic risk associated with the outcome of this evaluation report. A more detailed description of these alternatives can be found in Appendix B.

2.3.1 Basis of Evaluation

The aforementioned alternatives were all screened and evaluated using the same technical basis and criteria. The following elements were determined to be key bounding parameters of the technical screening process for the Silo 3 residues treatment alternatives:

- Due to time constraints, only existing information and data were used in this analysis. (The need for both more information and performance of additional treatability studies to develop or optimize specific alternatives in order to reduce technical uncertainty and programmatic risks would be qualitatively discussed.
- Only Rough Order of Magnitude Cost Estimates could be generated and would be presented as ranges for each alternative for this screening analysis. (More detailed cost estimates would be developed during detailed analysis for those alternatives passing the screening process.)
- Focus was placed upon developing the primary differences between alternatives and would be presented during the screening analysis.
- No comparisons to vitrification would be made during the screening process. (However, a comparative analysis would be performed following the detailed analysis of alternatives for those alternatives passing the screening process.)

2.3.2 Evaluation Criteria

The four criteria used to measure and determine the overall effectiveness of the alternatives in the screening analysis were:

- Institutional - Ability to implement the alternative within a viable regulatory framework under existing waste acceptance criteria and permitting levels, as well as consideration of stakeholder acceptance.
- Technical - Only conventional and proven treatment methods stand a strong likelihood of success.

The need to perform additional treatability studies in order to apply the technology to the Silo 3 residues must be identified and factored into the technical feasibility of the alternative.

- Schedule - All activities required to implement the alternative should be identified and placed in the schedule. The initiation of alternative treatment operations for Silo 3 residues should be before the current technical baseline date for initiation of vitrification operations (October, 2000).

- Cost - Alternative costs should be used to provide input to the economic viability of an option.

2.4 Summary of the Screening Process

Cost was not found to be a discriminator in this preliminary evaluation. The cost estimates for the alternatives were very rough orders of magnitude since detailed designs, layouts, or vendor quotes could not be fully developed. All four estimate ranges overlapped each other, making none a clear winner.

The blending alternative does not allow for early disposition of Silo 3 residues as the other alternatives do, and presents significant programmatic risk to the project. The selected remedy presented in the OU1 ROD provides a permanent solution to the threats posed by the material in Waste Pit 5. Excavation followed by thermal drying of Waste Pit 5 material provides for a volume decrease by removing a large volume of contaminated leachate from the wastes that might otherwise migrate from the disposed wastes. However, blending Silo 3 residues with material from Waste Pit 5 followed by thermal drying does not provide for adequate treatment to reduce the toxicity associated with the heavy metals present in Silo 3 residues. Therefore, implementation of this alternative would not be consistent with CERCLA Section 121(b)(i) preference for a remedial alternative that "permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances or contaminated materials."

Both onsite cementation and direct disposal with off-site treatment provided two viable alternatives to compare to vitrification. Since off-site treatment would consist of stabilization that would be performed at a representative permitted commercial disposal facility, these alternatives are both variations of cementation, which was identified as a feasible alternative within the OU4 FS. The only difference between onsite cementation and direct disposal with off-site treatment is the location of the treatment facility. Using either of these methods, it was estimated that remediation could begin within 24 to 36 months and be completed within 18 to 30 months thereafter. The cost ranges merit additional consideration and may compare favorably to vitrification costs. More detailed schedules have been developed for these alternatives in Section 3.0.

The vacuum extrusion alternative is similar in most respects to the stabilization alternative. Both alternatives would treat the Silo 3 residues and produce a waste form that is expected to meet disposal requirements. Facility sizes and costs would be nearly the same. Equipment and operation costs for vacuum extrusion would be similar to stabilization since it requires, in essence, a full cement plant for support. The vacuum extrusion equipment which is currently available as government excess at DOE's Mound Facility but is contaminated with transuranics, requiring decontamination prior to any FEMP use. The processing schedules would be similar. The volume of waste to be disposed, and its associated costs, would probably be less than cementation since vacuum extrusion is primarily a volume reduction process; however, without performing additional treatability studies it is uncertain how much volume reduction and cost savings could be realized.

2.4.1 Recommendations

Based upon the alternatives' criteria evaluation, the following recommendations were made in the *Summary of Screening Evaluation of Silo 3 Alternatives* (Appendix B):

The cementation alternative should be retained for full evaluation in detailed analysis. Since direct disposal with off-site treatment (stabilization) is exactly the same process as cementation but with different economics due to the location of the treatment facility (a commercial facility rather than a government plant) and process additives, it should be evaluated as a subset of the cementation alternative.

Since vacuum extrusion is nearly the same process as cementation and has similar economics, it should be considered as a potential cost savings opportunity, if cementation is selected over vitrification. Additional treatability work on vacuum extrusion would not be necessary as part of the Silo 3 evaluation process until cementation is chosen as the selected alternative. This exclusion would significantly simplify the evaluation process without loss of a potential cost savings opportunity.

Because there is not schedule advantage associated with blending Waste Pit 5 material and Silo 3 residues and because of the significant programmatic risks associated with the regulatory issues and complexities involved, the blending alternative should be dropped from further evaluation.

Shipment by rail should be deleted as part of the alternative considerations. Truck transport previously thoroughly assessed, is currently successful with other material, can be done more quickly for the OU4 residues, and is cost-effective. Rail transport would require additional facilities and schedule that offset the transportation savings. Also, current information indicates that neither a gondola car nor a sea/land

container, as they are presently designed, would be able to meet the U.S. Department of Transportation (DOT) requirements for Industrial Package- Type 2 (IP-2) used for shipping low specific activity - II (LSA-II) material, such as the Silo 3 residues.

2.5 Path Forward

Based upon its review of the screening evaluation report presented in Appendix B, the refinement and detailed analysis of alternatives will be performed in Section 3.0 on the following alternatives:

- Onsite Vitrification and Off-site Disposal at the NTS (Baseline);
- Onsite Stabilization (Cementation) and Off-site Disposal at the NTS;
- Onsite Stabilization with Off-site Disposal at a Representative Permitted Commercial Disposal Facility; and
- Off-site Stabilization and Disposal at a Representative Permitted Commercial Disposal Facility.

Although the *Summary of Screening Evaluation of Silo 3 Alternatives Report (FERMCO 1996)* recommended the elimination of the following alternative based upon its poor performance with the screening criteria:

- Onsite Blending with the OU1 Waste Pit 5 Material, and Disposal at a Representative Permitted Commercial Disposal Facility.

it will be carried forward so that a more detailed discussion of its regulatory issues and programmatic risks can be presented before the alternative is removed from consideration.

The development and analysis of the baseline vitrification alternative in Section 3.0 becomes necessary in order to establish the basis for comparative analysis of the new alternatives in Section 4.0. The comparison of the performance of the new alternatives (against the nine CERCLA criteria) relative to the baseline selected remedy (vitrification) would serve as the basis for determining whether the selection of an alternative remedy for the remediation of Silo 3 residues would be more appropriate.

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3.0 ANALYSIS OF ALTERNATIVES

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3.1 Introduction

This section presents the analysis of alternatives which passed the screening process conducted separately (FERMCO 1996) and summarized in Section 2 and presents the vitrification alternative which will serve as the basis for comparison in Section 4.0. Two of these alternatives were fully evaluated in the Final Operable Unit 4 Feasibility Study/Proposed Plan - Environmental Impact Statement (DOE 1994a) and three new alternatives were selected for reexamination (with new information) and further analysis, respectively. Table 3.1-1 summarizes the alternatives to be considered by the detailed analysis.

TABLE 3.1-1

SILO 3 RESIDUES TREATMENT ALTERNATIVES SELECTED FOR ANALYSIS

Alternative Designation	Description
VIT[1]	Removal, Onsite Vitrification, Off-site Disposal at the NTS
ALT1[1]	Removal, Onsite Cementation, Off-site Disposal at the NTS
ALT2	Removal, Onsite Stabilization, Off-site Disposal at a Representative Permitted Commercial Disposal Facility
ALT3	Removal, Off-site Stabilization and Disposal at a Representative Permitted Commercial Disposal Facility
ALT4	Removal, Onsite Blending with OU1 Waste Pit 5 Material, Off-site Disposal at a Representative Permitted Commercial Disposal Facility

[1]These vitrification and cementation alternatives were originally evaluated by the Operable Unit 4 Feasibility Study/Proposed Plan - Environmental Impact Statement (DOE 1994a).

3.1.1 Purpose and Need

As a result of the ongoing technical efforts supporting the implementation of the Operable Unit 4 ROD, development of improved technical, schedule, and cost data have made it appropriate to reevaluate vitrification and consider other alternatives for the treatment of the Silo 3 residues. The

purpose of this evaluation is to determine whether any alternatives could simplify the technical requirements for the remediation of the Silo 3 residues, accelerate the schedule, and/or save money while providing the same level of protection for human health and the environment.

This analysis includes a presentation and assessment of relevant information which provides the basis for selecting the most appropriate treatment alternative for Silo 3 residues and preparing preliminary documentation to support future procedural requirements under CERCLA and National Environmental Protection Act (NEPA). To the extent practicable, this analysis evaluates each alternative against nine criteria which have been developed by EPA to address CERCLA requirements.

Building upon the development and screening of alternatives, the detailed analysis presents more in-depth information to the extent practicable, including treatability study data, which are used in the assessment of the alternatives relative to the CERCLA criteria. It is recognized that the quantity and/or quality of existing data for a given alternative may preclude a more in-depth criteria evaluation. Where such instances occur, a brief qualitative discussion describing the need to perform more focussed treatability studies, optimization efforts, risk analysis, etc., would be included. The treatment systems being considered for stabilization of Silo 3 residues have been developed as viable ways to implement the alternative. Equivalent systems may exist and are not precluded from consideration during remedial design, including the use of subcontractor-supplied treatment systems and services.

Following the detailed analysis, a comparative analysis of the alternatives will be presented in Section 4.0. The comparative analysis evaluates the alternatives relative to two threshold criteria which must be met. This is followed by an assessment of the alternatives against the five balancing criteria, highlighting the key advantages, disadvantages, and tradeoffs which are considered as part of the selection process. Stakeholder input into the selection of the preferred alternative through the solicitation of community and state agency comments is incorporated into an assessment of the alternatives against the two modifying criteria of state and community acceptance.

3.1.1.1 Supplemental Analysis

In order to meet the substantive and procedural requirements of DOE's NEPA Implementing Regulations (10 CFR § 1021.2), the feasibility study and proposed plan for OU4 was prepared as an integrated CERCLA/NEPA Document. The final product was termed a Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS) which evaluated potential environmental impacts of

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the original alternatives and was issued for public review per the procedural requirements of NEPA. In addition, the ROD that was issued was also an integrated CERCLA/NEPA ROD. The DOE's NEPA regulations mandate that proposed changes to a federal action which has been subject to an EIS evaluation, must be evaluated in a supplemental analysis to determine if formal revision to the original EIS is required through issuance of a Supplemental EIS. Therefore, throughout this Silo 3 residues evaluation, potential environmental impacts associated with individual alternatives have been incorporated into the evaluation criteria. In addition, Appendix F contains the NEPA Supplemental Analysis for this proposal pursuant to the requirements of 10 CFR § 1021.314(c).

3.1.2 Overview of the Detailed Analysis

Specific statutory requirements for remedial actions are specified under CERCLA Section 121, as amended. These requirements include protection of human health and the environment, compliance with ARARs, a preference for permanent solutions which incorporate treatment as a principal element (to the maximum extent practicable), and cost-effectiveness. To assess whether alternatives meet the requirements, EPA has identified nine criteria in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) that must be evaluated for each alternative retained through the screening stage [Section 300.430(e)(9)(iii)]. Provided below are summaries of the factors that comprise the nine criteria and an overview of the approach taken by this evaluation to address the criteria. Because the first two criteria, overall protection of human health and the environment and compliance with ARARs, are the threshold criteria that relate directly to statutory findings that must be made in the enforcement documentation (i.e., ROD), additional detail and discussion regarding these criteria is provided in the Appendices.

3.1.2.1 Overall Protection of Human Health and the Environment

This evaluation criterion provides an assessment of whether the alternative achieves and maintains adequate protection of human health and the environment, in accordance with the remedial action objectives established in the OU4 FS. Evaluation of this criterion should describe how site risks, posed through each pathway addressed by the OU4 FS, are eliminated, reduced, or mitigated through treatment, engineering, or institutional controls. The acceptable risk levels under CERCLA for known or suspected carcinogens are generally concentration levels in environmental media that represent an excess upper bound of lifetime cancer risk to an individual between 10^{-4} to 10^{-6}.

To evaluate the alternatives for the attainment of protection of human health (and the associated criteria of compliance with ARARs, long-term effectiveness and permanence, and short-term

effectiveness), this report refers to the risk assessment performed as part of the OU4 Feasibility Study to the extent practicable. In addition, both a quantitative and qualitative discussion describing each alternative's ability to satisfy this criterion is also supported by the results of a limited risk assessment presented in Appendix D of this report.

3.1.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

This criterion addresses the attainment of compliance with promulgated federal and state environmental regulatory requirements. If an alternative cannot meet an ARAR, a determination may be made that a waiver under CERCLA may be appropriate and a basis for justifying the waiver discussed. ARARs consist of two types of requirements, those that are applicable and those that are relevant and appropriate. Applicable requirements are those promulgated substantive standards or limitations that specifically address the situation at a CERCLA site or otherwise satisfy the jurisdictional prerequisites for the application of the regulation. Relevant and appropriate requirements are those promulgated controls or requirements that are not applicable, but address sufficiently similar situations such that their use is well suited to the occasion.

In certain cases, standards may not exist (in the form of a promulgated regulation) that address the proposed action or the constituent of concern (COC). In these cases, nonpromulgated advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states are to be considered (TBC) in conducting activities or establishing remedial action objectives that are protective of human health and the environment.

In addition, there are other requirements that do not fall within the EPA-established criteria for ARARs. These other requirements include DOE Orders[1], which pertain only to DOE facilities. EPA's Compliance with Other Laws Manual (OSWER Directive 9234.1-01) states "...DOE orders are not promulgated requirements and are not potential ARARs." The manual further states that "to the extent that DOE orders are more stringent or cover areas not addressed by existing ARARs, they should be considered when necessary to develop a protective remedy." In this document, DOE

[1]AEA requirements for DOE's waste management are incorporated into DOE Orders, developed under DOE's AEA authority. The Orders are generally consistent with and typically include technical requirements similar or equivalent to those in NRC regulations and that are appropriate for DOE facilities. DOE Order substantive requirements are "To-Be-Considered" (TBC) requirements, which, when incorporated in a DOE CERCLA ROD, are enforceable cleanup standards under CERCLA. Substantive technical requirements of promulgated and nonpromulgated NRC requirements may be "Relevant and Appropriate" or TBCs to ensure protection of human health and the environment.

Orders are identified as TBCs only when no promulgated ARAR exists to ensure adequate protection of human health and the environment. A table summarizing other requirements pertinent to OU4 remediation is included in Appendix A.

Types of ARAR/TBCs

In addressing a requirement that may affect a remedial action being considered for a site, a determination is made regarding its relationship to: (1) the location of the action; (2) the contaminants involved, and (3) the specific components of the action, such as factors unique to a certain technology. Three types of ARARs result from this process: chemical-specific ARARs, location-specific ARARs, and action-specific ARARs.

Chemical-specific ARARs are usually health- or risk-derived numerical values that establish an acceptable level or concentration of chemical or radionuclide that may remain in specific environmental media after remediation is complete. These levels are deemed to be protective of human health and are used to help establish remedial cleanup goals.

Location-specific ARARs generally restrict certain activities or dictate where certain activities may be conducted solely because of geographical, hydrologic, or land use concerns.

Action-specific ARARs are usually restrictions on the conduct of certain activities or the operation of certain technologies at the site.

Summary of Key ARAR/TBCs

Appendix A of this report provides a complete listing and an analysis of compliance, with enforceable ARARs and TBCs for the remediation of Silo 3 residues as documented by the EPA-approved OU4 ROD. Appendix A also provides an updated listing and an analysis of compliance highlighting potential new ARARs and TBCs associated with the new alternatives. Included are tables that present the documentation of ARARs for each of the alternatives. The approach adopted by this evaluation is to focus the discussion in this section on the alternatives' ability to comply with key ARARs, which are critical to meeting this threshold criterion. The key ARAR/TBCs identified for OU4 Silo 3 residues include the following:

Chemical-Specific ARAR/TBCs

- CAA: 40 CFR § 61 Subpart H - radionuclides other than radon.

- CAA: 40 CFR § 61 Subpart Q - radon-222 flux.

Location-Specific ARAR/TBCs

- NEPA/DOE: 10 CFR § 1022 - floodplain/wetlands environmental review requirement.

Action-Specific ARAR/TBCs

- RCRA: 40 CFR § 264 Subpart B (various citations) - general standards for treatment, storage, and disposal facility.
- RCRA 40 CFR § 264 Subpart G (various citations) - closure and post-closure requirements.
- RCRA: 40 CFR § 264 Subpart I (various citations) - container storage requirements.
- RCRA: 40 CFR § 264 Subpart J (various citations) - tank system requirements.
- RCRA: 40 CFR § 264 Subpart S (various citations) - corrective action management units and temporary units.
- DOE Order 5400.5 - annual effective dose equivalent from all pathways.
- AEA/DOE: 10 CFR § 1021.2 - NEPA implementation.
- UMTRCA: 40 CFR § 192 Subpart C - cleanup standards for residual radioactive material.

3.1.2.3 Long-term Effectiveness and Permanence

This criterion evaluates the extent to which an alternative achieves an overall reduction in risk to human health and the environment after the response objectives have been met. It considers the degree to which the alternative provides sufficient long-term controls and reliability to maintain exposures to human and environmental receptors within protective levels. The principal factors addressed by this criterion include magnitude of residual risk and adequacy and reliability of controls. Also discussed are the uncertainties associated with both of these factors.

The evaluation considers the characteristics of any remaining untreated and treated waste forms which pose potential risks in the future. The magnitude of residual risk to environmental receptors is assessed in a qualitative manner. This discussion is further supported by describing the potential long-term environmental impacts of the alternative on soil and geology, water quality and hydrology, air quality, biotic resources, and wetlands and floodplains. Impacts on socioeconomics, land use, and cultural resources are also considered.

The evaluation of adequacy and reliability of controls assesses the effectiveness of any treatment, containment, or institutional measures which are part of the alternative. Factors considered include performance characteristics, maintenance requirements, and expected durability. Information and data from treatability studies, past performance, and similar technology applications are incorporated into the evaluation as appropriate. Institutional controls are considered where they potentially improve the effectiveness of engineered measures.

3.1.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion reflects the statutory preference for remedial alternatives containing a principal component which substantially reduces toxicity, mobility, or volume of hazardous substances. The evaluation considers the extent to which remedial action process technologies can effectively and irreversibly fix, transform, immobilize, and/or reduce the volume of waste materials and contaminated media.

Two treatment technologies are principal components of several alternatives selected for this detailed analysis. Vitrification and cement stabilization are assessed for their ability to reduce the toxicity, mobility, and volume of the contents of Silo 3. The evaluation includes the results of treatability studies which were conducted during the OU4 RI/FS and are currently being conducted under the OU4 RD/RA effort.

The treatability studies compare key characteristics (e.g., leachability of constituents of concern, reduction of radon emanation) of the untreated and treated waste forms in order to assess the reduction of risk afforded by the treatment processes. For several of the alternatives being considered by this report (ALT1, ALT2, ALT3, ALT4), there exists "data deficits" which preclude a thorough technical supported evaluation and contributes to increased level of uncertainty and risk. Where such data gaps exist, the need to perform additional treatability studies to support each alternative's evaluation will be discussed. The discussion will describe in general terms the need, scope and test objectives required of each treatability study and how the data could be used to eliminate current uncertainties and implementation risks.

3.1.2.5 Short-term Effectiveness

This criterion addresses the effects of the alternative during the construction and implementation phase until the remedial action objectives are achieved. The evaluation considers the effects on human health and the environment posed by operations conducted during the remedial action. Both the

potential impacts and associated mitigative measures are examined for maintaining protectiveness for the community, remedial action workers, and environmental receptors over the duration of the activities.

Appendix D of this report provides a limited evaluation of short-term risks to the public and workers under various scenarios associated with an alternative's operations. Potential short-term risks to the public include inhalation of radon gas released during waste removal and treatment operations, radiological exposure and physical injury during waste transport off-site. Potential short-term risks to workers include the following: direct radiation exposures during construction, waste treatment, and transportation; physical injury or death during construction and transportation activities; and nonremediation worker exposures to airborne radioactive and chemical contaminants during waste retrieval operations. The alternative analysis also includes an assessment of mitigative measures such as engineering and institutional controls which are expected to minimize potential risks to the public and workers.

3.1.2.6 Implementability

This criterion examines the technical, administrative, and regulatory factors affecting implementation of an alternative and considers the availability of services and materials required during implementation. Technical factors to be assessed include the ease and reliability to initiate construction and operations, the prospects for implementing any needed future actions, and the adequacy of monitoring systems to detect failures. Administrative factors examined include permitting and coordination requirements among the lead agency and regulatory agencies. Services and materials considerations include treatment, storage, and disposal capacities; equipment and operator availability; and prospective technology applicability or development requirements. Regulatory factors include the modification requirements to the OU4 enforcement documentation (i.e., Record of Decision) and stakeholder acceptance.

Where proven technologies are proposed for use by an alternative, the assessment of technical feasibility examines the performance history of the technologies in direct applications, or considers the expected performance for similar applications. For innovative technologies, data from bench-scale tests are evaluated for expected scale-up performance characteristics, and the feasibility of scaling up bench tests to pilot tests is reviewed. Any uncertainties associated with construction, operation, and performance monitoring are also addressed.

The evaluation of administrative feasibility includes a discussion of those actions required to coordinate with regulatory agencies to establish the framework for complying with any key substantive technical requirements which must be attained by an alternative. Additionally, alternatives involving off-site transportation are reviewed to assess the feasibility of implementing interstate transportation and disposal.

The availability of services and materials is addressed by analyzing the material components of the proposed technologies to determine the locations and quantities of those materials, and by reviewing process operations to identify any special services, operator skills, or training required to readily implement the process.

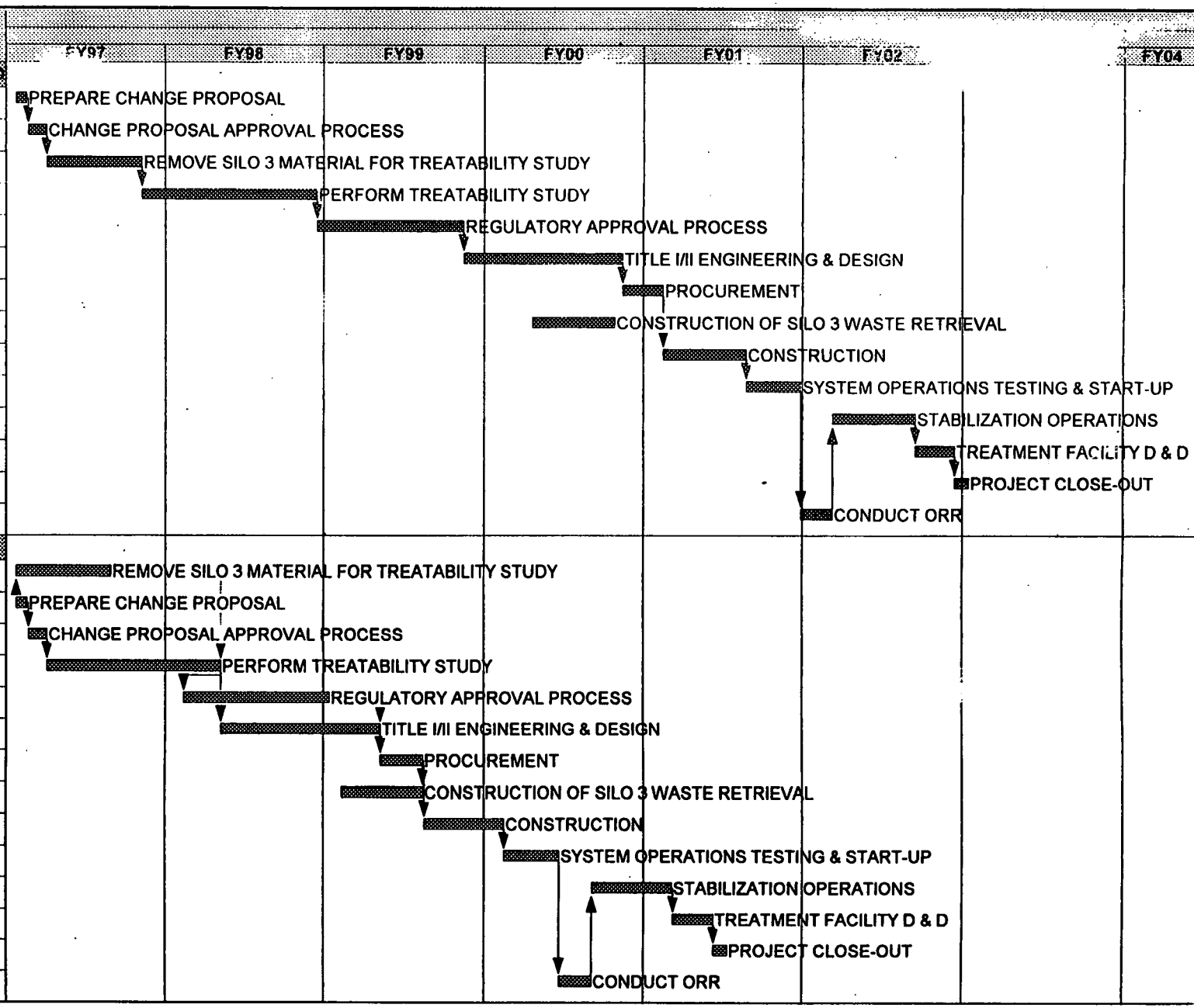
Schedule

The overall implementability of each alternative can be summarized and presented graphically through the development of a project schedule. The project schedule presents the procedural plan for implementing the required activities for a given alternative to successfully complete a task. The schedule addresses the logical relationships between activities, and indicates the duration required and sequence of each operation. For this evaluation report, the schedules for each alternative present the activities required to complete the remediation of the Silo 3 residues.

A measure of implementability for each Silo 3 residues treatment alternative can be determined by its ability to be implemented prior to or in parallel to the current technical baseline schedule for initiation of Silo 1, 2 and 3 vitrification operations by March, 2002. In addition, the completion of an alternative stabilization treatment/disposal method for Silo 3 residues must be completed on or before June, 2004, the April 1996 baseline completion date for remediation of the Silo 3 residues. This is necessary in order to achieve one of the primary goals of this report which is to identify a remedial alternative for Silo 3 residues which will accelerate the remediation schedule for the Silo 3 residues in parallel to the ongoing vitrification activities.

In order to achieve this goal, Figure 3.1-1 presents a schedule summary which compares two generic self-performance template schedules adopted for the Silo 3 alternatives. Both generic template schedules reflect the same fundamental activities and the durations in which they must be completed to successfully accomplish the remediation of Silo 3 residues; however, they differ in logic ties. The upper schedule entitled, "Silo 3 Alternatives Template - Traditional Schedule" presents a "low-risk" based schedule, with all activities having a sequential finish-to-start relationship with respect to each

Activity ID	Orig Dur	Early Start	Early Finish
SILO 3 ALTERNATIVES TEMPLATE - TRADITIO			
X2103	20*	22JUL96*	16AUG96
X2106	30*	19AUG96*	30SEP96
X2100	148	01OCT96	06MAY97
X2109	277	07MAY97	15JUN98
X2112	230	16JUN98	17MAY99
X2115	250	18MAY99	16MAY00
X2118	64	17MAY00	16AUG00
X2121	127	20OCT99	25APR00*
X2124	127	17AUG00	21FEB01
X2127	86	22FEB01	25JUN01
X2130	127	06SEP01	12MAR02
X2133	64	13MAR02	12JUN02
X2136	20	13JUN02	11JUL02
X2129	50	26JUN01	05SEP01
SILO 3 ALTERNATIVES TEMPLATE - ACCELE			
X3100	148	22JUL96	24FEB97
X3103	20*	22JUL96*	16AUG96
X3106	30*	19AUG96*	30SEP96
X3109	277	01OCT96	06NOV97
X3112	230	11AUG97	13JUL98
X3115	250	07NOV97	06NOV98
X3118	64	09NOV98	12FEB99
X3121	127	11AUG98	12FEB99
X3124	127	16FEB99	16AUG99
X3127	86	17AUG99	20DEC99
X3130	127	06MAR00	01SEP00
X3133	64	05SEP00	06DEC00
X3136	20	07DEC00	08JAN01
X3129	50	21DEC99	03MAR00



Project Start 01OCT95
Project Finish 11JUL02
Data Date 01OCT95
Plot Date 25JUN96

© Primavera S

Early Bar
Progress Bar
Critical Activity

SSFS

Sheet 1 of 1

COMPARISON OF SILO ALTERNATIVES TEMPLATE SCHEDULES

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other. The initiation and completion dates for the stabilization operations of the Silo 3 residues are approximately September, 2001 and March, 2002, respectively. The performance of all activities in sequence limits the risk associated with doing work in parallel and without agency approval; however, as one can see the schedule goal to improve the OU4 remedial operations baseline could be realized under this approach, but with minimal schedule improvement. Essentially the Silo 3 stabilization operations would be completed just as the vitrification operations are planned to begin.

The lower schedule entitled, "Silo 3 Alternatives Template-Accelerated Schedule," presents the same activities and durations; however, several activities are being performed in parallel. Under this scenario the opportunity to achieve significant schedule improvements for implementing the alternative could be achieved on a more accelerated basis. Further acceleration may be possible through enhanced, alternative procurement and design strategies.

Under the accelerated approach, the projected initiation and completion dates for the stabilization operations of the Silo 3 residues would be approximately March, 2000 and January, 2001 more than three years ahead of the current planned FRVP vitrification operations. With the exception of the VIT alternative, all the alternatives presented in this report will use the "accelerated schedule" template. The technical and programmatic risks will be qualitatively discussed in the evaluation of alternatives. Each alternative will customize the accelerated template schedule (i.e., adjust individual activity durations) to be alternative-specific in nature. The VIT alternative will present its current baseline remediation schedule.

Regulatory Implementability

The OU4 ROD was approved by the EPA on December 7, 1994, and identified vitrification followed by off-site disposal at the NTS as the selected alternative for the remediation of the Silo 3 residues. Guidance for making changes to an EPA-approved ROD are presented in 40 CFR §300.435(c)(2) and in OSWER Directive 9355.3-02, Chapter 8, "Post-ROD Significant Changes." 40 CFR §300.435(c)(2) states, . . . "After the adoption of the ROD, if the remedial action or enforcement action taken, or the settlement or consent decree entered into, differs significantly from the remedy selected in the ROD with respect to scope, performance, or cost, the lead agency shall consult with the support agency, as appropriate, and shall either: (i) publish an explanation of significant differences when the differences in the remedial or enforcement action, settlement, or consent decree significantly change but do not fundamentally alter the remedy selected in the ROD with respect to scope, performance, or cost. . .or (ii) propose an amendment to the ROD if the differences in the

remedial or enforcement action, settlement, or consent decree fundamentally alter the basic features of the selected remedy with respect to scope, performance, or cost," (EPA 1989).

OSWER Directive 9355.3-02, Chapter 8, "Post-ROD Significant Changes" states, . . . "After a ROD is signed, new information may be generated during the RD/RA process that could affect the remedy selected in the ROD. The lead agency should analyze this new information to determine if changes should be made to the selected remedy. Three types of changes could occur: (1) nonsignificant changes; (2) significant changes; and (3) fundamental changes," (EPA 1989).

The guidance states that nonsignificant changes should be simply recorded in the post-decision document file. If significant changes are made to a component of the remedy in the ROD, these changes should be documented in an explanation of significant differences (ESD). More importantly, fundamental changes are documented in a ROD amendment.

"A threshold for defining significant changes (or differences) has been established, which is intended to reduce the paperwork burden on the lead agency without compromising the public's right to be kept informed. Therefore, only changes that significantly alter the scope, performance, or cost of a component of the remedy as presented in the ROD should be addressed in an ESD." Section 8.6.2.1 of OSWER Directive 9355.3-02 provides guidance for preparing an ESD, (EPA 1989). The following activities should be included when issuing an ESD:

- Provide the support agency with a reasonable opportunity to comment on the ESD prior to publication (a maximum of 15 working days is recommended);
- Summarize the support agency's comments in the ESD;
- Publish a notice of availability and brief description of the ESD in a local newspaper of general circulation, as required by CERCLA Section 117(c);
- Make the ESD available to the public by placing it in the administrative record file and information repository; and
- Place the information supporting the change in the administrative record file, as well as the lead agency's response to any comments.

It should be noted that although not required, a public comment period will be incorporated into the ESD process to promote a higher degree of stakeholder involvement.

Implementing fundamental changes from the selected remedy in an approved ROD requires the preparation and approval of a ROD Amendment. Fundamental changes associated with several of the Silo 3 alternatives generally involve the adoption of a technology and/or process option which were not evaluated in the ROD. To amend the ROD the following activities must be conducted:

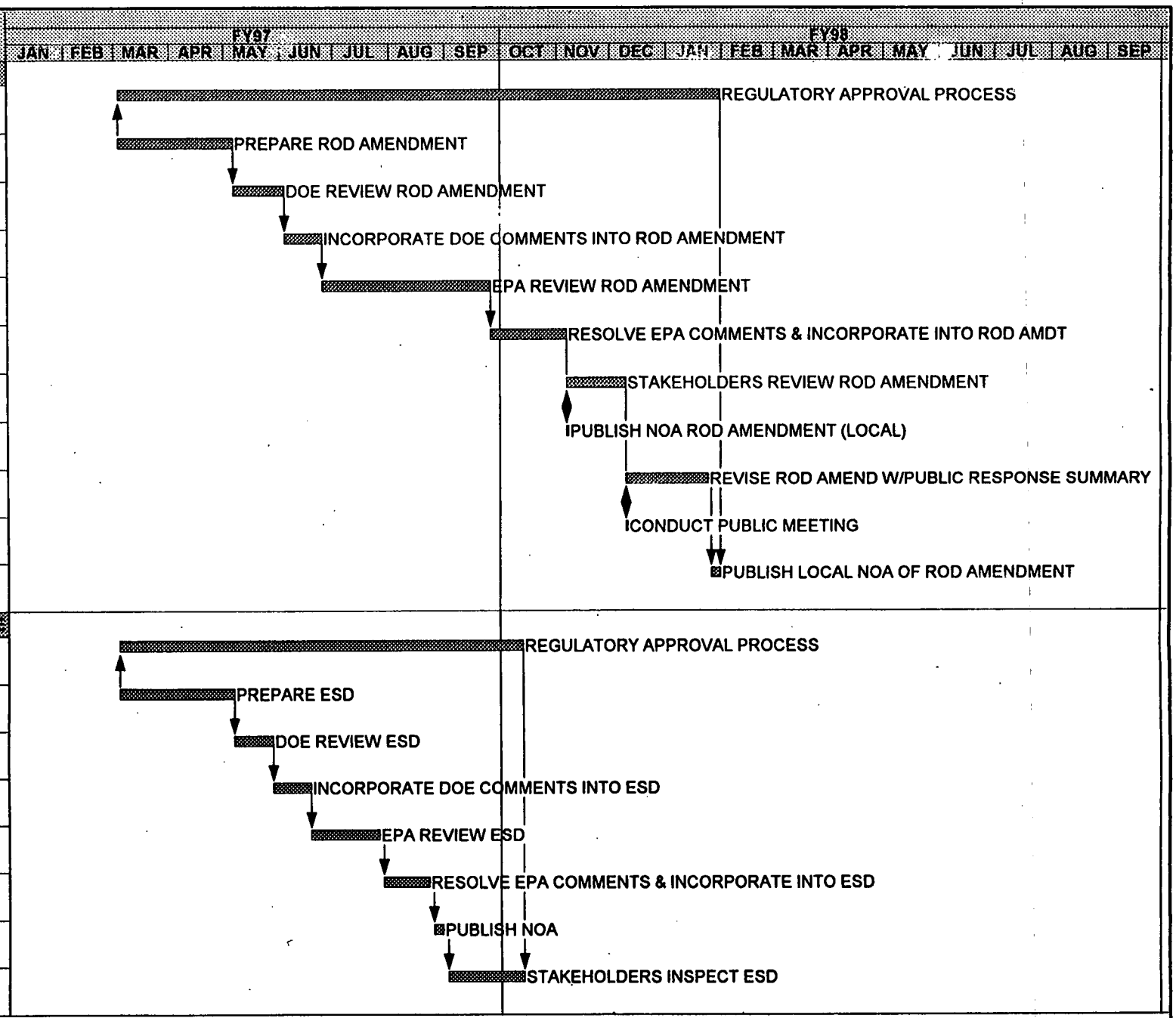
- Issue a notice of availability and brief description of the proposed amendment to the ROD in a major local newspaper of general circulation;
- Make the proposed amendment to the ROD and information supporting the decision available for public comment;
- Provide a reasonable opportunity, not less than 30 calendar days, for submission of written or oral comments on the amendment to the ROD;
- Provide the opportunity for a public meeting to be held during the public comment period at or near the facility at issue;
- Keep a transcript of comments received at the public meeting held during the public comment period;
- Include in the amended ROD a brief explanation of the amendment and the response to each of the significant comments, criticisms, and new relevant information submitted during the public comment period;
- Publish a notice of availability of the amended ROD in a major local newspaper of general circulation; and
- Make the amended ROD and supporting information available to the public in the administrative record and information repository prior to the commencement of the remedial action affected by the amendment.

Figure 3.1-2 presents a schedule for the regulatory approval process of the aforementioned ESD and ROD Amendment documents. Each Silo 3 alternative will discuss whether its implementation would require either the processing of an ESD or ROD Amendment. Each alternative's project specific schedule will adjust its "regulatory process" activity duration as appropriate to allow for the required time to modify the OU4 enforcement documentation through the approval of an ESD or ROD Amendment.

Treatability Study Requirements

In order to reduce the technical uncertainties and programmatic risks associated with developing and implementing each of the Silo 3 residues alternatives, the need to perform additional treatability studies is essential. Appendix E identifies issues associated with each alternative that require resolution through the performance of additional treatability studies. Figure 3.1-3 presents a

Activity ID	Orig Dur	Early Start	Early Finish
ROD AMENDMENT			
Y13H1	230*	03MAR97	30JAN98
Y1300	45	03MAR97*	05MAY97
Y1305	20	06MAY97	03JUN97
Y1310	15	04JUN97	24JUN97
Y1315	65	25JUN97	25SEP97
Y1320	30	26SEP97	06NOV97
Y1330	20	07NOV97	09DEC97
Y1325	1	07NOV97	07NOV97
Y1340	30	10DEC97	23JAN98
Y1335	1	10DEC97	10DEC97
Y1345	5	26JAN98	30JAN98
EXPLANATION OF SIGNIFICANT DIFFERENCE			
Y14H1	157*	03MAR97	13OCT97
Y1400	45	03MAR97*	05MAY97
Y1405	15	06MAY97	27MAY97
Y1410	15	28MAY97	17JUN97
Y1415	27	18JUN97	25JUL97
Y1420	20	28JUL97	22AUG97
Y1425	5	25AUG97	29AUG97
Y1430	30	02SEP97	13OCT97



Project Start 01OCT95
Project Finish 11JUL02
Data Date 01OCT95
Plot Date 26JUN96

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Early Bar
Progress Bar
Critical Activity

SSFS

Sheet 1 of 1

TYPICAL REGULATORY APPROVAL PROCESS
SUMMARY SCHEDULES
RE 3.1 - 2

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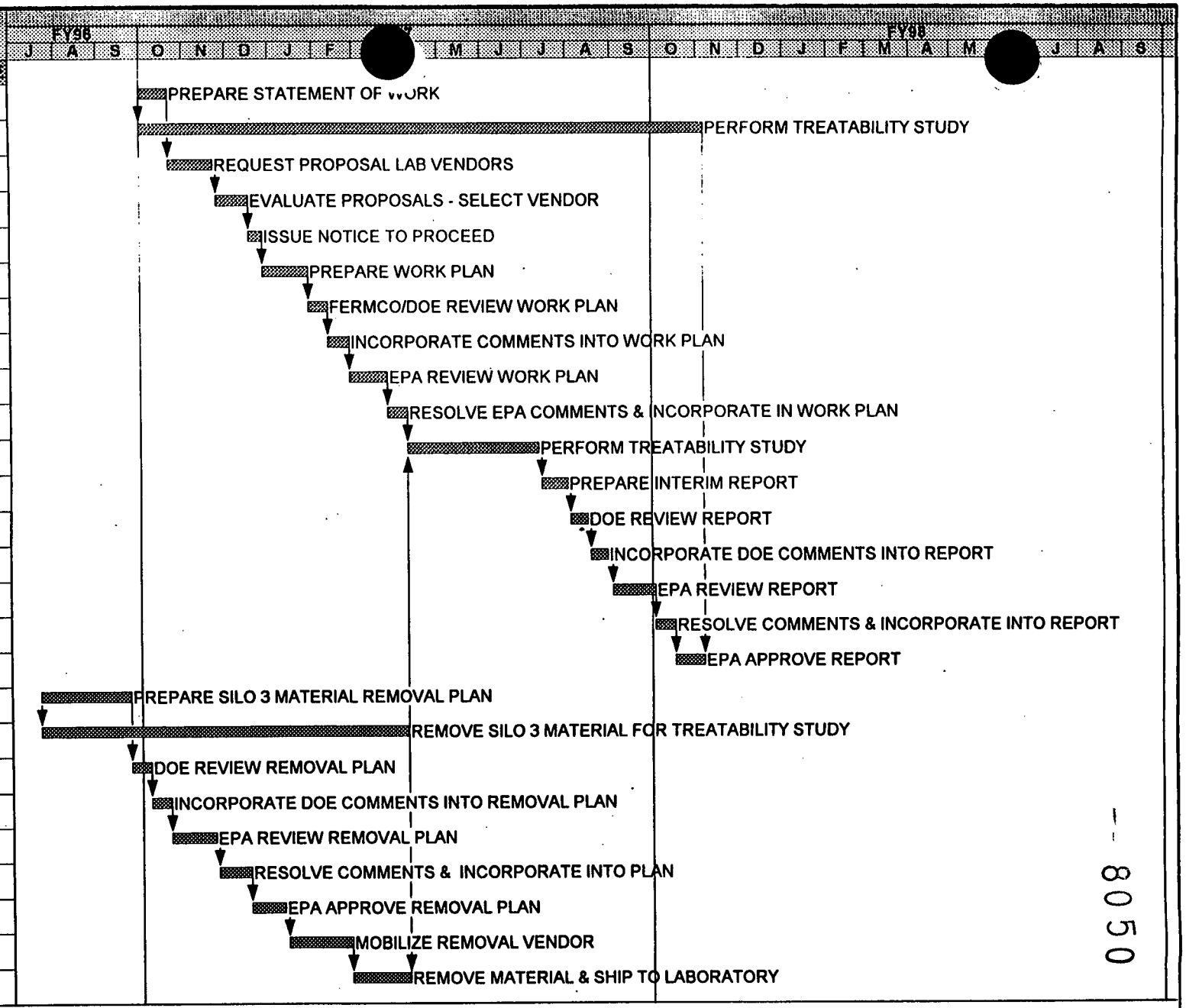
Activity ID	Orig	Early Start	Early Finish
TREATABILI		DY SUMMARY SCHEDULE	
Y1100	15	01OCT96*	21OCT96
Y11H1	277*	01OCT96	06NOV97
Y1105	23	22OCT96	22NOV96
Y1110	15	25NOV96	17DEC96
Y1115	5	18DEC96	26DEC96
Y1120	22	27DEC96	28JAN97
Y1125	10	29JAN97	11FEB97
Y1130	10	12FEB97	26FEB97
Y1135	20	27FEB97	26MAR97
Y1140	10	27MAR97	09APR97
Y1145	64	10APR97	11JUL97
Y1150	15	14JUL97	01AUG97
Y1155	10	04AUG97	15AUG97
Y1160	10	18AUG97	29AUG97
Y1165	23	02SEP97	02OCT97
Y1170	10	03OCT97	16OCT97
Y1175	15	17OCT97	06NOV97
Y1200	45	22JUL96*	23SEP96
Y121H1	180*	22JUL96	09APR97
Y1205	10	24SEP96	07OCT96
Y1210	10	08OCT96	21OCT96
Y1215	23	22OCT96	22NOV96
Y1220	15	25NOV96	17DEC96
Y1230	15	18DEC96	10JAN97
Y1235	32	13JAN97	26FEB97
Y1225	30	27FEB97	09APR97



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Project Start	01OCT95	Early Bar	
Project Finish	11JUL02	Progress Bar	
Data Date	01OCT95	Critical Activity	
Plot Date	25JUN96		

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Sheet 1 of 1

SILO 3 ALTERNATIVES
TREATABILITY STUDY SUMMARY SCHEDULE
FIGURE 3.1 - 3

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Restoration Management Corporation

summary of the activities required to perform a treatability study under EPA guidelines. These lower-level activities collectively "roll-up" to form the basis for the duration of the "Perform Treatability Study" hammock activity in Figure 3.1-1.

The outcome of this technical effort may indicate that the selection of another alternative may be more appropriate for the remediation of the Silo 3 residues. In order to approach the regulatory agencies and obtain their approval to formally modify the selected remedy for the Silo 3 residues, the DOE must technically support the request. Each alternative evaluated within this report requires either ongoing or additional treatability studies to either confirm the adaptability of the stabilization process and/or optimize the parameters of the stabilization process. This could be accomplished through the performance of an EPA-approved treatability study.

In addition, there exists limited quantities of Silo 3 residues to support the performance of any treatability study effort. The DOE would be required to obtain additional quantities of Silo 3 residues (i.e., several 55-gallon drum equivalents) to perform vendor proof-of-process testing. Therefore, Figure 3.1-3 also contains a schedule of the lower-level activities supporting the "Remove Silo 3 Material for Treatability Study" hammock activity.

3.1.2.7 Cost

The cost criterion reviews capital costs (direct and indirect), waste disposal costs, O&M costs, and D&D costs. A life-cycle cost analysis evaluates costs that occur over different time periods. A sensitivity analysis may be conducted if there is sufficient uncertainty concerning specific assumptions.

This evaluation presents cost information for the alternatives. The approach adopted by this evaluation includes a presentation of capital costs, operating, packaging, transportation and disposal costs, along with a summary of assumptions used to estimate the capital cost for each major component of the alternative. A cost analysis table provides detail for each of the major cost elements of each alternative. Cost estimate details are provided in Appendix C.

3.1.2.8 State Acceptance

This criterion measures the extent to which the comments made by the Ohio Environmental Protection Agency (OEPA) on the alternatives being considered for site remediation are satisfactorily addressed. With the exception of Alternative VIT, because formal state comments will not be received until after

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this evaluation report has been issued for public review, this modifying criterion will be addressed in the regulatory process following the public review period.

3.1.2.9 Community Acceptance

This criterion measures the extent to which the comments made by the community on the alternatives being considered are satisfactorily addressed. With the exception of Alternative VIT, because formal public comments will not be received until after this evaluation report has been issued for review, this modifying criterion will be addressed in regulatory process following the public review period.

3.1.3 Overview of Section 3.0

Sections 3.2 through 3.6 present the detailed analysis of alternatives for the VIT, ALT1, ALT2, ALT3, and ALT4 alternatives respectively. Consistent with the approach of presenting the OU4 Feasibility Study alternatives, the analysis evaluates the respective Silo 3 residues treatment alternatives against the CERCLA criteria.

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3.2 Removal, Onsite Vitrification, Off-site Disposal at the NTS

3.2.1 Description of Alternative

Vitrification, as described as a waste stabilization alternative in the *Feasibility Study Report for Operable Unit 4* (DOE 1994a), is the process of blending silo residues with glass-forming constituents, heating the mixture in a melter, casting the molten glass into a form, then allowing the glass to cool prior to packaging and off-site disposal. The referenced feasibility study considered two vitrification campaigns: (1) vitrifying a blend of Silo 1 and 2 residues, and (2) vitrifying Silo 3 residues. The basis of this Silo 3 alternative considers the impact of modifying a reference 25-tonne per day vitrification facility, referred to as Fernald Residue Vitrification Plant (FRVP), designed to vitrify a blend of Silo 1 and 2 residues (noted as series "A" glass), to a 25-tonne per day facility designed to vitrify a blend of residues from Silos 1, 2 and 3 (noted as series "D" glass). Although this represents a deviation from the cases presented in the Feasibility Study, the blending of all silo residues makes use of recent laboratory developments at Catholic University's Vitreous State Laboratory (VSL) that demonstrated the feasibility of producing both a series "A" and series "D" glass.

This alternative requires the removal of cold metal oxide residues from Silo 3; blending the residues with additives, glass-formers and residues from Silos 1 and 2; stabilizing of the material(s) by vitrification, and disposing of them off-site at the low-level radioactive waste disposal facility at the NTS.

3.2.1.1 Residue Retrieval

The cold metal oxides are to be removed by a mechanical/pneumatic removal system introduced into the Silo 3 structure. The cold metal oxides are then mechanically/pneumatically transferred to the FRVP for vitrification, packaging, and transportation off-site for disposal.

Site Preparation/Construction

The site preparation activities for the implementation of this alternative include the clearing and grubbing of vegetated areas and excavation in the vicinity of Silo 3. These activities are in preparation for the construction of the mechanical/pneumatic removal system and the construction of roads and equipment staging areas. Approximately 0.02 ha (0.05 acres) would require clearing and grubbing. The site preparation activities would also consist of the installation of site fencing, site lighting, power poles, and the extension of site power to the area(s) requiring service.

Site preparation for FRVP is included under an existing task (Site Preparation/Underground Utilities). Original estimates for the facility required approximately 3.2 ha (8 acres) to be cleared and grubbed. In addition to the clearing and grubbing activities, the southern area of the remediation site would be filled, as required, to level the site. The volume of fill soil is estimated to be approximately 11,500 m^3 (15,000 yd^3), which could be obtained from excess unaffected soil removed from the silo berms during Silos 1 and 2 superstructure installation or from other onsite stockpiles..

The FRVP site preparation activities also include the installation of roadways, site fencing, site lighting, process water piping, sewer lines, power poles, and the extension of site power to the processing elements requiring service.

Removal

The residue retrieval system for Silo 3 uses a combination of mechanical and pneumatic retrieval equipment. The silo contents are accessed at grade through two penetrations at the base of the silo wall. The retrieval equipment is housed in two identical, fully equipped Equipment Enclosures (EEs), located adjacent to the silo and 180 degrees apart. Two access locations would be provided for redundancy and to allow better access to the residues in the silo. Since the floor of the silo is below the existing grade, the EEs are installed partially below grade to allow access to the silo floor by the bulk and heel retrieval equipment and ensure a more effective retrieval operation. The EEs would provide radiological containment and would include a radiological buffer area and ventilation controls to maintain directional airflow and allow personnel access as needed. The silo headspace would be ventilated as needed to help maintain directional airflow and a negative pressure relative to EE.

The primary retrieval equipment would consist of mechanical augers, pneumatic tubes and hoses, pneumatic conveying system, filter receiver, and a teleoperated robotic vehicle. The pneumatic conveying system blower is located at the vitrification facility in order to pull, rather than push, the residue to its destination. In this way, the conveying process will be under negative pressure with respect to atmosphere. This, along with the use of double-walled piping and HEPA filters, ensures containment of the residue during retrieval and transfer operations.

The residue retrieval operation is completed in stages. Initially, two holes approximately 20.3 cm (8 inches) in diameter and 180 degrees apart (located near the existing decant ports) are drilled in a contained manner through the silo walls to allow access for the first stage of retrieval equipment. The first stage of retrieval uses mechanical augers that are inserted several feet into the silo through

the new penetrations. The augers are fed to a delumper/crusher and subsequently to the pneumatic conveying system for transport to the vitrification plant. The augers are used to remove as much residue as the angle of repose allows (previously measured at 20 to 30 degrees).

The second stage of retrieval requires the removal of the augers from the EEs and enlargement of the 20.3-cm (8-inch) diameter silo penetrations to an approximate 1.22 m (4 ft) by 0.91 m (3 ft) rectangular opening. This allows a pneumatic tube and roller system to be advanced into the silo to continue bulk residue retrieval. The tube is directly connected to the pneumatic conveying system. This stage of retrieval allows the bulk of the center portion of the silo to be cleared of residue and is estimated to leave approximately 20 percent of residue remaining for the subsequent heel retrieval stage.

The final stage of retrieval, known as heel retrieval, involves the use of a remotely controlled vehicle. The vehicle resembles a scaled-down bulldozer equipped with a robotic arm for tool and object manipulation. The vehicle is deployed from the EE through the rectangular opening and is used to push residue towards the pneumatic retrieval tube. In addition, the vehicle manipulates a nozzle at the end of a hose which is connected to the pneumatic conveying system. The vehicle is also used to remove nonpumpable objects from the silo as deemed necessary.

Retrieval operations would be remotely controlled to the extent practical using closed circuit television (CCTV) systems mounted in the EEs and silo pressure and flow controllers and transmitters are also used. Personnel access to the EEs is required only during wall penetration enlargement, equipment removal and installation, and periodic preventative maintenance.

3.2.1.2 Material Processing: Vitrification

Cold metal oxides from Silo 3 would be blended with residues from Silos 1 and 2 and treated through vitrification. The vitrification process can be defined by five systems: melter feed preparation system, melter system, melter off-gas system, glass manufacturing system, and the balance of plant (BOP) systems. The paragraphs below provide process descriptions of these elements and serve as the basis for the reference vitrification facility design (series "A" glass). Discussions addressing facility and process modifications for the Silo 3 alternative (series "D" glass) are presented at the end of the discussion for each system.

Melter Feed Preparation: The function of the melter feed preparation system is to prepare and deliver a properly formulated melter feed slurry containing both silo residues and glass formers. A process flow diagram of the FRVP melter feed preparation system is provided in Figure 3.2-1. A description of this system is provided below. Modifications required to facilitate this alternative are illustrated by dashed lines in Figure 3.2-1 and are discussed at the end of this section.

Dewatering is provided upstream of the melter feed preparation system and will utilize flocculants from the cold chemical system to thicken a blend of Silos 1 and 2 residues into an acceptable melter feed slurry. Dewatering produces a clarified overflow stream that is reused in the retrieval of residue from the Silos 1 and 2. The downstream components of the melter feed preparation system consists of three process tanks. These include two parallel Feed Preparation Tanks and a Melter Feed Tank. A discussion of the melter feed process tanks is provided below.

The Feed Preparation Tanks (FPTs) alternately receive the concentrated melter feed slurry from the thickener on a continuous basis. As one FPT accumulates melter feed slurry from the Dewatering System, the other FPT (assumed at full capacity) prepares a properly formulated slurry containing both concentrated melter feed slurry and glass formers from the Cold Chemical System. The FPT process is performed on a batchwise basis and requires homogenization (e.g., mixing by mechanical means). Sampling is performed on the homogenized slurry in the FPT to confirm acceptability of composition and other properties. Acceptable FPT slurry is batch transferred to the Melter Feed Tank (MFT).

The function of the MFT is to receive batchwise product from the FPT and provide a continuous melter-ready feed slurry to the melter for the vitrification process. The MFT is adequately sized to provide surge capacity to the melter. A recirculation system discharges slurry from the MFT through a free draining recirculation loop that discharges back into the MFT. A small slipstream is drawn from the recirculation loop and provides the forward-feed to the melter.

All process tanks discussed above are closed tanks and are maintained at a slight negative pressure by overhead connections to the Process Vessel Vent System. The goal of this system is to help minimize air inleakage into the Melter Feed Preparation System.

The required modifications to the melter feed preparation process for the inclusion of Silo 3 residues (to prepare a series "D" glass) are illustrated in Figure 3.2-1. A vented vessel (Silo 3 Holding Bin)

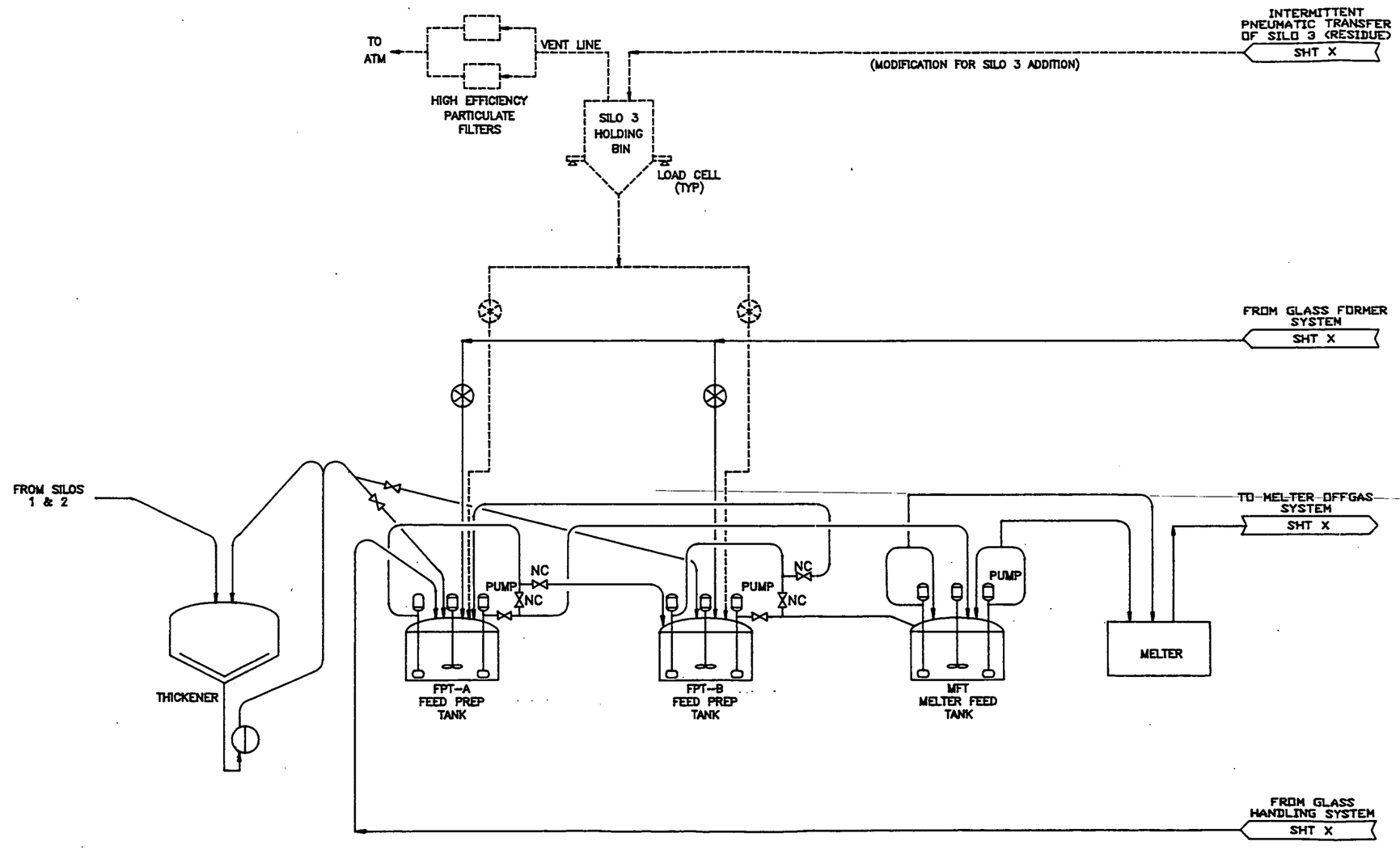

FIGURE 3.2-1

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UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FERMCO
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION
CINCINNATI, OHIO

FERNALD RESIDUES VITRIFICATION PLANT

PRELIM PFD SKETCH
MELTER FD PREP SYSTEM
REFERENCE PLANT, FRVP

J.DIAZ | 04-05-93 | S.SHARP | 04-05-93
OU4 | NONE
04424331 | SK-3026 | 1 | A

ACAD

000086

with redundant dust removal high efficiency particulate air (HEPA) filters, load cell system, constant volume feeders (e.g., rotary star feeder), and associated transfer equipment is required to deliver, stage, measure, and transport cold metal oxides to the feed preparation process. Cold metal oxides are added into the feed stream at the FPT and are blended with other constituents. No other modifications are required for the conversion of this alternative.

Melter: The referenced joule-heated melter is a 25-tonne per day Liquid Feed Ceramic-lined Melter (LFCM) system that is scalable to the VSL data. Joule-heating is achieved by passing a current through the glass pool using electrodes placed inside the melter. These types of melters are commonly refractory-lined chambers using fixed or movable electrodes submerged in the glass. Slurry is fed from the MFT into the melter.

Since melter performance characteristics change with varying glass formulations, melter design parameters will change. VSL and FDF data estimated the melter size to produce 25 tonnes per day of series "A" glass based on the glass processing surface area of a scaled-down minimelter (VSL 1996). The same data indicates that the series "D" glass throughput for the same size melter is approximately 33.3 tonnes per day. Since these production capacities are based on the same glass processing temperature of 1,250°C (2,282°F), the reference melter (campaigning series "A" glass) must be downsized to have a throughput of 25 tonnes per day of a series "D" glass. Since the scaling factor is based on the glass processing surface area of the minimelter (VSL test facility), the modified melter surface area would be downsized by the ratio of production capacities (25/33.3), or a factor of 0.75. It is anticipated that the difference in glass chemistry process control due to the modification will be developed and tested by both bench-scale laboratory (FEMP) and in pilot-scale demonstration at the Vitrification Pilot Plant.

Specific melter data used in this report is based on VSL and FEMP data, scaling factors and downsizing ratios discussed in the above paragraph. The required glass processing surface area for the 25 tonne per day reference melter (series "A" glass) is approximately 7.0 m^2 (75 ft^3). For the modified facility, this requirement is reduced to approximately 5.3 m^2 (57 ft^2) since this glass has more desirable processing characteristics (e.g., lower viscosity at temperature). Hence, the addition of Silo 3 residues to the reference glass formulation is actually a benefit since the glass processing surface area requirements are reduced. Further discussion is presented in Section 3.2.7. This information is summarized on Table 3.2-1.

TABLE 3.2-1

MELTER DATA: 25 TONNES PER DAY PRODUCTION CAPACITY

Melter	Series Glass	Glass Processing Rate ($kg/hr\text{-}m^2$)	Glass Processing Rate ($lb/hr - ft^2$)	Melter Surface Area m^2 (ft^2)
reference	A	135	27.7	7.0 (75.3)
modified	D	180	36.9	5.3 (56.5)

The increased volume of vitrified materials resulting from this alternative is a result of the inclusion of Silo 3 residues (approximately 3,913 tonnes of material) into the glass formulation. Table 3.2-2 summarizes this impact on residue disposal volume. The reference vitrification process (series "A" campaign) produces approximately 4,883 m^3 (6,386 yd^3) of glass product for disposal. Modification to a series "D" glass would increase this volume to approximately 6,620 m^3 (8,659 yd^3) of glass product. Therefore, the implementation of this alternative increases the total glass volume for disposal by approximately 1,737 m^3 (2,273 yd^3).

TABLE 3.2-2

COMPARISON OF GLASS VOLUMES

Case	Series Glass	Glass Density g/cm^3 (lb/ft^3)	Glass Volume Produced m^3 (yd^3)	FRVP Operating Life (yrs)
reference	A	2.76 (171.9)	4,883 (6,386)	2.17
modified	D	2.79 (173.0)	6,620 (8,659)	2.95
difference	-	-	1,737 (2,273)	0.78

Since the glass production rate for both the reference and the modified case is constant at 25 tonnes per day, the increased production capacity to accommodate the increased glass volume for the modified case is achieved by operating the FRVP for a longer period of time. This extension to the operating period of FRVP is calculated to be approximately 10 months (at 75% plant availability factor).

Melter Off-gas System: Due to the very high temperatures required for vitrification, superheated steam and volatilized matter is produced in the melter. The Melter Off-gas System (MOG), illustrated in Figure 3.2-2, has two primary functions. First, the MOG must prevent release of contamination (it must maintain negative pressure) from the melter under all credible normal and off-

LEGEND:

FRC = FLOW RECORDING CONTROL

PRC = PRESSURE RECORDING CONTROL

NNF = NORMALLY NO FLOW

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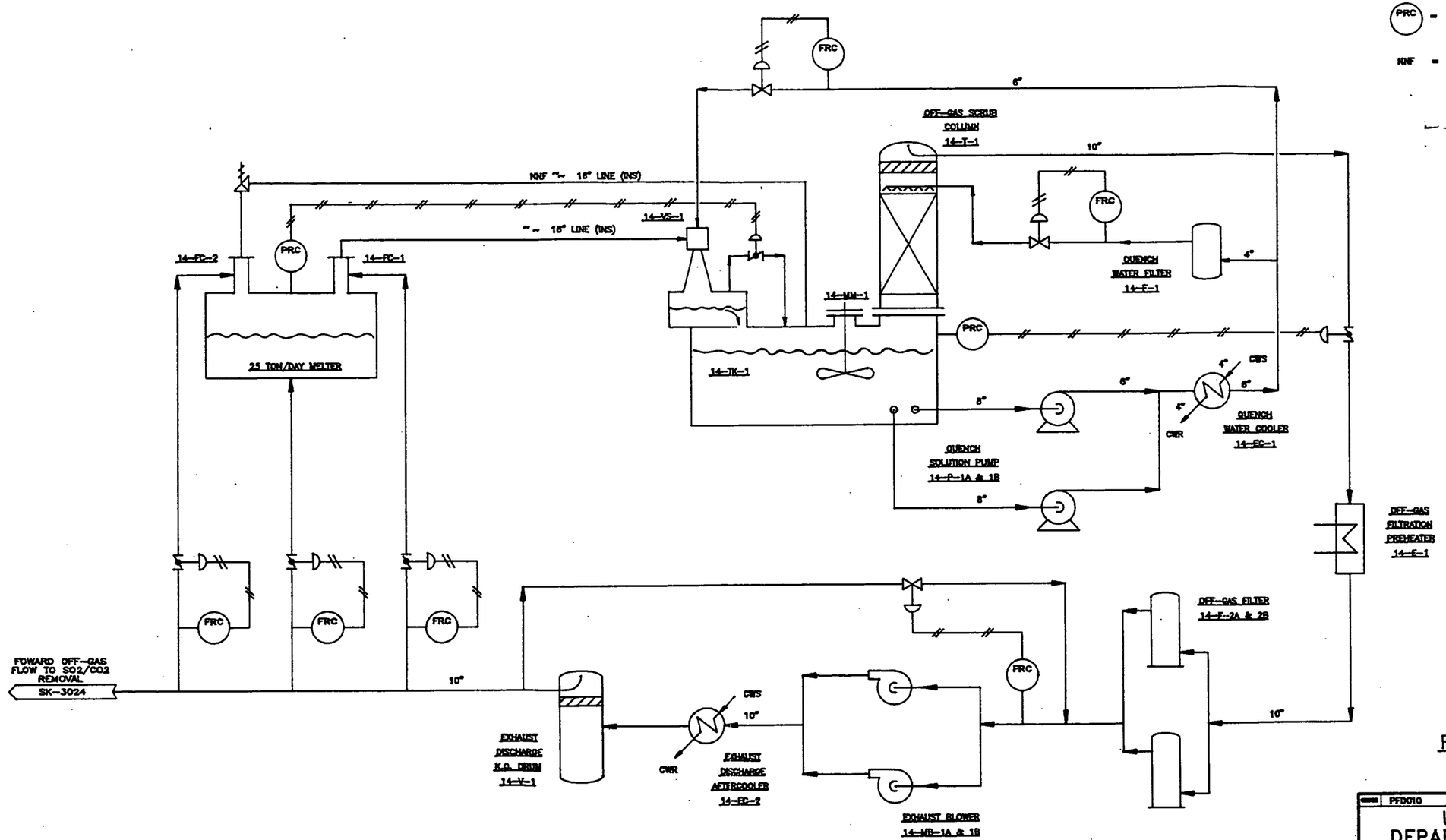

FIGURE 3.2-2
SH. 1

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UNITED STATES DEPARTMENT OF ENERGY FERNALD ENVIRONMENTAL MANAGEMENT PROJECT	
FERMCO FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION CINCINNATI, OHIO	
FERNALD RESIDUES VITRIFICATION PLANT	
PROCESS FLOW DIAGRAM 25 METRIC TON/DAY VITRIFICATION	
J.DIAZ 4-6-6	S.SHARP 4-6-6
DU4	NONE
04424331	SK-3023 1 A

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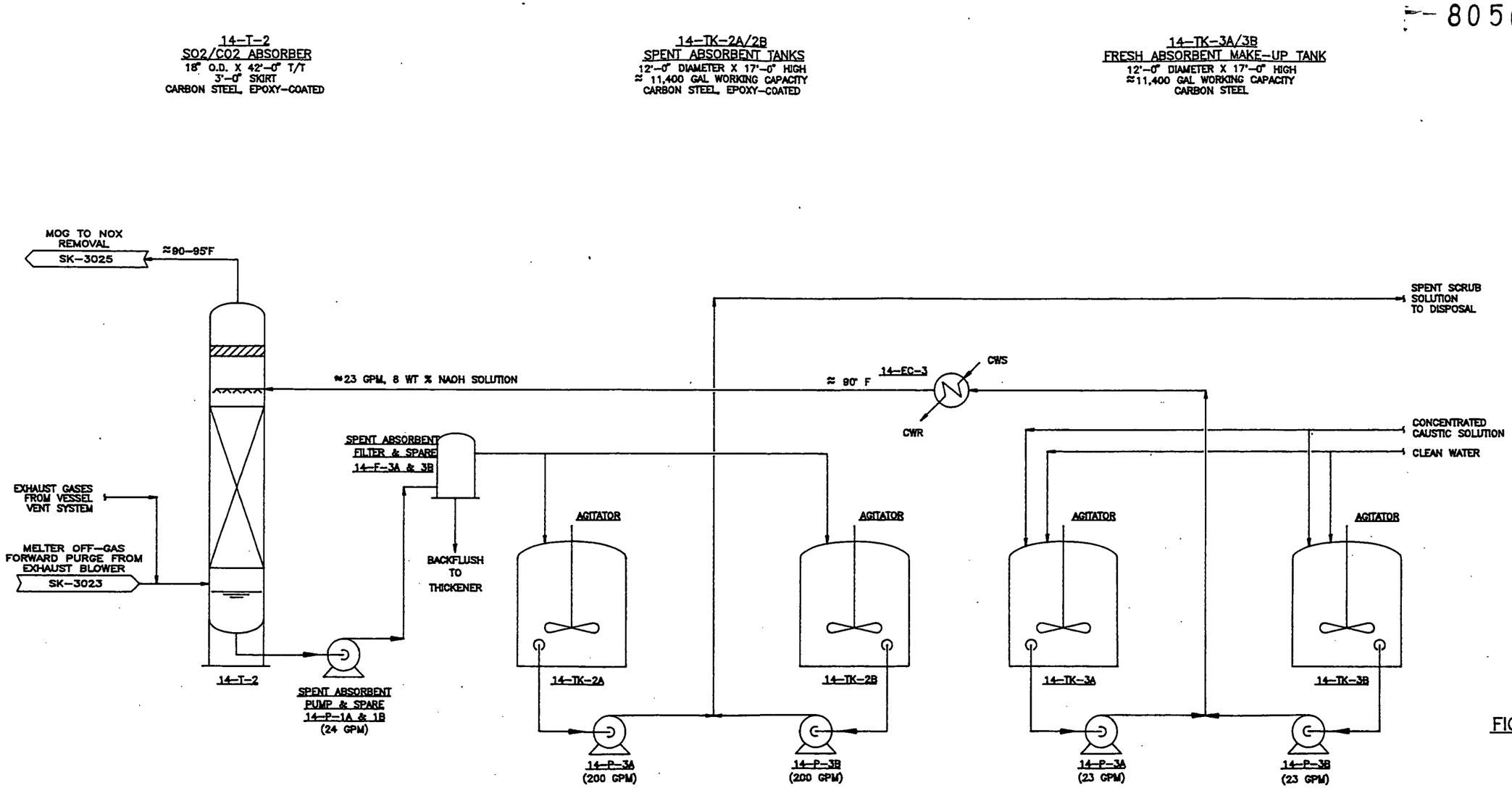

FIGURE 3.2-2
SH. 2

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PFD011	
UNITED STATES DEPARTMENT OF ENERGY FERNALD ENVIRONMENTAL MANAGEMENT PROJECT	
FERMCO FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION CINCINNATI, OHIO	
FERNALD RESIDUES VITRIFICATION PLANT	
PROCESS FLOW DIAGRAM 25 METRIC TON/DAY VITRIFICATION	
J.DIAZ 4-01-93	S.SHARP 4-01-93
OU4	NONE
04424331	SK-3024 1 A

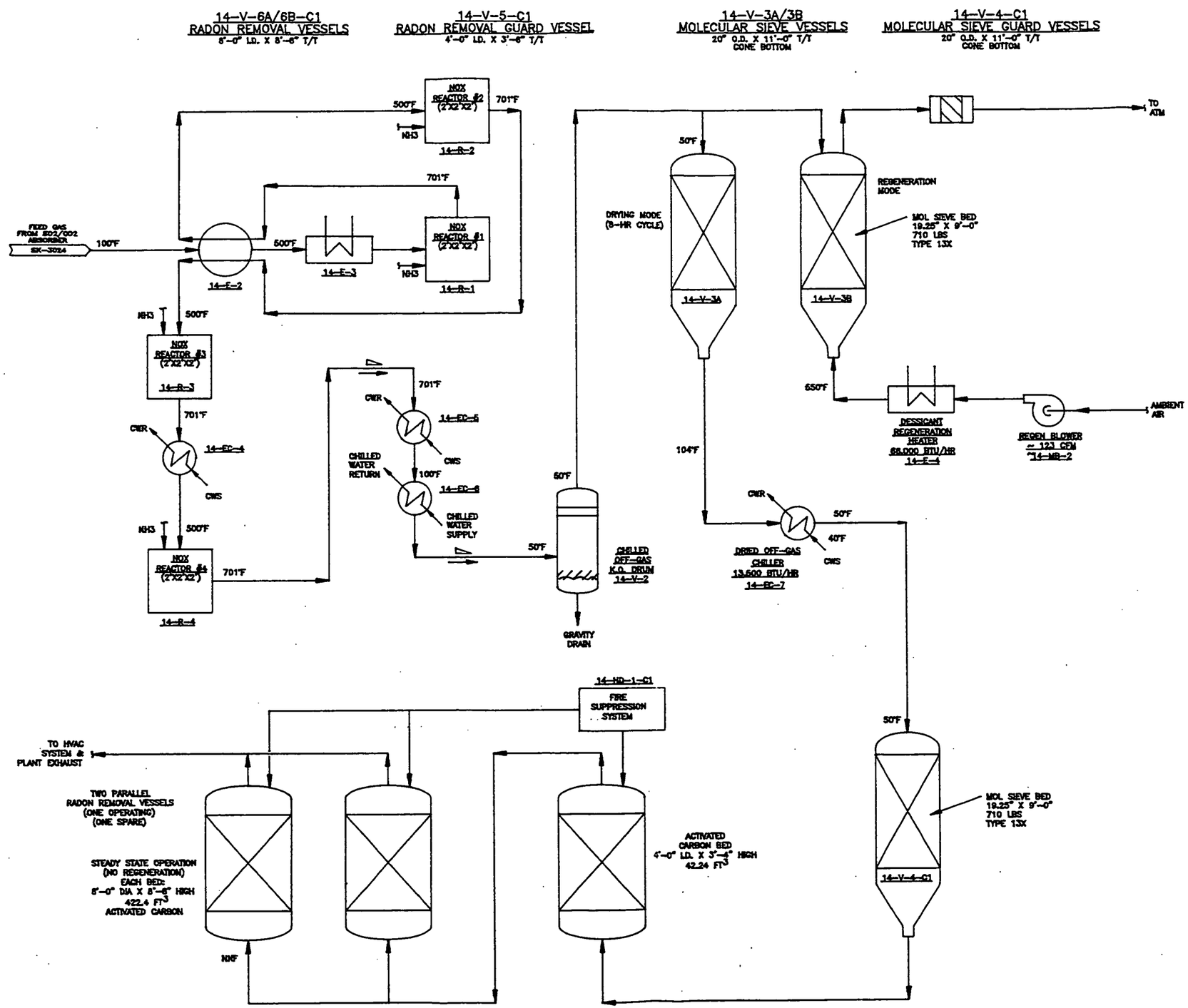

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FIGURE 3.2-2
SH. 3

PFD012

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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FERMCO
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION
CINCINNATI, OHIO

FERNALD RESIDUES VITRIFICATION PLANT

PROCESS FLOW DIAGRAM
25 METRIC TON/DAY
VITRIFICATION

J.DIAZ	4-01-03	S.SHARP	5-01-03		
OU4				HOME	
04424331		SK-3025		1	A

000091

normal operating conditions. Second, the MOG must decontaminate the effluent gases from the melter plenum prior to discharge into the environment. Because the potential exists for emissions of radionuclides to the ambient air in excess of 40 CFR § 61, Subpart H and Subpart Q, there is continuous radionuclide emissions monitoring of the off-gas treatment system.

Using current data available from developmental off-gas analysis, and for the purposes of this report, the differences in off-gas characteristics between a series "A" and series "D" glass are considered negligible. Therefore, there are no differences in the MOG system as a result of the Silo 3 addition to the vitrification process except for a favorable impact to downsizing the MOG system as a result of the implementation of this alternative, as discussed in Section 3.2.7. The following discussion provides details of the MOG process.

Melter off-gas is composed of noncondensibles (i.e., air inleakage and reaction gases), water vapor, and particulates from the molten glass. Exiting the melter, the off-gas passes through the film cooler where it is mixed and cooled with a controlled flow of cooled, partially decontaminated melter off-gas noncondensibles. This mixed off-gas stream is regulated such that the film cooler exit gas temperature is maintained at the optimal temperature to prevent glass deposition. Hot gases flow into the Venturi scrubber where they are quenched by a controlled flow of pressurized water and then are discharged into a vapor/liquid separator located on the top of the Quench Solution Tank (QST). Here, the quenched liquids drain to the bottom of the QST while the uncondensed gases exit the separator, enter the vapor space of the QST, then enter the bottom of the Off-gas Scrub Column (OSC).

The OSC performs two functions. First, it cools and quenches hot gases that were diverted around the Venturi scrubber (particularly during a process upset), and secondly, it provides additional cooling and particulate removal during normal operations. Prior to the gas exiting the OSC, the gas passes through a mist eliminator. Exiting the OSC, the off-gas is heated in the off-gas filtration preheater, then passes through the off-gas HEPA filters. At this point, the off-gas contains acceptably low levels of radionuclide particulates; however, it must be further processed to remove gaseous radionuclides.

The filtered off-gas is discharged by the exhaust blowers at a positive gauge pressure and undergoes cooling and separation of formed condensate in the Exhaust Discharge Knockout (K.O.) drum. Most of the off-gas (liquid free) at this point is recycled to the film cooler and to the melter (if required for

bubbler air). This recycle stream serves to minimize the size and cost of downstream MOG equipment.

The forward flow of off-gas (the remainder of the off-gas stream) is combined with gas flow from the Process Vessel Vent (PVV) System. The off-gas enters the bottom of the SO_2/CO_2 Adsorber, where a solution of sodium hydroxide reacts with the SO_2/CO_2 and forms soluble salts. Here, spent solutions are further processed and recycled prior to disposal.

The melter off-gas, now depleted of SO_2/CO_2, enters into the Selective Catalytic Reaction (SCR) unit. In the SCR unit, NO_x reacts with injected ammonia (on a catalyst) to produce nitrogen. Several water-cooled reactors are provided for this function due to the heat rejection (the reaction is exothermic) in series with intercooling. Off-gas exits the SCR units and then passes through the effluent cooler and chiller. Condensate is separated in the chilled gas K.O. drum.

The chilled, dry off-gas enters one of two parallel molecular sieve vessels. The sieve beds perform a high-efficiency dehydration of the off-gas, remove trace NO_x to protect the carbon beds downstream and, due to the exothermic nature of these reactions, heat the exiting off-gas. Exiting the molecular sieve vessel, the off-gas temperature is lowered in the dried off-gas chiller and sent to the molecular sieve guard vessel where NO_x content is reduced to minimal levels.

Purified melter off-gas from the molecular sieve guard vessel is processed for radon adsorption in a series of activated carbon beds (radon removal guard vessel and radon removal vessels). The treated effluent from the radon removal vessels is discharged into the atmosphere via HEPA's and the plant stack.

Glass Forming: Since the production output of the melter system is held constant for this alternative (25 tonnes per day), no modifications are required in the glass forming process. Figure 3.2-3 illustrates the glass forming process. Differences in the glass chemistry (e.g., viscosity) imposed by the series "D" glass are not expected to impact the glass forming process significantly. The following paragraphs describe the gem making process.

Molten glass is continuously fed from the melter to the gem making device. This device, which is attached to the melter, consists of several orifices with a shearing mechanism. The shears cut the glass into small molten gobs. The glass gobs fall from the shearing mechanism directly onto a water-

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NOTE:
1. USE FORKLIFT FOR HANDLING CONTAINERS.

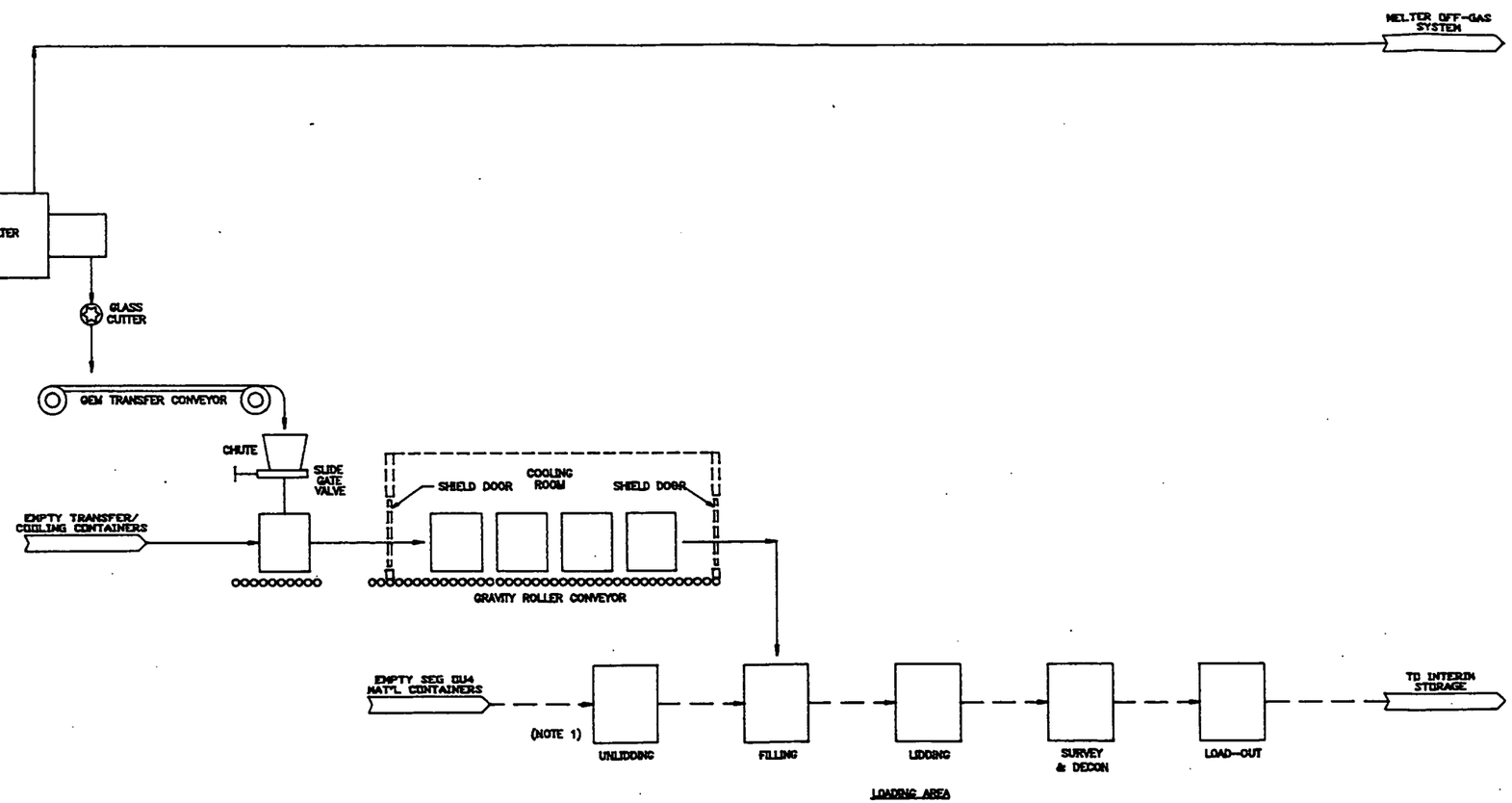

FIGURE 3.2-3

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FERMCO
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION
CINCINNATI, OHIO

FERNALD RESIDUES VITRIFICATION PLANT

PROCESS FLOW DIAGRAM
GEM PRODUCTION
25 METRIC TON/DAY
VITRIFICATION

J.DIAZ	3-13-98	J.THOMPSON	3-13-98		
GU4			NONE		
04424331		SK-3078	1	A	

ACAD

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cooled conveyor belt. The gobs cool on the belt to form nonspherical gems. Gems have the similar shape to that of wafer cookies. They are flat on the bottom with a rounded circular edge and a convex top and approximately 1-2 cm in diameter and 0.5 - 1 cm thick. The shearing mechanism can be adjusted to change the gob size and subsequently the size of the gems. Gem size is not a critical parameter and can vary during actual production.

Gems falling onto the conveyor are kept separate until they have cooled sufficiently so as not to stick to adjacent gems. Gems are then discharged from the belt conveyor into gem transfer containers (GTC). Filled GTCs are transferred to the cooling room via a roller conveyor for further cooling. After the gems have cooled sufficiently, they are ready for transfer into a shipping container. Two GTCs are moved to the loading room via monorail hoist and emptied into a DOT-approved shipping container. After installation of the lid and inspection, the container is transferred to an interim storage pad by forklift to await transportation to the NTS for disposal.

Balance of Plant: The reference vitrification facility design is for a 25-tonne per day joule-heated melter, producing series "A" glass gems. The required modifications to the reference facility are minimal for the series "D" glass. The melter footprint for the series "D" glass will be smaller; however, impacts to the reference facility are not obvious until a layout optimization can be performed. Figure 3.2-4 illustrates the plant layout and is discussed in the following paragraphs.

Characteristic of the reference plant layout, those functions performing confinement and mitigation functions (relating to probable accident scenarios) would be included in the process facility (at the preliminary design stage). Process functions performed inside the main facility include glass melting, glass forming, cooling and packaging, heating, ventilating, and air-conditioning (HVAC), and off-gas systems. Support functions inside the process facility include laboratory and health physics. Functions that can be performed outside of the process facility have been configured in a technically feasible and economic manner. These functions include melter feed preparation, glass former system, change house, and vitrification control room. The radon removal system is in a separate enclosure.

Minimal facility modifications are required for inclusion of Silo 3 residues to the vitrification process. Equipment to support the addition includes a holding bin (vented), HEPA filters, load cell system, rotary feeders, control system modifications, and associated facility space. Most of this equipment is located in the melter feed preparation area (details not shown on drawing).

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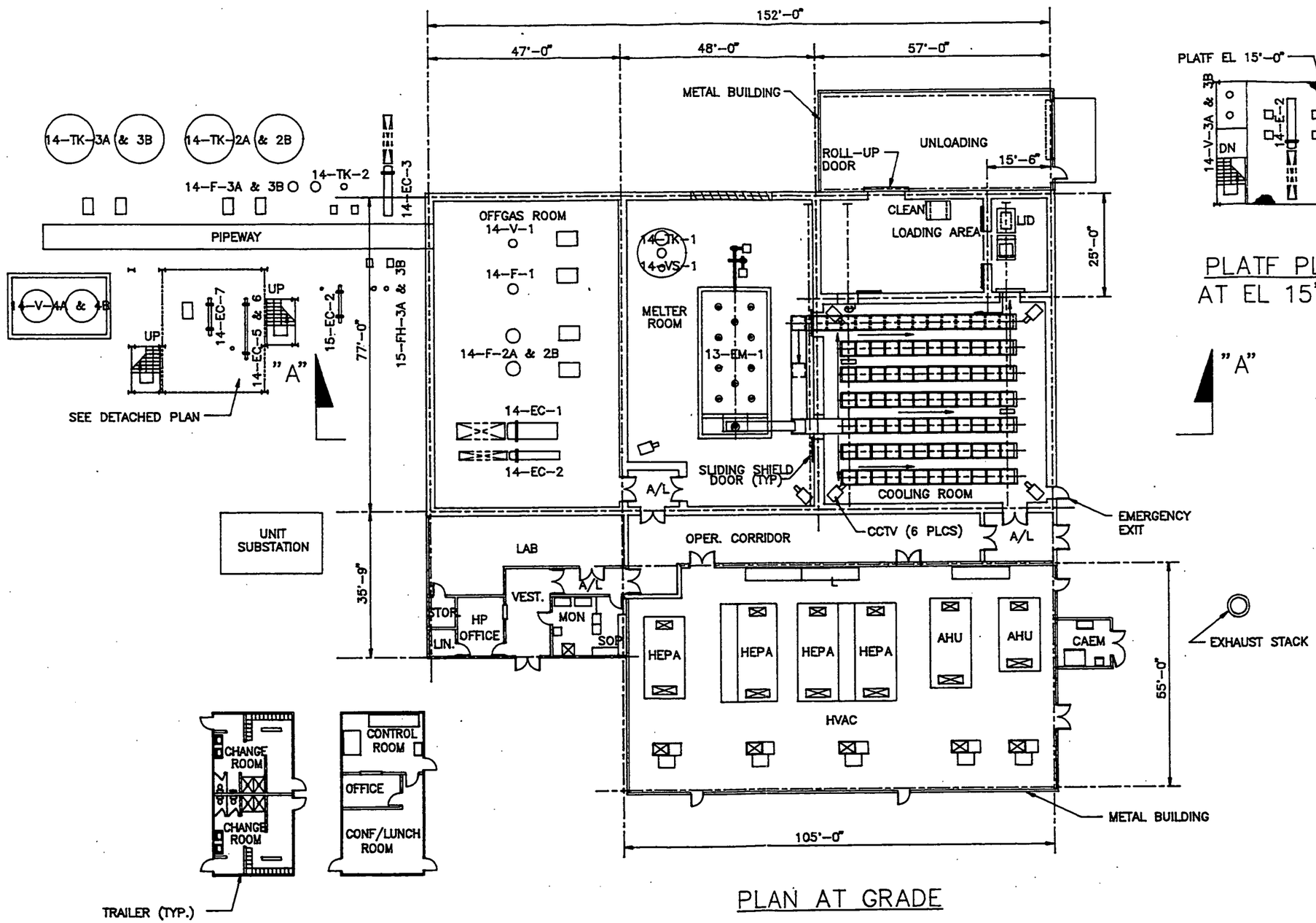

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NOTES:

1. BUILDING CONSTRUCTION
   - CONCRETE FLOOR SLAB AND FOUNDATIONS
   - STEEL FRAME STRUCTURE
   - INSULATED METAL SIDING
   - MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD
   - CONCRETE SHIELDING ONLY AS NOTED
2. GTC = GEM TRANSFER CONTAINER

FIGURE 3.2-4
SH. 1

SL03ALT1

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CINCINNATI, OHIO

FERNALD RESIDUES VITRIFICATION PLANT

FRVP
SILO 3 ALTERNATIVE
PLAN DRAWING

J. THOMPSON | S.SHARP | 0U4 | 3/32" = 1'-0"

04424331 | SK-7019 | 1 | A

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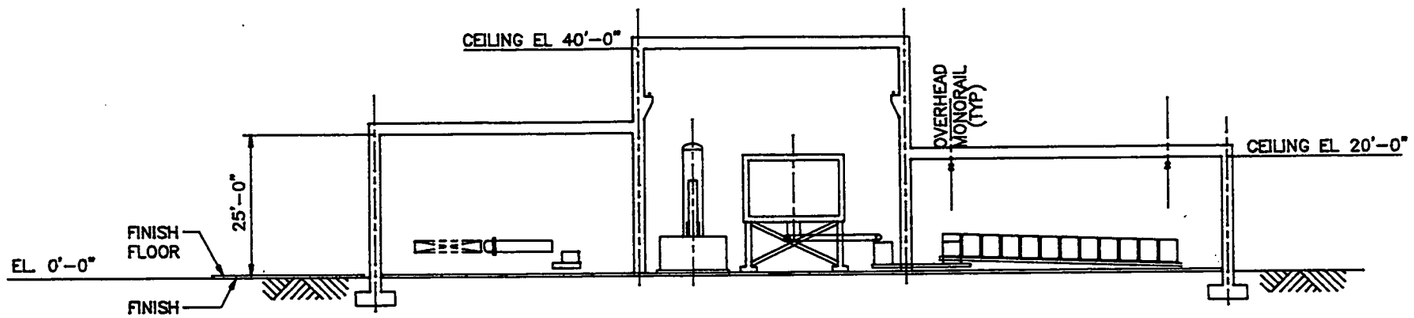

VITRIFICATION BUILDING SECTION "A"-"A"

LOOKING NORTH

NOTES:

1. BUILDING CONSTRUCTION
   - CONCRETE FLOOR SLAB AND FOUNDATIONS
   - STEEL FRAME STRUCTURE
   - INSULATED METAL SIDING
   - MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD
   - CONCRETE SHIELDING ONLY AS NOTED

FIGURE 3.2-4
SH. 2

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GRAPHIC SCALE 3/32" = 1'-0"

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FERNALD RESIDUES VITRIFICATION PLANT

FRVP
SILO 3 ALTERNATIVE
SECTION

J. THOMPSON | S.SHARP | OU4 | 3/32" = 1'-0"

04424331 | SK-7020 | 1 | A

AGAD

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3.2.1.3 Off-site Disposal

Off-site disposal for this alternative involves the packaging, loading, and shipping of the glass to the low-level radioactive waste disposal site at the NTS. Treated residue may be staged or placed into interim storage at the FEMP site as required to accommodate interruptions in the availability of transportation or disposal capacity.

3.2.2 Overall Protection of Human Health and the Environment

Alternative VIT meets the remedial action objectives for Silo 3 residues identified in the OU4 Feasibility Study (DOE 1994a). Stabilization by vitrification prevents direct contact by humans with residue and mitigates the migration of contaminants to the air, soil, and groundwater. This is accomplished by two components: treatment and off-site disposal.

Treatment of the Silo 3 residues through vitrification would reduce contaminant toxicity, mobility, and volume. Vitrification of the residues prior to disposal would provide additional protection in the event the off-site disposal facility were to degrade. The added benefit of treatment for Silo 3 residues is less than for Silos 1 and 2 residues because the material has been previously calcined, and the leachability from the material is less; however, its mobility through air dispersion is reduced. Additionally, the radionuclide content of the Silo 3 residues is significantly different (see Section 1.4.3) and does not require the same reduction of mobility for radon as Silos 1 and 2 residues.

The removal of the contaminants and their disposal off-site provides the final element of protectiveness for this alternative. The NTS disposal facility is located in a sparsely populated, arid environment with a low potential for leachate generation, contaminant release, migration, and direct contact with contaminants. The long-term effectiveness of the necessary institutional controls at the NTS disposal facility is believed to be very reliable.

Because NTS is maintained by DOE and used for the disposal of selected low level wastes from other DOE sites, the uncertainties associated with institutional controls are low. Further, the climatic (low average annual precipitation) and hydrologic (depths to groundwater ranging from 157 to 600 meters [515 to 2,000 ft] below ground surface) characteristics would tend to mitigate impacts to human health and the environment in the event that engineering and institutional controls fail.

Risk with off-site disposal of the vitrified product is associated with transportation accidents. Radiation exposure to workers and the public as a result of the transportation is expected to be low.

3.2.3 Compliance with Applicable or Relevant and Appropriate Requirements

Onsite vitrification followed by off-site disposal at the NTS, heretofore identified as Alternative VIT, would comply with all pertinent ARARs and TBC criteria previously identified and approved in Appendix B of the OU4 ROD (DOE 1994c). Only applicable requirements pertain to off-site portions of alternatives selected. In cases where relevant and appropriate requirements or TBC criteria are identified for activities under this alternative, the referenced citation pertains only to that portion of the activity conducted on site. These ARARs and TBCs are presented in Appendix A of this document. Compliance with the key chemical-, location-, and action-specific ARARs and TBCs presented in Appendix A for this alternative is discussed below.

Chemical-Specific ARARs and TBCs

Alternative VIT would comply with all pertinent chemical-specific ARARs identified in Appendix A for this alternative. All wastewater generated during operation of the vitrification plant would be directed to the FEMP Advanced Wastewater Treatment (AWWT) facility for treatment prior to release to receiving waters. Because the AWWT facility would be subject to the National Pollutant Discharge Elimination System (NPDES) permit issued by the State of Ohio under the Clean Water Act (CWA), any contaminants in this waste stream would be removed or treated to acceptable levels prior to discharge. The Ohio Water Quality Standards for a receiving surface water [Ohio Administrative Code (OAC) 3745-1-07] for a warm water aquatic life habitat would also be attained by this treatment. Restrictions on uncontrolled discharges to surface water bodies would be met through engineered controls, and through procedures such as Best Management Practices (BMPs).

The Clean Air Act (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) program established a radon flux rate standard for radium-bearing material. The maximum permissible surface release rate of radon-222, as specified in 40 CFR § 61 Subpart Q, is 20 picocuries per square meter per second (pCi/m^2-s), averaged over the entire source during periods of storage and disposal. This ARAR is applicable to the silos, as well as to the interim storage of vitrified material prior to, and following treatment of the Silo 3 residues. It is not an ARAR nor TBC for actual operation of the vitrification facility. Monitoring to ensure compliance with the release limits of this ARAR will be conducted at the interim storage facility used to store vitrified material prior to shipment to the NTS.

Although applicable to the silos, EPA and DOE entered into a Federal Facilities Agreement (FFA) on November 14, 1991, which acknowledged that the K-65 silos were exceeding the standard and

required a removal action to be conducted on Silos 1 and 2 to maintain compliance with the standard. The removal action was completed as required. In accordance with the terms of the FFA, demonstration of compliance with the standard at the silos is not required prior to remediation; however, compliance must be demonstrated when final remediation of OU4 is complete. Following removal and vitrification of the silo residues, the K-65 silos and Silo 3 will meet this requirement.

Requirements for the control of other radionuclide releases to the atmosphere are established in the CAA NESHAP program under 40 CFR § 61 Subpart H and DOE Order 5400.5, Chapter III. The NESHAP standard sets a maximum annual dose rate of 10 mrem to any member of the public, measured as an effective dose equivalent. The atmospheric release of radionuclides (including radon) will be controlled through engineered features of the vitrification facility during treatment, and will be essentially eliminated after treatment due to the nonporous vitrified waste form.

It should be noted that standards associated with meeting Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) would not be ARARs for this alternative since the source of the silo residues would be removed to an off-site disposal facility following treatment.

Location-Specific ARARs and TBCs

Location-specific requirements associated with Alternative VIT relate to the protection of three principal natural features or resources: floodplains, wetlands, and endangered species. Restrictions on activities conducted in floodplain areas are specified in 10 CFR § 1022. Compliance with these requirements would be met through appropriate planning, siting, design, and operational procedures. Restrictions on activities conducted in wetland areas are also presented in 10 CFR § 1022. In accordance with these requirements, steps would be taken to avoid wetland impacts to the maximum extent practicable. If avoidance is not practicable, based on the setback requirements and geomorphology, steps would be taken to minimize wetland impacts. Compensatory mitigation of wetland impacts would be determined using the 404(b)(1) guidelines of the CWA in consultation with the Corps of Engineers, EPA, and OEPA.

Protection of endangered species is mandated by 50 CFR § 402. Studies have been conducted to determine the extent of potential habitat of federally- and state-listed animal and plant species as well as any areas of archeological significance in relation to the location of the vitrification facility. If any

habitat or cultural artifacts or human remains are found, appropriate mitigative measures would be taken. This alternative would, therefore, comply with these identified location-specific requirements.

Action-Specific ARARs and TBCs

Alternative VIT would comply with all pertinent action-specific ARARs identified in Appendix A for this alternative. A NEPA supplement analysis evaluation would be performed prior to implementing specific remedial actions as required under 10 CFR § 1021.2. The design of the vitrification facility would include engineered features that satisfy the requirements of the CWA for BMPs (40 CFR § 125.100 and 125.104) and for discharge of stormwater runoff (40 CFR § 122.26). Engineering design and controls would also be used to attain compliance with the Ohio Water Quality Standards (OAC 3745-1-07) and RCRA Subtitle C for hazardous waste facilities. Construction and operational requirements for treatment and storage facilities, such as those specified in 40 CFR § 264 Subparts B, C, and D would also be complied with through design, planning, and the implementation of appropriate procedures. 40 CFR § 264 Subpart G requires facility closure in a manner that minimizes the release of hazardous constituents. Compliance with these RCRA requirements is met with the incorporation of the appropriate design features. Remediation waste generated during cleanup operations would be managed in accordance with the substantive RCRA storage and closure requirements for containers (40 CFR § 264 Subpart I) and tank systems (40 CFR § 264 Subpart J).

Use of a CAMU at a RCRA treatment, storage, or disposal facility (TSDF) for remedial activities is allowed by the EPA under 40 CFR § 264 Subpart S. The provisions of the CAMU regulation are designed to facilitate management of remediation wastes. Remediation wastes include both solid and hazardous wastes, as well as media and debris that may be contaminated with a hazardous waste. DOE-FN does not intend to invoke the CAMU ARAR for the management of the residues from the Silos. Use of the CAMU would be relevant and appropriate for management of soil and debris waste from remediation and D&D activities for disposal in the OSDF.

The provisions of 40 CFR § 264 Subpart S also allow for the use of temporary units (TUs) for the treatment or storage of remediation waste to provide additional flexibility during the process of remediation. Designated TUs would be either tanks or containers, and would be operated under this provision for a one-year time period (subject to a one-year extension). Management of the remediation wastes in the TUs would be in accordance with all pertinent ARARs and TBCs, including compliance with the substantive RCRA requirements for hazardous waste tanks and containers (40 CFR § Subparts I and J) as necessary to ensure protection of human health and the environment.

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During implementation of the remedial action (including facility construction and waste treatment), appropriate engineered features would be implemented to comply with the State of Ohio requirements for fugitive dust control (OAC 3745-17-08), the control of emissions of particulates (OAC 3745-17-07 and 3745-17-11), and the prevention of air pollution nuisance (OAC 3745-15-07).

Off-site disposition would require shipment of materials. Hazardous material transport requirements would be complied with by following the pertinent regulations under 40 CFR § 262 and 263, and the appropriate DOT shipping requirements under 49 CFR Subchapter C Hazardous Materials Regulations.

3.2.4 Long-term Effectiveness and Permanence

Magnitude of Residual Risks

The implementation of this alternative would reduce the residual risk to viable receptors to a hazard index (HI) of less than 0.2 and an incremental lifetime cancer risk (ILCR) of less than 10^{-6} (DOE 1994a). Because all of the material is removed from the site, there is no residual risk at the FEMP site. Residual risk at the NTS is limited by the facility institutional controls, the characteristics of the vitrified materials, and the arid climate.

Adequacy and Reliability of Controls

Vitrification is a proven production technology that is just now being innovatively applied to the stabilization of radioactive residues at the same scale as contemplated under this alternative. Over the period 1989 to 1993, the FEMP site has conducted a series of bench-scale treatability tests to examine the performance of vitrification technology on silo residues (including Silo 3 residues). The tests have repeatedly demonstrated consistent reductions in the leachability of both radionuclides and inorganic compounds. An ongoing glass optimization program for the silo residues has identified a relatively wide envelope of operating parameters (temperature, additive rate, and residue composition) under which the vitrification system could perform to produce an acceptable product. Additionally, the use of vitrification provides added operational flexibility to recycle glass product not meeting performance-based requirements through the glass melter. On this basis, there is a high probability that the vitrification treatment system would retain the required glass product performance requirements for silo residues.

Off-site disposal at the NTS has enhanced reliability because the facility is currently used by DOE for low level radioactive waste disposal. The institutional controls and potential for adequate facility

maintenance are likely to be reliable at the NTS. Additionally, if there is a release at the NTS, the climate, hydrologic conditions, and geologic characteristics would considerably reduce the potential for contaminant migration. The low population density would also reduce the potential for direct contact in the event of disposal facility failure.

Long-term Environmental Impacts

Long-term environmental impacts associated with off-site disposal of the treated residues at the NTS are presented in the following sections.

Soil and Geology

Approximately 5.0 ha (12.4 acres) of soil at the NTS would be permanently disturbed for the disposal of Silo 1 and 2 residues. If this alternative is implemented (Silo 3 residues are blended with Silos 1 and 2), approximately 0.8 ha (1.8 acres) of additional soil at the NTS would be permanently disturbed (based on the ratio of glass volumes from Table 3.2-2). Borrow material from the NTS may be required to accommodate disposal at the NTS. The geology of the NTS has been determined to be suitable for disposal of low level radioactive waste (LLRW) (DOE 1991). The NTS is characterized by great depths to the groundwater table. As stated previously, depths to groundwater beneath the NTS vary from about 155 m (515 ft) to more than 600 m (2,000 ft) (DOE 1991). Groundwater movement in the saturated and unsaturated zones is very slow and there is an extremely low potential for transport of contaminants to off-site areas. These parameters make the geology of the NTS highly suitable for long-term disposal activities.

Construction of the vitrification treatment facility at the FEMP site would not result in the permanent disruption of any land, as the systems would be constructed exclusively in previous disturbed areas and would be disassembled and removed when vitrification of all Silo 3 residues was complete. The regional geology of the FEMP site and surrounding area would not be affected by implementation of the alternative.

Water Quality and Hydrology

The disposal of treated residues at the NTS under this alternative is not expected to have significant impacts on water quality or hydrology. There are no continuously flowing streams on the NTS. Stream beds carry water only during unusually intense or persistent rains. Rainfall infiltrates quickly into the moisture-deficient soil. These parameters, coupled with very suitable geology, would help

minimize long-term impacts to water quality. Engineered controls (capping) and ongoing monitoring activities would also be used to control and minimize water quality impacts.

The vitrification treatment system would not have any effects on surface or subsurface water quality at the FEMP. During processing, containment measures would be employed to prevent the release of waste material to the environment. No wastewater effluent streams are anticipated to be produced by the operation of the vitrification treatment system. Wastewater generated during the course of processing would consist primarily of rinse water that would be collected and recycled back into the vitrification system.

Air Quality

Following implementation of this alternative, the air quality at the NTS site would be similar to current conditions. There would be no long-term impacts on air because the glass waste form and the cover system on the disposal facility would prevent radon emissions and because disturbed areas would be revegetated.

Following implementation of this alternative, the air quality at the FEMP site would be similar to current conditions. There would be no long-term effects on air quality because all of the Silo 3 residues would be removed from the silo, vitrified, and transported off-site. Disturbed areas created during construction of the vitrification treatment facility would be revegetated, to minimize release of fugitive dust and other particulates.

Biotic Resources

Most of the NTS is vegetated by various desert shrubs. There are 711 types of vascular plants within or near the boundaries of the NTS (DOE 1991). Several mammal species on the NTS (e.g., feral horses, burros, kit foxes) have been placed on the protected classification list by the State of Nevada. The desert tortoise (Gopherus agassizii) is federally listed as a threatened species and is present in some of the areas of the NTS. The disposal activities at the NTS related to this alternative are not expected to impact the habitat of the desert tortoise or displace any other species at the NTS.

Wetlands and Flood plains

No wetland areas have been delineated at the NTS (DOE 1991). In addition, no floodplain areas are located near the disposal areas of the NTS.

Socioeconomics and Land Use

The NTS encompasses about 3,500 km^2 (1,350 mi^2), an area larger than the State of Rhode Island. Since 1951, primary land use on the NTS has been nuclear weapons testing and low level radioactive waste disposal for onsite and off-site DOE-affiliated generators. The NTS is surrounded on the east, north, and west sides by public access exclusion zones (e.g., Nellis Air Force Base Bombing and Gunnery Range). This area provides a buffer zone between the test areas and public lands of 24 to 105 km (15 to 65 mi). The population density within a 150-km (93-mi) radius of the NTS is about 2.8 persons per km^2 (7.2 per mi^2). In comparison, the 48 contiguous states (1990 census) had a population density of approximately 29 persons per km^2 (75 per mi^2). The off-site areas adjacent to the NTS are predominantly rural; hence, aesthetic impacts would not be expected to change. Hence, treated material disposal activities (associated with this alternative) would not impact socioeconomics or land use at the NTS.

Cultural Resources

A sitewide archaeological survey would be performed for the areas to be impacted by this alternative. Any areas determined to be of significance from a cultural resources standpoint would be managed consistently with the requirements of National Historic Preservation Act (NHPA), State Historic Preservation Office, American Indian Religious Freedom Act (AIRFA), Native American Graves Protection and Repatriation Act (NAGPRA). Because any cultural resources identified would either be avoided or managed appropriately, there would be no impacts to cultural resources at the FEMP site. Archaeological sites have been surveyed and inventoried at the NTS and current disposal activities are avoided in those areas.

3.2.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

The reference case (series "A" glass) vitrification process treats all of the residues making up the contents of Silos 1 and 2, as well as the sludge in the decant sump tank. A remedy selection treatability study was conducted with OU4 residues to compare the performance of vitrification to other remediation technologies. The criteria upon which this comparison was based were the leachability of the glass form, the material volume reduction achieved, and the reduction in radon emanation from the material (Appendix C, Section C.3.0, Operable unit 4 Feasibility Study [DOE 1994a]).

Vitrification reduces contaminant mobility and volume of silo residues. Data from the treatability study reveals that significant volume reductions could be achieved through vitrification of all silo

residues. The Feasibility Study indicates that the reduction in volume of Silo 1 and 2 residues ranged from 50 to 68 percent, while for Silo 3 residues it was approximately 62 percent. The reduction in volume of Silo 3 residue is based on the thermal destruction of sulfates, phosphates, nitrates, and carbonates. There is also a reduction in volume due to a closer packing arrangement of the inorganics, including radionuclide material in a glass matrix, as opposed to the "particle-void-particle" arrangement of the residue in its present form. Based on data from the PNL glass composition development studies, final volume reduction for silo residue (series "D" glass) is expected to be on the order of 50 percent. Since the mobility of the radionuclide would be reduced the toxicity would also be reduced.

The chemical and physical properties of Silo 3 residues were determined and used in developing glass formulas for the bench-scale treatability study tests. Data from the study revealed that the radon emanation rate from the vitrified Silo 3 residues was below detection limits, far less than the EPA limit of 20 $pCi/m^2/s$ for radon emanation from uranium mill tailings (Silo 1 and 2 vitrified residues ranged from 0.01 to 0.06 $pCi/m^2/s$, more than two orders of magnitude less than the EPA limit). The measured radon emanation rate from the treated residues is approximately equal to the emanation rate from natural building materials such as brick and concrete, though the radium content is one thousand to one million times greater than that of natural building materials.

The results from the TCLP testing (VSL glass composition development studies) showed that the vitrified residue material for the series "D" glass did not exceed RCRA regulatory limits for applicable metals. Thus, the comparison of TCLP test results (through the leachate concentration) for the treated residues to the untreated residues demonstrates the effectiveness of vitrification as a treatment process for all silo residues. Leachate concentrations were below RCRA TC regulatory limits for glasses produced in the VSL glass composition development studies (the reference series "A" and series "D" glass). Table C.3-18 of the OU4 Feasibility Study (DOE 1994a) contains a comparison of the leachate activity from the untreated residues to the leachate activity from the vitrified residues. Treatability tests demonstrate that the vitrified product effectively immobilizes the RCRA constituents and reduces their release to levels less than the regulatory limits.

For the Silo 3 residues, the ratio of activity in the leachate of the untreated residue to that in the vitrified residue was less than that of Silos 1 and 2 residues. A wide variation in leaching of the various radionuclides achieved through vitrification was observed. The low ratios of the activity observed in the leachate from the untreated residue compared to the activity in the leachate from the

vitrified residue do not necessarily indicate that radionuclides are immobilized. Instead, the ratios show that some radionuclides are not leached as readily as others from the untreated residue. For example, while nearly 0.87 percent of the Ra-226 in the Silo 3 residues is leached from the untreated residue, only 0.0003 percent of the Th-230 is leached. Such differences can arise because of differences in solubility among the various elements at the conditions encountered in the leachate.

The normalized leach rates indicated that all glass formulas exhibited exceptional durability, comparable to glasses developed from vitrified high-level wastes. For discussion purposes only, the normalized leach rates were compared to the Defense Waste Processing Facility (a standard representing the maximum acceptable leach rate for high-level waste glasses) (Jantzen et al. 1992) and were found to be an order of magnitude less. Also, the rates are comparable to those measured for simulated high-level waste glasses (Piepel *et al.* 1989).

Another observation of the treatability tests was that the TCLP appears to leach constituents from the glass more aggressively than the product consistency test (PCT). The difference between the acid conditions of the TCLP and the neutral conditions of the PCT are likely the cause of the higher leaching rates observed in TCLP. The PCT leach testing demonstrated a high degree of durability for the vitrified OU4 residues.

Literature data on the leachability of the vitrified product from a variety of waste types indicate similar leach resistance; all vitrified residues tested to date have passed the RCRA TCLP test. Contaminant release from a vitrified product is controlled by diffusion and is governed by the same factors that affect release from a chemically stabilized/solidified product. The leachability of the vitrified product could be impacted by the development of immiscible phases in the melt because of the variable chemical composition of the residues; however, the short residence time in the melter would minimize the potential for immiscible phase development.

The weathering behavior of volcanic glass (a natural analog to the vitrified product) can provide some measure of the long-term stability and durability of the vitrified product. Only very thin weathering rinds develop on volcanic glass over a period of several million years. The slowness in the overall degradation of a glass grain suggests that the diffusion coefficient or leachability index would remain unchanged over time. Data on the long-term stability of vitrified residues are not available, and the life expectancy of the vitrified product is difficult to estimate from short-term leach rates. On the

basis of the longevity of volcanic glass and diffusion calculations, the vitrified product would be expected to withstand environmental exposure for thousands of years.

Treatment residuals of the vitrification process would be produced from the off-gas treatment system. Off-gases containing particulates and other pollutants would be removed and treated using conventional air pollution control equipment such as scrubbers. Changes in scrubber efficiencies could significantly affect the predicted amount of scrubber residuals. Remedial design treatability studies testing the off-gas treatment system would be necessary to adequately reduce the amount of fugitive emissions. Scrubber residuals would be recycled through the vitrification process until all the residuals are contained in the glass matrix. Furthermore, the effects of vitrification as a treatment are essentially irreversible. See Section 3.2.1.2 for the impact to the off-gas system implementing this alternative.

3.2.6 Short-term Effectiveness

Protection of the Community During Remedial Action

Through a combination of engineering controls and access controls, this alternative would be protective of the community during implementation. Direct emissions from the untreated residues and gas emissions during treatment are the release mechanisms that could potentially impact the surrounding community during remediation activities. Gas collection and treatment systems operated during vitrification of the residues would control gaseous contaminant releases. It is estimated that during implementation of this alternative, fence line radon exposure levels for the off-site public would be indistinguishable from background levels, less than 0.5 pCi/L (based on analyses performed for the Operable Unit 4 Feasibility Study [DOE 1994a]).

There is a very small risk to the public through transporting the treated residues off-site. The estimate of public radiation exposure, expressed in terms of ILCR, along the route to the NTS is $3x10^{-10}$ for the maximally exposed individual, far below the CERCLA target risk range of $1x10^{-4}$ to $1x10^{-6}$. It is estimated that 0.2 injuries and 0.02 deaths may occur to the public due to transportation accidents. All potential short-term risks to the public are so small that even a major deviation in the assumptions would not change the conclusion that this alternative is effective in protecting the community in the short term. The basis for these estimates is provided in Appendix D of this report.

The disposal of FEMP materials at the NTS for the additional volume of vitrified residues would not be expected to exceed protective levels for the community around NTS over the short term. The

vitrified residues would meet NTS waste acceptance criteria and, therefore, would be managed within the bounds of the NTS facility's protectiveness criteria. The area required for the disposal of the additional vitrified low level waste at the NTS represents only a small fraction of the site. Surveillance systems operated around NTS showed no radiological exposures that could be attributed to site operations in 1991. A hypothetical resident living 73 km (45 mi) west of the NTS would be exposed to a maximum calculated dose of 8.6×10^{-3}mrem. In addition, the collective dose equivalent to the approximately 21,800 residents living within 80 km (50 mi) in 1991 from NTS airborne sources was 4.2×10^{-2} person-rem. All of the dose estimates calculated are much less than one percent of the most restrictive standard (DOE 1991). The additional glass volumes from this alternative would require only 0.8 ha (1.8 acres) of the 1,350 square miles at the NTS. This represents about a 16 percent increase in area requirement for the series "A" glass. Therefore, the disposal of the vitrified blend of silo is not expected to result in increased exposures to the public.

Protection of Workers During Remedial Action

There are no unacceptable risks to workers as a result of implementation of this alternative. This alternative involves the handling of the residues and, therefore, there are several potential exposure pathways for workers. Both the release of gases and exposure to direct radiation from the residue could cause a risk to workers. It has been estimated that, with appropriate protection, the removal and treatment of materials would result in an excess cancer risk level to remediation workers of 1×10^{-5} (see Appendix D), well within the occupational standards required by DOE Orders. Most of this risk would occur during handling of the untreated residue (i.e., during the residue retrieval process). As appropriate, workers would wear protective clothing. Shielding would also be used, along with remote operations where needed.

There are safety issues associated with the vitrification process. The high temperatures and power requirements of vitrification results in potential risk. All remediation activities would be conducted in accordance with a health and safety plan developed to meet 29 CFR § 1910.120(b)(4). Training and procedures would assure that worker exposure would be as low as reasonably achievable (ALARA).

There are additional radiation exposure risks to the worker resulting from transporting the material to the NTS. The excess ILCR is estimated at 8×10^{-4}. The estimate of injuries during remediation activities is 6 injuries and 0.08 deaths. The risk to workers due to radiological exposures during off-loading activities at the NTS is assumed to be below the estimated ILCR risk level of 1×10^{-5} during treatment/construction activities at the FEMP site because the residue would already be packaged and

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in a stabilized form. There is uncertainty for some additional risk due to exposure to wastes already present at the NTS in the vicinity of off-loading operations for FEMP materials.

Short-term Environmental Impacts

The short-term environmental impacts at the FEMP site for vitrification of Silo 3 residues are limited to the land that is disturbed for the preparation of the Silo 3 mechanical/pneumatic removal system. There is no additional short-term impact due to this alternative (the inclusion of the Silo 3 residues to the vitrification process) since land disturbance for the FRVP would already occur. The total area disturbed at the FEMP site for the preparation of Silo 3 residue retrieval facility is 0.02 ha (0.05 acres).

This alternative involves off-site disposal of the treated residue form at the NTS. Short-term environmental impacts for the NTS are discussed below.

Soil and Geology

Soils at the NTS would be disturbed during disposal activities. Appropriate mitigative controls (e.g., cover and grading) would be used at the NTS to control erosion, the off-site transport of residue material, and radon release. Groundwater at the NTS would not be impacted in the short term by disposal of the vitrified residues due to the treated residue form, disposal under a cover system, and depth to groundwater. Ongoing monitoring would identify any unacceptable releases, with maintenance occurring to minimize the potential for release.

Soil disturbance during implementation of this alternative at the FEMP would primarily result from construction of access roads, silo retrieval systems, treatment/packaging facility, packaged waste staging area, and support facilities. Construction and excavation activities could disturb a total of approximately 0.08 ha (0.2 acres) of the site. These same activities could also result in the erosion of exposed soil areas. Erosion controls such as straw bales and berms would be used to minimize potential erosion as necessary. Measures for reducing fugitive dust generation, such as wetting surfaces or using dust suppressants, would be used in exposed soil areas as appropriate. Following completion of all construction and excavation activities, disturbed areas would be filled with clean backfill and topsoil and revegetated with native grasses.

Water Quality and Hydrology

The implementation of this alternative is expected to have minor impacts on the surface water hydrology at the NTS. The NTS lies in an arid region with little rainfall. There are no continuously flowing streams on the NTS.

Through erosion control and dust suppression, contaminants disturbed during remediation at the FEMP would not be transported to adjacent surface water bodies. Surface water near the site would be monitored during remediation in accordance with the existing water discharge permit to assess potential impacts to the water from remediation. Remediation would not increase the release of contaminants to the groundwater since the material would always be contained.

Air Quality

Ambient air quality in areas accessible to the public is regulated by both state and federal standards. There are three potential sources of air emissions: 1) dust from construction and earth-moving activities, 2) airborne particulate and radon releases during treatment, and 3) heavy equipment exhaust. Shipping treated residues for disposal would result in negligible increases in emissions related to vehicle exhaust. Short-term impacts would be negligible.

Fugitive dust would be controlled as discussed above in the soil section. With the appropriate dust suppression, excavation activities are not expected to negatively impact the air quality. The exhaust emissions from heavy construction equipment are also not expected to impact air quality. Airborne particulate and radon emissions would be controlled through both collection and treatment during operations. Therefore, no significant releases into the environment are expected to occur.

Biotic Resources

Disposal activities would disturb portions of the NTS. However, habitat at the NTS in the disposal area is limited (DOE 1991), and little displacement of species would occur.

The areas where stabilization treatment activities would take place are previously industrialized, and do not provide habitat for threatened or endangered species. Therefore, the short-term disturbance of land under this alternative is not anticipated to impact biotic resources.

There also is the potential for impact to biota from contaminant releases such as through erosion, dust emissions, gas releases, and direct radiation. As discussed in previous short-term effectiveness

discussions, the releases would be minimized through engineering controls such as erosion control, dust suppression, and airborne effluent collection and treatment. There should be no negative impact on biota during implementation of this alternative.

Wetlands and Floodplains

No wetland or floodplain areas exist at the NTS (DOE 1991). A FEMP sitewide wetlands delineation identified several areas of wetlands adjacent to planned location for Silo 3 residues treatment facilities. Wetlands north and south of the material treatment facility would not be expected to be affected. Engineering controls implemented as needed during site activities, such as silt fences and straw bales, would control the migration of eroded soil to wetland areas.

The 100- and 500-year Paddys Run floodplains are located immediately west of Silo 3. This alternative activities are not planned to occur within the floodplains, and contaminant migration during remediation would be controlled through engineered erosion controls to minimize impacts on the floodplains.

Socioeconomics and Land Use

Short-term disposal activities for this alternative would not impact socioeconomics at the NTS. The implementation of this alternative would have minimal short-term impacts on socioeconomic and land use at and around the FEMP site.

It is assumed for this analysis that all resources needed for remedial work would be purchased within the consolidated metropolitan statistical area (CMSA) resulting in a minor beneficial impact to the CMSA in the short-term. Furthermore, the removal of the Silo 3 residues would help eliminate any impacts on future population and economic growth in the area.

Transportation

The implementation of this alternative would result in negligible increases in traffic flow on and around the FEMP site. Temporary increases in deliveries and workers to the FEMP site are not expected to result in any significant impact to traffic patterns or roadways.

Treated residues could be transported by trucks to the NTS. Environmental impacts from shipping and disposing of treated residues are expected to be minimal from normal transportation because all procedures would be in compliance with applicable DOT requirements and DOE Orders. However,

added risk to the public from transportation off-site would increase public radiation exposure along the route to the NTS to $2x10^{-10}$, still far below the target range. More information on the risk to workers and the public associated with the transportation of treated residues is addressed in Appendix D of this report.

Duration of Remedial Activities

The duration of remedial activities for the inclusion of Silo 3 residues into the vitrification process is assumed to be completed in approximately 2.7 years (or, approximately 9 months longer than the reference FRVP case). There is more uncertainty in the time estimate since the development and demonstration of the vitrification process, transportation or waste acceptance problems could easily add time to the estimate.

3.2.7 Implementability

Technical Feasibility

Construction and operation of the removal component of for Silo 3 residues would be readily implementable. Mechanical/pneumatic removal is a standard technology that is normally reliable and readily available. Mechanical/pneumatic transfer was used to fill Silo 3 with the cold metal oxides, and it has been used to remove material(s) of similar consistency.

Currently, a degree of uncertainty exists with respect to residue from characterization of silo residues. Early elemental analysis (e.g., spectroscopic) of silo samples provided the basis for glass formulations used in laboratory testing (results of which are the basis of melter sizing, process control of glass chemistry, etc.). This analysis provided mass accounts of elements present in the samples, but provided no information about the chemical structure (i.e., a metal oxide, sulfate, nitrate, or carbonate). Hence, assumptions were made in the laboratory during the development of surrogate glass forms, and these assumptions served to influence test results (e.g., processing rates, method of sulfate reduction). Further investigation and development is required to determine the impact these assumptions have on glass process chemistry and melter control for the series "A" and series "D" glass formulations (see discussion in Section 1.4.2).

From the results of VSL, blending the Silo 3 cold metal oxides with Silo 1 and 2 residues is advantageous from a glass processing point of view (see discussion in Section 1.4.2). The reference series "A" glass exhibits less desirable processing characteristics than the alternate series "D" glass. For example, since the viscosity of the series "D" glass is lower than the series "A" glass (at the

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given melter operating temperature of 1,250 °C), the series "D" glass can be processed at a faster rate than the series "A" reference glass. This impact is favorable for this alternative for two of reasons: (1) it imparts more desirable glass processing characteristics for glassmaking, and (2) it allows designers to reduce the size of the melter.

The technical feasibility of the vitrification process is expected to be moderately straightforward, but a full-scale system for vitrifying this specific waste form has never been built and remains to be demonstrated. The vitrification technology requires engineering scale-up prior to full-scale implementation at OU4; however, this effort will take advantage of FERMCO and VSL testing and pilot testing. Detailed design, fabrication, installation, start-up, and some period of full-scale operation would likely be needed to optimize the treatment process.

The vitrification system consists of five basic systems: a feed preparation system, a melter system, a melter off-gas treatment system, a glass manufacturing system, and the balance-of-plant systems. Joule-heated ceramic melters have been used to vitrify liquid high-level radioactive material, radioactively-contaminated soil, and waste contaminated with heavy metals in quantities ranging from 4.5 to 410 metric tonnes/day (5 to 450 tonnes/day). Hence, a high degree of assurance exists for melter operations, and several vendors have been identified for the vitrification technology. However, the feed preparation system, melter process control, and the melter off-gas treatment system are unique to the residue characteristics at Fernald and remain to be demonstrated.

Implementation of this treatment alternative relies on existing personnel at the reference vitrification facility. Hence, no additional personnel are required. Start-up of the reference vitrification facility is estimated to require at least four months.

Potential operational problems in the melter system include temperature variation, incomplete melting, immiscible phase development, and thermocouple or heat sensor failure. Refractory failure would not be anticipated to be a problem because the design life of the melter operation is less than the design life of the refractory at the operating temperatures. Temperature variation and improper control could result in the incomplete melting of feed material. Temperature fluctuations could also cause phase immiscibility. The use of electricity in the joule-heated melter allows for almost immediate control over melt temperatures and thus would aid in controlling variability in melt viscosity and phase immiscibility. The capability to recycle unacceptable glass will be provided.

Temperatures within the system would be continuously monitored by thermocouples and heat detectors. These thermocouples would probably be prone to failure at the high operating temperature of the melter, necessitating the placement of redundant thermocouples at critical locations in the system and routine replacement and repair as part of maintenance activities. Any product from the vitrification system that was incompletely melted or contained immiscible phases would be returned to the facility and recycled.

The reliability of the melter system for residue treatment is not well established because this system has not yet been implemented at full-scale or continuous operation. Similar melting systems used in commercial glassmaking report a 90 percent total operating efficiency. The economics of this alternative are based on a 75 percent total operating efficiency. The effectiveness of the vitrification process would be monitored by regular testing of the treated product. If a sample fails the leachability criteria, additional samples would be collected, tested, and analyzed to determine the cause of the problem. The failed treated residues would be recycled.

The off-gas treatment system would use standard air pollution treatment and control devices. Although the capabilities of the individual off-gas treatment devices are known and well demonstrated, the effects are less well known with regard to linking multiple treatment devices together to treat the off-gas expected from vitrification of the silo contents.

Technical uncertainties regarding the production of NO_x in the melter and the ability of the scrubbing devices in the off-gas system to remove NO_x lead to off-gas system design uncertainties. It has been established that the prevalent NO_x specie produced in the melter is nitric oxide, (NO). If the Silo 3 residues are processed in the FRVP with K-65 residues, it will be necessary to remove NO from the off-gas by selective catalytic reduction (SCR) to meet regulatory standards. The processing of only K-65 residues will not require an SCR unit in the off-gas system. The uncertainties associated with this system are: 1) The addition of urea to the melter at VSL has apparently lead to the conversion of NO_x to N_2 and O_2. (This reaction has not been thoroughly substantiated.); and 2) The off-gas system material balance for NO removal by scrubbing has yet been completed. Therefore, the quantity of NO_x which could ultimately be an emission from the FRVP has not been established for both the Silos 1 and 2 residues (only) and the Silos 1, 2, and 3 residues cases. The cost of an SCR unit is included in the capital cost estimates for both cases.

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The implementation of this alternative would not adversely impact the performance of additional remedial actions at the FEMP site since it is limited to the OU4 and adjacent areas.

The technical feasibility of off-site transport and disposal at the NTS is straightforward and reliable. Off-site transport of the treated residues to the NTS would consist of truck transport from the FEMP site to the NTS. The treated residues would be placed in appropriate containers that meet transportation and disposal requirements.

Administrative Feasibility

The substantive technical requirements of air emissions permits would need to be demonstrated for both the reference and the modified vitrification process. This may include calculating estimated emissions, providing air emissions controls, developing a sampling and analysis plan to monitor air emissions, and air sampling.

NTS is a DOE-owned facility; thus, no special permits would be required. This alternative would require agency approvals and coordination for the interstate shipment of the material. Many states require advance notification or permitting for shipments of radioactive material entering their state. All material shipments would be required to meet applicable federal and state regulations. The public and regulatory agencies from the states located within the transportation route from FEMP to the NTS may oppose transport; thus, some coordination would be required to obtain these approvals.

Availability of Services and Materials

The construction activities involved in this alternative include the building, mechanical/pneumatic removal equipment, clearing, grubbing and excavation of areas around the silos, and construction of access roads, fencing, lighting, water, and electrical services.

The construction of the mechanical/pneumatic removal equipment would involve the purchase of materials and services which are standard in the construction industry. The clearing, grubbing and excavation, and construction of roads, fencing, lighting, and electrical services would involve the use of standard construction equipment and trades, the use of a fence installation contractor, and the purchase of appropriate materials.

In summary, the resources and materials would be readily available. It would be necessary to ensure that EPA, OEPA, and the local community are fully involved in the development of RD/RA work

plans for the modified treatment process. Close coordination with the regulatory agencies and the community prior to and during remedial activities would be essential for successful implementation.

NTS currently accepts low level waste, and it has adequate facilities to accept vitrified material. Transfer areas, storage areas, decontamination facilities, and a laboratory are available on the site. An NTS-approved sampling program would be established to ensure that the treated residues would be tested at the FEMP to verify that it complies with NTS waste acceptance criteria prior to shipment.

Schedule

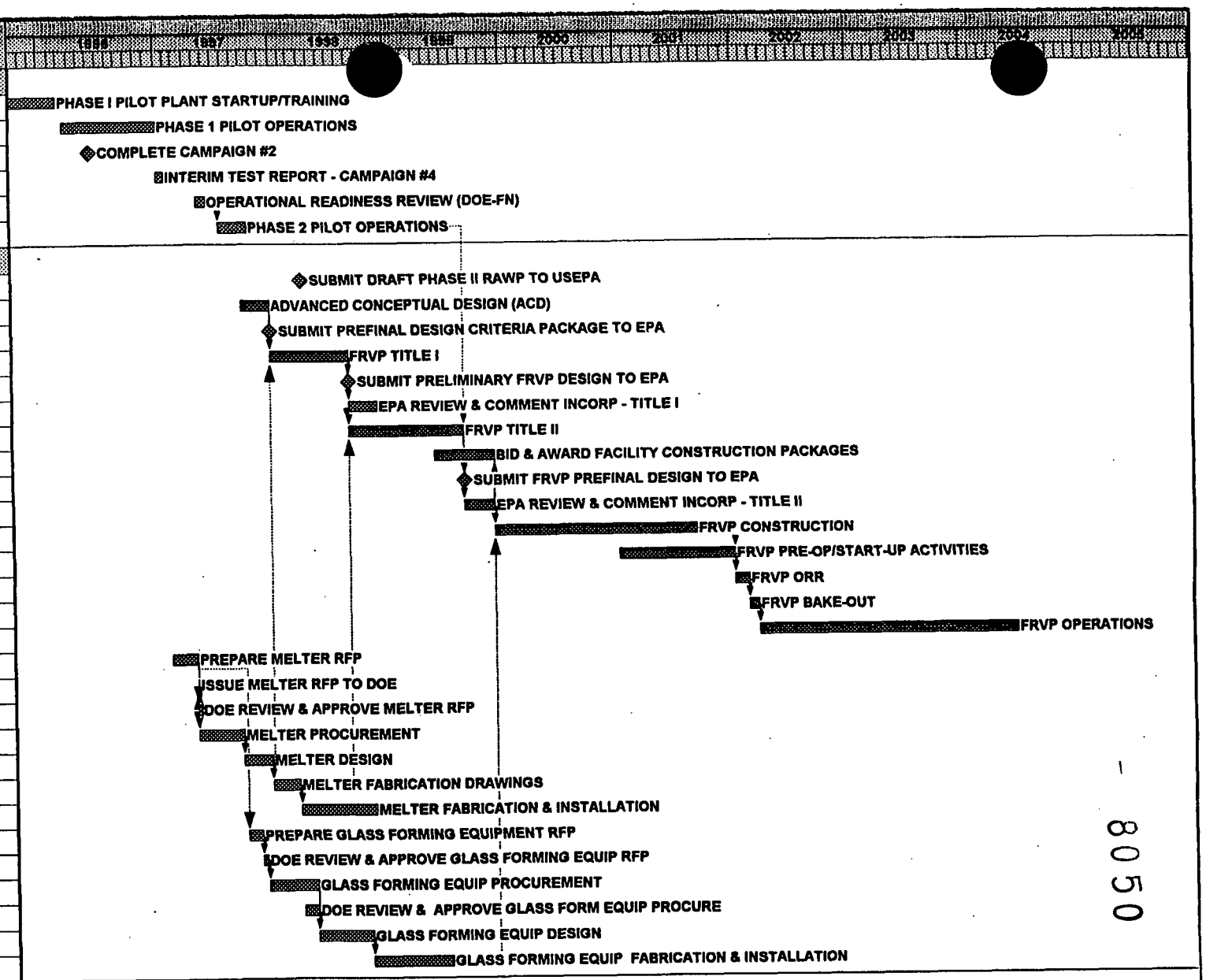
Figure 3.2-5 presents the implementation summary schedule for Alternative VIT. The schedule identifies all the activities, along with their durations and relationships, necessary to successfully implement the schedule. The schedule has been prepared with the assumption that adequate resources are available to support the schedule. Table 3.2-3 itemizes the activities and their durations. It should be noted that the FRVP operations duration is based upon a 24 hr/day, 7 day/week operational period, which has been rounded-up to the nearest month for project planning purposes.

TABLE 3.2-3
SCHEDULE SUMMARY - ALTERNATIVE VIT

ACTIVITY	DURATION (WORK DAYS)
FRVP Title I/II	421
Procurement	130
FRVP Construction	440
FRVP Pre-Op/Start-Up Activities	250
FRVP ORR	30
FRVP Bakeout	30[1]
FRVP Operations	824[1]

[1]Based upon a 24 hr/day, 7 day/week schedule

Activity ID	Orig Dur	Early Start	Early Finish
VITPP PRO			
4AAC5600	J1	02OCT95	28FEB96
4AAC1399	295	21MAR96	09JAN97
4AACM001	0		12JUN96
4AAC8240	15	10JAN97	30JAN97
4AAF0430	22	13MAY97	12JUN97
4AAF0267	90	24JUL97	21OCT97
FRVP PROJECT			
4ACCM020	0		09APR98
4ACCH004	60	01OCT97*	30DEC97
4ACCM017	0		30DEC97
4ACCH000	171	31DEC97	02SEP98
4ACCM018	0		02SEP98
4ACC7R00	63	03SEP98	04DEC98
4ACCH008	250	03SEP98	02SEP99
4ACCH600	130	01JUN99	06DEC99
4ACCM021	0		02SEP99
4ACC7001	63	03SEP99	06DEC99
4ACCH700	440	07DEC99	07SEP01
4ACCH500	250	08JAN01	07JAN02
4ACC8000	30	08JAN02	19FEB02
4ACC8100	30	20FEB02	21MAR02
4ACCH200	824	22MAR02	22JUN04
4ACCH031	52	14FEB97	30APR97
4ACC5002	1	01MAY97	01MAY97
4ACC5034	10	01MAY97	14MAY97
4ACCH005	103	01MAY97	25SEP97
4ACCH011	60	26SEP97	23DEC97
4ACCH006	59	26DEC97	20MAR98
4ACCH010	168	23MAR98	18NOV98
4ACC5118	31	07OCT97	19NOV97
4ACC5121	10	20NOV97	05DEC97
4ACCH100	106	08DEC97	11MAY98
4ACC5127	29	31MAR98	11MAY98
4ACCH101	125	12MAY98	05NOV98
4ACCH102	168	06NOV98	13JUL99



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Project Start	01OCT95
Project Finish	30SEP05
Data Date	01OCT95
Plot Date	24JUN96

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Early Bar
Progress Bar
Critical Activity

CRUB

Sheet 1 of 1

ALTERNATIVE VIT - IMPLEMENTATION SUMMARY SCHEDULE

FIGURE 3.2 -5

Fernald Environmental FERMCO Restoration Management Corporation

3.2.8 Cost

The total life-cycle cost of this alternative is $24.8 million as shown in Table 3.2-4. A detailed breakdown of the life-cycle cost is provided in the following sections.

TABLE 3.2-4

LIFE-CYCLE COSTS - ALTERNATIVE VIT
(Millions)

Case	Capital Cost	Packaging and Certification Cost	Transportation Cost	Disposal Cost	O&M Cost	D&D Cost	Total Life-cycle Costs
Reference	$104.9	$19.2	$ 7.2	$11.9	$24.9	$5.6	$173.7
Modified	$106.5	$26.0	$9.8	$16.1	$34.5	$5.6	$198.5
Difference	$1.6	$6.8	$2.6	$4.2	$ 9.6	$0.0	$24.8

3.2.8.1 Capital Costs

The capital cost associated with the modification of the reference FRVP facility for the inclusion of Silo 3 residue include Silo 3 removal equipment, process equipment additions to the feed preparation system, and the cost savings from melter down sizing (discussed in Section 3.2.1.2). These costs are detailed in Table 3.2-5.

TABLE 3.2-5

CAPITAL COSTS - ALTERNATIVE VIT
(Millions)

Item	Reference Facility	Modified Facility	Difference
Vitrification Facility	$57.4	$57.1	($0.3)
Silo 3 Retrieval	$0.0	$1.2	$1.2
Project & Construction Management	$16.1	$16.3	$0.2
Engineering	$20.7	$21.1	$0.4
Sales Tax	$2.0	$2.0	$0.0
Risk Budget	$8.7	$8.8	$0.1
Total Capital Cost	$104.9	$106.5	$1.6

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3.2.8.2 Operating Costs

The operating costs for the inclusion of Silo 3 residues consist of the following components: packaging, transportation, disposal, and operating and maintenance (O&M) for the extended FRVP duration.

Packaging

Packaging costs include the cost of purchasing the containers and the labor associated with handling and documentation. Estimated costs are based on the following:

- Packagings would be DOT Specification 7A Type A containers with exterior dimensions of approximately 1.4 m (4.5 ft) width by 1.8 m (6 ft) length by 1.5 (5 ft) depth. Interior dimensions would be approximately 1.1 m (3.5 ft) width by 1.5 (5 ft) length by 1.1 m (3.5 ft) depth, providing approximately 1.7 m^3 (61 ft^3) of packaging volume.

- Total payload of each container (including weight of the container) would not exceed a weight of approximately 9,555 kg (21,000 lbs) with an interior volume of approximately 1.7 m^3 (61 ft^3).

- Interstitial void volume for packaging gems assumed to be 30 percent.

- The total volume of vitrified residues is taken from Table 3.2-2.

- Vitrified glass densities for packaging calculations are taken from Table 3.2-2.

- Packaging costs associated with the implementation of this alternative were estimated based on 4,038 containers for the reference vitrification facility and 5,475 containers for the modified facility. Therefore, approximately 1,437 additional containers would be required for shipment to implement this alternative.

- Packages will be produced at a rate of 1,860 per year for either facility.

- A unit cost of $4,746 per container was determined based on a material cost of $3,500 per unit, plus sales tax of 5.5 percent applied to the purchase price of each container, a labor cost of $545 per unit for certification, and a 12 percent risk factor.

Transportation

This cost item includes transportation of the packaged material, and is based on the following assumptions:

- Packages would be transported by truck to the NTS.

- Two packages would be placed on each truck for a gross shipping weight, including the weight of the container and its contents, of approximately 19,110 kg (42,000 lb).

- Transportation costs were estimated using a unit rate of $3,584 per truck shipment based on current average shipping costs to the NTS, including a 12 percent risk factor.

Disposal

- Vitrified silo residues would be disposed at the NTS.
- Disposal volume was estimated by multiplying the number of containers, 1437, required to ship the material to the NTS by the external volume of the container, 3.7 m^3 (131 ft^3).
- Unit disposal cost was estimated as \$791/m^3 (\$22.40/ft^3) based upon projected disposal costs for fiscal year 1998, including a 12 percent risk factor.

Operations and Maintenance

Annual O&M costs are summarized in Table 3.2-6. These costs are based on the following assumptions:

Item	Quantity	Rate
Staff	116 full-time equivalents	\$ 23.35/hr
Glass-formers	8,390 tonnes/yr	\$ 519/tonne
Flocculent	3 tonnes/yr	\$ 4,600/tonne
Misc. Chemicals	NA	\$ 166,000/yr
Electricity	6,400 kW operating load	\$ 0.04/kWh
Equipment Replacement	5% of Direct Field Costs/yr	NA

TABLE 3.2-6
ANNUAL O&M COSTS - ALTERNATIVE VIT
(Costs in Millions)

Case	Annual Staff Costs	Annual Chemical Costs	Annual Electric Costs	Annual Equipment Replacement Costs	Total Annual Operating Cost	Years of Operation	Total O&M Costs
Reference Vit Plant	\$5.63	\$1.63	\$2.24	\$1.96	\$11.46	2.17	\$24.87
Silo 3 Retrieval	\$0.09	\$0.00	\$0.01	\$0.12	\$0.22	NA[1]	NA[1]
Modified Vit Plant	\$5.72	\$1.63	\$2.25	\$2.08	\$11.68	2.95	\$34.46

[1]"NA" indicates this item is not applicable.

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3.2.8.3 Decontamination and Decommissioning Cost

Decontamination and decommissioning (D&D) costs are estimated by the following components:

- $83 per square foot of building area. Since the inclusion of Silo 3 residues does not add to the building size, both buildings are approximately 20,400 ft^2. D&D costs for this component is $1.7 million.

- Vitrification plant equipment is estimated at 180 manhours per equipment item, including an indirect labor factor of 1.5, at an average hourly salary for FDF labor assumed at $23.35 per hour. For the FRVP, it is assumed 500 pieces of equipment require D&D. D&D cost for this component is $2.1 million.

- Project/Construction Management cost is estimated at 15.8 percent of subcontractor costs. D&D cost for this component is $0.6 million.

- Engineering cost is estimated at 3 percent of subcontractor costs. D&D cost for this component is $0.1 million.

- Waste Management is estimated at 12.1 percent subcontractor costs. D&D cost for this component is $0.5 million.

- Risk (contingency) budget is estimated at 11 percent of total D&D costs. Cost for this component is $0.6 million.

The total estimated D&D costs for both the reference and modified FRVP is $5.6 million.

3.2.9 State Acceptance

This criterion measures the extent to which the comments made by the Ohio Environmental Protection Agency (OEPA) on the VIT alternative. The OEPA has already approved this alternative, as it is the selected remedy identified in the OU4 ROD (DOE 1994c) for Silo 3 residues.

3.2.10 Community Acceptance

This criterion measures the extent to which the comments made by the community on alternative VIT were satisfactorily addressed. The OU4 ROD (DOE 1994c) documents the public's response and acceptance of this alternative as the selected remedy for the Silo 3 residues.

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3.3 Removal, Onsite Stabilization, Off-site Disposal at the NTS

In this alternative (ALT1), the Silo 3 residues would be removed from Silo 3 using the same retrieval system described in Section 3.2 for the VIT alternative. The Silo 3 residues would then be stabilized in an onsite treatment facility, by mixing with portland cement and other additives, placed into shipping containers, and transported by truck to the NTS for final disposal.

The treatment system described in this section is based upon data from the OU4 FS and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration during remedial design, including the use of subcontractor-supplied treatment systems and services. Additional data obtained during treatability testing may also allow reduction of some process and containment controls described in this alternative.

Site Preparation and Construction

Site preparation activities would include clearing, grubbing, and filling activities in an area around Silo 3 which would be the site of equipment used for removal, stabilization, packaging, and final transportation of the stabilized residues. Construction activities would include installation of an access road and equipment staging areas; construction/installation of the Silo 3 residues retrieval system; construction of cement stabilization process equipment; and installation of transportation packaging equipment for transport of stabilized Silo 3 residues.

Removal of the Silo 3 Residues

The Silo 3 residues would be removed from the silo using a combination of mechanical and pneumatic equipment as described in Section 3.2. Once residues are removed from the Silo 3 by this system, it would be transferred to a storage silo located in the cement stabilization area. Once at this storage silo, the Silo 3 residues would be separated from the air conveying stream using a cyclone separator and series of filters. The Silo 3 residues would be available for transfer to the stabilization mixing process using a gravity transfer system assisted by screw conveyors.

The removal system is currently designed to support the baseline vitrification process. The planned throughput for this system would be approximately one-third the required input for the stabilization treatment system. It is anticipated that the removal system would need to operate three shifts to support one shift of stabilization activities. It would be appropriate during the design of the removal system to consider resizing the removal system in order to support the feed requirements for the stabilization system.

Storage and Handling of Stabilization Materials

The stabilization process used for this evaluation requires that three solid powder materials (cement, blast furnace slag[2], and Silo 3 residues) be mixed thoroughly with water. Each of the solid materials required for stabilization would be contained in storage silo bins located outside the stabilization facility (Figure 3.3-1). Portland cement and blast furnace slag cement would be pneumatically transferred into their respective storage silos located adjacent to, and in line with the two Silo 3 residues bins. The portland cement and blast furnace slag pneumatic conveyance and silo systems would be equipped with standard filters used by the cement industry.

The four silo bins would be positioned in-line over a single screw conveyor. Star feeders located at the base of each silo would be used to provide a controlled feed of silo contents into the screw conveyor which transfers the materials to the stabilization mixer. Each storage silo bin would be installed with a load cell weighing system which provides an accurate indication of loss-in-weight for each bin's contents, providing the necessary control of mix ingredients. The star feeders also provide pneumatic isolation between the silo volumes and the screw conveyor, and a shutoff device would be installed below the screw conveyor to provide positive shutoff of solids flow to the mixer.

Cement Stabilization

It is necessary to perform the Silo 3 stabilization operations in a controlled environment to mitigate the potential release of the highly dispersable Silo 3 material during treatment. A temporary facility (new or existing) would offer a high level of containment and environmental controls. Such a temporary building would house the vendor's stabilization equipment until the equipment is removed by the vendor immediately upon completion of treatment and D&D activities. The temporary building, if constructed in the Silo 3 vicinity, then could be reused by the Silos Project to support planned full-scale operations for Silos 1 and 2 as a maintenance support facility and as a staging area for D&D activities with the Silos themselves. Utilization of an existing facility(ies) is currently being evaluated so that appropriate actions can be incorporated into the request for proposal documentation.

Material handling and stabilization equipment would be constructed as a closed system that would provide primary containment of the Silo 3 residues and mitigate fugitive emissions. In addition to this primary containment, a confinement room would be constructed around potential points of release for

[2]Blast furnace slag was previously evaluated as part of the OU4 FS treatability studies and was found to be a good binding agent at a relative low percent of the total waste volume. Blast furnace slag sources are locally available.

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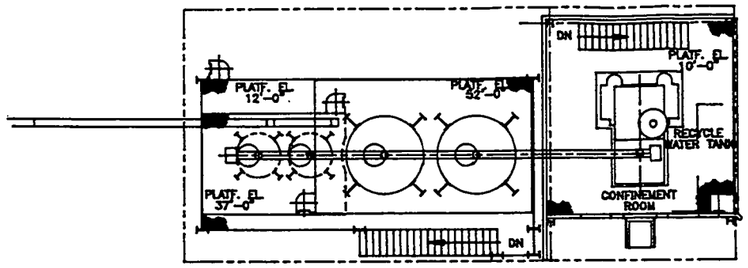
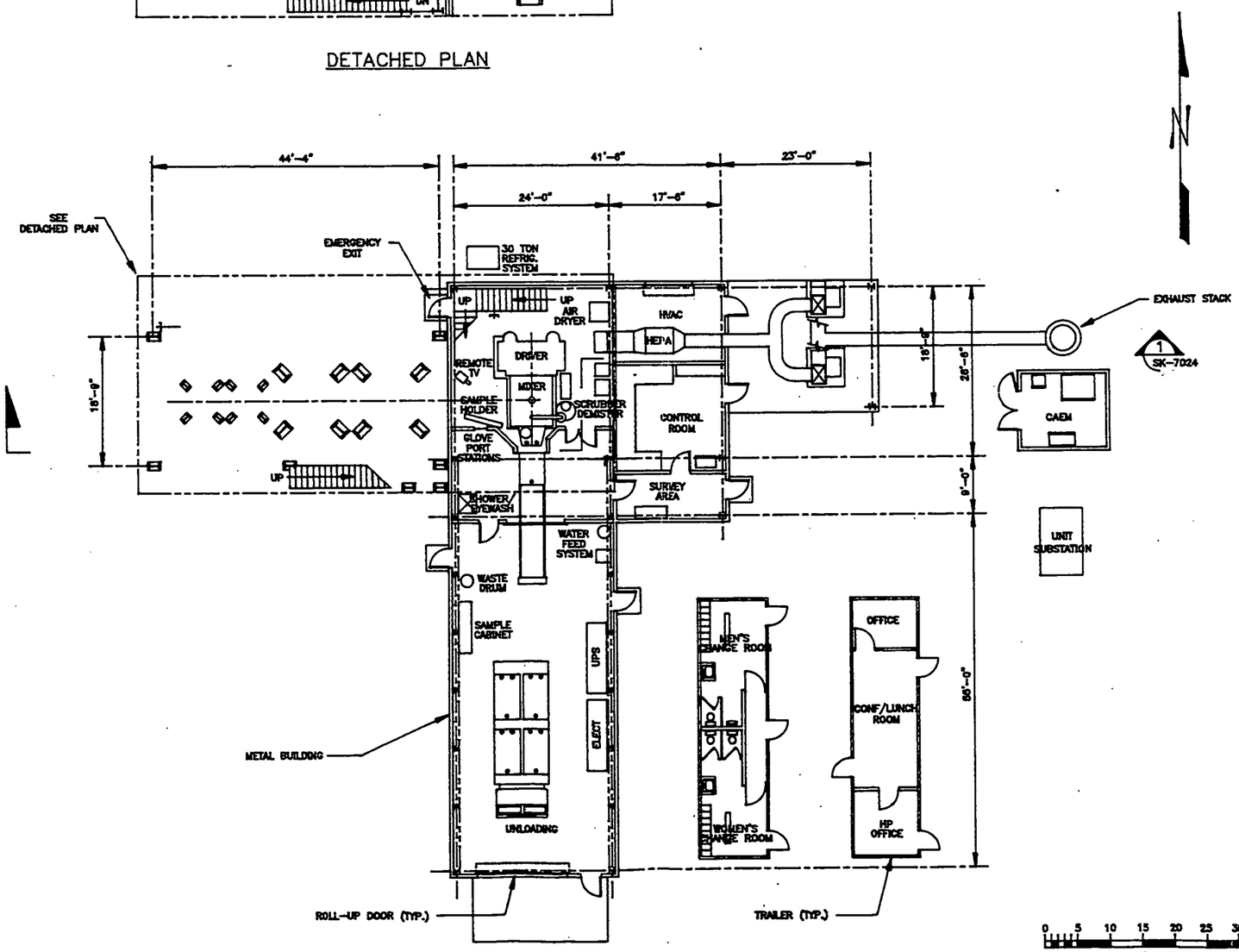


DETACHED PLAN



PLAN AT GRADE

NOTES:

1. BUILDING CONSTRUCTION
   - CONCRETE FLOOR SLAB AND FOUNDATIONS
   - STEEL FRAME STRUCTURE
   - INSULATED METAL SIDING
   - MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD
   - CONCRETE SHIELDING ONLY AS NOTED

FIGURE 3.3-1
SHEET 1

000127

SL03ALT3	IBM: ACAD13: SS

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DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FERMCO
FERNALD ENVIRONMENTAL RESTORATION MANAGEMENT CORPORATION
CINCINNATI, OHIO

FERNALD RESIDUES VITRIFICATION PLANT

POURABLE MIX PROCESSING FACILITY
DRAWING PLAN
SILO 3 ALTERNATIVES

J THOMPSON	4-3-98		
OU4			1/8"=1'-0"
04424331		SK-7023	1 / A

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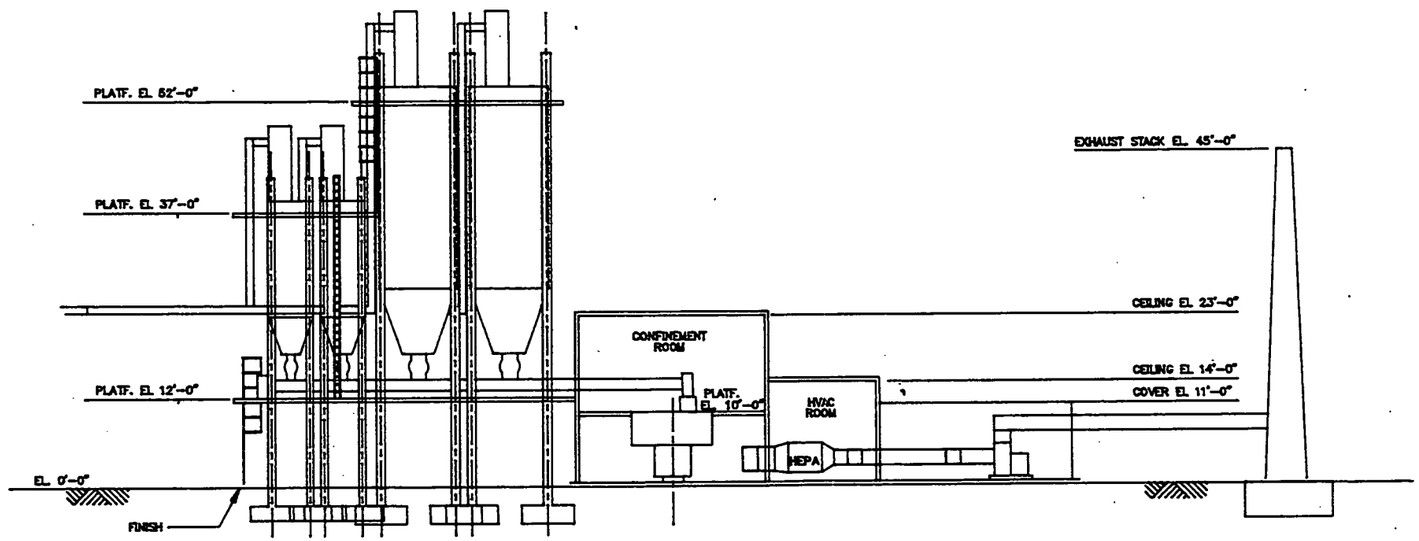

SECTION 1 / SK-7023
1/8" = 1'-0"

NOTES:

1. BUILDING CONSTRUCTION
   - CONCRETE FLOOR SLAB AND FOUNDATIONS
   - STEEL FRAME STRUCTURE
   - INSULATED METAL SIDING
   - MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD
   - CONCRETE SHIELDING ONLY AS NOTED

FIGURE 3.3-1
SHEET 2

000128

GRAPHIC SCALE 1/8" = 1'-0"
0 5 10 15 20 25 30 35 40

SL03ALT3 | IBM: ACAD13:SS

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FERNALD RESIDUES VITRIFICATION PLANT

POURABLE MIX PROCESSING FACILITY
SECTION
SILO 3 ALTERNATIVES

J THOMPSON | 4-3-98 | OU4 | 1/8"=1'-0"
04434331 | SK-7024 | 1 | A
ACAD | DETAILS: JSD | DATE: 4-23-98

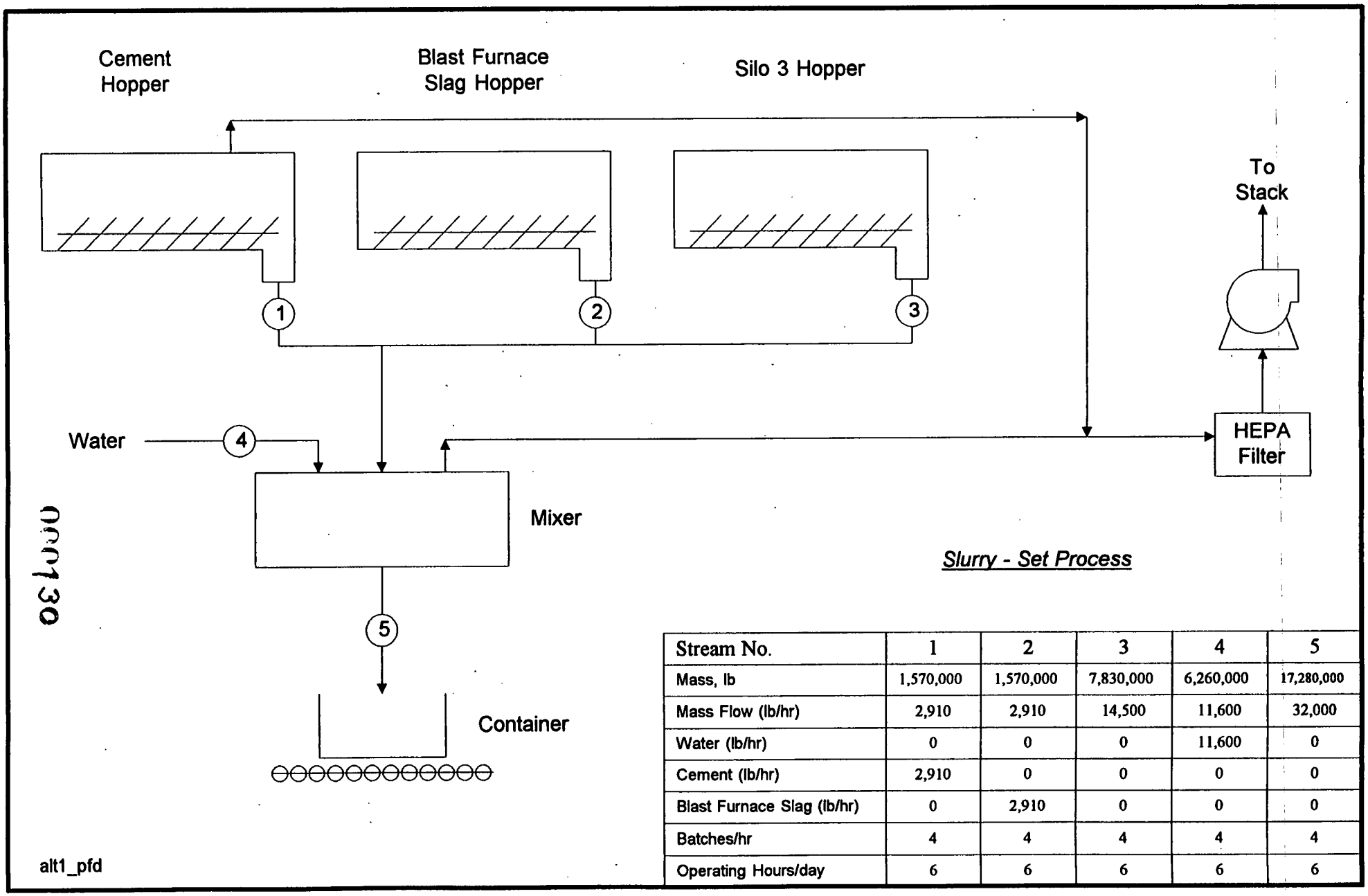
dry Silo 3 residues or spills of stabilized residues. The confinement room would be constructed around the discharge of the screw feeder from the storage silos and the mixer. Negative pressure would be maintained on the room to prevent the release of airborne radioactive particulates. The interior of the confinement room would be constructed to allow decontamination by rinsing with water sprays, which would collect in a floor sump. Water collected in the sump would be pumped to a recycle tank for use in the stabilization process and waste minimization.

The process described in this section is based upon using a formulation mix consisting, by weight, of approximately 45 percent Silo 3 residues, 9 percent cement, 37 percent water, and 9 percent blast furnace slag (Figure 3.3-2). This prospective mix is based on formulations evaluated during treatability testing conducted during the OU4 FS and incorporates a higher waste loading than the final formulation (Formulas 1 and 2) of the OU4 FS. Based on analysis of the FS formulations, it is assumed that this increased waste loading would stabilize the waste sufficiently to pass RCRA TCLP metals leaching requirements.

Additional treatability testing must be performed to determine the final formulation to be used in stabilizing the Silo 3 residues. Appendix E outlines necessary data to be obtained during treatability testing. Stabilization of the Silo 3 residues would be performed as a batch process using a high intensity mixer designed for completely enclosed operation. The mixer would be capable of completely mixing a batch size of 2.8 cubic yards (nominally 90% of a single container volume), which would consist of approximately 7,560 pounds of stabilized waste containing approximately 3,400 pounds of Silo 3 residues. A total of 2,152 batches would therefore be required to stabilize all of the residues contained within Silo 3. At completion of the mixing process the stabilized material would be in a flowable liquid form for transfer to containers.

Package Loading and Handling

Packages would be filled to approximately 90 percent of volumetric capacity at a loading station located adjacent to the confinement room. At this location, connections would be made between the container located outside the confinement room, and the stabilization mixer inside the room. The container lid, which would be secured on the container, would be fitted with one approximately 8-inch and one 4-inch diameter threaded openings. One opening would be used for filling the container with stabilized residues, while the second would be used to vent displaced air back into the confinement room during the filling process. Filling and venting would be accomplished by raising the container until a positive seal is made with the fill and vent lines. Although the mixer would be



Stream No.	1	2	3	4	5
Mass, lb	1,570,000	1,570,000	7,830,000	6,260,000	17,280,000
Mass Flow (lb/hr)	2,910	2,910	14,500	11,600	32,000
Water (lb/hr)	0	0	0	11,600	0
Cement (lb/hr)	2,910	0	0	0	0
Blast Furnace Slag (lb/hr)	0	2,910	0	0	0
Batches/hr	4	4	4	4	4
Operating Hours/day	6	6	6	6	6

Figure 3.3-2 Stabilization Process Flow Diagram - Alt 1

sized to produce a single container volume per batch, density sensors located external to the container would be used to monitor the process and ensure that containers would not overfill. Once the container has been filled, the fill and vent openings would be closed and sealed.

As containers are filled, sealed, and surveyed, they would be transferred by bridge crane within the processing building and placed on a semitrailer. After a trailer had been loaded with four containers, it would be moved to an outdoor holding area where it would remain for approximately two days, the estimated time necessary to complete final testing of samples collected during container filling.

The cement stabilization system would be designed to have a theoretical processing time of 5 minutes per container. However, other factors including transfer of material to the mixer, positioning and filling containers, and other operational factors would increase the actual processing time to about 15 minutes. A total of 538 processing hours would therefore be required to stabilize all of the Silo 3 residues. At an assumed rate of 6 operational processing hours per work day, a total of 90 work days would be required to stabilize all of the Silo 3 residues.

Transportation and Disposal

With a maximum of four containers per semitrailer, an estimated 540 truck shipments would be necessary to transport all of the stabilized Silo 3 residues to the NTS. The distance by truck to the NTS is approximately 3,300 Km (2,050 mi).

3.3.1 Overall Protection of Human Health and the Environment

Implementation of this alternative would meet the remedial action objectives for OU4 Silo 3, as developed in the OU4 FS (DOE 1994a). This would be accomplished using onsite treatment and off-site disposal at the NTS. Treatment of Silo 3 residues through stabilization would reduce contaminant mobility while slightly increasing the volume of contaminated material. The leaching rate of the stabilized waste form would be sufficiently low that protection of groundwater at the NTS would be assured. Protection of the environment would therefore be assured by the waste form rather than the waste packaging.

There would be no unacceptable short-term risks from this alternative. Direct contact with the waste material during treatment would be prevented by the use of containment and confinement measures during treatment system operation. Releases to the air would be prevented by the use of filtration equipment incorporated into the pneumatic conveying and other material handling systems.

Additional risk would be associated with the transportation of stabilized residues; however, radiation exposure to workers and the public as a result of transportation would be low.

The removal of Silo 3 residues from the FEMP followed by disposal off-site provides the final element of protection. The NTS disposal facility would provide protection by eliminating access to the waste and preventing migration of contaminants from the waste. The NTS disposal facility is located in a sparsely populated, arid environment with a low potential for leachate generation, contaminant release, migration, and direct contact with contaminants. The long-term effectiveness of the necessary institutional controls at the NTS disposal facility is believed to be very high.

3.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Issues related to ARAR compliance for onsite stabilization followed by off-site disposal at the NTS, heretofore identified as ALT1, are similar to VIT with the exception of the process option used to treat the Silo 3 residues. In this alternative, stabilization would be used in place of vitrification. Compliance of this alternative with the identified ARARs would be substantially identical to that for vitrification of the Silo 3 residues presented in Section 3.2.3 and is summarized below.

Chemical-Specific ARARs and TBCs

ALT1 would comply with all pertinent chemical-specific ARARs identified in Appendix A for this alternative. Included would be those CWA requirements associated with the Ohio Water Quality Standards; the control of radionuclide airborne emissions including radon-222 under the CAA; and the control of radionuclide releases to air and water and their resulting doses to the public during remedial operations at the FEMP site as required under DOE Order 5400.5. Compliance with SDWA MCLs and MCLGs would be ensured by removal of the source of waste to an off-site disposal facility following treatment.

Location-Specific ARARs and TBCs

ALT1 would comply with all pertinent location-specific ARARs identified in Appendix A for this alternative. Included would be those requirements associated with the protection of floodplains, wetlands, and endangered species and their habitat during the onsite treatment of the material.

Action-Specific ARARs and TBCs

ALT1 would comply with all pertinent action-specific ARARs identified in Appendix A for this alternative. This alternative would comply with ARARs associated with NEPA (for environmental

documentation), the CAA (for release of dust and nonradioactive particulates), and the CWA (for storm water runoff, BMPs, and dredge and fill activities). Onsite activities would comply with the substantive RCRA closure requirements for tanks and containers used in the cement stabilization process.

As described for vitrification, contaminated media and debris generated during remediation activities may be managed in a designated CAMU under 40 CFR § 264 Subpart S, to facilitate staging, treating, or packaging the material for off-site transport.

TUs, as provided in 40 CFR § 264 Subpart S, and/or containment buildings as provided in 40 CFR § 264 Subpart DD, might also be used under this alternative for the treatment or storage of remediation waste, including media and debris which may be contaminated with a hazardous waste. These units would comply with all pertinent ARARs, including closure of the units in accordance with the pertinent closure requirements of 40 CFR § 264 as necessary to ensure protection of human health and the environment from operation of these units.

Off-site disposition would require shipment of materials. Hazardous material transport requirements would be complied with by following the pertinent regulations under 40 CFR § 262 and 263, and the appropriate DOT shipping requirements under 49 CFR Subchapter C Hazardous Material Regulations.

3.3.3 Long-term Effectiveness and Permanence

Magnitude of Residual Risks

The implementation of this alternative would reduce the residual risk to viable receptors to a HI of less than 0.2 and an ILCR of less than 1×10^{-6} (DOE 1994a). Because all of the material would be removed from the site, there would be no residual risk from Silo 3 residues at the FEMP site. Residual risk at the NTS would be limited by the disposal facility institutional controls, the characteristics of the cement-stabilized residues, and the arid environment.

Adequacy and Reliability of Controls

The reliability of stabilization of Silo 3 residues is high based on experience gained during widespread use of this technology to stabilize similar materials. Off-site disposal at the NTS is reliable. The facility is currently owned and used by DOE for low level radioactive waste disposal. The institutional controls and potential for adequate facility maintenance are very reliable at the NTS. Additionally, if there were a release at the NTS, the climate, hydrologic, and geologic characteristics

would considerably reduce the potential for contaminant migration. The low population density of the area surrounding the NTS would also reduce the potential for direct contact with released materials.

Long-term Environmental Impacts

Long-term impacts associated with this alternative are essentially the same as those discussed in Section 3.2.4 for VIT. Construction of support facilities to implement this alternative would not result in permanent disruption of land, as they would be constructed in previously disturbed areas and would be designed for removal when processing was complete. Water quality and air quality would be protected due to control measures (e.g., secondary containment, scrubbers) engineered into the system. No wetland, floodplain, or biotic resources would be impacted in the long-term.

Long-term impacts at the NTS are essentially the same as those discussed in Section 3.2.4 for VIT.

3.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The selected remedy for Silo 3 residues in the OU4 ROD is vitrification followed by off-site disposal at the NTS. The OU4 FS also fully evaluated cement stabilization of Silo 3 residues followed by off-site disposal at the NTS, and found this to be a feasible and effective alternative. Either waste form provides sufficient waste immobilization for safe handling and transportation.

This alternative uses cement stabilization to treat the inorganic hazardous and radioactive constituents of the Silo 3 residues. There are no organic contaminants present at levels of concern in the Silo 3 residues. Cement stabilization is a standard treatment technology for these types of contaminants, and reduces contaminant mobility through a combination of the following physical and chemical processes:

- Solidification: materials added to the waste produce a solid form with decreased surface area across which contaminants can leach.
- Stabilization: waste constituents (particularly metals) are converted to more chemically stable and leach-resistant forms.
- Chemical Fixation: waste constituents are chemically bound to other materials rendering them less mobile.
- Encapsulation: waste particles are coated thereby isolating them from the environment.

The OU4 treatability study evaluated two final cement formulations for solidification of Silo 3 residues, both of which produced a solid material form with significant compressive strength, and

TCLP results that were below the regulatory limits. The treated residues was also effective in reducing radon emanation by an average of 45 percent. Data from the study revealed that the radon emanation rates from the cement stabilized treated Silo 3 residues were less than the 20 $pCi/m^2/s$ criteria established for DOE in 40 CFR § 61. The rates averaged between 13 to 17 $pCi/m^2/s$.

In both cases the formulations from the OU4 FS were developed based on waste acceptance criteria associated with a potential onsite disposal facility. These criteria, which were more stringent than those established for off-site disposal facilities, resulted in aggressive cement formulations that combined approximately equal proportions of waste, cement, other solids, and water, producing an average volume increase of 55.6 percent.

Because compressive strength of the waste form is not a criterion for disposal at the NTS, other formulations using reduced quantities of cement, other additives, and water may be equally effective in reducing the mobility of inorganics without significantly increasing waste volume. Although additional testing is required to determine the precise composition of alternative formulations, such tests would be straightforward. The composition of Silo 3 residues itself includes several oxide materials with pozzolanic properties that would hydrate and could solidify to a degree if mixed with water. Appendix E outlines the approach to conducting treatability testing and identifies the necessary data that must be obtained.

3.3.5 Short-term Effectiveness

Protection of the Community During Remedial Action

Through a combination of engineering controls and access controls, this alternative would be protective of the community during implementation. Short-term risks to the public primarily arise from transportation of the stabilized residues to the NTS. These risks were calculated in Appendix D and were found to be acceptable. The estimate of public radiation exposure, expressed in terms of ILCR, along the route to the NTS is 8×10^{-10} for the maximally exposed individual, far below the CERCLA target risk range of 1×10^{-4} to 1×10^{-6}. It is estimated that 0.1 injuries and 0.01 deaths may occur to the public due to transportation accidents. The release of airborne particulates and radon during treatment are the mechanisms that could potentially impact the community during remediation activities. Airborne effluent collection and treatment systems operating during treatment of the material would control airborne contaminant releases. During implementation of this alternative, fenceline radon and airborne particulate exposure levels for the off-site public would be indistinguishable from background levels.

Current FEMP access controls would be continued during remediation to prevent public access to the treatment processes. The potential short-term risks to the public are sufficiently small that even significant changes in the calculation assumptions would not change the conclusion that this alternative is effective in protecting the community in the short term.

Protection of Workers During Remedial Action

There are no unacceptable risks to workers as a result of implementation of this alternative. The most significant safety issue would be the potential for airborne radioactive materials arising from the handling of the Silo 3 residues during removal and stabilization activities. This hazard can be controlled through the use of appropriate engineering controls in the design of the cementation system and the Silo 3 residues removal system. The processing area and all vessels and systems storing and conveying dry Silo 3 residues would be subject to ventilation controls, including HEPA filtration, to prevent airborne release of particulates. Packaged Silo 3 residues can be contact-handled because of their low external dose rate.

The risk to the remediation workers and other workers for removal and treatment of materials is detailed in Appendix D and is well within the occupational standards required by DOE Orders. It is estimated that removal and treatment of materials would result in an excess cancer risk level to remediation workers of $1x10^{-4}$. As appropriate, workers would wear protective clothing.

Cement stabilization of hazardous wastes is a commonly used technology that does not present unusual hazards. Hazards are present when operating rotating equipment such as would be used for mixing the cement stabilization additives with the Silo 3 residues.

Appendix D estimates the number of injuries and fatalities that could result from the removal, treatment, and transportation activities associated with this alternative during remediation. All remediation activities would be conducted in accordance with a health and safety plan developed to meet 29 CFR § 1910.120(b)(4). Training and procedures would assure that worker exposure would be ALARA.

Short-term Environmental Impacts

Minor soil disturbances would occur in the short-term due to construction of support structures, roads, etc. Those disturbances would create the potential for increased erosion and dust which will be minimized through controls such as straw bales, wetting, etc. These controls would also ensure that

short-term impacts to water quality and air quality would be minimized and kept within acceptable levels. Because project activities would be occurring in previously disturbed areas, short-term impacts to biotic resources, wetlands, floodplains, and cultural resources would be negligible. Project activities would be monitored to ensure that impacts do not extend into undisturbed areas. Minor socioeconomic benefit would occur within the CMSA due to material purchases, etc., during project activity.

Short-term impacts at the NTS would be the same as those discussed in Section 3.2.6 for VIT. The short-term impacts at the FEMP resulting from the implementation of this alternative during remedial activities are summarized below.

Duration of Remedial Activities

Remedial action activities under this alternative are expected to be completed in a period of approximately 2-1/2 years. Construction, testing, and startup of the material processing facility is anticipated to require approximately 14 months. Material removal activities would require approximately 5 months, assuming six processing hours/day, 5 days/week.

3.3.6 Implementability

The activities involved in this alternative include gaining regulatory approval for cement stabilization of Silo 3 residues; remedial design and procurement of necessary equipment, materials, and services; clearing and grubbing of areas around the silos and at the location of the material processing facility; construction of access roads, the pneumatic removal device, and materials processing facility; operation of the retrieval system and processing facility; transport of wastes to the NTS for disposal; and disassembly and decontamination of the processing equipment and facility.

Technical Implementability

Design, construction and operation of the removal component of this alternative would be readily implementable. The mechanical and pneumatic transfer of solids is a standard industrial technology that is normally reliable and readily available. Pneumatic transfer was originally used to place the cold metal oxides in Silo 3. Samples of Silo 3 residues collected within the past decade exhibited the characteristics of a free flowing fine powder; however, samples have not been collected from the base and sides of the Silo where the powdery material may have "solidified" if moisture has penetrated the Silo floor and lower sidewalls. If samples are collected to perform treatability tests on the Silo 3

residues, additional investigation of the sides and floor of the silo is warranted to eliminate this uncertainty.

The cement stabilization facility would be reliable and straightforward to design, construct and operate. All of the necessary equipment would be readily available because the process is widely used in the construction and mining industries and is frequently used in hazardous material treatment applications. The treatment system would consist of a standard configuration of industrial equipment, combined with airborne contamination control and confinement systems common in the nuclear industry. Because these systems and this application are not complex, time frames for design and procurement would be short.

The cement stabilization facility would require a supervisor and general laborers with industrial and radiological work experience, as well as maintenance personnel. After remedial design testing has further defined and optimized the reagent to cold metal oxide blend, the plant supervisor would be able to respond to operational problems that could arise during processing. Continual testing of treatment batches during operation would confirm immobilization of contaminants. A temperature rise was noted during the treatability testing for the Silo 3 residues. This heat rise needs to be better controlled for Silo 3 stabilization. Optimization of reagent addition over time or use of retardants should be investigated. The vendor will be required to demonstrate through proof-of-process testing and the development of a process control plan that the vendor's process can achieve specified waste acceptance criteria for the disposal facility. Waste acceptance criteria of the treated Silo 3 residues would include, but not be limited, to the following: passing TCLP metals and waste loading. The vendor will be required to determine the necessary curing period for the process as part of the testing.

The benefits of cement stabilization technology are the moderate processing costs, the compatibility with a wide variety of disposal options, and the ability to meet stringent processing and performance requirements using a proven technology, and the potential for expedition of the overall OU4 remediation schedule. This technology can be implemented with minimal lead time, and it provides the operational capacity to complete the treatment of Silo 3 residues in a relatively short time-frame.

The off-site transport and disposal at the NTS is straightforward and reliable. Off-site transport of the treated residues to the NTS would consist of truck transport directly from the FEMP site to the NTS. The FEMP currently transports radioactive wastes to the NTS on a routine basis. The treated material would be placed into existing containers that currently meet both transportation and disposal

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requirements. The lids of these containers would require slight modification from the current design to incorporate filling and venting ports.

Administrative Feasibility

No permits or licenses would be required to conduct stabilization activities, but permit information summary packages may be necessary. The substantive technical requirements of air emissions permits would also need to be demonstrated and may include calculating estimated emissions, providing air emissions controls, developing a sampling and analysis plan to monitor air emissions, and air sampling.

The NTS is a DOE-owned facility; thus, no special permits would be required. However, an addendum to the current "FEMP Application to Ship Waste to the Nevada Test Site" would be required to be approved by the NTS because this waste stream is a new stream not covered by current application. This alternative would require agency approvals and coordination for the interstate shipment of the material. Many states require advance notification or permitting for shipments of radioactive material entering their state. All material shipments would be required to meet applicable federal and state regulations. The public and regulatory agencies from the states located within the transportation route from FEMP to the NTS may oppose transport, however, early coordination and the relatively low hazard associated with stabilized Silo 3 residues would facilitate the necessary approvals.

Regulatory Implementability

The OU4 ROD was approved by the EPA on December 7, 1994, and identified vitrification followed by off-site disposal at the NTS as the selected alternative for the remediation of the Silo 3 residues. Guidance for making changes to an approved ROD are presented in 40 CFR § 300.435(c)(2) and in OSWER Directive 9355.3-02 Chapter 8 "Post-ROD Significant Changes". 40 CFR § 300.435(c)(2) states, " After the adoption of the ROD, if the remedial action or enforcement action taken, or the settlement or consent decree entered into, differs significantly from the remedy selected in the ROD with respect to scope, performance, or cost, the lead agency shall consult with the support agency, as appropriate, and shall either: (i) publish an explanation of significant differences when the differences in the remedial or enforcement action, settlement, or consent decree significantly change but do not fundamentally alter the remedy selected in the ROD with respect to scope, performance, or cost...or (ii) propose an amendment to the ROD if the differences in the remedial or enforcement action,

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settlement, or consent decree fundamentally alter the basic features of the selected remedy with respect to scope, performance, or cost," (EPA 1989).

OSWER Directive 9355.3-02 Chapter 8 Post-ROD Significant Changes states, "After a ROD is signed, new information may be generated during the RD/RA process that could affect the remedy selected in the ROD. The lead agency should analyze this new information to determine if changes should be made to the selected remedy. Three types of changes could occur: (1) non-significant changes; (2) significant changes; and (3) fundamental changes," (EPA 1989).

The guidance states that non-significant changes should be simply recorded in the post-decision document file. If significant changes are made to a component of the remedy in the ROD, these changes should be documented in an Explanation of Significant Differences (ESD). More importantly, fundamental changes are documented in a ROD amendment.

"A threshold for defining significant changes (or differences) has been established, which is intended to reduce the paperwork burden on the lead agency without compromising the public's right to be kept informed. Therefore, only changes that significantly alter the scope, performance, or cost of a component of the remedy as presented in the ROD should be addressed in an ESD," (EPA 1989).

Changing the selected remedial alternative for Silo 3 residues from vitrification to stabilization, followed by off-site disposal at the NTS (ALT1) would not fundamentally alter the remedy selected in the ROD. Both technologies would stabilize the heavy metals present in the residues to reduce the toxicity of the material. In addition, both alternatives provide for removal of the treated residues to an off-site disposal facility. The disposal facility in both alternatives is the NTS, where the treated residues will be disposed and maintained under the management of the DOE.

Because Alternative ALT1 does not fundamentally alter the remedy selected in the OU4 ROD, selection of Alternative ALT1 may only require an issuance of an ESD to the EPA, OEPA, and the public to notify them of the new technology to be used. Section 8.6.2.1 of OSWER Directive 9355.3-02 provides guidance for preparing an ESD. The following activities should be included when issuing an ESD:

- Provide the support agency with a reasonable opportunity to comment on the ESD prior to publication (a maximum of 15 working days is recommended);
- Summarize the support agency's comments in the ESD;

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- Publish a notice of availability and brief description of the ESD in a local newspaper of general circulation, as required by CERCLA section 117(c);
- Make the ESD available to the public by placing it in the administrative record file and information repository; and
- Place the information supporting the change in the administrative record file, as well as the lead agency's response to any comments.

Though not required, it is anticipated that if an ESD process was used to modify the existing OU4 ROD, a public comment period would be incorporated into the process to promote stakeholder involvement.

Because the OU4 ROD also served as the Fernald site NEPA ROD, any revisions to the ROD would have to integrate NEPA requirements into the process.

Availability of Services and Materials

Vendors would be requested to propose their own stabilization method and to provide services and materials. The clearing and grubbing, excavation, and construction would involve the use of standard construction equipment and trades, and the purchase of appropriate materials. These are all readily available.

The construction of a materials processing facility would involve the purchase of an engineered metal sided building, the process equipment, the process chemicals/materials, and the instrumentation and controls. It would also involve the use of standard construction equipment and services. Some engineering would be required during construction, start-up, and debugging of the process equipment. Qualified personnel would be available to operate and maintain the facility.

The use of a cement stabilization system provides opportunity for the use of experienced private vendors to provide "turnkey" treatment capability. The use of off-the-shelf systems decrease the risk associated with implementation because the technology and equipment have been significantly tested and refined. However, modification to off-the-shelf equipment, systems and components may be required due to the contamination control issues (i.e., stringent dust control) associated with the cement stabilization process.

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The NTS currently accepts low-level waste from the FEMP and other DOE sites, and it has adequate facilities to accept the cement stabilized Silo 3 residues. Transfer areas, storage areas, decontamination facilities, and a laboratory are available on the site. The treated residues would be tested to ensure that it complies with the NTS waste acceptance criteria.

Schedule

Figure 3.3-3 presents the implementation summary schedule for ALT1. The schedule identifies all the activities, along with their durations and relationships, necessary to successfully implement the schedule. The schedule has been prepared with the assumption that adequate resources are available to support the schedule. Table 3.3-1 itemizes the activities and their durations.

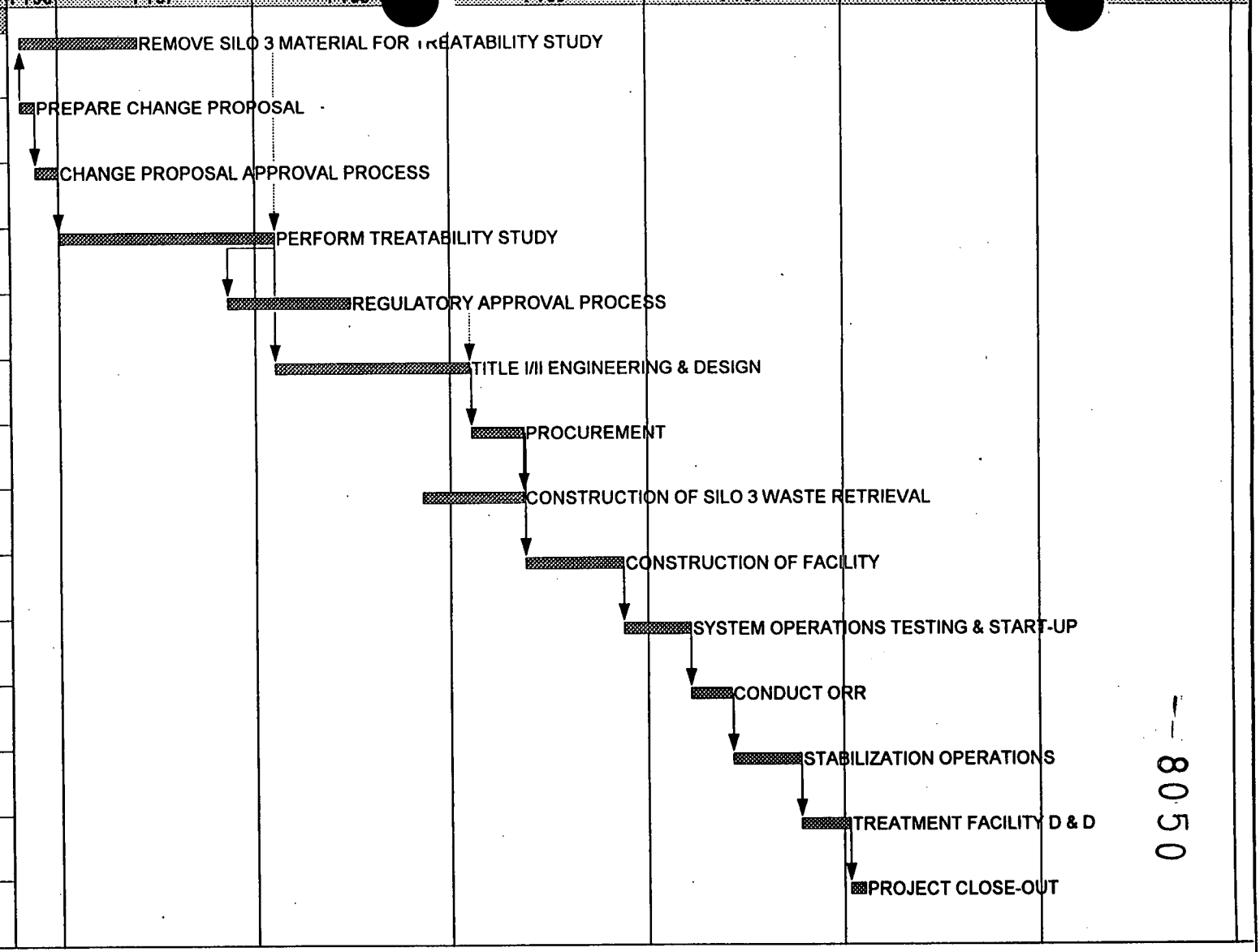
TABLE 3.3-1

SCHEDULE SUMMARY - ALT1

ACTIVITY	DURATION (WORK DAYS)
Perform Treatability Study	277
Regulatory Approval Process (ESD)	157
Title I/II Engineering & Design	122
Procurement	64
Construction of Silo 3 Waste Retrieval	127
Construction	127
System Operating Testing and Start-up	86
ORR	50
Stabilization Operations	90
Treatment Facility D&D	64
Project Close-Out	20

The remediation of Silo 3 residues under ALT1 can be started prior to commencing vitrification of Silos 1 and 2 according to the schedule presented in Figure 3.3-3. As discussed in Section 3.1.2.6, planning activities would be conducted in parallel to receiving formal regulatory agency approval. In order to meet project milestones for OU4 remediation, treatability studies and support activities must

Activity ID	Orig	Early Start	Early Finish
SILO 3 ALTE		E 1 - ACCELERATED SCH	
A3100	140	22JUL96	24FEB97
A3103	20*	22JUL96*	16AUG96
A3106	30*	19AUG96*	30SEP96
A3109	277	01OCT96	06NOV97
A3112	157	11AUG97	27MAR98
A3115	250	07NOV97	06NOV98
A3118	64	09NOV98	12FEB99
A3121	127	11AUG98	12FEB99
A3124	127	16FEB99	16AUG99
A3127	86	17AUG99	20DEC99
A3129	50	21DEC99	03MAR00
A3130	90	06MAR00	12JUL00
A3133	64	13JUL00	11OCT00
A3136	20	12OCT00	08NOV00



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Project Start	01OCT95	Early Bar
Project Finish	11JUL02	Progress Bar
Data Date	01OCT95	Critical Activity
Plot Date	26JUN96	

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SSFS

Sheet 1 of 1

ALTERNATIVE ALT 1 - IMPLEMENTATION
SUMMARY SCHEDULE
FIGURE 3.3 - 3

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be initiated in July 1996. However, the additional information obtained on Silo 3 during this process can only be beneficial to implementing any final remedial action for this silo.

Because additional data regarding process formulations exist for this alternative, uncertainties are associated with the schedule outlined for this alternative. The duration of treatment is currently estimated at 90 days based on estimated formulations and processing rates. The following uncertainties may impact the schedule:

- Cement formulation
- Volumes for transportation and disposal
- Mixing time and throughput
- Material Flowability into containers
- Final density and amount in each container
- Requirement for an Explanation of Significant Differences document
- Waste retrieval rate and downtime

3.3.7 COST

The total present life-cycle cost for removal, onsite cement stabilization, and off-site disposal at the NTS is $19.5 million as shown in Table 3.3-2. A detailed breakdown of the cost is provided in Appendix C.

TABLE 3.3-2

LIFE-CYCLE COSTS - ALT 1
(Millions)

Case	Capital Cost	Packaging and Certification Cost	Transportation Cost	Disposal Cost	O&M Cost	D&D Cost	Total Cost
ALT1	$6.7	$3.4	$1.9	$5.4	$1.2	$0.9	$19.5

Capital Cost

The capital cost associated with ALT1 are summarized in Table 3.3-3 below.

TABLE 3.3-3

CAPITAL COSTS - ALT1
(Millions)

ITEM	ESTIMATED COST
Cementation Facility	$2.4
Silo 3 Retrieval	$2.3
Project & Construction Management	$0.7
Engineering	$0.8
Sales Tax	$0.1
Risk Budget	$0.4
Total Capital Cost	$6.7

Assumptions used to estimate the capital cost of each of the major components of this alternative are provided below.

Site Preparation

Site preparation activities would include clearing, grubbing, and filling activities around Silo 3; construction of access road and equipment staging areas, construction/installation of the Silo 3 residues removal system; construction of the cement stabilization process equipment; and installation of transportation packaging equipment for transport of stabilized Silo 3 residues. The basis of estimate includes the following assumptions:

- An area of approximately 0.2 acres will be cleared and grubbed.
- Approximately 312 yd^3 would be constructed in the remediation area. The roads would be constructed of compacted gravel.
- Filling would be performed where necessary. The volume of fill was estimated to be 105 yd^3. It was assumed that this soil could be obtained from onsite.
- Transfer conveyors and pneumatic piping would be installed between Silo 3 and the handling and process equipment.

Process/Personnel Buildings

- (1) 25 ft. x 100 ft. x 23 ft. high, engineered, metal sided building with 17 ft. x 30 ft. x 10 ft. engineered metal sided annex building would have (2) roll-up doors, 5 personnel doors, and 5 windows.

- (1) 40 ft. x 10 ft. trailer with men's and women's change rooms and lunch room.
- (1) 150 ft. x 150 ft. paved trailer storage area.

Confinement Room

- (1) 25 ft. x 26 ft. x 23 ft. room, lined with epoxy coated thin-gauge steel sheet.
- (1) 4 ft. x 7 ft. steel access door.
- (3) Observation windows.
- (3) HEPAs for inlet air.
- (2) Ceiling mounted I-beam 1-ton hoists.
- (1) 25 ft. x 15 ft. deck and staircase.
- (2) Glove port stations.

Removal/Transfer System

This cost component includes the storage hoppers, screw conveyors, and the load cell system. The residues will be removed from Silo 3 by a mechanical/pneumatic method, transferred by auger to an air pneumatic conveying system for transport to a storage hopper. Assumptions used for this cost estimate include the following:

Materials Storage and Feed

- (2) 2,100 ft^3 silos (with rotary vane variable speed feeder, stand, railing, vibrator, manhole, cyclone, etc.) for Silo 3 residues.
- (2) 1,400 ft^3 silos with same features as above.
- (1) 18 in. diameter auger feeder (40 ft. long) with 5 hp motor.
- (1) Custom enclosure around auger and rotary vane feeders with drain to cell.
- (1) Fresh water feed system (inside) with 100-gallon isolation tank, 50 gpm 100 psi centrifugal pump, automatic refill capability (low-level start, high-level shutoff) and 200 ft. of 1 in. piping with 100 flush nozzles, 10 manual valves and 5 solenoid valves.

Stabilization

This cost item includes the cost of the stabilization equipment and is based on the following assumptions:

Mixer and Recycle Water System

- (1) 3.28 yd^3 high intensity mixer.
- (1) 400-gallon recycle water tank with electric motor-actuated 4-inch ball valve at tank drain.
- (1) Electric rubber diaphragm pump, 50 gpm against low head with automatic startup and shutoff per high-level and low-level liquid levels in sump.
- (1) Liquid level sensing system with ± 1/4 in. accuracy (for 400-gallon tank).
- (1) Top-entering agitator with 1/2 hp motor and gear drive.

Air Treatment System

- (1) Custom 300-gallon tank with integral Venturi scrubber and knockout pot and mist eliminator.
- (1) 50 gpm low-head progressive cavity pump.
- (1) 200 cfm Air Dryer (price includes 1 hp motor).
- (1) 200 cfm Air Gear Pump (price does not include 7-1/2 hp motor).
- (1) Modular air filtration system (assuming 4,000 cfm system with prefilters, heater, and HEPA).
- (1) 4,000 cfm blower.
- (1) Stack.
- (1) 2,000 cfm HVAC system with 30-ton refrigeration system.

Packaging Charging System

- (1) Custom end drain valve for mixer with small hydraulic positioner (6 in. throw).
- (1) Custom splash mitigation funnel 2 ft. dia. x 2 ft.
- (1) Custom tiltable chute (6 ft. x 4 ft.) for pouring mix with small hydraulic positioner (3 ft. throw).
- (1) Custom sliding drip pan (4 ft. x 4 ft.) with small hydraulic positioner (2 ft. throw).
- (1) Container elevator 4 in., 5-ton hydraulic lift.

- (1) Battery powered 4 ft. x 7 ft. cart on track.

Packaging Loading/Unloading and Storage System

- (1) 5-ton bridge crane with 24 ft. span and 50 ft. travel.
- (1) Custom container lifting frame.
- (1) Dedicated semitruck cab.
- (1) Dedicated small flatbed truck with rail and access stairs for checking for set/water.

Operating Cost

The operating costs for the inclusion of Silo 3 residues consist of the following components: packaging, transportation, disposal, and O&M.

Packaging

Packaging costs include the cost of purchasing the containers and the labor associated with handling and documentation. Estimated cost is based on the following:

- Packaging would be industrial packaging-type 2 (IP-2) containers with exterior dimensions of approximately 1.2 m (4 ft) width by 2.1 m (7 ft) length by 1.2 (4 ft) depth. Interior dimensions would be approximately 1.1 m (3.6 ft) width by 2 m (6.6 ft) length by 1.1 m (3.6 ft) depth, providing approximately 2.4 m^3 (84 ft^3) of packaging volume.
- Empty weight of each container would be approximately 455 kg (1,000 lb).
- Total payload of each container would not exceed a weight of approximately 4,100 kg (9,000 lbs) or an interior volume of approximately 2.4 m^3 (84 ft^3).
- The total volume of Silo 3 residues stabilized in Alternative ALT1 was assumed to be 4,660 m^3 (164,380 ft^3) with a bulk packaging density of 1,610 kg/m^3 (100 lb/ft^3).
- Total packaging cost was estimated assuming 2,160 containers would be required to ship material to the NTS.
- Standard packaging lid may require modification to include two flush mounted filling ports and one sampling port to facilitate loading of treated material by minimizing dust and particulate emissions.
- A unit cost of $1,556 per container was determined based on a material cost of $800 per unit, a 5.5 percent sales tax applied to the purchase price of the container, a labor cost of $545 per unit for handling and documentation, and a 12 percent risk budget.

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Transportation

This cost item includes transportation of the packaged material and is based on the following assumptions:

- Silo 3 residues stabilized in ALT1 would be transported by truck to the NTS.
- Four packages would be placed on each truck for a gross shipping weight, including the weight of the container and its contents, of approximately 15,580 kg (34,240 lb).
- Transportation costs were estimated using a unit rate of $3,584 per truck shipment, based on current average shipping costs to the NTS and a 12 percent risk budget.

Disposal

- Silo 3 residues stabilized in ALT1 would be disposed at the NTS.
- Disposal volume was estimated by multiplying the number of containers, 2,160, required to ship the stabilized material to the NTS by the external volume of the container, 3.2 m^3 (112 ft^3).
- Unit disposal cost was estimated as $791/$m^3$ ($22.40/$ft^3$), based on projected disposal costs for fiscal year 1998 and a 12 percent risk budget.

O&M Cost

O&M costs incurred during implementation of this alternative are estimated based upon the operating parameters, feed requirements and throughputs described in Section 3.3. The following assumptions were also used to develop the estimate for this alternative.

- 1,538 kWh/day electricity required for operations at $0.04/kWh.
- Ten laboratory personnel working 8 hr/day throughout operations.
- Materials cost are estimated using $90/ton for portland cement and $80/ton for blast furnace slag.
- Three security officers working 8 hr/day shifts.
- Thirteen operators and safety personnel required for processing 8 hrs/day.
- Five maintenance personnel required 8 hrs/day.
- Labor rate of $23.35/hr.
- Six hours of operations per day for five days a week.
- O&M cost for waste retrieval from Silo 3 are included in O&M costs.
- Retrieval costs are estimated to require 1.2 persons for 3 shifts per day.

- Retrieval electrical requirements are estimated at 63,300 kWh total electrical usage.

The O&M costs for ALT1 are summarized in Table 3.3-4 below:

TABLE 3.3-4

ANNUAL O&M COSTS - ALT1
(Millions)

ALTERNATIVE	STAFF	CHEMICAL	UTILITY	TOTAL COST
1	$1.1	$0.1	<$0.1	$1.2

Decontamination and Decommissioning Cost

Decontamination and decommissioning costs are estimated by the following components:

- $83 per square foot of building area. The size of the building is estimated at 2,500 ft^2. D&D costs for this component is $0.21 million.

- Stabilization plant equipment is estimated at 180 manhours per equipment item, including an indirect labor factor of 1.5, at an average hourly salary for FDF labor assumed at $23.35 per hour. It is assumed 100 pieces of equipment require D&D. D&D cost for this component is $0.42 million.

- Project/Construction Management cost is estimated at 15.8 percent of subcontractor costs. D&D cost for this component is $0.1 million.

- Engineering cost is estimated at 3 percent of subcontractor costs. D&D cost for this component is $0.02 million.

- Waste Management is estimated at 12.1 percent of subcontractor costs. D&D cost for this component is $0.08 million.

- Risk (contingency) budget is estimated at 11 percent of total D&D costs. Cost for this component is $0.09 million.

The total estimated D&D costs for the stabilization facility is $0.9 million.

3.3.8 State Acceptance

This criterion measures the extent to which the comments made by the OEPA on the alternatives being considered are satisfactorily addressed. Because formal state comments will not be received until after this evaluation report has been issued for review, this modifying criterion will be addressed during the regulatory process following the public comment period.

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3.3.9 Community Acceptance

This criterion measures the extent to which the comments made by the community on the alternatives being considered are satisfactorily addressed. Because formal public comments will not be received until after this evaluation report has been issued for review, this modifying criterion will be addressed during the regulatory process following the public comment period.

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3.4 Removal, Onsite Stabilization, Off-site Disposal at the Representative Permitted Commercial Disposal Facility

In this alternative (ALT2), the Silo 3 residues would be removed from Silo 3 and stabilized in a treatment facility similar to that described in Section 3.3 for ALT1 (Figure 3.4-1). The primary differences between ALT2 and ALT1 are: 1) the waste would be shipped to a representative permitted commercial disposal facility (RPCDF) for disposal rather than the NTS, 2) the formulation mix would be adjusted to produce the compactible waste form preferred by the RPCDF, and 3) the system would be operated differently to produce the compactible waste form. Activities associated with site preparation and construction, removal of Silo 3 residues, and storage and handling of stabilization materials would be identical to ALT1. The differences between ALT2 and ALT1 relative to cement stabilization, container loading and handling, and transportation and disposal are discussed in the sections that follow.

The treatment system described in this section is based upon data from the OU4 FS and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration during remedial design, including the use of subcontractor-supplied treatment systems and services. Additional data obtained during treatability testing may also allow reduction of some process and containment controls described in this alternative.

Cement Stabilization

As described in Section 3.3 for ALT1, stabilization would be performed within a metal sided building. Material handling and stabilization equipment would be constructed as a sealed primary containment system, and a confinement room would be constructed around potential points of release. The confinement room would be constructed around the discharge of the screw feeder from the storage silos and the mixer. Negative pressure would be maintained on the cell to prevent the release of airborne radioactive particulates.

Stabilization would be performed using a formulation mix consisting, by weight, of approximately 52 percent Silo 3 residues, 11 percent cement, 26 percent water, and 11 percent blast furnace slag. This prospective mix is based on the ALT1 formulation, adjusted to produce a drier granular waste form. Stabilization of the Silo 3 residues would be performed as a batch process using a high intensity mixer that would be designed for completely enclosed operation. The mixer would be capable of completely mixing a batch size of 2.5 cubic yards (nominally 80 percent of a single container volume), which would produce approximately 6,000 pounds of stabilized waste containing approximately 3,135

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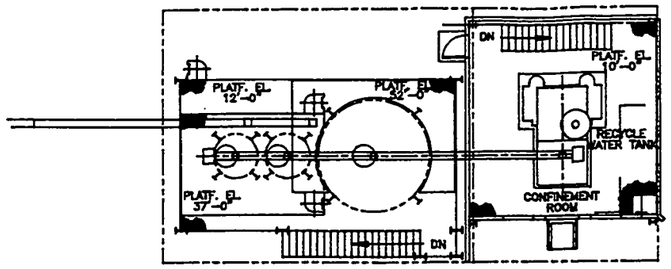

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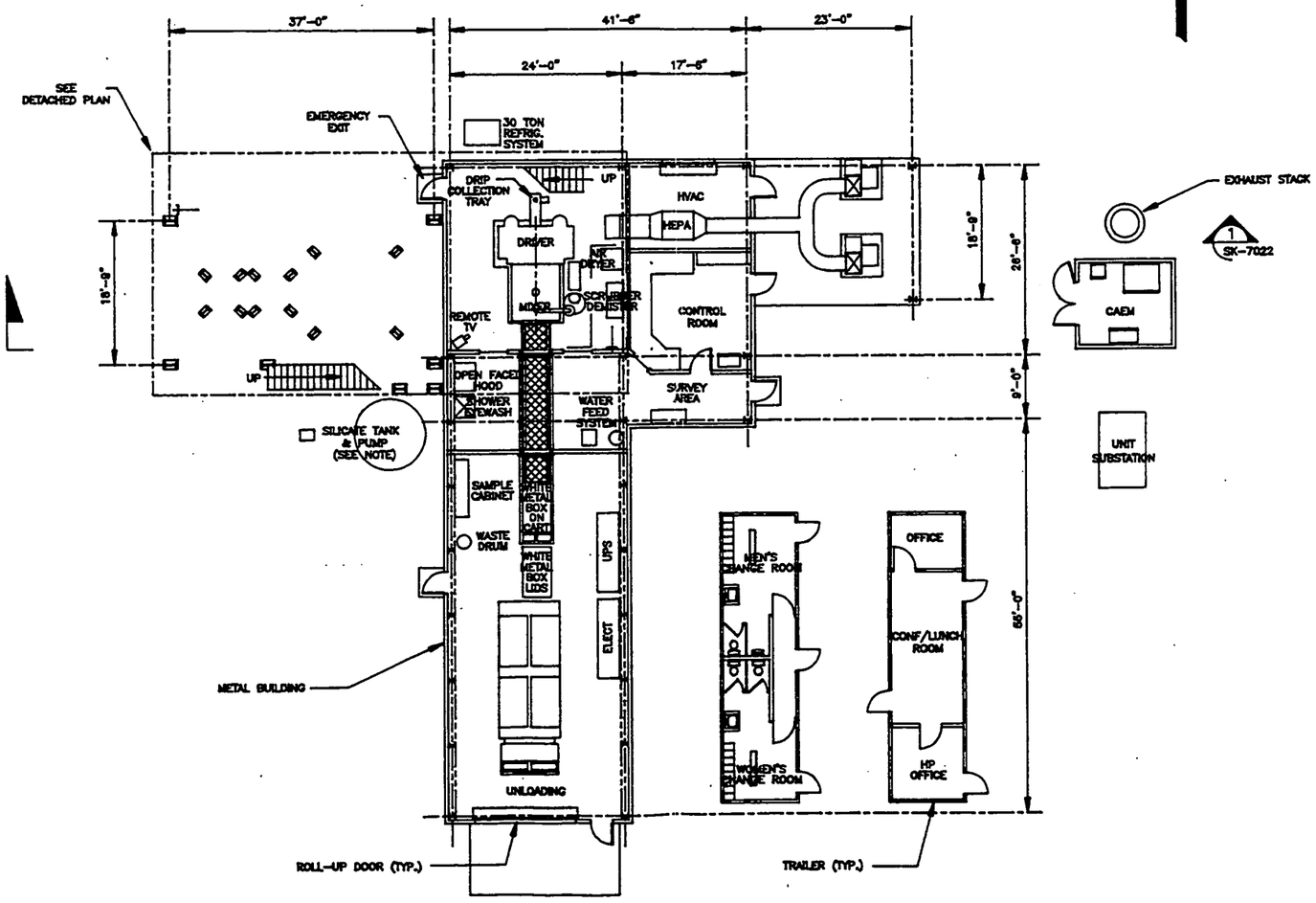

PLAN AT GRADE

NOTES:

1. BUILDING CONSTRUCTION
   - CONCRETE FLOOR SLAB AND FOUNDATIONS
   - STEEL FRAME STRUCTURE
   - INSULATED METAL SIDING
   - MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD
   - CONCRETE SHIELDING ONLY AS NOTED
   - SILICATE TANK & PUMP REQUIRED FOR GROUT TYPE PROCESS WHERE BLS AND CEMENT NOT REQUIRED

FIGURE 3.4-1
SHEET 1

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FERNALD RESIDUES VITRIFICATION PLANT

GRANULAR PROCESSING FACILITY
DRAWING PLAN
SILO 3 ALTERNATIVES

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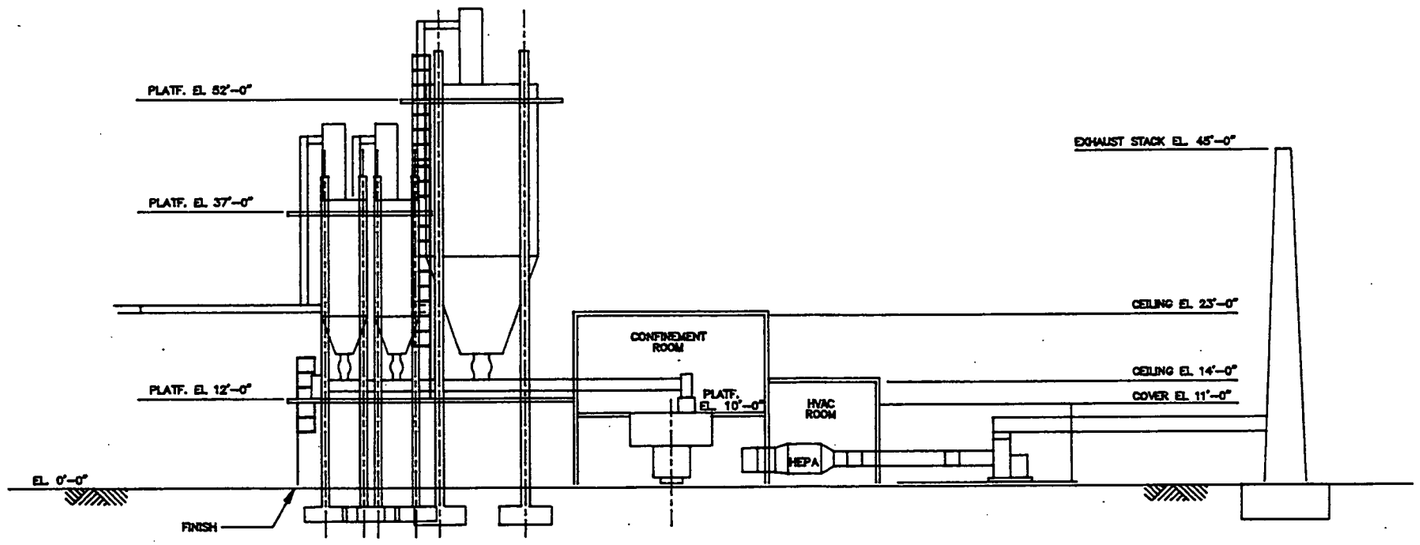

SECTION 1 / SK-7021
1/8" = 1'-0"

NOTES:

1. BUILDING CONSTRUCTION
   - CONCRETE FLOOR SLAB AND FOUNDATIONS
   - STEEL FRAME STRUCTURE
   - INSULATED METAL SIDING
   - MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD
   - CONCRETE SHIELDING ONLY AS NOTED

FIGURE 3.4-1
SHEET 2

SL03ALT2 | IBM: ACAD13: SS

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PROJECT NAME
FERNALD RESIDUES VITRIFICATION PLANT

DRAWING TITLE
GRANULAR PROCESSING FACILITY
SECTION
SILO 3 ALTERNATIVES

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GRAPHIC SCALE
1/8" = 1'-0"

pounds of Silo 3 residues. A total of 2,500 batches would therefore be required to stabilize all of the residues contained within Silo 3. At the completion of an extended mixing process, the stabilized residues would be in a loose granular form for transfer to containers. Figure 3.4-2 is a process flow diagram of the stabilization process.

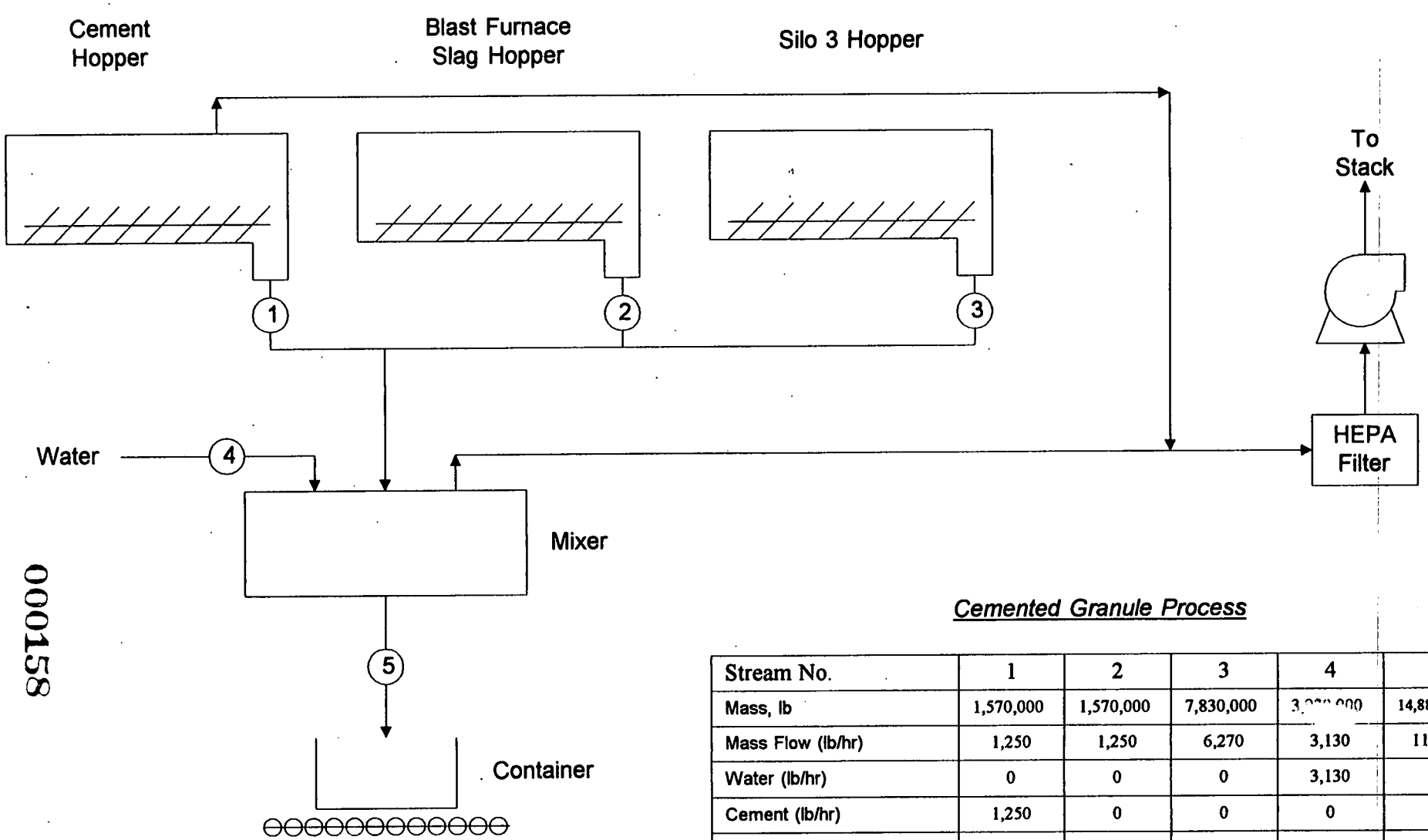
Package Loading and Handling

Packages would be filled to approximately 80 percent of volumetric capacity at a loading station located directly below the mixer within the confinement room. Empty containers would be conveyed on a motorized cart that passes into the confinement room through a vertical opening door. Once in position below the mixer, the cart would elevate until the container seats firmly against the base of the mixer. When mixing is complete a full length slide gate in the bottom of the mixer would open, allowing the mixer contents to discharge into the container. Because the stabilized waste would be produced in a loose granular form, it would be expected to mound somewhat in the middle of the container, resulting in a lower utilization of the container volume (80 percent in this alternative versus 90 percent in ALT1), and to contain approximately 20 percent interstitial air space between the granules, further reducing the amount of waste material that could be placed in the container.

When the mixer is fully discharged, the gates would close, and water sprays would mist the inside of the container while it is still in contact with the base of the mixer to ensure that no dusting occurs when the container is lowered and removed from the room. After the cart had been lowered and removed the container from the room, a lid would be bolted into place, the container surveyed, and decontamination performed as needed.

After the containers are surveyed, they would be transferred by bridge crane within the processing building and placed on a semitrailer. After a trailer has been loaded with five containers, it would be moved to an outdoor holding area where it would remain for approximately two days, the estimated time necessary to complete final testing of samples collected during container filling.

Considering operational factors that include transfer of materials to the mixer, extended mixing durations, positioning and filling containers, the estimated processing time would be about 30 minutes per container. A total of 1,250 processing hours would therefore be required to stabilize all of the Silo 3 residues. At an assumed rate of 6 operational processing hours per working day, a total of 208 work days would be required to stabilize all of the Silo 3 residues.



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alt2_pfd

Cemented Granule Process

Stream No.	1	2	3	4	5
Mass, lb	1,570,000	1,570,000	7,830,000	3,[illegible]000	14,880,000
Mass Flow (lb/hr)	1,250	1,250	6,270	3,130	11,900
Water (lb/hr)	0	0	0	3,130	0
Cement (lb/hr)	1,250	0	0	0	0
Blast Furnace Slag (lb/hr)	0	1,250	0	0	0
Batches/hr	2	2	2	2	2
Operating Hours/day	6	6	6	6	6

Figure 3.4-2 Stabilization Process Flow Diagram - Alt 2

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Transportation and Disposal

With a maximum of five containers per semitrailer, an estimated 504 truck shipments would be necessary to transport all of the stabilized wastes to the RPCDF. The distance by truck to the RPCDF would be approximately 2,900 km (1,800 mi).

3.4.1 Overall Protection of Human Health and the Environment

Implementation of ALT2 would meet the remedial action objectives for OU4 Silo 3 in the same manner as described for ALT1 in Section 3.3. There would be no unacceptable short-term risks from this alternative. Direct contact with the residues and releases to the air would be prevented by the use of operational controls and air filtration systems. Risks associated with the transportation of stabilized residues would be expected to be low.

The removal of Silo 3 residues from the FEMP followed by disposal off-site would provide the final element of protection. The RPCDF would provide protection by eliminating access to the waste and preventing migration of contaminants from the waste. The characteristics of a RPCDF would include being located in a sparsely populated, arid environment with a low potential for leachate generation, contaminant release, migration, and direct contact with contaminants. The long-term effectiveness of the necessary institutional controls at the RPCDF is believed to be high.

3.4.2 Compliance with ARARs

Issues related to ARAR compliance for onsite stabilization followed by off-site disposal at a RPCDF, heretofore identified as ALT2, are similar to ALT1 with the exception of a private disposal facility being used in place of the DOE-owned NTS. Compliance of this alternative with the identified ARARs would be substantially identical to that for vitrification of the Silo 3 residues presented in Section 3.2.2, and are summarized below.

Chemical-Specific ARARs and TBCs

ALT2 would comply with all pertinent chemical-specific ARARs identified in Appendix A for this alternative. Included would be those CWA requirements associated with the Ohio Water Quality Standards; the control of radionuclide airborne emissions including radon-222 under the CAA; and the control of radionuclide releases to air and water and their resulting doses to the public during remedial operations at the FEMP site as required under DOE Order 5400.5. Compliance with SDWA MCLs and MCLGs would be ensured by removal of the source of waste to an off-site disposal facility following treatment.

Location-Specific ARARs and TBCs

ALT2 would comply with all pertinent location-specific ARARs identified in Appendix A for this alternative. Included would be those requirements associated with the protection of floodplains, wetlands, and endangered species and their habitat during the onsite treatment of the residues.

Action-Specific ARARs and TBCs

ALT2 would comply with all pertinent action-specific ARARs identified in Appendix A for this alternative. This alternative would comply with ARARs associated with NEPA (for environmental documentation), the CAA (for release of dust and nonradioactive particulates), and the CWA (for stormwater runoff, BMPs, and dredge and fill activities). Onsite activities would comply with the substantive RCRA closure requirements for tanks and containers used in the cement stabilization process.

As described for vitrification, contaminated media and debris generated during remediation activities may be managed in a designated CAMU under 40 CFR § 264 Subpart S, to facilitate staging, treating, or packaging the material for off-site transport.

TUs, as provided in 40 CFR § 264 Subpart S, and/or containment buildings as provided in 40 CFR § 264 Subpart DD, might also be used under this alternative for the treatment or storage of remediation waste, including media and debris, which may be contaminated with a hazardous waste. These units would comply with all pertinent ARARs, including closure of the units in accordance with the pertinent closure requirements of 40 CFR § 264 as necessary to ensure protection of human health and the environment from operation of these units.

Off-site disposition would require shipment of materials. Hazardous material transport requirements would be complied with by following the pertinent regulations under 40 CFR § 262 and 263, and the appropriate DOT shipping requirements under 49 CFR Subchapter C Hazardous Material Regulations.

3.4.3 Long-term Effectiveness and Permanence

Magnitude of Residual Risks

As with the ALT1 alternative described in Section 3.3, the implementation of ALT2 would reduce the residual risk to viable receptors to an hazard index of less than 0.2 and an increased level of cancer risk of less than 1×10^{-6}. Because all of the material would be removed from the site, there would be no residual risk from Silo 3 residues at the FEMP site. Residual risk at the RPCDF would be limited

by the disposal facility institutional controls, the characteristics of the cement stabilized materials, and the arid environment.

Adequacy and Reliability of Controls

Off-site disposal at the RPCDF would be reasonably reliable because the facility would be inspected by its governing state and assumed to be licensed for the receipt and disposal of low-level radioactive, byproduct, mixed, and hazardous waste disposal. The institutional controls and potential for adequate facility maintenance are assumed to be reasonably reliable at the RPCDF. Additionally, if there were a release at the RPCDF, the climate, hydrologic, and geologic characteristics would considerably reduce the potential for contaminant migration. The low population density of the area surrounding the RPCDF would also reduce the potential for direct contact with released materials.

Long-term Environmental Impacts

The long-term environmental impacts from removal and treatment actions of ALT2 would be similar to those for ALT1 (Section 3.3.3). Differences between the two alternatives would be associated only with the off-site disposal facility and are discussed below.

Soil and Geology

Impacts to the soil and geology of the FEMP site and surrounding area are as discussed in Section 3.3.3 for ALT1.

Approximately 5.0 ha (12.6 acres) of soil at the RPCDF would be permanently disturbed for the disposal of the Silo 3 residues. The geology of the RPCDF has been determined by the State to be suitable for disposal of low-level radioactive waste. The RPCDF is characterized by great depths to the groundwater table. Groundwater movement in the saturated and unsaturated zones is very slow and there would be an extremely low potential for transport of contaminants to off-site areas. These parameters make the geology of the RPCDF very suitable for long-term disposal activities.

Water Quality and Hydrology

Water quality and hydrology at the FEMP site are discussed in Section 3.3.3 for ALT1.

The disposal of treated residues at the RPCDF under this alternative would not be expected to have significant impacts on water quality or hydrology. There are no continuously flowing streams on the RPCDF. Stream beds carry water only during unusually intense or persistent rains. Rainfall [which

averages 15 cm (6 in) per year] ponds on the low conductivity soil. The water ponds on the surface of the soil and the majority of the water evaporates with little infiltration or migration. These parameters, coupled with very suitable geology, would help minimize long-term impacts to water quality. Engineered controls (capping) and ongoing monitoring activities would also be used to control and minimize water quality impacts.

Air Quality

Air quality at the FEMP site is discussed in Section 3.3.3 for ALT1.

Following implementation of this alternative, the air quality at the RPCDF site would be similar to current conditions. There would be no long-term impacts on air because the cover system on the disposal facility would prevent radon emissions and because disturbed areas would be revegetated.

Biotic Resources

Biotic resources at the FEMP are discussed in Section 3.3.3 for ALT1.

Most of the RPCDF is vegetated by various desert shrubs. Disposal activities at the RPCDF related to this alternative are not expected to impact the habitats of any sensitive species.

Wetlands and Floodplains

Wetlands and floodplains at the FEMP are discussed in Section 3.3.3 for ALT1.

No wetland areas have been delineated at the RPCDF. In addition, no floodplain areas are located near the disposal areas of the RPCDF.

Socioeconomics and Land Use

The RPCDF encompasses about 540 acres. The population density within a 150-km (93-mi) radius of the RPCDF is about 14 persons per km^2 (37 per mi^2). In comparison, the 48 contiguous states (1990 census) had a population density of approximately 29 persons per km^2 (75 per mi^2). The off-site areas adjacent to the RPCDF are predominantly rural; hence, aesthetic impacts would not be expected to change. Hence, the treated residues disposal activities (associated with this alternative) would not impact socioeconomics or land use at the RPCDF.

Cultural Resources

Cultural resources at the FEMP are discussed in Section 3.3.5 for ALT1. Archaeological sites have been surveyed and inventoried at the RPCDF and disposal activities are avoided in those areas.

3.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

ALT2 uses cement stabilization to treat the inorganic hazardous and radioactive contents of Silo 3. As discussed in Section 3.3.4 for ALT1, the OU4 treatability study evaluated two final cement formulations for solidification of Silo 3 residues, both of which produced a solid material form with significant compressive strength, and TCLP results that were below the regulatory limits. Other formulations using reduced quantities of cement, other additives, and water may be equally effective in reducing the mobility of inorganics without significantly increasing waste volume. Treatability testing as outlined in Appendix E must be conducted prior to implementing this alternative.

The formulation envisioned for stabilization of Silo 3 residues to be disposed at the RPCDF would allow production of a final waste form that is nonmonolithic and compactible in nature. It is anticipated that this final waste form would have a somewhat granular nature, use reduced quantities of stabilization reagents and water, and require longer mixing times prior to discharge into packages. The specific stabilization formula and the properties of the final stabilized waste form must be determined during additional future treatability testing. Although very similar to the formulation anticipated for ALT1, a higher degree of uncertainty exists with this alternative because the required formulation for this specific waste form was not tested during the original OU4 FS treatability study.

The ALT2 wastes would likely be less effective in reducing radon emanation as a result of their small granular form which provides a shorter path for radon emanation from the solid matrix. Although the treated wastes themselves may exceed the 20 $pCi/m^2/s$ criteria established for DOE in 40 CFR § 61, the rate of radon emanation into the environment after placement in the RPCDF would be less than the criteria.

3.4.5 Short-term Effectiveness

Protection of the Community During Remedial Action

Short-term risks to the public primarily arise from the transportation of the stabilized residues to the RPCDF. These risks are presented in Appendix D and are considered to be acceptable. The release of airborne particulates and radon during treatment are the mechanisms that could potentially impact the community during remediation activities. Airborne effluent collection and treatment systems

operating during treatment of the material would control airborne contaminant releases. The granular nature of the ALT2 stabilized waste form may create a higher potential for airborne particulates during handling, primarily at the RPCDF where the wastes are removed from the transport containers and spread within the disposal cell using conventional heavy equipment. Additional dust control measures may be required at the RPCDF (e.g., use of water sprays) to adequately mitigate this risk. The estimate of public radiation exposure, expressed in terms of ILCR, along the route to the NTS is $8x10^{-10}$ for the maximally exposed individual, far below the CERCLA target risk range of $1x10^{-4}$ to $1x10^{-6}$. It is estimated that 0.2 injuries and 0.02 deaths may occur to the public due to transportation accidents.

Current FEMP access controls would be continued during remediation to prevent public access to the treatment processes. The potential short-term risks to the public are sufficiently small that even significant changes in the calculation assumptions would not change the conclusion that this alternative is effective in protecting the community in the short-term.

Protection of Workers During Remedial Action

Protection of workers is discussed in Section 3.3.5 for ALT1 and are considered the same for ALT2. No unacceptable risks would be anticipated to result from implementation of ALT2. The most significant safety issue would be the potential for airborne radioactive materials arising from the handling of the Silo 3 residues and the treated wastes. This hazard could be controlled through the use of appropriate engineering controls as discussed in Section 3.3.5 for ALT1. Additional dust control measures would be implemented at the RPCDF as necessary to control dust when the stabilized Silo 3 residues are removed from their transport containers and spread within the disposal cell.

The risk to the remediation and nonremediation workers for removal and treatment of materials is detailed in Appendix D and are well within the occupational standards required by DOE Orders. It is estimated that removal and treatment of materials would result in an excess cancer risk level to remediation workers of $3x10^{-4}$. As appropriate, workers would wear protective clothing.

Short-term Environmental Impacts

The short-term environmental impacts from removal and treatment actions of ALT2 would be the same as those for ALT1 (Section 3.3.5).

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3.4.6 Implementability

The activities involved in this alternative would include gaining regulatory approval for cement stabilization of Silo 3 residues and disposal at the RPCDF; remedial design and procurement of necessary equipment, materials, and services; clearing and grubbing of areas around the silos and at the location of the material processing facility; construction of access roads, the pneumatic removal device, and materials processing facility; operation of the retrieval system and processing facility; transportation of wastes to the RPCDF for disposal; and disassembly and decontamination of the processing equipment and facilities.

Technical Implementability

Technical implementability is discussed in Section 3.3.6 for ALT1. ALT2 is expected to be equally implementable because it uses the same standard technologies.

The temperature rise noted during treatability testing of Silo 3 residues would not be anticipated to present a problem for the ALT2 granular waste form based on the higher rate of heat transfer from the small particles. However, additional treatability testing would be necessary to identify the appropriate stabilization formula to achieve a granular physical form while adequately stabilizing TCLP metals.

The off-site transport to the RPCDF is straightforward and reliable. Off-site transport of treated residues to the RPCDF would consist of truck transport directly from the FEMP site to the RPCDF. The FEMP currently transports radioactive wastes by truck for off-site disposal. The treated residues would be placed into existing containers that currently meet transportation requirements.

Additional study would be necessary to further evaluate the implementability of disposal at the RPCDF. The granular nature of the ALT2 stabilized waste form may create a higher potential for airborne particulates during handling, primarily at the RPCDF where the wastes are removed from the transport containers and spread within the disposal cell using conventional heavy equipment. Additional dust control measures could be implemented if necessary (e.g., use of water sprays) to mitigate this risk.

Administrative Implementability

Administrative implementability is discussed in Section 3.3.6 for ALT1.

Regulatory Implementability

As stated previously, the selected remedy for Silo 3 residues is vitrification followed by off-site disposal at the NTS. In addition, Section 3.3.6 of this document states that an ESD is required for differences that significantly change but do not fundamentally alter the remedy selected in the ROD.

Changing the selected remedial alternative for Silo 3 residues from vitrification to stabilization would not fundamentally alter the remedy selected in the OU4 ROD. Both technologies would stabilize the heavy metals present in the residues at the FEMP, to reduce the toxicity of the material. In addition, both alternatives provide for removal of the treated residues to an off-site disposal facility. However, ALT2 identifies a RPCDF as the disposal facility compared to the NTS for the selected remedy in the ROD.

Because ALT2 does not fundamentally alter the remedy selected in the OU4 ROD, selection of ALT2 may only require issuance and approval of an ESD to the EPA, OEPA, and the public to notify them of the new technology to be used. The activities that must be conducted for preparing and issuing an ESD were previously presented in Section 3.3.6 of this document.

Availability of Services and Materials

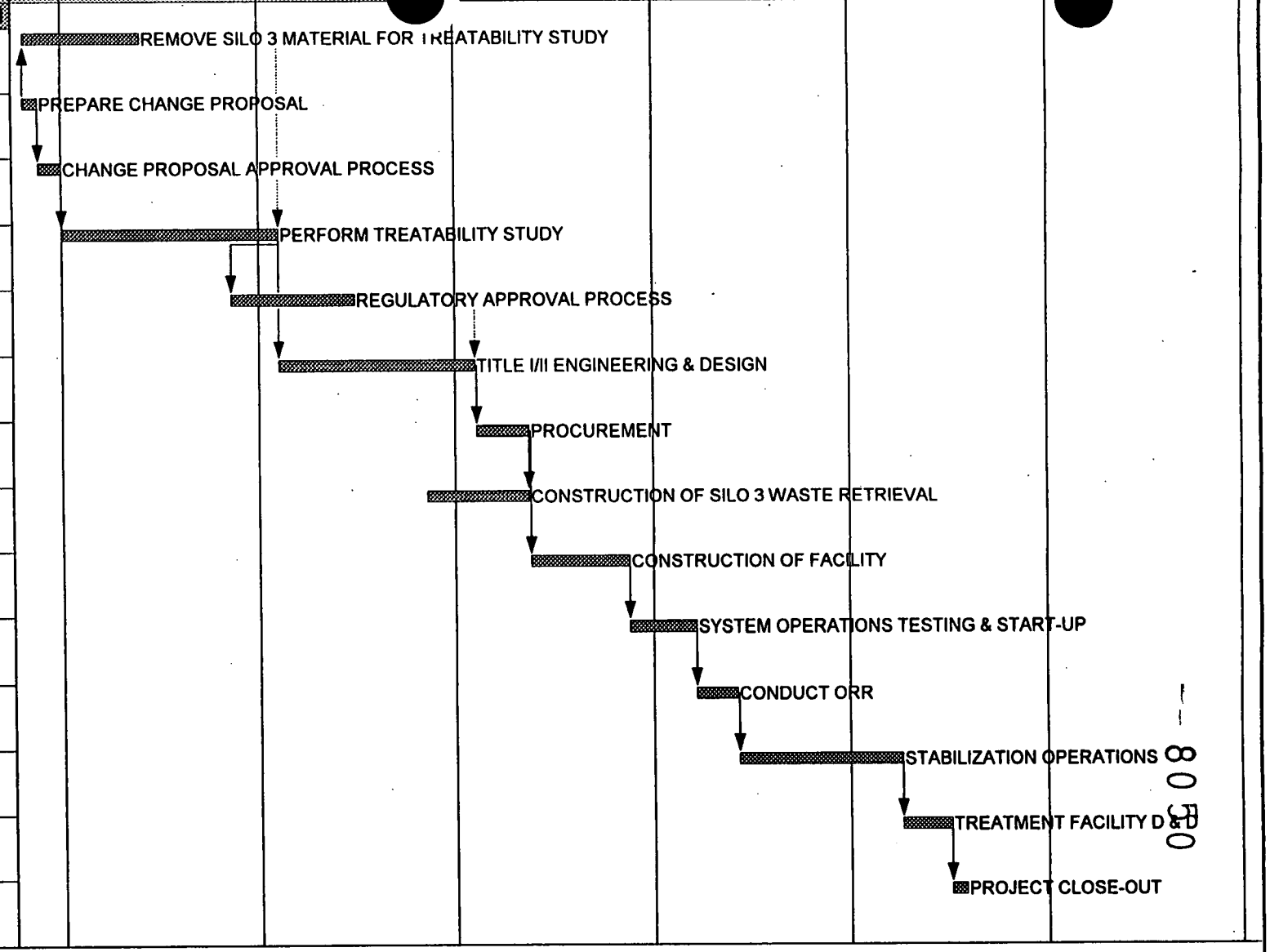
The availability of services and materials are discussed in Section 3.3.6 for ALT1.

The RPCDF currently accepts low-level waste and has adequate facilities to accept the cement stabilized Silo 3 residues. Transfer areas, storage areas, decontamination facilities, and a laboratory are available on the site. The treated residues would be tested to ensure that it complies with RPCDF waste acceptance criteria.

Schedule

Figure 3.4-3 presents the implementation summary schedule for Alternative ALT2. The schedule identifies all the activities, along with their durations and relationships, necessary to successfully implement the schedule. The schedule has been prepared with the assumption that adequate resources are available to support the schedule. Table 3.4-1 itemizes the activities and their durations.

Activity ID	Orig	Early Start	Early Finish
SILO 3 ALTE		E 2 - ACCELERATED SCH	
B3100	148	22JUL96	24FEB97
B3103	20*	22JUL96*	16AUG96
B3106	30*	19AUG96*	30SEP96
B3109	277	01OCT96	06NOV97
B3112	157	11AUG97	27MAR98
B3115	250	07NOV97	06NOV98
B3118	64	09NOV98	12FEB99
B3121	127	11AUG98	12FEB99
B3124	127	16FEB99	16AUG99
B3127	86	17AUG99	20DEC99
B3129	50	21DEC99	03MAR00
B3130	208	06MAR00	03JAN01
B3133	64	04JAN01	04APR01
B3136	20	05APR01	03MAY01



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Project Start	01OCT95	Early Bar
Project Finish	11JUL02	Progress Bar
Data Date	01OCT95	Critical Activity
Plot Date	26JUN96	

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Sheet 1 of 1

ALTERNATIVE ALT 2 - IMPLEMENTATION
SUMMARY SCHEDULE
FIGURE 3.4 - 3

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FERMCO
Restoration Management Corporation

TABLE 3.4-1

SCHEDULE SUMMARY - ALT2

ACTIVITY	DURATION (WORK DAYS)
Perform Treatability Study	277
Regulatory Approval Process (ESD)	157
Title I/II Engineering & Design	122
Procurement	64
Construction of Silo 3 Waste Retrieval	127
Construction	127
System Operating Testing and Start-up	86
ORR	50
Stabilization Operations	208
Treatment Facility D&D	64
Project Close-Out	20

The remediation of Silo 3 under ALT2 can be started prior to commencing vitrification of Silos 1 and 2 according to the schedule presented in Figure 3.4-3.

Because additional data regarding process formulations exist for this alternative, uncertainties are associated with the schedule outlined for this alternative. The duration of treatment is currently estimated at 208 work days based on estimated formulations and processing rates. The following uncertainties impact the schedule.

1) Ability of alternative formulations to produce granular waste form with a low dusting potential.
   - Cement formulation
   - Volumes for transportation and disposal
   - Mixing type

2) Effectiveness of granular waste form to meet TCLP requirement
   - Final density and amount in each container

- Mixing time, throughput and process time

3) Flowability of granular waste form
   - Throughput
   - Hardware and procedures
   - Risks
4) Dusting characteristics
   - Hardware and procedures
   - Risks
5) Requirement for a ROD Amendment
6) Stakeholder acceptance

3.4.7 COST

The total present life-cycle cost for removal, onsite cement stabilization, and off-site disposal at the RPCDF is $17.9 million as shown in Table 3.4-2. A detailed breakdown of the cost is provided in Appendix C.

TABLE 3.4-2
LIFE-CYCLE COSTS - ALT2
(Millions)

Case	Capital Cost	Packaging and Certification Cost	Transportation Cost	Disposal Cost	O&M Cost	D&D Cost	Total Cost
ALT2	$6.8	$2.3	$3.6	$2.7	$1.6	$0.9	$17.9

Capital Cost

The capital cost associated with ALT2 are summarized in Table 3.4-3 below.

TABLE 3.4-3

CAPITAL COSTS - ALT 2
(Millions)

ITEM	ESTIMATED COST
Cementation Facility	$2.5
Silo 3 Retrieval	$2.3
Project & Construction Management	$0.7
Engineering	$0.9
Sales Tax	$0.1
Risk Budget	$0.3
Total Capital Cost	$6.8

Assumptions used to estimate the capital cost of each of the major components of this alternative are provided below.

Site Preparation

Site preparation activities would include clearing, grubbing, and filling activities around Silo 3; construction of access road and equipment staging areas; construction/installation of the Silo 3 residues removal system; construction of the cement stabilization process equipment; and installation of transportation packaging equipment for transport of stabilized Silo 3 residues. The basis of estimate includes the following assumptions:

- An area of approximately 0.2 acres will be cleared and grubbed at Silo 3.
- Approximately 312 yd^3 roads would be constructed in the remediation area. The roads would be constructed of compacted gravel.
- Filling would be performed where necessary. The volume of fill was estimated to be 105 yd^3. It was assumed that this soil could be obtained from onsite.
- Transfer conveyors and pneumatic piping would be installed between Silo 3 and the handling and process equipment.

Process/Personnel Buildings

- (1) 25 ft. x 100 ft. x 23 ft. high, engineered metal sided building with 17 ft. x 30 ft. x 10 ft. metal sided annex building would have (2) roll-up doors, (5) personnel doors, and (5) windows.
- (1) 40 ft. x 10 ft. trailer with men's and women's change rooms and lunch room.

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Confinement Room

- (1) 25 ft. x 26 ft. x 23 ft. room lined with epoxy coated thin-gauge steel sheet.
- (1) 4 ft. x 7 ft. steel access door.
- (3) Observation windows.
- (3) HEPAs for inlet air.
- (2) Ceiling mounted I-beam 1-ton hoists.
- (1) 25 ft. x 15 ft. deck and staircase.
- (2) Glove port stations.

Removal/Transfer System

This cost component includes the storage hoppers, screw conveyors, and the load cell weighing system. Residues will be removed from Silo 3 by a mechanical/pneumatic method, transferred by auger to an air pneumatic conveying system for transport to a storage hopper. Assumptions used for this cost estimate include the following:

Materials Storage and Feed

- (2) 2,100 ft^3 silos (with rotary vane variable speed feeder, stand, railing, vibrator, manhole, cyclone, etc.) for Silo 3 residues.
- (2) 1,400 ft^3 silos with same features as above.
- (1) 18 in. diameter auger feeder (40 ft. long) with 5 hp motor.
- (1) Custom enclosure around auger and rotary vane feeders with drain to cell.
- (1) Fresh water feed system (inside) with 100-gallon isolation tank, 50 gpm 100 psi centrifugal pump, automatic refill capability (low-level start, high-level shutoff) and 200 ft. of 1 in. piping with (100) flush nozzles, (10) manual valves and (5) solenoid valves.

Stabilization

This cost item includes the cost of the stabilization equipment and is based on the following assumptions:

Mixer and Recycle Water System

- (1) 3.28 yd^3 high intensity mixer.

- (1) 400-gallon recycle water tank with electric motor-actuated 4-inch ball valve at tank drain.
- (1) Electric rubber diaphragm pump, 50 gpm against low head with automatic startup and shutoff per high-level and low-level liquid levels in sump.
- (1) Liquid level sensing system with ± 1/4 in. accuracy (for 400-gallon tank).
- (1) Top-entering agitator with 1/2 hp motor and gear drive.

Air Treatment System

- (1) Custom 300-gallon tank with integral Venturi scrubber and knockout pot and mist eliminator.
- (1) 50 cpm low-head progressive cavity pump.
- (1) 200 cfm Air Dryer (price includes 1 Hp motor).
- (1) 200 cfm Air Gear Pump (price does not include 7-1/2 hp motor).
- (1) Modular air filtration system (assuming 6,000 cfm system with prefilters, heater, and HEPA).
- (1) 6,000 cfm blower.
- (1) Stack.
- (1) 2,000 cfm HVAC system with a 30-ton refrigeration system.

Packaging Container Charging System

- (1) container elevator 4 in., 5-ton hydraulic lift.
- (1) Battery powered 4 ft. x 7 ft. cart on track.
- (1) 4.5 ft. x 4.5 ft. cell charging door and electric motor activator for vertical motion.
- (1) 4.5 ft. x 5 ft. x 10 ft. sealed vestibule under mixer.
- (1) Misting system for wetting surface of mix in containers.
- (1) 3 ft. x 8 ft. drip pan with electric motor activator.

Package Loading/Unloading and Storage System

- (1) 5-ton bridge crane with 24 ft. span and 50 ft. travel.
- (1) Custom container lifting frame.
- (1) Dedicated semitruck cab.

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Operating Cost

The operating costs for the inclusion of Silo 3 residues consist of the following components: packaging, transportation, disposal, and O&M.

O&M Cost

O&M costs incurred during implementation of this alternative are estimated based upon the operating parameters, feed requirements and throughputs described in Section 3.4. The following assumptions were also used to develop the estimate for this alternative.

- 1538 kWh/day electricity required for operations at $0.04/kWh.
- Ten laboratory personnel working 8 hrs/day throughout operations.
- Materials cost are estimated using $90/ton for portland cement and $80/ton for blast furnace slag.
- Three security officers working 8 hr/day shifts.
- Thirteen operators and safety personnel required for processing 8 hrs/day.
- Five maintenance personnel required 8 hrs/day.
- Labor rate of $23.35/hr.
- Six hours of operations per day, for five days a week.
- O&M cost for waste removal from Silo 3 are included in O&M costs.
- Retrieval is estimated to require 1.2 persons for 3 shifts per day.
- Retrieval electrical requirements are estimated at 121,500 kWh total electrical usage.

The O&M costs for ALT2 are summarized in Table 3.4-4 below.

TABLE 3.4-4

ANNUAL O&M COSTS SUMMARY - ALT2
(Millions)

ALTERNATIVE	STAFF	CHEMICAL	UTILITY	TOTAL COST
2	$1.5	$0.1	<$0.1	$1.6

Packaging

Packaging costs include the cost of purchasing the containers and the labor associated with handling and documentation. Estimated cost is based on the following:

- Packaging would be industrial packaging-type 2 (IP-2) containers with exterior dimensions of approximately 1.2 m (4 ft) width by 2.1 m (7 ft) length by 1.2 (4 ft) depth. Interior dimensions would be approximately 1.1 m (3.6 ft) width by 2 m (6.6 ft) length by 1.1 m (3.6 ft) depth, providing approximately 2.4 m^3 (84 ft^3) of packaging volume.

- Empty weight of each container would be approximately 455 kg (1,000 lb).

- Total payload of each container would not exceed a weight of approximately 4,100 kg (9,000 lbs) or a volume of approximately 2.4 m^3 (84 ft^3).

- The total volume of Silo 3 residues stabilized in Alternative ALT2 was assumed to be 4,830 m^3 (170,550 ft^3), with a bulk packaging density of 1,410 kg/m^3 (88 lb/ft^3).

- Total packaging cost was estimated assuming containers could be decontaminated and reconditioned for reuse three times for shipment of stabilized material to RPCDF. An estimated 2,520 containers would be required to ship material to the RPCDF. If each container was used three times, only 840 containers would need to be purchased.

- Standard packaging lid may require modification to include two flush mounted filling ports and one sampling port to facilitate loading of treated material by minimizing dust and particulate emissions.

- A unit cost of $1,556 per container was determined based on a material cost of $800 per unit, a 5.5 percent sales tax applied to the purchase price of each container, a labor cost of $545 per unit for handling and documentation, and a 12 percent risk budget.

Transportation

This cost item includes transportation of the packaged material and is based on the following assumptions:

- Silo 3 residues stabilized in Alternative ALT2 would be transported by truck to the RPCDF.

- Five packages would be placed on each truck for a gross shipping weight, including the weight of the container and its contents, of approximately 15,925 kg (35,000 lb).

- Transportation costs were estimated using a unit rate of $3,524 per truck shipment based on the current average shipping costs to the RPCDF and a 12 percent risk budget.

- Return shipments of reconditioned containers from the RPCDF were estimated also using the unit rate of $3,524 per truck shipment.

Disposal

- Silo 3 residues stabilized in Alternative ALT2 would be disposed at a RPCDF.

- Disposal volume was estimated to be 4,830 m^3 (170,550 ft^3) based on 2,500 batches required to stabilize all the Silo 3 residues, resulting in approximately 6,000 pounds of treated material produced per batch, at a bulk packaging density of approximately 88 lb/ft^3.

- The current Corps of Engineers contract with RPCDF states a range of costs for disposal of compactible material between \$8.50/ft^3 and \$12.50/ft^3 depending on the degree of handling required that may be associated with the material after receipt for disposal. Due to the envisioned handling requirements related to the dispersibility of Silo 3 residues and Radon-222 concentrations, the unit disposal cost was estimated at \$494/m^3 (\$14/ft^3), based on a disposal cost of \$12.50 ft^3 and a 12 percent risk budget.

- Unit cost for decontamination and reconditioning containers for reuse was estimated as \$112 per container., which includes a 12 percent risk budget. It is assumed that containers will be reconditioned after third use and sent back to the FEMP for use in other onsite projects.

Sensitivity Analysis

A sensitivity analysis was performed to determine the cost impacts of the final waste volume of the stabilized Silo 3 residues generated under Alternative ALT2. In the *"Summary of Screening Evaluation of Silo 3 Alternatives,"* included as Appendix B of this report, a process technology known as vacuum extrusion was identified as an alternative that may offer volume reduction capabilities.

The sensitivity analysis evaluates the potential cost impacts of implementing vacuum extrusion as a treatment alternative to reduce waste volume and therefore, minimize packaging, transportation, and disposal costs associated with implementing ALT2. The sensitivity analysis assumes that vacuum extrusion process would utilize the same formulation as the stabilization process discussed in ALT2 in order to meet the RPCDF waste acceptance criteria. The formulation presented in ALT2 results in an estimated 24 percent increase in waste disposal volume compared to untreated Silo 3 residues. The sensitivity analysis considered potential waste volume reductions of zero, ten, twenty, and thirty percent compared to the estimated waste disposal volume of 4,830 m^3 (170,550 ft^3) for the ALT2 treated Silo 3 residues. In addition to the impacts on packaging, transportation and disposal costs resulting from vacuum extrusion, the sensitivity analysis also considered capital costs associated with implementation, operation, and maintenance of the DOE-owned vacuum extrusion in comparison to the alternative evaluated in the discussion of ALT2.

In addition to the packaging, transportation, and disposal costs already discussed in this section, the following assumptions were used in this sensitivity analysis:

- The total weight of stabilized Silo 3 residues remained constant at 6,828,970 kg (15,008,720 lbs).

- The void fraction associated with packaged, stabilized Silo 3 residues remained constant at 20 percent.

- Assuming no reduction in stabilized material volume results in an effective packaging and disposal volume of approximately 4,830 m^3 (170,550 ft^3) and a bulk packaging density of 1,410 kg/m^3 (88 lb/ft^3).

- Assuming a 10 percent reduction in stabilized material volume results in an effective packaging and disposal volume of approximately 4430 m^3 (156,340 ft^3) and a bulk packaging density of 1,540 kg/m^3 (96 lb/ft^3).

- Assuming a 20 percent reduction in stabilized material volume results in an effective packaging and disposal volume of approximately 3,800 m^3 (134,010 ft^3) and a bulk packaging density of 1,800 kg/m^3 (112 lb/ft^3).

- Assuming a 30 percent reduction in stabilized material volume results in an effective packaging and disposal column of approximately 3,320 m^3 (117,260 ft^3) and a bulk packaging density of 2,060 kg/m^3 (128 lb/ft^3).

Table 3.4-5 presents the results of the sensitivity analysis of the packaging, transportation and disposal cost impacts resulting from implementing vacuum extrusion.

TABLE 3.4-5

PACKAGING, TRANSPORTATION AND DISPOSAL COST SUMMARY - ALT2, SENSITIVITY ANALYSIS OF VOLUME REDUCTION THROUGH VACUUM EXTRUSION

COST COMPONENT	PERCENT REDUCTION FROM VACUUM EXTRUSION			
	0% REDUCTION	10% REDUCTION	20% REDUCTION	30% REDUCTION
Packaging & Certification	$2,332,300	$2,131,800	$1,826,400	$1,596,400
Transportation	$3,556,200	$3,245,800	$3,478,700	$3,048,200
Disposal	$2,670,000	$2,446,400	$2,096,800	$1,834,900
Total	$8,558,500	$7,824,000	$7,401,900	$6,479,500
Delta	Base	$734,500	$1,156,600	$2,079,000

The results of the sensitivity analysis show that the overall packaging, transportation and disposal cost reductions would <u>not</u> be directly proportional to volume reductions. While it would nearly be proportional to the 10 percent volume reduction, it clearly would not for 20 percent and 30 percent. This could be attributed to the increased bulk packaging density of the material and the gross

container weight and transportation restrictions. Due to the 42,000 lb gross weight restrictions for truck shipments, only four containers could be placed on each truck under the 20 percent and 30 percent scenarios compared to five containers under the 0 percent and 10 percent volume reduction scenarios.

The decision to use vacuum extrusion as a cost savings optimization process would be based on several factors (i.e., product reliability and performance based on treatability study data, implementability, cost, etc.). Table 3.4-6 presents the estimated cost savings that could be achieved through vacuum extrusion calculated at various volume reduction percentages. If the DOE-owned vacuum extrusion equipment could be decontaminated at the DOE-Mound Site and transported to the FEMP for less than the estimated cost savings associated with the corresponding target volume reduction, then this option could be an economically viable element of the stabilization alternative.

TABLE 3.4-6

VACUUM EXTRUSION
COST-EFFECTIVENESS SUMMARY
(Millions)

STABILIZATION ALTERNATIVE	CAPITAL COST	PACKAGING, TRANSPORTATION & DISPOSAL COST	O&M COST	D&D COST	TOTAL COST	POTENTIAL SAVINGS
ALT2	$6.8	$8.6	$1.6	$0.9	$17.9	0
ALT2 with Vacuum Extrusion 0% Reduction	$6.3	$8.6	$1.6	$0.9	$17.4	$0.5
ALT2 with Vacuum Extrusion 10% Reduction	$6.3	$7.8	$1.6	$0.9	$16.6	$1.3
ALT2 with Vacuum Extrusion 20% Reduction	$6.3	$7.4	$1.6	$0.9	$16.2	$1.7
ALT2 with Vacuum Extrusion 30% Reduction	$6.3	$6.5	$1.6	$0.9	$15.3	$2.6

Decontamination and Decommissioning Cost

Decontamination and decommissioning costs are estimated by the following components:

- $83 per square foot of building area. The size of the building is estimated at 2,500 ft^2. D&D costs for this component is $0.21 million.

- Stabilization plant equipment is estimated at 180 manhours per equipment item, including an indirect labor factor of 1.5, at an average hourly salary for FDF labor assumed at $23,35 per hour. It is assumed 100 pieces of equipment require D&D. D&D cost for this component is $0.42 million.

- Project/Construction Management cost is estimated at 15.8 percent of subcontractor costs. D&D cost for this component is $0.1 million.

- Engineering cost is estimated at 3 percent of subcontractor costs. D&D cost for this component is $0.02 million.

- Waste Management is estimated at 12.1 percent of subcontractor costs. D&D cost for this component is $0.08 million.

- Risk (contingency) budget is estimated at 11 percent of total D&D costs. Cost for this component is $0.09 million.

The total estimated D&D costs for the stabilization facility is $0.9 million.

3.4.8 State Acceptance

This criterion measures the extent to which the comments made by the OEPA on the alternatives being considered are satisfactorily addressed. Because formal state comments will not be received until after this evaluation report has been issued for review, this modifying criterion will be addressed during the regulatory process following the public comment period.

3.4.9 Community Acceptance

This criterion measures the extent to which the comments made by the community on the alternatives being considered are satisfactorily addressed. Because formal public comments will not be received until after this evaluation report has been issued for review, this modifying criterion will be addressed during the regulatory process following the public comment period.

3.5 Removal, Off-site Stabilization, Disposal at the Representative Permitted Representative Disposal Facility

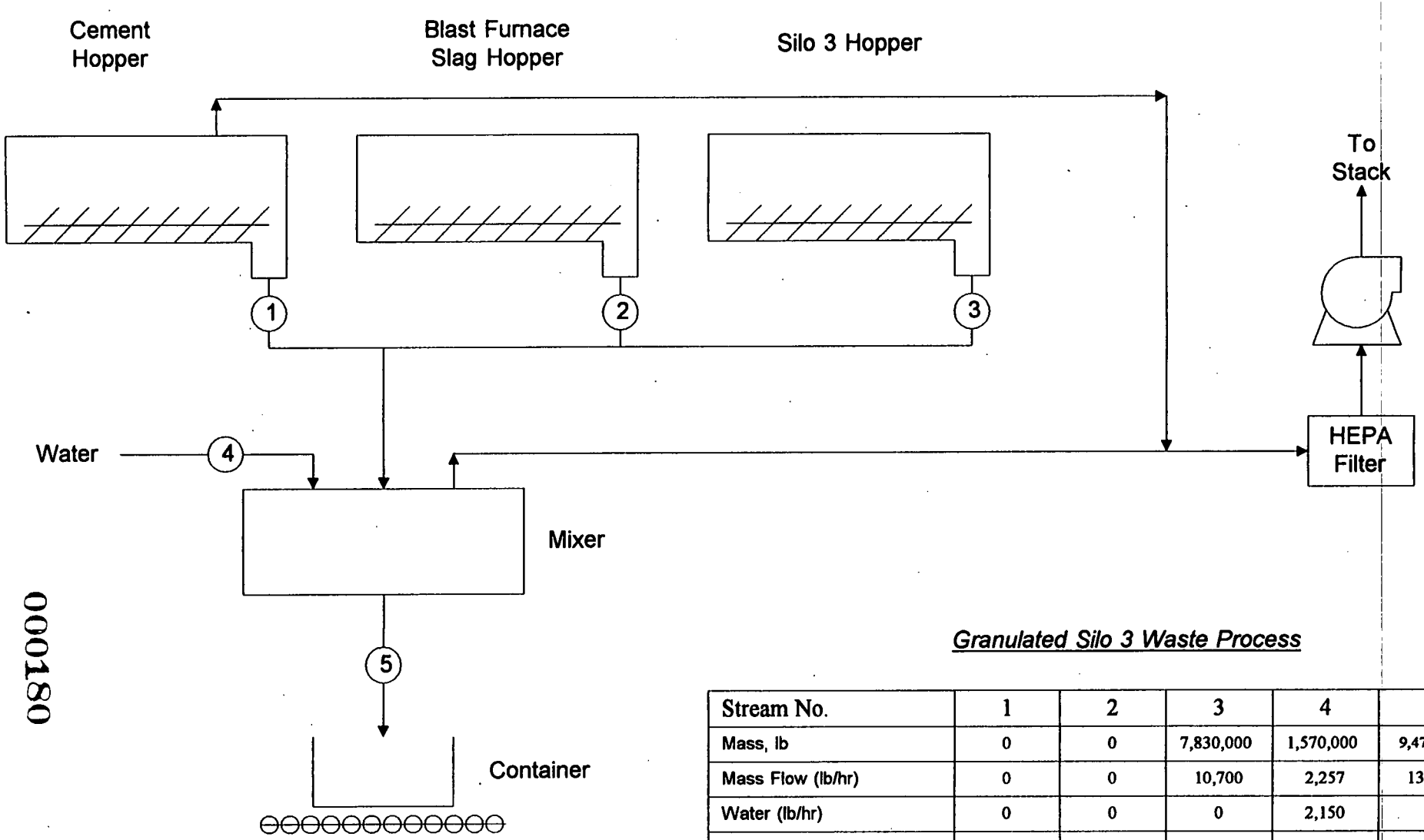
In this alternative (ALT3), the Silo 3 residues would be removed from Silo 3, conditioned for off-site transport in an onsite treatment facility, and transported to a RPCDF for final treatment and disposal. ALT3 is similar to ALT2, with the exception that only water and sodium silicate are blended with Silo 3 residues to wet them for handling purposes to reduce dispersibility prior to off-site transport. The primary differences in this alternative relative to ALT2 would be the following: 1) the portland cement and blast furnace slag storage silos are eliminated, 2) a sodium silicate feed tank is added, and 3) the conditioned waste is shipped to a RPCDF for both stabilization and disposal.

The treatment system described in this section is based upon data from the OU4 FS and has been developed as a viable way to implement this alternative. Equivalent systems may exist and are not precluded from consideration during remedial design, including the use of subcontractor-supplied treatment systems and services. Additional data obtained during treatability testing may also allow reduction of some process and containment controls described in this alternative.

Waste Conditioning

Conditioning would be performed within a temporary, metal sided building as described in Section 3.3 for ALT1. Material handling and conditioning equipment would be constructed as a sealed primary containment system, and a confinement room would be constructed around potential points of release. The confinement room would be constructed around the discharge of the screw feeder from the storage silo and the mixer. Negative pressure would be maintained on the room to prevent the release of airborne radioactive particulates.

Conditioning would be performed using a formulation mix consisting, by weight, of 83 percent Silo 3 residues, 13 percent water, and 4 percent sodium silicate. Conditioning of the Silo 3 residues would be performed as a batch process using a high intensity mixer that would be designed for completely enclosed operation. The mixer would be capable of completely mixing a batch size of 2.5 cubic yards (nominally 80 percent of a single container volume), which would produce approximately 4,330 pounds of conditioned waste containing approximately 3,580 pounds of Silo 3 residues. A total of 2,190 batches would therefore be required to stabilize all of the residues contained within Silo 3. At the completion of an extended mixing process, the conditioned material would be in a loose granular form for transfer to containers. Figure 3.5-1 presents a process flow diagram of the stabilization process.



Granulated Silo 3 Waste Process

Stream No.	1	2	3	4	5
Mass, lb	0	0	7,830,000	1,570,000	9,478,000
Mass Flow (lb/hr)	0	0	10,700	2,257	13,000
Water (lb/hr)	0	0	0	2,150	0
Sodium Silicate (lb/hr)	0	0	0	107	0
Batches/hr	0	0	3	3	3
Operating Hours/day	0	0	6	6	6

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Figure 3.5-1 Stabilization Process Flow Diagram - Alt 3

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Packaging Loading and Handling

Containers would be filled to approximately 80 percent of volumetric capacity at a loading station located directly below the mixer within the confinement room, as described in Section 3.4 for ALT2. Considering operational factors, a total of 729 processing hours would be required to condition all of the Silo 3 residues. At an assumed rate of 6 operational processing hours per working day, a total of 122 work days would be required to condition all of the Silo 3 residues.

Transportation and Disposal

With a maximum of six containers per semitrailer, an estimated 365 truck shipments would be necessary to transport all of the stabilized wastes to the RPCDF. The distance by truck to the RPCDF is approximately 2,900 km (1,800 mi).

3.5.1 Overall Protection of Human Health and the Environment

Implementation of ALT3 would meet the remedial action objectives for OU4 Silo 3 in the same manner as the ALT1 alternative described in Section 3.3, with the exception that final treatment of the Silo 3 residues would be accomplished off-site rather than onsite. There are no unacceptable short-term risks from this alternative. Direct contact with the waste material and releases to the air would be prevented by the use of operational controls and air filtration systems. Risks associated with the transportation of stabilized residues are expected to be low.

The removal of Silo 3 residues from the FEMP, followed by treatment and disposal off-site, provides the final element of protection. The RPCDF would provide protection by eliminating access to the waste and preventing migration of contaminants from the waste. The RPCDF would be located in a sparsely populated, preferably, arid environment with a low potential for leachate generation, contaminant release, migration, and direct contact with contaminants. The long-term effectiveness of the necessary institutional controls at the RPCDF is believed to be reliable.

3.5.2 Compliance with Applicable or Relevant and Appropriate Requirements

CERCLA requires alternatives that involve off-site treatment to comply only with those ARARs that have been identified as "applicable" requirements. Therefore off-site stabilization followed by off-site disposal at a RPCDF, heretofore identified as ALT3, need only comply with those ARARs that have been identified as "applicable" requirements in Appendix A for this alternative. However, both substantive and administrative parts of these requirements must be met. Compliance with the key "applicable" requirements identified in Appendix A for this alternative are summarized below.

Chemical-Specific ARARs and TBCs

ALT3 would comply with all applicable chemical-specific ARARs identified in Appendix A for this alternative. Included would be those CWA requirements associated with the Ohio Water Quality Standards and the control of radionuclide airborne emissions including radon-222 under the CAA. Compliance with SDWA MCLs and MCLGs would be ensured by removal of the source of waste to an off-site facility for treatment and disposal.

Raw Silo 3 residues are classified as 11(e)(2) byproduct material and are exempt from regulations under RCRA as specified in 40 CFR § 261.4(a)(4). However, the existing license at the RPCDF does not allow the receipt of the Silo 3 residues as 11(e)(2) material. Currently, Silo 3 residues can be received by the RPCDF only as low-level radioactive waste (LLRW). For the RPCDF to receive the material as LLRW, the residues must be shipped to the RPCDF as LLRW, which would in turn negate classification of the residues as 11(e)(2) byproduct material and negate the associated exclusion from RCRA requirements.

Since untreated Silo 3 residues contain heavy metals in leachate that exceed the limits for the toxicity characteristic under 40 CFR § 261.24, this reclassification would result in the residues being considered mixed waste under RCRA. Thus, the RCRA requirements for treatment, storage, and disposal, including those under the land disposal restrictions (LDRs), would be applicable to the transportation and management of the conditioned residues. Since remediation of the residues will be conducted off-site, CERCLA requires only "applicable" requirements be met. However, both the substantive and administrative parts to these "applicable" requirements must be met. This would require that the applicable permitting and recordkeeping requirements be met. The RPCDF would treat Silo 3 residues by stabilizing the RCRA metals to comply with the LDR treatment standards under 40 CFR § 268.41.

Furthermore, the EPA has issued a proposed rule (60 FR 43654) that when promulgated would require waste that exhibits the toxicity characteristic by either the extraction procedure (EP) toxicity test or the TCLP be treated to the new universal treatment standards (UTS) that have been previously promulgated for wastes characteristic for ignitability and corrosivity. As shown in Table 3.5-1, the UTS for metals that are proposed for toxicity characteristic waste are considerably lower than the existing treatment levels under the LDRs.

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Furthermore, the proposed rule would require toxicity characteristic wastes be treated to meet treatment standards for any underlying hazardous constituents (UHCs) reasonably expected to be present in those wastes at the point of generation. In addition to the RCRA metals presented in Table Table 3.5-2, the following metals would be considered UHCs for the Silo 3 residues: beryllium (Be), nickel (Ni), thallium (Tl), and vanadium (V). Although zinc (Zn) is present in the Silo 3 residues, per 40 CFR § 268.2(i), zinc is not considered to be a UHC in characteristic waste. Table 3.5-2 presents the treatment standards for the UHCs present in the Silo 3 residues.

TABLE 3.5-1

PROPOSED CHANGES FOR TC METALS (NONWASTEWATER)

TC Metal	Current LDR Treatment Level (mg/L TCLP)	Proposed UTS Treatment Level (mg/L TCLP)
Arsenic (D004)	5.0	5.0
Barium (D005)	100	7.6
Cadmium (D006)	1.0	0.19
Chromium (D007)	5.0	0.86
Lead (D008)	5.0	0.37
Mercury-retort residues (D009)	0.20	0.20
Mercury-all others (D009)	0.20	0.025
Selenium (D010)	1.0	0.16
Silver (D011)	5.0	0.30

TABLE 3.5-2

UNDERLYING HAZARDOUS CONSTITUENTS TREATMENT STANDARDS

UHC	UHC Treatment Level (mg/L TCLP)
Beryllium	0.014
Nickel	5.0
Thallium	0.078
Vanadium	0.23

Since the UTS for toxicity characteristic metal waste is currently a proposed rule, it could only be a TBC criteria under the ARAR process. In addition, since off-site remedial alternatives are required to comply only with "applicable" requirements, the proposed UTS is not required to be identified as an ARAR or TBC for ALT3. However, if the UTS for toxicity characteristic waste is promulgated prior to implementation of ALT3, Silo 3 residues classified as LLRW would be required to be treated to the UTS levels for both the RCRA metals and UHCs present in the residues by the RPCDF in order to be land disposed at the RPCDF.

Location-Specific ARARs and TBCs

ALT3 would comply with all applicable location-specific ARARs identified in Appendix A for this alternative. Included would be those requirements associated with the protection of floodplains and wetlands during preparation of the material for transport to an off-site facility for treatment and disposal.

Action-Specific ARARs and TBCs

ALT3 would comply with all applicable action-specific ARARs identified in Appendix A for this alternative. This alternative would comply with ARARs associated with NEPA (for environmental documentation), the CAA (for release of dust and nonradioactive particulates), and the CWA (for storm water runoff and dredge and fill activities).

Engineering design and controls would be used to attain compliance with RCRA Subtitle C for hazardous waste facilities. Construction and operational requirements for treatment and storage facilities, such as those specified in 40 CFR § 264 Subparts B, C, and D would also be complied with through design, planning, and the implementation of appropriate procedures. 40 CFR § Subpart G requires facility closure in a manner that minimizes the release of hazardous constituents. Compliance with these RCRA requirements is met with the incorporation of the appropriate design features. Remediation waste generated during cleanup operations would be managed in accordance with RCRA storage and closure requirements for containers (40 CFR § 264 Subpart I) and tank systems (40 CFR § 264 Subpart J).

As described for vitrification, contaminated media and debris, generated during remediation activities may be managed in a designated CAMU under 40 CFR § 264 Subpart S, to facilitate staging, treating, or packaging the material for off-site transport.

TUs, as provided in 40 CFR § 264 Subpart S, and/or containment buildings as provided in 40 CFR § 264 Subpart DD, might also be used under this alternative for the treatment or storage of remediation waste, including media and debris which may be contaminated with a hazardous waste. These units would comply with all pertinent ARARs, including closure of the units in accordance with the pertinent closure requirements of 40 CFR § 264 as necessary to ensure protection of human health and the environment from operation of these units.

Off-site disposition would require shipment of materials. Hazardous material transport requirements would be complied with by following the pertinent regulations under 40 CFR § 262 and 263, and the appropriate DOT shipping requirements and as mixed waste under 49 CFR Subchapter C Hazardous Material Regulations.

As stated previously, Silo 3 residues would be reclassified as LLRW for this alternative and would therefore be subject to requirements under RCRA, including the LDRs. The RPCDF would treat the Silo 3 residues by stabilizing the RCRA metals present in the material to comply with the LDRs and allow for land disposal at the RPCDF.

Other Requirements

In addition to the types and classes of ARARs described, other requirements exist that are neither ARARs nor TBCs. These other requirements do not fit into the applicable, relevant and appropriate, or TBC categories either because they are not promulgated regulations or because they are not environmental requirements subject to waiver or negotiation. This latter category includes those requirements such as site worker protection standards under the Occupational Safety and Health Administration and off-site transportation requirements found in DOT regulations.

Preconditioning of the Silo 3 residues is not required to meet DOT requirements for shipping radioactive material, nor is preconditioning an ARAR, because it is not an environmental regulation. Preconditioning of Silo 3 residues prior to shipment is necessary from a health and safety requirement. DOE has regulations in place to protect workers under 10 CFR § 835. Preconditioning of the Silo 3 residues before off-site treatment and disposal is necessary to reduce the dispersibility of the Silo 3 residues in order to meet design and control requirements for worker protection under 10 CFR § 835 Subpart K. The nature and extent of preconditioning of the Silo 3 residues will be dependent upon the vendor's proposed process waste form and disposal facility requirements. In

addition, as a Nuclear Regulatory Commission Licensed facility, the RPCDF would be required to meet worker protection requirements under 10 CFR § 20. Preconditioning to reduce the Silo 3 residues dispersibility and associated hazards prior to shipment would assist the RPCDF in meeting worker protection requirements.

3.5.3 Long-term Effectiveness and Permanence

Magnitude of Residual Risks

As with the ALT1 alternative described in Section 3.3, the implementation of ALT3 would reduce the residual risk to viable receptors to a HI of less than 0.2 and an ILCR of less than $1x10^{-6}$. Because all of the material is removed from the site, there would be no residual risk from Silo 3 residues at the FEMP site. Residual risk at the RPCDF would be limited by the disposal facility institutional controls, the characteristics of the cement stabilized residues, and the arid environment.

Adequacy and Reliability of Controls

Off-site treatment and disposal at the RPCDF is reasonably reliable because the facility has been inspected by the State and licensed for low-level radioactive, byproduct, mixed, and hazardous waste disposal. The institutional controls and potential for adequate facility maintenance are reasonably reliable at the RPCDF. Additionally, if there were a release at the RPCDF, the climate, hydrologic, and geologic characteristics would considerably reduce the potential for contaminant migration. The low population density of the area surrounding the RPCDF would also reduce the potential for direct contact with released materials.

Long-term Environmental Impacts

The long-term environmental impacts from removal and treatment actions of the ALT3 alternative are similar to those from the ALT2 alternative (Section 3.3.3).

3.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The ALT3 alternative uses cement stabilization to treat the inorganic hazardous and radioactive contents of Silo 3. As discussed in Section 3.3.4 for the ALT1 alternative, the OU4 treatability study evaluated two final cement formulations for solidification of Silo 3 residues, both of which produced a solid material form with significant compressive strength and TCLP results that were below the regulatory limits. Other formulations using reduced quantities of cement, other additives, and water may be equally effective in reducing the mobility of inorganics without significantly increasing waste volume.

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The formulation envisioned for stabilization of Silo 3 residues at the RPCDF would allow production of a final waste form that is nonmonolithic and compactible in nature. It is anticipated that this final waste form would have a somewhat granular nature, use reduced quantities of stabilization reagents and water, and require longer mixing times prior to discharge into transport containers. The final stabilization formula and the properties of the final stabilized waste form must be determined during additional future treatability testing.

The ALT3 wastes are likely to be less effective in reducing radon emanation as a result of their small granular form which provides a shorter path for radon emanation from the solid matrix. Although the treated wastes themselves may exceed the 20 pCi/m^2-s criteria established for DOE in 40 CFR § 61, the rate of radon emanation into the environment after placement in the RPCDF would be less than the criteria.

3.5.5 Short-term Effectiveness

Protection of the Community During Remedial Action

The moist granular nature of the conditioned ALT3 waste form should maintain a low potential for dispersibility of particulates during handling at the FEMP and during transportation to the RPCDF. The risk to workers and public have been calculated in Appendix D and have been found to be acceptable. The estimate of public radiation exposure, expressed in terms of ILCR, along the route to the NTS is 8×10^{-10} for the maximally exposed individual, far below the CERCLA target risk range of 1×10^{-4} to 1×10^{-6}. It is estimated that 0.1 injuries and 0.02 deaths may occur to the public due to transportation accidents.

When these wastes are received at the RPCDF they may have dried somewhat during transport and could pose an increased potential for airborne particulates. Additional dust control measures may therefore be necessary at the RPCDF during unloading and final treatment operations. Following final treatment at the RPCDF, the stabilized residues would be spread within the disposal cell using conventional heavy equipment, and further dust control measures (e.g., use of water sprays) can be implemented if necessary to adequately mitigate this risk.

Current FEMP access controls would be continued during remediation to prevent public access to the treatment processes. The potential short-term risks to the public are sufficiently small that even significant changes in the calculation assumptions would not change the conclusion that this alternative is effective in protecting the community in the short-term.

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Protection of Workers During Remedial Action

Protection of workers is discussed in Section 3.3.5 for ALT1. There are no unacceptable risks anticipated to result from implementation of the alternative. The most significant safety issue would be the potential for airborne radioactive materials arising from the handling of the Silo 3 residues and the treated wastes. This hazard would be controlled through the use of appropriate engineering controls as discussed in Section 3.3.5 for ALT1. Additional dust control measures would be implemented at the RPCDF as necessary to control dust when the stabilized Silo 3 residues are removed from their transport containers for final treatment and spreading within the disposal cell.

The risk to the remediation and nonremediation workers for removal and treatment of materials is detailed in Appendix D and are well within the occupational standards required by DOE Orders. It is estimated that removal and treatment of materials would result in an excess cancer risk level to remediation workers fo $3x10^{-4}$. Workers would wear protective clothing as appropriate.

Short-term Environmental Impacts

The short-term environmental impacts from removal and treatment actions of the ALT3 alternative would be the same as those from ALT1 (Section 3.3.5).

3.5.6 Implementability

The activities involved in this alternative would include: gaining regulatory approval for off-site cement stabilization of Silo 3 residues and disposal at the RPCDF; remedial design and procurement of necessary equipment, materials, and services; clearing and grubbing of areas around the silos and at the location of the material processing facility; construction of access roads, the pneumatic removal device, and materials processing facility; operation of the retrieval system and processing facility; transport of wastes to the RPCDF for final treatment and disposal; and disassembly and decontamination the processing equipment and facilities.

Technical Implementability

Technical implementability is discussed in Section 3.3.6 for ALT1. ALT3 is expected to be equally implementable because it uses the same standard technologies.

The temperature rise noted during treatability testing of Silo 3 residues would not be anticipated to present a problem for the ALT3 granular waste form based on the higher rate of heat transfer from the small particles. However, additional treatability testing would be necessary to identify the

appropriate stabilization formula to achieve a granular physical form, while adequately stabilizing TCLP metals.

The off-site transport to the RPCDF is straightforward and reliable. Off-site transport of wetted material to the RPCDF would consist of truck transport directly from the FEMP site to the RPCDF. The FEMP currently transports radioactive wastes by truck for off-site disposal. The treated residues would be placed into existing containers that currently meet transportation requirements.

Additional study would be necessary to further evaluate the implementability of disposal at the RPCDF. The granular nature of the ALT3 stabilized waste form may create a higher potential for airborne particulates during handling, primarily at the RPCDF where the wastes are spread within the disposal cell using conventional heavy equipment. Additional dust control measures could be implemented if necessary (e.g., use of water sprays) to mitigate this risk.

Administrative Implementability

Administrative implementability is discussed in Section 3.3.6 for ALT1.

Regulatory Implementability

As stated previously, the selected remedy for Silo 3 residues is vitrification followed by off-site disposal at the NTS. In addition, Section 3.3.6 of this document states that an ESD is required for differences that significantly change but do not fundamentally alter the remedy selected in the ROD.

Though the treatment process is not fundamentally altered by switching from vitrification to stabilization, since both technologies stabilize the residues to prevent leaching and reduce toxicity. ALT3 fundamentally differs from the selected remedy in regard to the location for both treatment and final disposition of the Silo 3 residues. Where the selected remedy identifies onsite treatment followed by off-site disposal at the NTS, ALT3 identifies a RPCDF as both the location for treatment and final disposal of the Silo 3 residues. Under ALT3, management (not ownership) of the Silo 3 residues during treatment and disposal changes from the DOE to the owner of the RPCDF.

In addition, further treatment of the Silo 3 residues would be required before final disposal at the RPCDF. To meet the radionuclide concentration levels established in the current RPCDF license, the conditioned Silo 3 residues may need to be blended with local soils or other material to reduce its overall radiological activity for a given placement (or lift) in the disposal cell.

Because ALT3 is a fundamental change from the remedy selected in the approved OU4 ROD, a ROD amendment would be required to change the selected remedy to off-site treatment and disposal at a RPCDF. To amend the OU4 ROD the following activities must be conducted:

- Issue a notice of availability and a brief description of the proposed amendment to the OU4 ROD in a major local newspaper of general circulation;
- Make the proposed amendment to the OU4 ROD and information supporting the decision available for public comment;
- Provide a reasonable opportunity, not less than 30 calendar days, for submission of written or oral comments on the amendment to the OU4 ROD;
- Provide the opportunity for a public meeting to be held during the public comment period at or near the FEMP;
- Keep a transcript of comments received at the public meeting held during the public comment period;
- Include in the amended OU4 ROD a brief explanation of the amendment and the response to each of the significant comments, criticisms, and new relevant information submitted during the public comment period;
- Publish a notice of availability of the amended OU4 ROD in a major local newspaper of general circulation; and
- Make the amended OU4 ROD and supporting information available to the public in the administrative record and information repository prior to the commencement of the remedial action affected by the amendment.

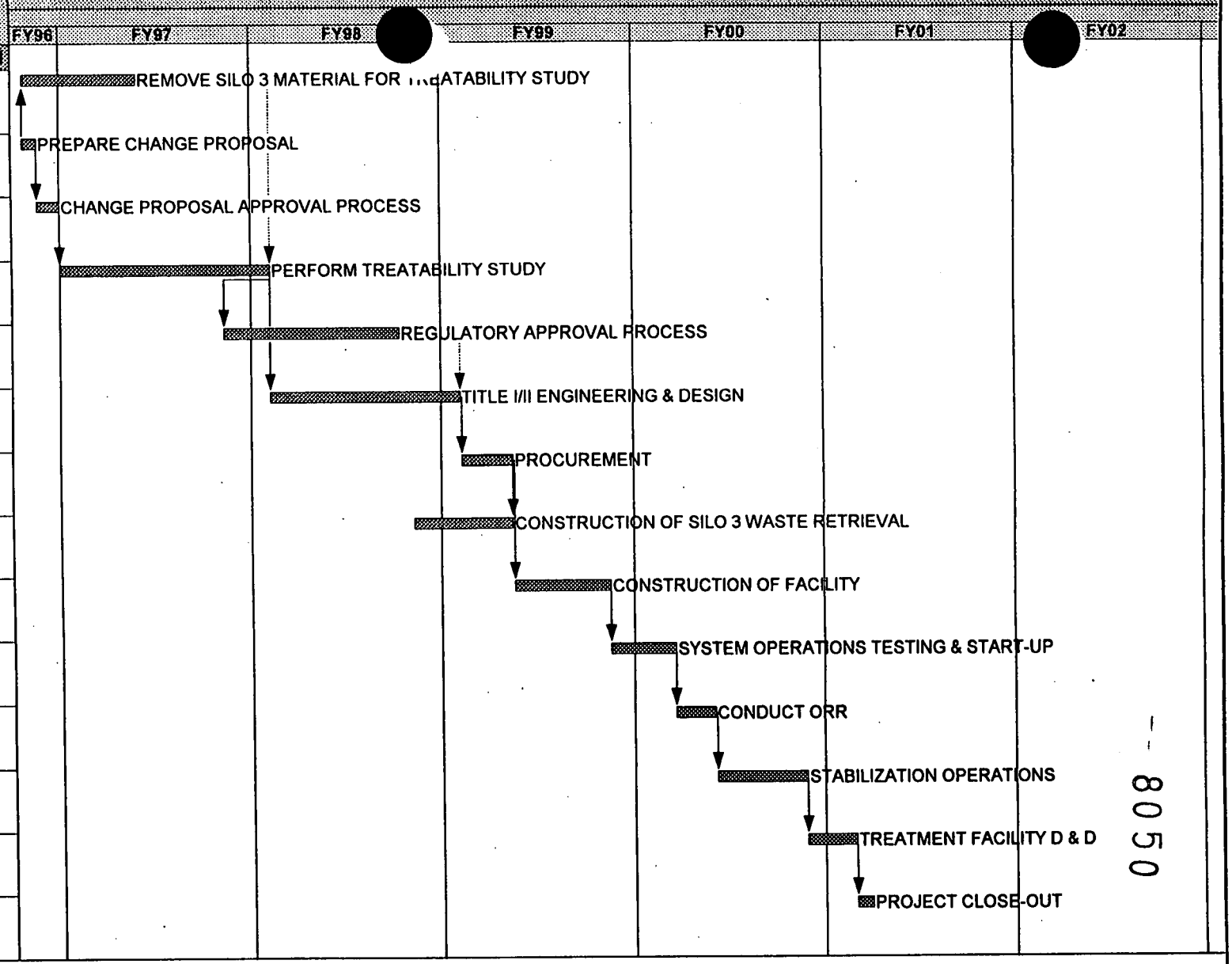
Availability of Services and Materials

The availability of services and materials are discussed in Section 3.3.6 for ALT1. The RPCDF currently accepts low-level waste, and it has adequate facilities to accept the wetted Silo 3 residues for final stabilization. Treatment facilities, transfer areas, storage areas, decontamination facilities, and a laboratory are available on the site. The treated residues would be tested to ensure that it complies with RPCDF waste acceptance criteria.

Schedule

Figure 3.5-2 presents the implementation summary schedule for ALT3. The schedule identifies all the activities, along with their durations and relationships, necessary to successfully implement the schedule. The schedule has been prepared with the assumption that adequate resources are available to support the schedule. Table 3.5-3 itemizes the activities and their durations.

Activity ID	Orig	Early Start	Early Finish
SILO 3 ALTE		E 3 - ACCELERATED SCH	
C3100	140	22JUL96	24FEB97
C3103	20*	22JUL96*	16AUG96
C3106	30*	19AUG96*	30SEP96
C3109	277	01OCT96	06NOV97
C3112	230	11AUG97	13JUL98
C3115	250	07NOV97	06NOV98
C3118	64	09NOV98	12FEB99
C3121	127	11AUG98	12FEB99
C3124	127	16FEB99	16AUG99
C3127	86	17AUG99	20DEC99
C3129	50	21DEC99	03MAR00
C3130	122	06MAR00*	25AUG00
C3133	64	28AUG00	29NOV00
C3136	20	30NOV00	29DEC00



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Project Start	01OCT95	Early Bar
Project Finish	11JUL02	Progress Bar
Data Date	01OCT95	Critical Activity
Plot Date	26JUN96	

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Sheet 1 of 1

ALTERNATIVE ALT 3 - IMPLEMENTATION
SUMMARY SCHEDULE
FIGURE 3.5 - 2

Fernald Environmental FEMP Restoration Management Corporation

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TABLE 3.5-3

SCHEDULE SUMMARY - ALT3

ACTIVITY	DURATION (WORK DAYS)
Perform Treatability Study	277
Regulatory Approval Process (ROD Amendment)	230
Title I/II Engineering & Design	122
Procurement	64
Construction of Silo 3 Waste Retrieval	127
Construction	127
System Operating Testing and Start-up	86
ORR	50
Stabilization Operations	122
Treatment Facility D&D	64
Project Close-Out	20

The remediation of Silo 3 under ALT3 can be started prior to commencing vitrification of Silos 1 and 2 according to the schedule presented in Figure 3.5-2.

Because additional data regarding process formulations exist for this alternative, both technical and programmatic, uncertainties are associated with the schedule outlined for this alternative. The duration of treatment is currently estimated at 122 work days based on estimated formulations and processing rates. The following uncertainties impact the schedule:

1) Ability of alternative formulations to produce required waste form
   - Formulation for conditioning
   - Volumes for transportation and disposal
   - Final density and amount in each container
   - Mixing time, throughput and process time

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2) RPCDF formulation requirements
   - Ability of waste to pass TCLP requirements
   - Equipment modifications to handle material

3) Flowability of waste form
   - Throughput
   - Hardware and procedures
   - Risks
   - Residue retrieval rate and downtime

4) Dusting characteristics
   - Hardware and procedures
   - Risks

5) Requirement for a ROD Amendment

6) Stakeholder Acceptance

3.5.7 Cost

The total life-cycle cost for removal of Silo 3 residues to an off-site RPCDF for treatment and disposal is $20.3 million as shown in Table 3.5-4. A detailed breakdown of the cost is provided in Appendix C of this report.

TABLE 3.5-4

LIFE-CYCLE COSTS - ALT3
(Millions)

Case	Capital Cost	Packaging and Certification Cost	Transportation Cost	Disposal Cost	O&M Cost	D&D Cost	Total Cost
ALT3	$6.7	$2.0	$2.6	$6.7	$1.4	$0.9	$20.3

Capital Cost

The capital cost associated with ALT3 include site preparation, construction of the removal/transfer system, and the stabilization processing facility. These costs are summarized in Table 3.5-5 below.

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TABLE 3.5-5

CAPITAL COSTS -ALT3
(Millions)

ITEM	ESTIMATED COST
Cementation Facility	$2.4
Silo 3 Retrieval	$2.3
Project & Construction Management	$0.7
Engineering	$0.9
Sales Tax	$0.1
Risk Budget	$0.3
Total Capital Cost	$6.7

Assumptions used to estimate the capital cost of each of the major components of this alternative are provided below.

Site Preparation

The basis of estimate for site preparation includes the following assumptions:

- An area of approximately 0.2 acres will be cleared and grubbed.
- Approximately 312 yd^3 of roads would be constructed in the remediation area. The roads would be constructed of compacted gravel.
- Filling would be performed where necessary. The volume of fill was estimated to be 105 yd^3. It was assumed that this soil could be obtained from onsite.
- Transfer conveyors and pneumatic piping would be installed between Silo 3 and the handling and process equipment.
- (1) 25 ft. x 100 ft. x 23 ft. high, engineered metal sided building with 17 ft. x 30 ft. x 10 ft. engineered annex building would have (2) roll-up doors, (5) personnel doors, and (5) windows.
- (1) 40 ft. x 10 ft. trailer with men's and women's change rooms and lunch room.

Confinement Room

- (1) 25 ft. x 26 ft. x 23 ft. room lined with epoxy coated thin-gauge steel sheet.
- (1) 4 ft. x 7 ft. steel access door.
- (3) Observation windows.
- (3) HEPAs for inlet air.

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- (2) Ceiling mounted I-beam 1-ton hoists.
- (1) 25 ft. x 15 ft. deck and staircase.
- (2) Glove port stations.

Removal/Transfer System

This cost component includes the storage hoppers, screw conveyors, and the load cell weighing system. Material will be removed from Silo 3 by a mechanical/pneumatic method, transferred by auger to an air pneumatic conveying system for transport to a storage hopper. Assumptions used for this cost estimate include:

Materials Storage and Feed

- (2) 2,100 ft^3 silo bins with rotary vane variable speed feeder, stand, railing, vibrator, manhole, cyclone, etc. for Silo 3 residues.
- (1) 18 in. diameter auger feeder (40 ft. long) with 5 hp motor.
- (1) Custom enclosure around auger and rotary vane feeders with drain to cell.
- (1) Fresh water feed system (inside) with 100-gallon isolation tank, 50 gpm 100 psi centrifugal pump, automatic refill capability (low-level start, high-level shutoff) and 200 ft. of 1 in. piping with (100) flush nozzles, (10) manual valves, and (5) solenoid valves.
- (1) Sodium silicate solution 5,000-gallon tank (outside) with 50 gpm 100 psi feed pump with 30 ft. of 1 in. pipe and two manual valves and one solenoid valve.

Stabilization

This cost item includes the cost of the stabilization equipment and is based on the following assumptions:

Mixer and Recycle Water System

- (1) 3.28 yd^3 high intensity mixer
- (1) 400-gallon recycle water tank with electric motor activated 4-inch ball valve at tank drain.
- (1) Electric rubber diaphragm pump, 50 gpm against low head with automatic startup and shutoff per high-level and low-level liquid levels in sump.
- (1) Liquid level sensing system with $\pm$ 1/4 in. accuracy (for 400-gallon tank).
- (1) Top-entering agitator with 1/2 hp motor and gear drive.

Air Treatment System

- (1) Custom 300-gallon tank with integral Venturi scrubber and knockout pot and mist eliminator
- (1) 50 gpm low-head progressive cavity pump.
- (1) 200 cfm Air Dryer (price includes 1 hp motor).
- (1) 200 cfm Air Gear Pump (price does not include 7-1/2 hp motor).
- (1) Modular air filtration system (assuming 6,000 CFM system with prefilters, heater, and HEPA).
- (1) 6,000 cfm blower.
- (1) Stack.
- (1) 2,000 cfm HVAC system with a 30-ton refrigeration system.

Packaging Container Charging System

- (1) container elevator 4 in., 5-ton hydraulic lift.
- (1) Battery powered 4 ft. x 7 ft. cart on track.
- (1) 4.5 ft. x 4.5 ft. cell charging door and electric motor activator for vertical motion.
- (1) 4.5 ft. x 5 ft. x 10 ft. sealed vestibule under mixer.
- (1) Misting system for wetting surface of mix in containers.
- (1) 3 ft. x 8 ft. drip pan with electric motor activator.

Package Loading/Unloading and Storage System

- (1) 5-ton bridge crane with 24 ft. span and 50 ft. travel.
- (1) Custom container lifting frame.
- (1) Dedicated semitruck cab.

Operating Cost

The operating costs for the inclusion of Silo 3 residues consist of the following components: packaging, transportation, disposal, and O&M.

O&M Cost

O&M costs incurred during implementation of this alternative are estimated based upon the operating

parameters, feed requirements and throughputs described in Section 3.5. The following assumptions were also used to develop the estimate for this alternative.

- 1538 kWh/day electricity required for operations at $0.04/kWh.
- Ten laboratory personnel working 8 hrs/day throughout operations.
- Three security officers working 8 hr/day shifts.
- Thirteen operators and safety personnel required for processing 8 hrs/day.
- Five maintenance personnel required 8 hrs/day.
- Labor rate of $23.35/hr.
- Six hours of operations per day, for five days a week.
- O&M cost for waste removal from Silo 3 are included in O&M costs.
- Materials cost estimated using $150,000 for sodium silicate.
- Retrieval is estimated to require an average of 1.2 persons for 3 shifts per day.
- Retrieval electrical requirements are estimated at 80,200 kWh total electrical usage.

The O&M costs for ALT3 are summarized in Table 3.5-6 below.

TABLE 3.5-6

ANNUAL O&M COSTS SUMMARY - ALT3
(Millions)

ALTERNATIVE	STAFF	CHEMICAL	UTILITY	TOTAL COST
ALT3	$1.2	$0.2	<$0.1	$1.4

Packaging

Packaging costs include the cost of purchasing the containers and the labor associated with handling and documentation. Estimated cost is based on the following:

- Packagings would be industrial packaging-type 2 (IP-2) containers with exterior dimensions of approximately 1.2 m (4 ft) width by 2.1 m (7 ft) length by 1.2 (4 ft) depth. Interior dimensions would be approximately 1.1 m (3.6 ft) width by 2 m (6.6 ft) length by 1.1 m (3.6 ft) depth, providing approximately 2.4 m^3 (84 ft^3) of packaging volume.
- Empty weight of each container would be approximately 455 kg (1,000 lb).

- Total payload of each container would not exceed a weight of approximately 4,100 kg (9,000 lbs) or an interior volume of approximately 2.4 m^3 (84 ft^3).

- The total volume of Silo 3 residues shipped for treatment at the RPCDF in Alternative ALT3 was assumed to be 4,140 m^3 (146,200 ft^3) with a bulk packaging density of 1,030 kg/m^3 (64 lb/ft^3).

- Total packaging cost was estimated assuming containers could be decontaminated and reconditioned for reuse three times for shipment of stabilized material to RPCDF. An estimated 2,190 containers would be required to ship material to the RPCDF. If each container was used three times only 730 containers would need to be purchased.

- Standard packaging lid may require modification to include two flush mounted filling ports and one sampling port to facilitate loading of Silo 3 residues by minimizing dust and particulate emissions.

- A unit cost of $1,556 per container was determined based on a material cost of $800 per unit, a 5.5 percent sales tax applied to the purchase price of each container, a labor cost of $545 per unit for handling and documentation, and a 12 percent risk budget.

Transportation

This cost item includes transportation of the packaged material, and is based on the following assumptions:

- Silo 3 residues would be transported by truck to the RPCDF for treatment and disposal.

- Six packages would be placed on each truck for a gross shipping weight, including the weight of the container and its contents, of approximately 14,560 kg (32,000 lb).

- Transportation costs were estimated using a unit rate of $3,524 per truck shipment based on the current average shipping costs to the RPCDF and a 12 percent risk budget.

- Return shipments of reconditioned containers from the RPCDF were estimated also using the prorated unit rate of $3,524 per truck shipment.

Disposal

- In Alternative ALT3 Silo 3 residues would be treated at the RPCDF prior to disposal. Treatment costs for Silo 3 residues at the RPCDF were estimated using a unit treatment cost of $1,186/$m^3$ ($33.60/$ft^3$) based on treatment costs for material requiring special handling and a 12 percent risk budget.

- Volume of Silo 3 residues requiring treatment is estimated at 4,140 m^3 (146,200 ft^3), based on 2,190 batches required to condition all Silo 3 residues resulting in approximately 4,330 pounds of treated material produced per batch at a bulk packaging density of approximately 64 lb/ft^3.

- Disposal volume was estimated assuming a 10 percent increase in volume of Silo 3 residues after treatment at the RPCDF, 4,555 m^3 (160,820 ft^3).

- The current Corps of Engineers contract with a RPCDF states a range of costs for compactible material between $8.50/ft^3 and $12.50/ft^3 depending on the degree of handling required that may be associated with the material after receipt for treatment and disposal. Since the RPCDF would be treating the Silo 3 residues under this alternative it is assumed treated material would be amenable to compaction at the RPCDF. Therefore a unit disposal cost of $335.35/m^3 ($9.50/ft^3) was assumed based on a unit disposal cost of $8.50/ft^3 and a 12 percent risk budget.

- Unit cost for decontamination and reconditioning containers for reuse was estimated at $112 per container which includes a 12 percent risk budget. It is assumed that containers will be reconditioned after third use and sent back to the FEMP for use in other onsite projects.

Decontamination and Decommissioning Cost

Decontamination and decommissioning costs are estimated by the following components:

- $83 per square foot of building area. The size of the building is estimated at 2,500 ft^2. D&D costs for this component is $0.21 million.

- Conditioning plant equipment is estimated at 180 manhours per equipment item, including an indirect labor factor of 1.5, at an average hourly salary for FDF labor assumed at $23.35 per hour. It is assumed 100 pieces of equipment require D&D. D&D cost for this component is $0.42 million.

- Project/Construction Management cost is estimated at 15.8 percent of subcontractor costs. D&D cost for this component is $0.1 million.

- Engineering cost is estimated at 3 percent of subcontractor costs. D&D cost for this component is $0.02 million.

- Waste Management is estimated at 12.1 percent of subcontractor costs. D&D cost for this component is $0.08 million.

- Risk (contingency) budget is estimated at 11 percent of total D&D costs. Cost for this component is $0.09 million.

The total estimated D&D costs for the conditioning facility is $0.9 million.

3.5.8 State Acceptance

This criterion measures the extent to which the comments made by the OEPA on the alternatives being considered are satisfactorily addressed. Because formal state comments will not be received until after this evaluation report has been issued for review, this modifying criterion will be addressed during the regulatory process following the public comment period.

3.5.9 Community Acceptance

This criterion measures the extent to which the comments made by the community on the alternatives being considered are satisfactorily addressed. Because formal public comments will not be received

until after this evaluation report has been issued for review, this modifying criterion will be addressed during the regulatory process following the public comment period.

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3.6 Removal, Onsite Blending with Waste Pit 5 Material, Off-site Disposal at the Representative Permitted Commercial Disposal Facility

The following description of the blending of Silo 3 residues with OU1 pit waste, hereafter referred to as ALT4, is based on the Title I Design for Operable Unit 1 (OU1). If this alternative is selected, the substantive components of the design will be provided with the request for proposal (RFP) for the Alternative Remedial Action Subcontracting Approach (ARASA). ARASA is an approach in which a subcontractor provides the services necessary to perform certain aspects of the remedy delineated in the OU1 ROD, with oversight by FDF.

Description

The following description summarizes the overall process. Detailed process descriptions are presented later in this section. The overall objective of the remediation of Operable Unit 1 (OU1) is to remove the pit wastes and other contaminated materials, treat them so they meet the WAC for disposal, load them into railcars, and ship them to an off-site disposal facility. To achieve this objective, a conceptual remediation process has been designed consisting of waste retrieval and transfer, waste preparation, drying and off-gas treatment, waste blending and loadout, and wastewater handling. The Silo 3 residues would be retrieved from the silo and transferred to a storage bin in the waste blending area near a tri-auger mixer intended to blend dry material with wet material. Since the Silo 3 residues are easily dispersible, provisions would be made to control dust emissions. The following paragraphs summarize the remediation process.

Most of the OU1 waste materials would be retrieved by standard mechanical excavation. The wet and dry waste materials would be transported by truck to the waste preparation area. The Silo 3 residues would be pneumatically conveyed to the blending area.

The waste preparation area operations would consist of (1) receiving and storing the retrieved waste, (2) blending, (3) waste segregation, (4) size reduction, and (5) debris management.

All OU1 material sent to the Debris Management Area would be manually segregated by sight. The remaining waste (after removal of ferrous and nonferrous metals) would be sent to a process shredder for size reduction, then transferred to the 2,650 cubic yard storage pile used to feed the dryer and mixer. This pile would be sampled and analyzed for total metals and specific radioisotopes before feeding to the dryer. Failed material would be reworked with incoming waste.

Part of the material from the 2,650 cubic yard storage area would be dried to a target moisture content of 10 percent (dry weight basis). Another portion of the 2,650 cubic yard storage pile would bypass the dryer and be blended with the dried product in an auger mixer in a ratio specified to achieve a moisture content of the waste within ± 5 percent of optimum, which is approximately 20% moisture. This material would be sent to the waste blending and loadout operation. The Silo 3 residues would be blended with Waste Pit 5 material that has passed through the dryer but has not been completely dried. The Silo 3 residues, being drier, would serve to absorb some moisture from the Waste Pit 5 material.

An indirect rotary dryer heated by combustion of natural gas would be used to dry the wastes. The waste would pass through the dryer concurrently with a controlled flow of heated sweep air.

The combustion gases would not come in contact with the waste. These combustion gases would be used as a source of heat in a heat economizer that would provide heated sweep air for the dryer. After leaving the heat economizer, the combustion gases would be combined with outside air for further cooling. The cooled combustion gases would then be released to the atmosphere through a dedicated exhaust fan and stack. The process off-gas leaving the indirect dryer would pass through the off-gas treatment system, which would remove water vapor and other volatiles, particulates, and acid gases.

The final operation in this remediation process is blending and loadout. Products from a single stage debris shredder, dry waste and soil, and product from the twin auger mixer would be blended, then transported by front-end loaders to storage piles. These piles would be sampled before loading into railcars for activity per mass only. Nonprocessable debris from the Debris Management Area and larger, nonprocessable debris from the waste pits would be placed on top of the waste already loaded into the railcars. The railcars would then be lidded, decontaminated, and shipped off site. At the final loading stage before shipping, the waste in the railcar would be at optimum moisture for compaction.

Wastewater handling is an important ancillary operation supporting the waste retrieval operation. Successful mechanical excavation would depend on control and removal of stormwater from the pits and the water that drains from the pit materials during excavation. Drainage water from the pit materials collected in the waste preparation area would also be handled by this operation. All of this water would be collected in a sump, then pumped either directly to the Biodenitrification Surge

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Lagoon, or to the Clearwell and then to the Biodenitrification Surge Lagoon, with final treatment at the FEMP wastewater treatment system.

Site Preparation

Site preparation would begin with clearing and grubbing vegetated areas in preparation for the material processing facility, construction of roads, equipment staging areas, and other site facilities.

Contaminated soils encountered would be managed in the same manner as contaminated surface soils. Site preparation activities would include the construction of roadways; implementation of soil erosion control and stormwater management measures; and installation of site fencing, lighting, process water piping, sewer lines, and power poles. Processing elements to be constructed would include a waste preparation facility, a drying facility and a blending and loadout facility. These facilities would be a pre-engineered metal buildings that would house the equipment, storage, and work areas associated with each part of the process. Concrete floors would be sloped to drain excess free water from stockpiled waste.

Removal of Residues from Silo 3

This process is described above in section 3.2, Removal, Onsite Vitrification, Off-site Disposal at the NTS.

Excavation

Both top and bottom excavation methods would be employed in which one set of equipment would be on top of the pit cap (i.e., on top of the soil cover overlying the pit waste) to strip the cap and waste, and a second operation would simultaneously complete waste removal from the pit bottom. Equipment operations are not planned or anticipated to occur directly on pit wastes. Operations would be performed on top of pit caps and on the pit bottoms.

Waste Pit 5 Material Preparation

The Waste Pit 5 material would arrive by truck at the waste preparation area. A contingency stockpile (maximum 7,000 cubic yards) would be maintained, but not used, on a continual basis. The contingency stockpile location is shown on the project preliminary site plan (Figure 3.6-1). The stockpile would be covered to provide ready access to waste materials if inclement weather (or other factors) restrict excavation in the waste pits. The stockpile would incorporate a liner and wastewater

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collection to remove water draining from the waste. Wet materials would be stockpiled to take advantage of natural drainage.

The primary wet and dry pit waste streams would be dumped into their respective storage pits as shown in Figure 3.6-2. This sketch shows the location of the transfer area and storage pits for the primary waste streams. Wet waste would be kept in the storage pits for approximately three days to allow free moisture to drain before further processing. Handling and destination of wastewater collected at various locations in the waste preparation area is discussed in the Wastewater Treatment section.

In the initial preparation step, waste would be retrieved from the pits to blend wetter and drier materials to achieve a waste material that is handleable. This mixing would be performed by operator discretion, with the purpose and objective of preparing a blended working pile suitable for material handling and size separation. Waste Pit 5 retrieval and mixing would be accomplished with the front-end loader in the working pile area of the Waste Preparation Area.
The Silo 3 residues would be retrieved from the silo and transferred to a storage bin in the waste blending area near a tri-auger mixer intended to blend dry material with wet material. Since the Silo 3 residues are easily dispersible, provisions would be made to control dust emissions.

Waste Segregation

The first step in waste segregation would be to remove debris larger than 12 inches from the blended waste stream. Waste from the blended working pile would be retrieved using front-end loaders and transferred to a skip hoist, which would dump the waste onto an apron feeder, for transfer to a vibrating grizzly with 12-inch openings. Oversize material (> 12 inches) from the grizzly would be collected in a pile, then transferred to the Debris Management Area by means of a front-end loader. Undersize material (< 12 inches) from the grizzly would be discharged onto the grizzly undersize conveyor. Two separate operations occur on the undersize conveyor: ferrous metal removal and nonferrous metal removal. Ferrous metal would be separated from the waste by a magnetic belt separator. The separated ferrous metal would be collected in a pile, then transferred to the Debris Management Area by a front-end loader. Nonferrous metal would be detected in the waste by a metal detector, and the waste flow would be diverted momentarily to remove the detected material. The separated nonferrous metal would be collected in a pile, then transferred to the Debris Management Area by a front-end loader.

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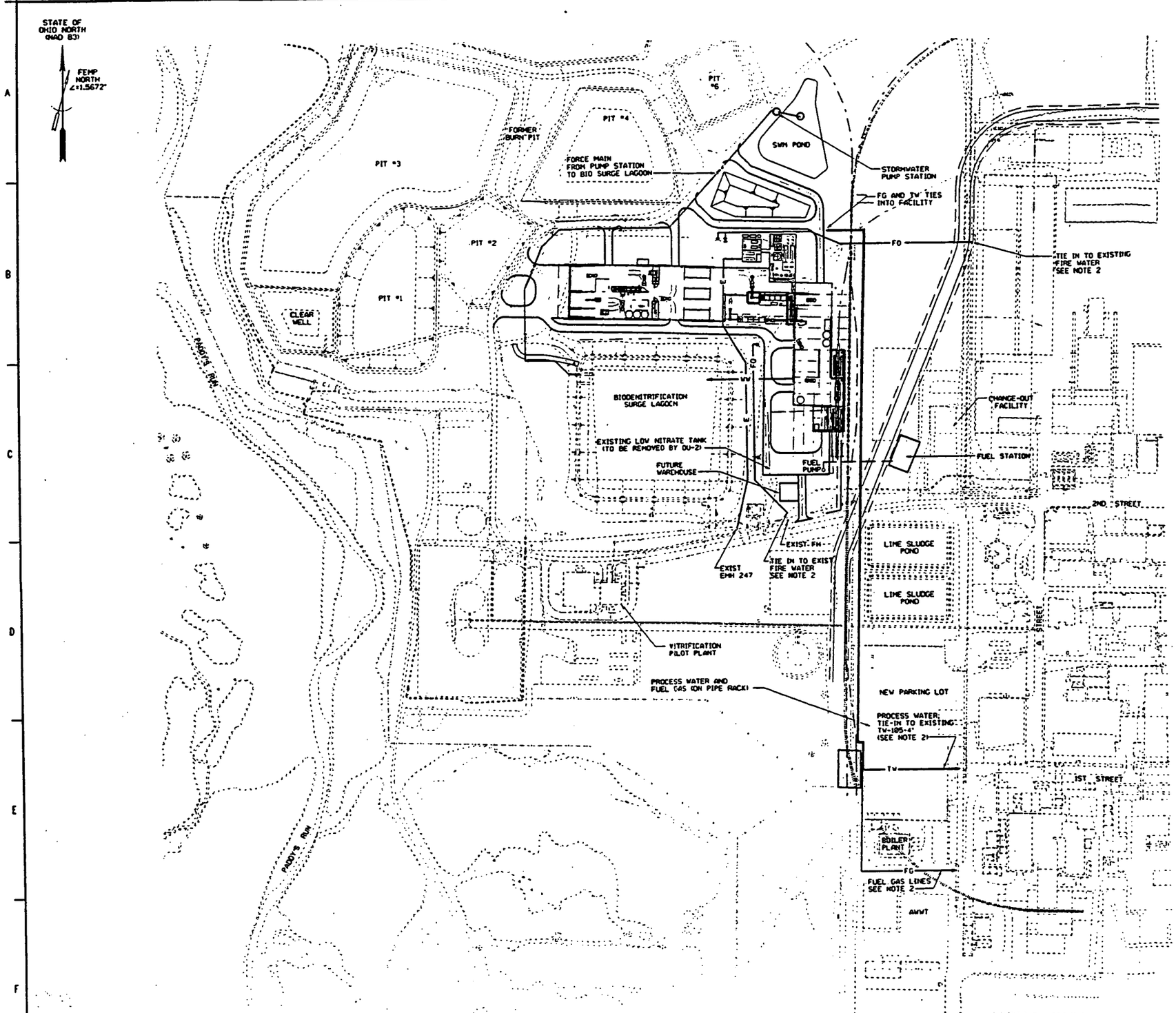

FIGURE 3.6-1

NOTES

1. EXISTING CONDITIONS SHOWN ON THIS DRAWING WERE PREPARED FROM FEMP SITE PROVIDED DATA FROM THE DOCUMENTS LISTED BELOW.

   EXISTING SITE DATA SOURCE (IN PLANT FILES)
   FEMP 1992 FLYOVER SURVEY
   FEMP CONTRACTOR PROJECT DESIGN DOCUMENTS

2. INTERFACE POINTS WITH EXISTING UTILITY LINES MAY CHANGE DURING TITLE DESIGN.

3. THIS DRAWING SUPERSEDES DRAWING NO. SK-G-03666 REV. B.

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LEGEND

EXISTING		PROPOSED
	ROAD/PAVEMENT	
	RAILROAD	
	STRUCTURE	
	FENCE	
	FIREWATER LINE	FO
	PROCESS WATER	TW
	WASTEWATER	WW
	ELECTRICAL	E

REF DWG NO.	DRAWING TITLE
SK-G-04164	PRELIMINARY SITE PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

REV. NO.	REVISION PURPOSE - DESCRIPTION	DRAWN	CHECKED	DATE
A	ISSUED FOR CLIENT REVIEW PREFINAL DESIGN FOR EPA	RA		2/19/96

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
OU1 REMEDIATION SYSTEM DESIGN

DRAWING TITLE
CIVIL
PRELIMINARY UTILITY PLAN

DRAWN BY	DATE	LEAD ENGINEER	DATE	CHECKED BY	DATE
Y. AFSHAR	01/30/96			ED KUBRIN	2-6-96

PROJECT/BLDG. NO.	FLOOR	SCALE	CLASS
		1"=100'	

SUBMITTED FOR APPROVAL	FUNDED ON APPROVAL
	NA

PREPARED UNDER PARSONS PROJECT ORDER NUMBER	SAE PROJECT NO.	FEMP PROJECT NO.	DRAWING REV. CODE NO.	SHEET NO.	REV.
WPRAP/P0145		VBS LLLLLJJ 00-90701	SK-G-04165	G0002	

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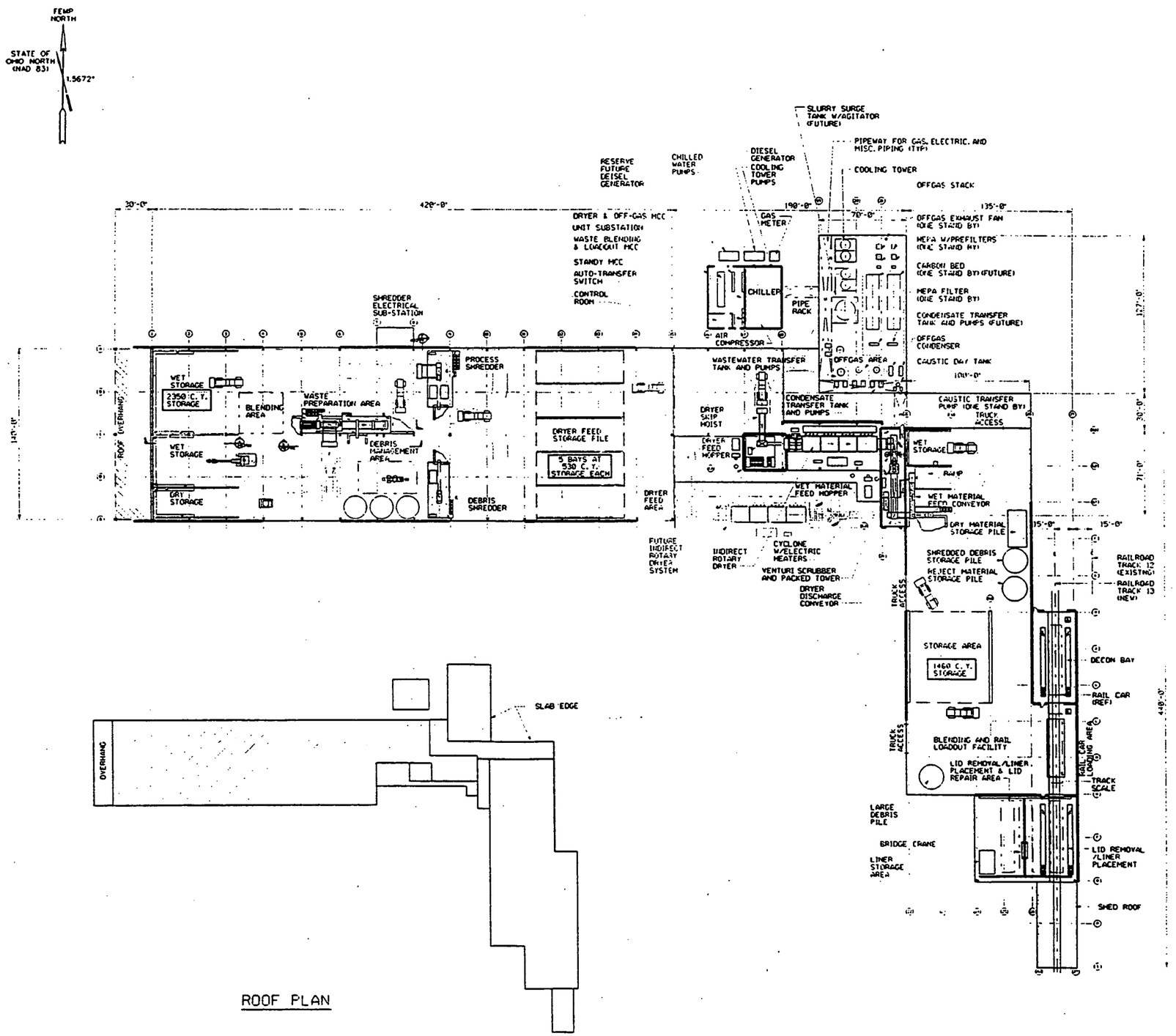

NOTES

1. MOBILE EQUIPMENT WILL BE SUPPLIED WITH ENGINEERED CONTROLS TO MAINTAIN WORKER EXPOSURE ALARA.

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LEGEND

- PARTIAL WALL
- FULL HEIGHT WALL
- CONCRETE PAD
- ROOF OVERHANG

REF DWG NO.	DRAWING TITLE
SK-M-03917	PLAN - WASTE PREPARATION AREA
SK-M-03919	PLAN - DRYING AREA
SK-M-03921	PLAN - BLENDING/RAIL LOADOUT AREA
SK-G-03942	CIVIL SITE - PLAN

PRELIMINARY
NOT FOR CONSTRUCTION

REV. NO.	REASON FOR REVISION - DESCRIPTION			DATE
D	ISSUED FOR EPA SUBMITTAL PREFINAL DESIGN			2/19/96
C	ISSUED FOR CONCEPTUAL DESIGN (CLIENT COMMENTS INCORPORATED)			
B	ISSUED FOR CONCEPTUAL DESIGN (CLIENT COMMENTS INCORPORATED)			
A	ISSUED FOR CONCEPTUAL DESIGN			

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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CINCINNATI, OHIO

PROJECT NAME
OU1 REMEDIATION SYSTEM DESIGN

DRAWING TITLE
MATERIALS HANDLING
GENERAL ARRANGEMENT PLAN
PIT WASTE REMEDIATION FACILITY

DRAWN BY: FON TERRY — DATE: 10-3-95 — LEAD ENGINEER — DATE — CHECKED BY: V. TULI — DATE: 10-3-95
PLANT/BLDG NO — FLOOR — SCALE: 1/8" = 1'-0" — SHEETS
SUBMITTED FOR APPROVAL — FERNALD ENV. APPROVAL: N/A 000208
DOE PROJECT NO — DATE — DATE

PARSONS UNIT FILE/DWG PROJECT CODE NUMBER: WPRAP/F0145 — FEMP PROJECT NO: WBS 1.1.1.1.1.3.1 00-90701 — DRAWING SHEET CODE NO.: SK-M-03916 — SHEET NO: M0011 — REV. NO: D

FIGURE 3.6-2

After the ferrous and nonferrous material is removed from the waste, the remaining waste would discharge from the grizzly undersize conveyor into a pile, then would be transferred by front-end loader to the process shredder skip hoist. The shredder skip hoist feeds the waste to the process shredder. The process shredder size reduces the waste and debris to 4 inches cubed or less.

The smaller-than-4-inch material from the process shredder would be used to form five 530-cubic yard piles (2,650-cubic yards). Part of this storage pile would be fed directly to the dryer, which would reduce the moisture content in this feed to approximately 10 percent dry wt.% (9 percent on a wet weight basis).

Debris Management

The Debris Management area would be in the Waste Preparation Area and would receive the large processable debris from excavation, the grizzly oversize, the ferrous metal from the grizzly undersize, and the nonferrous metal from the grizzly undersize. Once in the Debris Management Area, these wastes would be segregated, using a backhoe with a grapple, into three waste streams. Any derbies (or pieces of uranium, croptops, etc.) found during this segregation would be collected and sent to FEMP Materials Management for handling. Bulky or awkward debris that requires size reduction would be sent to a debris shredder for processing, and would then be transported to the blending area. The remaining debris from the Debris Management Area would be transferred to railcar loading, where it would be placed on top of the waste loaded into the railcar from the blending area. This operation would be carried out using a front-end loader.

Thermal Treatment

An indirectly heated rotary dryer would receive and process wet waste material of various moisture contents, depending on the type of waste. The dryer would reduce the moisture content of the waste materials to 10 percent (dry weight basis). Waste material would be fed to the dryer primarily from the 2,650-cubic yard storage pile. Materials from the storage pile would be transferred to a skip hoist using a front-end loader. The skip hoist would dump into the dryer feed hopper placed over the feeder and feed conveyor, which would deliver the material into the dryer. Feed spirals inside the rotating shell of the dryer would convey the feed materials quickly into the heated section of the dryer.

Slurry feed to the dryer would be provided as a means to accommodate the hydraulic retrieval contingency only, and is not anticipated to be part of the normal operation. However, if slurry feed is

required, waste slurry from a tank truck would be metered directly to the feeder where it would be mixed with the normal feed (to avoid having to make dramatic adjustments to the dryer operations) discharging from the dryer feed hopper.

The rotary dryer system would consist of a cylindrical shell rotated with a variable speed drive. The rotating cylinder would be heated externally by a furnace with adequate length to satisfy heat transfer requirements. Using natural gas as fuel for combustion, heat energy for the indirect drying would be produced in multiple furnace zones by a set of burners in each zone. The indirect rotary dryer would have multiple furnace zones and would be provided with individual temperature control of each zone. This ability to control the temperature throughout the dryer would provide flexibility and simplicity in drying wastes with varying levels of incoming moisture content to achieve the desired moisture content in the dried product. The slope and speed of the cylinder's rotation would determine the retention time in the dryer. The slope would be fixed, but the rotation speed would be variable and would be used to adjust the retention time as necessary, providing additional control of the drying process.

Preheated sweep air would be introduced to the dryer in a cocurrent direction to aid in both heating the waste and carrying the vapors produced during the drying process through the off-gas treatment system. After exiting the dryer, the process off-gas stream would be drawn first through the heated cyclone and then through the rest of the off-gas treatment. The cyclone would remove the larger particulate matter entrained in the process off-gas, while keeping the steam and vapors in the process off-gas from condensing. The captured particulate matter would be blended with the dryer product.

The dryer product would be discharged into a hopper that feeds the dryer discharge conveyor. The conveyor delivers the dried product to a twin auger mixer, where it would be blended with wet (not dried) waste from the 2,650 cubic yard storage pile or Silo 3 residues in a ratio specified to achieve the optimum moisture content (about 20%) at the railcars.

<u>Dryer Operating Data</u>

- Operating time: 24 hours per day, 7 days per week
- Equipment: Indirect rotary dryer with the furnace surrounding cylinder
- Maximum dryer feed rate: 22 tons per hour (wet) (nominal, to be determined by vendor)
- Maximum dryer feed size: 4 inches (any direction)

- Maximum evaporation rate: 4.2 tons of water per hour
- Dryer product moisture percent: 10 percent (dry basis)
- Product temperature: 250°F (maximum)
- Dryer/furnace fuel: Natural gas
- Natural gas gross heat value: 1,027 British thermal units/standard cubic foot
- Natural gas supply pressure: 60 pounds per square inch gauge
- Natural gas composition: CH_4 (96 percent), C_2H_6 (1.9 percent), N_2 (0.036 percent), other (2.064 percent)

Off-gas Treatment System

The first step in the off-gas treatment system would be removal of large entrained solids in the electrically heated cyclone. The cyclone would be heated to prevent condensation of acid gases, steam, and organics within the unit. The cyclone off-gas would pass through a venturi scrubber for further removal of solids to protect the downstream equipment from solids buildup. From the venturi scrubber, the off-gas would pass through a packed tower scrubber equipped with a mist eliminator where most of the acid gases would be removed. The scrubber would use a caustic solution that would be maintained at the desired strength in the combined sump for the two scrubbers.

The off-gas from the packed tower would then be cooled and condensed (water and organics) in two shell-and-tube heat exchangers operated in parallel using chilled water as the cooling medium. An electric air heater would be used to reheat the off-gas leaving the condenser, thus reducing its relative humidity to prevent condensation in the downstream medium efficiency particulate air (MEPA) filters and HEPA filters. Finally, the off-gas would pass through the induced-draft fan and the stack before release to the atmosphere.

Chilled water would be used as the cooling medium at this time since a carbon bed for radon removal would possibly be a future addition to the off-gas treatment system. To be effective at radon removal, the carbon beds must operate at a low relative humidity (<30 percent) and thus the off-gas temperature must be dropped sufficiently. If the carbon beds are removed from future consideration, based on the radon emission and working level limits, the chilled water could be replaced with cooling water (using a cooling tower instead of a chiller).

The scrubber bleed would be sent to the contaminated water collection tank. The much cleaner

condensate stream would be sent to the recycle water collection tank. Both liquid effluent streams pass through small transfer tanks from which they would be pumped to their respective collection tanks.

Waste Loadout and Storage

The Blending Area would receive waste from four different sources: material from a debris shredder, dry material storage, material from the twin auger mixer, and dryer bypass. These materials would be retrieved from their respective storage with a front-end loader and blended on a pad with the same front-end loader for ease of handling and to achieve the desired moisture content. The operator would determine the blending ratio of these materials. After blending, the material would be transferred to a storage pile and a grab sample would be pulled before loading into railcars.

The loadout facility would consist of three discrete areas. Area 1 would be the railcar lid removal and liner placement area; Area 2 would be the railcar loading area, and Area 3 would be the decontamination area. A car mover would move the railcars into the various areas of the facility. The facility equipment would be under a roof to prevent exposure to precipitation. The facility would have a curbed concrete floor that would be sloped to a sump to provide containment for any liquids, such as windblown precipitation.

If a particular car does not meet all of the shipping and disposal requirements, then the car would be removed from the train and returned by the yard locomotive to the loadout facility. Once the lid is removed, a backhoe or other suitable equipment would be used to remove the waste from the car and transfer it back to the blending area via a dump truck. Here, it would be blended with other waste to meet the shipping and disposal requirements. Reject waste could be blended with other waste either in the waste loadout or waste preparation areas.

The waste loadout facility would be operated one shift (8 hours) per day, 5 days per week, 52 weeks per year, and would be designed for a loadout rate of 680 tons/day.

Transportation and Disposal

To support rail transportation operations, a major upgrade of facilities at the FEMP would be required. Site improvements would include construction of the waste loading facility, and installation of fencing around all tracks.

Before releasing the unit train from the FEMP, the train would be radiologically surveyed, and inspected for mechanical safety (e.g., brakes). In addition, shipping papers would be prepared for the railroad and the disposal facility. The disposal facility would require certification that the waste has been analyzed and meets the disposal facility's WAC.

CSX Transportation, Inc., (CSXT) would move the loaded unit trains from the FEMP through Cincinnati, Ohio, to East St. Louis. Union Pacific Railroad Company (UPRR) would move the unit train from East St. Louis to the RPCDF.

The away-from-site round-trip cycle for a unit train would be 16 calendar days that include one day for delays en route, and five days at the disposal facility. With the addition of two days (one at the start and one at the conclusion of the trip) for assembling and breaking-down the unit train at the FEMP, the total cycle time used for planning purposes is 18 calendar days.

Tracking the location of railcars is standard practice with all major railroad companies. Tracking data would be received from railroad transponders at main switches along the tracks. With this system, the location of each car can be determined based on the last transmission. WPRAP's traffic management organization can access the system to determine the locations of the trains/cars at any time. If cars are stopped due to a transportation incident, the FEMP would be immediately notified by the railroads' control centers.

It is assumed that the RPCDF is licensed to accept for disposal the following: (a) specific low concentrations of radionuclides within LLRW classification; (b) Naturally Occurring Radioactive Material (NORM); (c) mixed waste; and (d) 11(e)(2) byproduct materials (uranium and thorium mill tailings). The disposal facility of approximately 540 acres is next to a DOE mill tailings disposal site (100 acres). The facility is near Clive, Utah, about 75 miles west (65 miles by air) (NRC 1993) of Salt Lake City, Utah. The disposal facility has been successful in working with their regulators to obtain additional licenses and processing amendments to its existing licenses and has ample disposal capacity to accept WPRAP material. The disposal site is one mile south of the main line of UPRR and is connected by a rail spur. It has facilities to hold 300 railcars at one time. Gondola cars would be unloaded with a rollover device.

The FEMP would attempt to ensure that all waste material shipped to the disposal facility meets its WAC. The FEMP would perform confirmatory analysis before shipping to the treated residues

disposal facility. The disposal facility can treat and dispose of nonconforming waste, such as waste with free liquids or waste that fails TCLP. Waste that does not conform to the accepted waste profile at the FEMP would be sent to the Disposal facility for treatment and disposal. In the unlikely event that any waste arriving at the disposal facility does not conform to the accepted waste profile, based on the facility's sampling and analysis of the waste shipment, then the waste material would not be unloaded. The FEMP would be notified immediately, and the material would be resampled and reanalyzed. If the material fails the more rigorously sampled second analysis, the RPCDF would treat and dispose of the material. Due to the waste acceptance procedure of the NTS, transshipment from the RPCDF is not currently believed to be feasible.

3.6.1 Overall Protection of Human Health and the Environment

This alternative meets the remedial action objectives for OU1 and OU4 and would be protective of human health and the environment. The pit wastes would be excavated, treated, and transported off-site for disposal and the restored pit area would be covered with a multimedia cap. Implementation of this alternative would prevent direct access to contaminated soil and would mitigate the migration of contaminants to the air, surface soil, and groundwater.

The off-site disposal would provide a major element of protectiveness. A permitted commercial facility in an arid environment would be protective against direct contact with the pit waste material and migration of contaminants and material. Disposal at an off-site permitted commercial facility is subject to some uncertainties associated with long-term protectiveness. Since the facility owner maintains operations according to applicable permits, protectiveness is ensured. It should be noted that there are no residences within 40 miles of the representative facility. Due to extremely harsh climatic conditions, it is unlikely that these population trends would change. Also, there is no valuable groundwater resource at the facility. There is no surface water at the facility. These factors mitigate some of the above-referenced uncertainties.

There are no unacceptable short-term risks from this alternative. The transportation risks are less than those for disposal at the NTS because the waste can be sent in bulk by rail instead of a rail/truck combination (See Appendix D of the OU1 FS). Through the implementation of a worker health and safety plan in compliance with 29 CFR 1910.120(b)(4), exposures would be kept to ALARA levels and would comply with DOE orders.

3.6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Issues related to ARAR compliance for blending Silo 3 residues with material from Waste Pit 5, heretofore identified as Alternative ALT4, are discussed below. As part of Operable Unit 1, material in Waste Pit 5 will be excavated, thermally dried to a moisture content of twenty percent, and transported by rail to a RPCDF for final disposal. The ARARs and TBCs that pertain to the OU1 selected alternative are presented in Appendix F of the OU1 Feasibility Study. The ARARs and TBCs for Alternative ALT4 would be similar to those identified for the OU1 selected alternative and are presented in Appendix A of this document. Compliance of Alternative ALT4 with the identified ARARs and TBCs would be substantially identical to that of OU1 material, and is summarized below.

Chemical-Specific ARARs and TBCs

ALT4 would comply with all pertinent chemical-specific ARARs identified in Appendix A for this alternative. Included would be those CWA requirements associated with the Ohio Water Quality Standards; the control of radionuclide airborne emissions including radon-222 under the CAA; and the control of radionuclide releases to air and water and their resulting doses to the public during remedial operations at the FEMP site as required under DOE Order 5400.5. Compliance with SDWA MCLs and MCLGs would be ensured by removal of the source of waste to an off-site disposal facility.

Location-Specific ARARs and TBCs

ALT4 would comply with all pertinent location-specific ARARs identified in Appendix A for this alternative. Included would be those requirements associated with the protection of floodplains, wetlands, and endangered species and their habitat during blending and thermal drying operations involving Silo 3 residues and Waste Pit 5 material.

Action-Specific ARARs and TBCs

ALT4 would comply with all pertinent action-specific ARARs identified in Appendix A for this alternative through engineering controls and treatment of the waste to comply with the waste acceptance criteria of the representative RPCDF. This alternative would comply with ARARs associated with NEPA (for environmental documentation), the CAA (for release of dust and nonradioactive particulates), and the CWA (for storm water runoff, BMPs, and dredge and fill activities). Onsite activities would comply with the substantive RCRA closure requirements for management and treatment of hazardous waste.

Other Requirements

Off-site disposition will require shipment of materials. Shipments of hazardous waste are regulated by the EPA under 40 CFR § 262 and 40 CFR § 263 and by the DOT under 49 CFR Subchapter C, Hazardous Materials Regulations. Thermally dried OU1 material would be classified as low specific activity-I (LSA-I) material under the DOT regulations. As LSA-I material, OU1 material can be shipped in bulk packaging, such as a gondola car, provided the packages meet the requirements of 49 CFR § 173 Subpart B and are shipped under exclusive use conditions in a closed transport vehicle. Silo 3 residues, however, would be classified as LSA-II material. At a minimum, LSA-II material was be packaged in an industrial package-type 2 (IP-2) container. Blending of Silo 3 residues with material from Waste Pit 5 should result in a material that could be classified as LSA-I and therefore could be transported by gondola car. However, if any of the resulting blended material must be classified as LSA-II material, IP-2 containers would be required in place of the gondola cars. An exemption to allow use of the gondola cars for shipment of any blended material that requires classification as LSA-II material can be obtained from the DOT provided the packaging alternative can display an equal level of safety for protection of human health and the environment. The process for filing for an exemption from DOT requirements is presented in 49 CFR § 107 Subpart B and is estimated to take six months to process through proper DOE and DOT channels.

Excavating Waste Pit 5 contents, treating them by thermal drying, and disposing of the waste at a RPCDF will provide a permanent solution to the threats posed by the subject contaminated materials. Treatment of Waste Pit 5 material by thermal drying as required to meet the RPCDF waste acceptance criteria would accomplish several objectives. First, there is the potential that a slight volume decrease would be realized by removal of excess interstitial pore water in the wastes. More importantly, this would remove a large volume of contaminated leachate from the Waste Pit 5 wastes that might otherwise migrate from the disposed wastes. Finally, the thermal drying facilitates more efficient material handling through the remediation process, as well as more economical shipment of the waste.

However, the selected alternative for OU1 material, including material in Waste Pit 5, does not provide adequate treatment for Silo 3 residues. As stated previously, Silo 3 residues are classified as 11(e)(2) byproduct material and are exempt from regulation under RCRA. However, as part of the CERCLA process, pertinent environmental regulations must be evaluated to determine if they are "applicable" or "relevant and appropriate" to conditions at the site being investigated. Because Silo 3 residues are classified as byproduct material as defined under the AEA of 1954 and are excluded from

the definition of solid waste, requirements under RCRA are not applicable. However, based on Extraction Procedure Toxicity test results conducted and reported in the Operable Unit 4 Remedial Investigation, leachate from the Silo 3 residues exceed the toxicity characteristic limits for As, Cd, Cr, and Se established for hazardous waste in 40 CFR § 261.24.

Since metals in the residues have been demonstrated to be mobile by exhibiting the toxicity characteristic that RCRA is designed to control and pose a potential threat to impact groundwater that may be used for human consumption, the residues are sufficiently similar to hazardous waste regulated by RCRA and some RCRA requirements are relevant and appropriate for management of the Silo 3 residues. Although the 11(e)(2) byproduct material can be blended with other nonhazardous waste material through its exclusion from RCRA requirements, the relevance and appropriateness of RCRA requirements to the Silo 3 residues preclude the use of blending as a treatment option since RCRA does not recognize blending as a substitute for adequate treatment.

In addition, implementation of ALT4 would not be consistent with CERCLA section 121(b)(1) preference for a remedial alternative that "permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances or contaminated materials. This section further states "The off-site transport and disposal of hazardous substances or contaminated materials without such treatment should be the least favored alternative remedial action where practicable treatment technologies are available." Both stabilization and vitrification are "practicable treatment technologies" available for treating Silo 3 residues to reduce the toxicity resulting from the presence of heavy metals.

Because blending Silo 3 residues with material from the OU1 Waste Pit 5 followed by thermal drying does not provide for adequate treatment to reduce the toxicity associated with the heavy metals present in the Silo 3 residues, ALT4 was dropped from further consideration in this document.

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4.0 COMPARATIVE ANALYSIS

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4.1 Introduction

Section 4.0 presents a comparative analysis of the remedial action alternatives considered for the Silo 3 residues with respect to the CERCLA evaluation criteria described in Section 3.0. This analysis is the second stage of the evaluation process and provides information which forms the basis for selecting a preferred treatment alternative for the Silo 3 residues. For this analysis, the evaluation criteria include two categories, threshold and primary balancing. More information concerning the evaluation criteria can be found in Section 3.1.2, Overview of the Detailed Analysis. The modifying criteria of state and community acceptance will not be addressed in this comparative analysis. Because formal state and community comments will not be received until after this report has been issued for stakeholder inspection, these two modifying criteria will be addressed during the regulatory process following stakeholder inspection.

The threshold category contains the two criteria that must be satisfied by the selected alternative:

- Overall protection of human health and the environment; and
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs).

These criteria are of greatest importance in the comparative analysis because they reflect the key statutory mandates of CERCLA, as amended. If an alternative does not satisfy both of these criteria, it cannot be carried forward to the primary balancing category and is not eligible to be selected as the final remedy.

The primary balancing category contains the five criteria under which the relative advantages and disadvantages of the alternatives are compared to determine the most appropriate remedy:

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

The first and second criteria address the statutory preference for treatment as a principal element of the remedy and the bias against off-site land disposal of untreated material. Together with the third and fourth criteria, they form the basis for determining the general feasibility of each potential remedy and

determining whether costs are proportional to the overall effectiveness, considering both the cleanup period and the time following cleanup (if applicable). By this means, it can be determined whether a potential remedy is cost effective.

Consistent with the format of the detailed analysis of alternatives in Section 3.0, a comparative analysis under the threshold and primary balancing criteria for the alternatives is presented in Section 4.2. Table 4.2-1 summarizes the comparative analysis for each alternative. Short-term risks are provided to assess the potential impacts to the public and remedial action workers during implementation of the alternative. The basis for determining the risks are detailed in Appendix D.

4.2 Alternatives to Silo 3 Residues Treatment

The five alternatives compared include:

- VIT - Removal, Onsite Vitrification, Off-site Disposal at the NTS;
- ALT1 - Removal, Onsite Stabilization, Off-site Disposal at the NTS;
- ALT2 - Removal, Onsite Stabilization, Off-site Disposal at a RPCDF;
- ALT3 - Removal, Off-site Stabilization and Disposal at a RPCDF; and
- ALT4 - Removal, Onsite Blending with OU1 Waste Pit 5 material, Off-site Disposal at a RPCDF.

A summary of the Silo 3 Alternatives comparative analysis results is presented in Table 4.2-1.

4.2.1 Threshold Criteria

4.2.1.1 Overall Protection of Human Health and the Environment

Assessment of protectiveness for the Silo 3 treatment alternatives assumes the same future land use scenario as discussed in Appendix D of the Operable Unit 4 FS (DOE 1994a). Appendix D provides details on the assumptions used to develop the scenarios and examine risks to the receptors.

All of the Silo 3 alternatives would provide overall protection of human health and the environment. With the exception of ALT4, all of the alternatives (VIT, ALT1, ALT2, and ALT3) would limit exposures to contaminants by removing the sources of contamination, treating the source materials, and placing the treated materials either in an off-site facility (NTS) owned by DOE or at a Commercial Facility. The basic differences among these action alternatives are the treatment options (vitrification or cement stabilization) and the disposal options (at the NTS or a Commercial Facility). As stated in Section

TABLE 4.2-1

SILO 3 ALTERNATIVES - COMPARATIVE ANALYSIS

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

[1]This cost represents the incremental cost of vitrifying the Silo 3 residues in addition to the Silos 1 and 2 residues by the Fernald Residues Vitrification Plant.
[2]ALT1, ALT2, and ALT3 offer a significant schedule acceleration for the remediation of the Silo 3 residues.
[3]"NA" means "not analyzed."

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3.6.2, blending Silo 3 residues with material from the OU1 Waste Pit 5 followed by thermal drying does not provide adequate treatment for Silo 3 residues. Therefore, ALT4 was dropped from consideration as a viable remedial alternative for Silo 3 residues.

Both vitrification and stabilization options provide a final waste form which reduces the potential for contaminant migration and radon emanation. Both options would immobilize the heavy metal contaminants present in the Silo 3 residues to reduce their leachability to within regulatory limits. Table 4.2-2 presents data from treatability studies demonstrating vitrification and cement stabilization technologies effectiveness in treating Silo 3 residues to below toxicity characteristic regulatory limits for metals established in 40 CFR § 261.24. In addition, both technologies show the ability to reduce radon-222 levels to below the regulatory limit of 20 pCi/m^2-sec established in 40 CFR § 61 Subpart Q.

Table 4.2-2 COMPARISON OF VITRIFICATION AND CEMENT STABILIZATION IN TREATING SILO 3 RESIDUES[1]

Contaminant	Untreated (mg/L)[1]	Vitrified (mg/L)[2]	Cement Stabilization (mg/L)[3]	Regulatory Limit (mg/L)
Arsenic	1-45	0.1	0.1	5
Cadmium	1-6	0.009	0.005	1
Chromium	1-12	Not Detected	1	5
Selenium	1-12	Not Detected	0.3	1
Radon-222	70 pCi/m^{2}sec	0.03 pCi/m^2-sec	17 pCi/m^2-sec	20 pCi/m^2-sec

[1]U.S. DOE 1993b
[2]Batelle 1994
[3]U.S. DOE 1993c

The off-site disposal locations would be the DOE-owned NTS facility or a RPCDF which has been used selectively by DOE for disposal of low-level radioactive waste. A RPCDF could only be used for disposal of DOE-generated low-level radioactive waste after processing an exemption under DOE Order 5820.2A and receiving DOE approval. The NTS and the RPCDF incorporate engineering and institutional controls to ensure protectiveness, and both are located in a climatic, demographic, and hydrogeologic setting which favors minimization of contaminant migration to both human and environmental receptors. In the long-term event of degradation of engineered features or loss of institutional controls, these site characteristics coupled with the waste form of the treated residue would ensure continued protectiveness for both facilities.

4.2.1.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Except for ALT 4, all Silo 3 alternatives would attain all pertinent chemical, location, and action-specific ARARs and TBCs. A comprehensive list of potential ARARs is presented in Appendix A. Key requirements are discussed in Section 3.0 within the evaluation of each alternative against this criterion. The following summarizes those evaluations.

Chemical-Specific ARARs

VIT, ALT1, ALT2, and ALT3 would meet the chemical-specific ARARs associated with potential releases to groundwater, surface water, and air. The most critical chemical-specific ARAR relative to airborne releases for Silo 3 residues relates to radon. The maximum permissible flux rate of radon-222, as specified in the NESHAP, 40 CFR § 61 Subpart Q, is 20 pCi/m^2-s, surface averaged. Requirements for other radionuclides are established in 40 CFR § Subpart H and DOE Order 5400.5 Chapter III. Compared to the untreated Silo 3 residues, both the vitrified and the stabilized residue waste forms are effective in reducing radon emanation from the treated residues to less than these prescriptive requirements.

Another critical chemical-specific ARAR is the LDR treatment standards for nonexcluded waste generated under ALT3. Treatment standards are established in 40 CFR § 268.41 for toxicity characteristic metals. The RPCDF stabilization process would be able to treat nonexcluded waste generated from ALT3 to meet the LDR treatment standards. Furthermore, if the proposed rule, presented in 60 FR 43654, which establishes treatment standards for toxicity characteristic waste is promulgated prior to implementation of ALT3, the RPCDF would be required to treat material exhibiting the toxicity characteristic for metals to the more restrictive universal treatment standards and would be required to treat the underlying hazardous constituents reasonably expected to be in the waste.

Location-Specific ARARs

VIT, ALT1, ALT2, and ALT3 would meet the location-specific ARARs as they relate to floodplains, wetlands, and endangered species and their habitats. Compliance with these alternatives would be met through proper planning, siting, design, and operational procedures.

Action-Specific ARARs

VIT, ALT1, ALT2, and ALT3 would meet the action-specific ARARs identified for these alternatives. Appropriate engineering controls would be implemented for each alternative to comply with Ohio Water Quality Standards and Air Quality Standards. Hazardous material transportation requirements would be

complied with by following the regulations under 40 CFR §§262 and 263, and the appropriate Department of Transportation shipping standards under 49 CFR Subchapter C Hazardous Materials regulations.

A critical action-specific ARAR is the LDR treatment standards for nonexcluded waste generated under ALT3. Both onsite activities and activities conducted at the RPCDF for treatment and disposal of the Silo 3 residues would be in compliance with RCRA regulations, including the LDRs.

Other Requirements

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

4.2.2 Primary Balancing Criteria

Those alternatives that satisfy the threshold criteria comparative analysis are carried forward for comparative analysis under the primary balancing criteria. Alternatives that will be carried forward include:

- VIT - Removal, Onsite Vitrification, Off-site Disposal at the NTS;
- ALT1 - Removal, Onsite Stabilization, Off-site Disposal at the NTS;
- ALT2 - Removal, Onsite Stabilization, Off-site Disposal at a RPCDF; and
- ALT3 - Removal, Off-site Stabilization and Disposal at a RPCDF.

4.2.2.1 Long-term Effectiveness and Permanence

All alternatives would ensure long-term protectiveness to human health and the environment. All alternatives include the removal of Silo 3 residues for treatment of the source materials at either the FEMP or an RPCDF, followed by off-site disposal. Removal and treatment of the Silo 3 residues eliminates the potential for residual risks to remain at the FEMP site following completion of the actions.

Operable Unit 4 FS treatability studies demonstrated that both the vitrified and the cement-stabilized residue forms exhibit reduced leachability of constituents compared to the untreated materials. However, treatability data for the vitrification process option indicated that the activity of uranium-238 in the leachate from the untreated Silo 3 residues to the activity in the leachate from vitrified Silo 3 residues was not reduced. Both treated forms exhibited TCLP leachate concentrations for hazardous constituents that were below relevant and appropriate limitations defined in RCRA. Both vitrification and cement stabilization significantly reduced radon emanation as shown in Table 4.2-2. The vitrification alternatives are anticipated to achieve a better than 50 percent reduction in volume requiring disposal. The cement stabilization alternatives would increase volumes requiring disposal by approximately 20 percent due to the addition of additives.

Off-site disposal at the NTS or a RPCDF would provide protection by eliminating access to the treated materials and preventing migration of constituents from the materials. The NTS and the RPCDF are located in a sparsely populated, arid environment with a reduced potential for leachate generation, contaminant migration, and direct contact with contaminants. Because the NTS is maintained by DOE and utilized for the disposal of selected low-level wastes from other DOE sites, the uncertainties associated with institutional controls are low. As a result of low average annual precipitation and great depths to groundwater, impacts to human health and the environment would be mitigated in the event that engineering and institutional controls fail for both facilities.

Long-term environmental impacts for all alternatives would include those associated with the removal and treatment activities performed at the FEMP site and disposal activities at the NTS and at the RPCDF. There are no long-term environmental impacts at the FEMP site pertaining to the removal and treatment processes. Long-term environmental impacts at the NTS and the RPCDF would include some permanent disturbance of soils (i.e., acquisition of borrow material) associated with disposal activities. No significant long-term impacts would be expected for water quality and hydrology, air quality, biotic resources, socioeconomics and land use, or cultural resources. No wetland or floodplain areas have been delineated at the NTS or the RPCDF.

4.2.2.2 Reduction of Toxicity, Mobility or Volume Through Treatment

Alternatives employing vitrification would exhibit a greater overall reduction in the mobility, and volume of the residues. VIT uses the vitrification process to treat the contaminated material. This technology will physically bind the contaminants in a glass-like matrix, which will significantly reduce contaminant mobility and material volume. Mobility would be reduced since the contaminants would be bound in the

matrix and the volume of the treated material would be reduced by approximately 55 percent of the untreated Silo 3 residues volume. Although most contaminants in the treated material would be incorporated into the vitrified product to reduce mobility over the long term, some contaminants would be released during the vitrification process and must be treated through the off-gas treatment system. The material generated through the off-gas treatment system may require additional stabilization to limit subsequent contaminant mobility.

ALT1, ALT2, and ALT3 use a cement stabilization process or chemical stabilization process to treat the contaminated material. This technology would physically and chemically bind the contaminants in a cement-like matrix, so the mobility of contaminants via leaching from this treated material would be greatly reduced, thereby reducing the associated toxicity of the material as well. The total volume of material would increase by approximately 19 percent, 24 percent, and 17 percent for ALT1, ALT2, and ALT3, respectively, as a result of adding the cemtn stabilizing and setting agents.

4.2.2.3 Short-term Effectiveness

Under all the alternatives, short-term disturbance of soil would occur. All alternatives involve site preparation and construction for a processing facility, construction of a waste retrieval facility, removal of the Silo 3 residues, and treatment of the contents. Short-term impacts include the temporary loss of habitats at the FEMP site and possible impacts of accidental spills of construction and operational materials. Fugitive dust and exhaust emissions as a result of excavation and construction activities could temporarily result in minimal impacts to air quality and water quality at the FEMP site or the NTS. Minimal impacts to biotic resources is expected at the NTS and/or the FEMP site. In addition, minimal impacts to wetlands and floodplains would occur. Proper engineering controls and mitigative measures should limit these impacts.

Because the vitrification facility is estimated to operate three years compared to one year for cement stabilization, the short-term risks to onsite workers is increased for vitrification. In addition, vitrification is considered to pose a moderate occupation risk to workers because of high operating temperatures and limited field experience. Table D.4-2 and D.4-3 in Appendix D of this document present a comparison of the estimated risk to workers during construction and operation of the treatment facilities for all alternatives.

Although vitrification process would reduce the volume of contaminated residues, blending Silo 3 residues with K-65 residues during vitrification result in the need for a container that provides the necessary

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shielding to protect the general public and transportation workers from radiation levels associated with K-65 residues. Because of the weight associated with the shielded containers, fewer containers can be placed on one truck resulting in the need for more shipments. As a result, the difference in short-term risks between the different alternatives is negligible. Table D.4-1 and D.4-3 in Appendix D of this document presents estimated transportation risk to the general public and workers for all alternatives.

The granular nature of the ALT2 stabilized waste form may create a higher potential for airborne particulates during handling at the RPCDF where the wastes are removed from the transport boxes and spread within the disposal cell using conventional heavy equipment. In addition, the ALT2 wastes would likely be less effective in reducing radon emanation as a result of their small granular form which provides a shorter path for radon emanation from the solid matrix.

Similar to ALT2, the ALT3 conditioned waste form may create a higher potential for airborne particulates during handling at the RPCDF where the conditioned waste may have dried, thereby increasing dispersibility. In addition, the anticipated compactible nature of the Silo 3 waste from following treatment at the RPCDF would likely be similar to the waste form from ALT2. This form would likely be less effective in reducing radon emanation.

4.2.2.4 Implementability

The time required to implement the ALT1, ALT2 or ALT3 treatment alternatives would be approximately 6 months ahead of VIT, the vitrification baseline schedule. Figure 4.2-1 presents a comparison of implementation schedules for ALT1, ALT2, and ALT3. Of the new alternatives evaluated, ALT1 represents the most implementable alternative of all treatment alternatives due to use of proven treatment and disposal technology in addition to use of existing DOE-owned property for disposal. In addition, it is anticipated that ALT1 along with ALT2 would require only an ESD for implementation versus the ROD amendment anticipated for ALT3. Furthermore, implementation of ALT2 would require an exemption under DOE Order 5820.2A for use of a RPCDF for disposition of low-level radioactive waste. However, it is expected that the request for exemption could be processed and approved in parallel to the design process and thus, would not impact the implementation schedule.

Since DOE allows the use of a RPCDF for disposal of mixed waste, implementation of ALT3 would not require an exemption if the Silo 3 residues are reclassified as mixed waste. However, implementation of ALT3 would require compliance with the administrative, as well as the substantive requirements under RCRA, including the LDRs. In addition, implementation of ALT3 may require modification of the

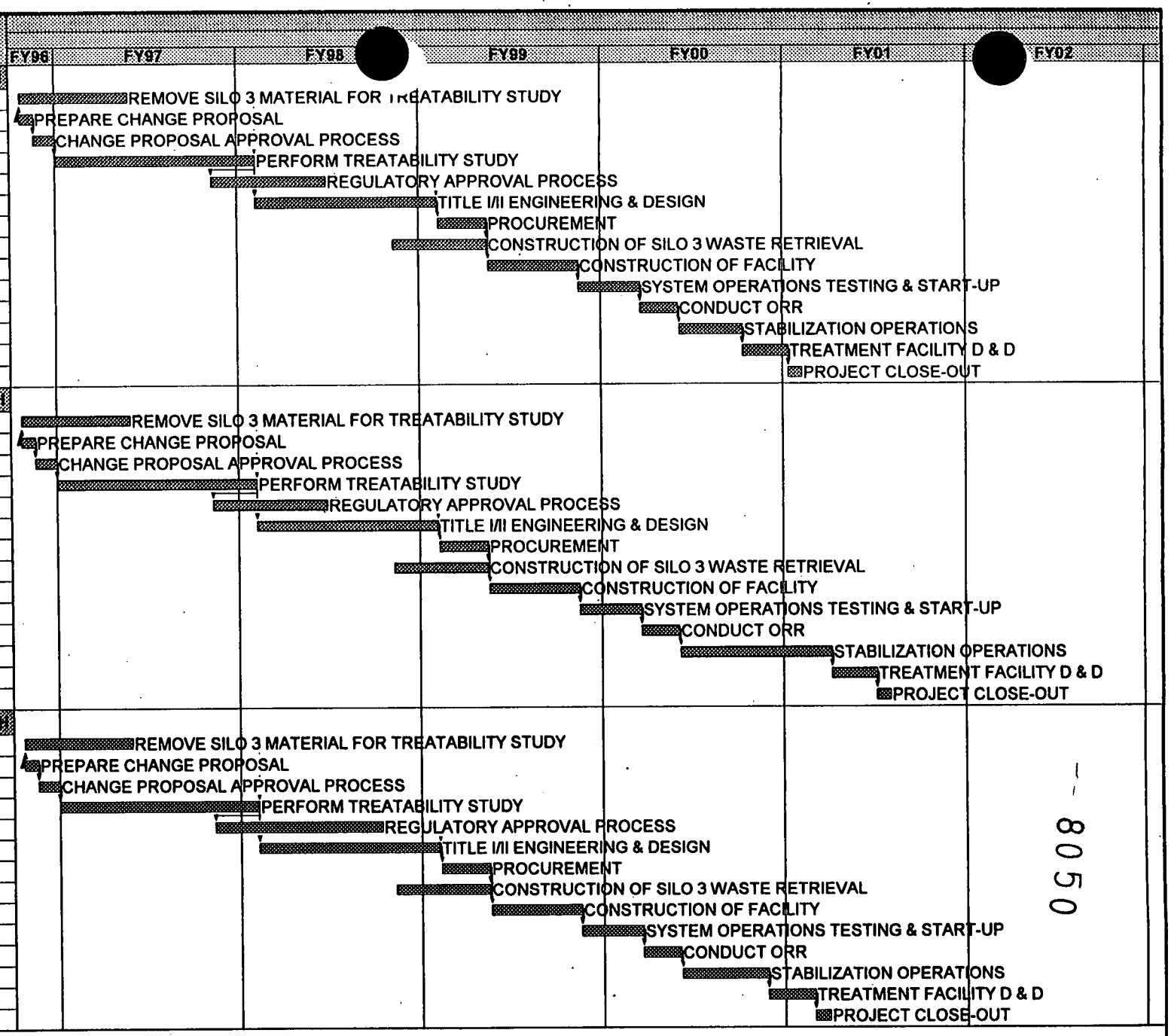
RPCDF treatment process to ensure stabilization of metals to meet the UTS and UHC treatment standards.

The removal and treatment activities in VIT, ALT1, ALT2 and ALT3 could be implemented with standard equipment, procedures, and readily available resources. Pneumatic removal is a standard technology that is normally reliable and uses readily available equipment. The cement stabilization technology has been applied successfully at a number of remedial sites. EPA considers cement stabilization a demonstrated treatment technology and has approved its use in the final remedy for many NPL sites. The cement stabilization process (ALT1) or chemical stabilization process (ALT2 and ALT3) would require large quantities of cement and other chemical additives which are readily available.

Although the removal and disposal aspects are the same for VIT as for ALT1, ALT2, ALT3 the treatment component (vitrification) of this alternative is more difficult to implement. Vitrification is developing technology, with very little operating experience available in the DOE complex. The vitrification process would require more complex chemical formulations for the Silo 3 residues than for a stabilization/solidification process and larger amounts of energy. In addition, the vitrification process equipment and support systems would be more complex to design, construct, and operate than that of the stabilization/solidification process. There is limited experience available for the types and quantities of material from the silos on which to base an assessment of the likely performance of the vitrification technology. Off-gas treatment is also an additional complexity with vitrification where delays could occur. The combination of these complexities makes implementation of VIT more difficult than ALT1, ALT2 and ALT3. Operational experience is being gained as part of the structured treatability studies and from the vitrification pilot facility currently undergoing startup.

Off-site transportation would be technically straightforward, and the necessary resources are available. For disposal, the NTS and the RPCDF have the resources and capacity to accept the treated Silo 3 residues and to receive and treat the Silo 3 residues, respectively. Off-site transport and disposal would be subject to coordination with various state and federal agencies to address transport. Approval to dispose the Silo 3 11(e)(2) by-product material at the NTS has been received from NTS and DOE-HQ. However, approval to dispose of the Silo 3 residues either as low-level waste (treated at the FEMP) or mixed waste treated at the RPCDF must be negotiated and approved by DOE-HQ, the RPCDF, and regulatory agencies.

Activity ID	Orig	Early Start	Early Finish
SILO 3 ALTERNATIVE 1 - ACCELERATED SCH			
A3100	148	22JUL96	24FEB97
A3103	20*	22JUL96*	16AUG96
A3106	30*	19AUG96*	30SEP96
A3109	277	01OCT96	06NOV97
A3112	157	11AUG97	27MAR98
A3115	250	07NOV97	06NOV98
A3118	64	09NOV98	12FEB99
A3121	127	11AUG98	12FEB99
A3124	127	16FEB99	16AUG99
A3127	86	17AUG99	20DEC99
A3129	50	21DEC99	03MAR00
A3130	90	06MAR00	12JUL00
A3133	64	13JUL00	11OCT00
A3136	20	12OCT00	08NOV00
SILO 3 ALTERNATIVE 2 - ACCELERATED SCH			
B3100	148	22JUL96	24FEB97
B3103	20*	22JUL96*	16AUG96
B3106	30*	19AUG96*	30SEP96
B3109	277	01OCT96	06NOV97
B3112	157	11AUG97	27MAR98
B3115	250	07NOV97	06NOV98
B3118	64	09NOV98	12FEB99
B3121	127	11AUG98	12FEB99
B3124	127	16FEB99	16AUG99
B3127	86	17AUG99	20DEC99
B3129	50	21DEC99	03MAR00
B3130	208	06MAR00	03JAN01
B3133	64	04JAN01	04APR01
B3136	20	05APR01	03MAY01
SILO 3 ALTERNATIVE 3 - ACCELERATED SCH			
C3100	148	22JUL96	24FEB97
C3103	20*	22JUL96*	16AUG96
C3106	30*	19AUG96*	30SEP96
C3109	277	01OCT96	06NOV97
C3112	230	11AUG97	13JUL98
C3115	250	07NOV97	06NOV98
C3118	64	09NOV98	12FEB99
C3121	127	11AUG98	12FEB99
C3124	127	16FEB99	16AUG99
C3127	86	17AUG99	20DEC99
C3129	50	21DEC99	03MAR00
C3130	122	06MAR00*	25AUG00
C3133	64	28AUG00	29NOV00
C3136	20	30NOV00	29DEC00



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0029

Project Start 01OCT95
Project Finish 11JUL02
Data Date 01OCT95
Plot Date 26JUN96

Early Bar
Progress Bar
Critical Activity

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SSFS

Sheet 1 of 1

COMPARISON OF SILO 3 ALTERNATIVES
IMPLEMENTATION SCHEDULES
FIGURE 4.2 - 1

Fernald Environmental
FEMPO
Restoration Management Corporation

4.2.2.5 Cost

The categories of costs developed were capital, short-term O&M (during remediation), and long-term O&M (post-remediation). Total present worth costs were developed for each alternative, assuming a discount rate of 7 percent, so that all alternatives with costs incurred over differing time periods could be compared on an equivalent basis. Capital and O&M costs for each Silo 3 alternative evaluated in the detailed analysis (Section 3.0) are presented in Table 4.2-3.

Although VIT results in a reduction in waste volume compared to waste volume increase for the other alternatives, it remains the more expensive alternative. This can be attributed to a more complex processing operation for vitrification compared to cement or chemical stabilization, a more restrictive DOT certified container to manage vitrified K-65 residues, and the limit of two containers per shipment for the vitrified residues.

TABLE 4.2-3

PRESENT WORTH COST ANALYSIS - SILO 3 ALTERNATIVES
($ Millions)

Alternative	Initial Capital Cost	Total Packaging, Transportation, and Disposal Costs	Total O&M Costs	End of Life D&D Costs	Total Life-Cycle Cost	Operating Life (years)	Total Present Worth Cost[1]
VIT - Removal, Onsite Vitrification, Off-site Disposal at the NTS	$1.6	$13.6	$9.6	$0.0	$24.8	0.78	$20.4
ALT1 - Removal, onsite Stabilization, Off-site Disposal at the NTS	$6.7	$10.7	$1.2	$0.8	$19.4	0.35	$18.8
ALT2 - Removal, Onsite Stabilization, Off-site Disposal at a RPCDF	$6.8	$8.6	$1.6	$0.8	$17.8	0.80	$17.1
ALT3 - Removal, Off-site Stabilization and disposal at a RPCDF	$6.7	$11.3	$1.4	$0.8	$20.2	0.47	$19.5

[1]Based on a 7.0 percent discount rate. See Appendix C for details.

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APPENDIX A

ANALYSIS OF POTENTIAL ARARs FOR SILO 3 RESIDUES

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LIST OF ACRONYMS

AEA	Atomic Energy Act
ARAR	applicable or relevant and appropriate requirement
CAA	Clean Air Act
CAMUs	Corrective Action Management Units
CCWE	constituent concentrations in waste extract
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	constituent of concern
CWA	Clean Water Act
DOE	United States Department of Energy
DOT	Department of Transportation
EDE	effective dose equivalent
EPA	United States Environmental Protection Agency
ERA	Energy Reorganization Act
FEMP	Fernald Environmental Management Project
FS	Feasibility Study
ISA	Initial Screening of Alternatives
IP-2	Industrial Package - type 2
LDRs	land disposal restrictions
LLRW	low level radioactive waste
LSA	low specific activity
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
OEPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
OU	operable unit
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
RPCDF	representative permitted commercial disposal facility
RTS	radon treatment system
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
TBC	to be considered
TUs	Temporary Units
UMTRCA	Uranium Mill Tailings Radiation Control Act
WAC	waste acceptance criteria
WEMCO	Westinghouse Environmental Management Company of Ohio

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A.1.0 ANALYSIS OF POTENTIAL ARARs FOR SILO 3 RESIDUES

A.1.1 INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) created a federal program for the cleanup of uncontrolled releases of hazardous substances into the environment. The Superfund Amendments and Reauthorization Act (SARA), enacted in 1986, reauthorized the program for an additional five years, and the Omnibus Reconciliation Act of 1990 again extended the CERCLA program. SARA added guidance on developing cleanup standards, a preference for permanent solutions and support for the development of innovative technologies, and codified many U.S. Environmental Protection Agency (EPA) practices that evolved during site evaluation and remediation occurring in the first years of the program.

CERCLA provides guidance on the specific cleanup standards that should be applied to a remedial action, or to the criteria for choosing among remedial alternatives when implementing regulations for CERCLA and SARA, 40 Code of Federal Regulations (CFR) 300, which are referred to as the National Oil and Hazardous Substances Pollution Contingency Plan (the NCP). Nine selection criteria for choosing among remedial actions are presented in Subpart E - Hazardous Substance Response, 40 CFR 300.430(e)(9). One of these nine criteria states that the action will comply with applicable or relevant and appropriate requirements (ARARs). The NCP further defines the criteria for remediation of a facility by requiring that onsite remedial actions must attain or exceed the ARARs in federal and state environmental and public health laws.

This appendix provides an analysis of the proposed potential ARARs which were used in evaluating the performance of alternatives for the remediation of Silo 3 metal oxides.

A.1.2 ARARs DEFINED

Section 121(d) of CERCLA requires that, at the completion of remedial actions, the site should achieve a level of control that complies with federal and state environmental laws that are applicable or relevant and appropriate for the hazardous substances, pollutants, or contaminants that remain on site.

The NCP defines applicable requirements as those "cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant,

contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by the state in a timely manner and that are more stringent than federal requirements may be applicable" (40 CFR § 300.5). "Applicable" implies that the remedial action or the circumstances at the site satisfied all of the jurisdictional prerequisites of a requirement.

Although a requirement may not be applicable as defined in the NCP to a specific release, it may be "relevant and appropriate". The NCP defines relevant and appropriate requirements as those "cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site". Only those state standards that are identified by the state in a timely manner and are more stringent than these federal requirements may be relevant and appropriate (40 CFR § 300.5). In some circumstances, a requirement may be "relevant" but not "appropriate" for the site-specific situation. A requirement must satisfy both the "relevant" and "appropriate" components.

Section 121 of CERCLA requires selection of a remedial action that is protective of human health and the environment. Such protectiveness, as determined by a site risk assessment, may not always be attained by the ARARs. In certain cases, standards may not exist in the promulgated regulations that address the proposed action or the constituent of concern. In these cases, nonpromulgated advisories, criteria, or guidance that were developed by the EPA, other federal agencies, or states are "to be considered" (TBC) in establishing remedial action objectives that are protective of human health and the environment. In addition, TBCs may provide information that is utilized to develop CERCLA remedies.

In addressing a requirement that may affect a remedial action being considered for a site, a determination is made regarding its relationship to: (1) the location of the action, (2) the contaminants involved, and (3) the specific components of the action, such as factors unique to a certain technology. Three types of ARARs result from this process: location-specific ARARs, chemical-specific ARARs, and action-specific ARARs.

For the Fernald Environmental Management Project (FEMP) the formal definition of the term "site" in the context of this CERCLA remedial action includes not only the former Production Area inside

the fence, but also any areas contaminated by the migration of a hazardous substance, pollutant, or contaminant from any of the properties under the custody or accountability of DOE-FN. The term "on property" is included in the definition of "onsite," but includes only that part of the site under direct control or ownership by DOE. The term "off-site" refers to all other areas that are not under the direct control of DOE, and are not contaminated by DOE waste or activities. Onsite actions are required to comply with ARARs, but must comply only with the substantive parts of an ARAR. For applicable requirements that are identified for alternatives involving off-site treatment, both administrative and substantive parts of that ARAR must be met. Since only applicable requirements are required to be met for remedial activities conducted off-site, relevant and appropriate requirements that are identified for alternatives involving off-site disposal must be met for only the onsite portions of that alternative. The application of specific environmental regulations to activities being considered for off-site facilities, such as land disposal of stabilized waste at the Nevada Test Site (NTS) or the representative permitted commercial disposal facility (RPCDF), would be addressed by the facility owners/operators in the environmental compliance documents and requirements which govern those facilities.

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A.2.0 ARAR IDENTIFICATION METHODOLOGY

The first step in identifying the ARARs for the site involved identifying the potential contaminant and action- and location-specific requirements. The next step involved analyzing those requirements to determine if they were applicable. For a requirement to be applicable, the site circumstances must meet all of the jurisdictional prerequisites of the requirement. Such jurisdictional prerequisites may include:

- Who, as specified by the statute or regulations, is subject to its authority.
- The types of substances or activities listed as falling under the authority of the statute or regulation.
- The time period for which the statute or regulation is in effect.
- The types of activities the statute or regulation requires, limits, or prohibits.

If the requirement failed to meet a jurisdictional prerequisite, the requirement is not applicable. The analysis then addressed whether the requirement is relevant and appropriate. The evaluation factors used for determining whether a requirement is relevant and appropriate included:

- Whether the specific objectives of the statute and regulations under which the requirement was created are similar to the specific objectives of the CERCLA action.
- Whether the media regulated or affected by the requirement are similar to the media contaminated or affected at the CERCLA site.
- Whether the substances regulated by the requirement are similar to the substances found at the CERCLA site.
- Whether the entities or interests affected or protected are similar to the entities or interests affected by the CERCLA site.
- Whether the actions or activities regulated by the requirement are similar to the remedial action contemplated at the CERCLA site.
- Whether the type of place regulated is similar to the type of place affected by the CERCLA site or CERCLA action.
- Whether the type of structure or facility regulated is similar to the type of structure or facility affected by the release or contemplated by the CERCLA action.
- Whether any consideration of use, or potential use, of affected resources in the requirement is similar to the use, or potential use of the affected resource.

- Whether the purpose of the requirement in the program of its origin is served by its application at the CERCLA site.
- Whether any variances, waivers, or exemptions from the requirement are available for the circumstances of the CERCLA site or CERCLA action.

If a regulatory scheme appeared to be relevant and appropriate, each provision in that scheme was reviewed to determine its relevance and appropriateness for the site. If an evaluation of a provision against these factors indicated that the site circumstances are "sufficiently similar" to the problems addressed by the provision, then the provision was selected as relevant and appropriate for evaluating remedial alternatives. Otherwise, it was dropped from consideration. When the analysis resulted in a determination that a requirement was both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

If an ARAR did not exist, or if it was insufficient to protect human health and the environment, then criteria, guidance, proposed rules, advisories, or other TBCs that were developed or approved by federal or state agencies were analyzed for their pertinence in establishing a protective remedy. These TBC materials, which are not legally binding, become enforceable if they are incorporated into an accepted Record of Decision (ROD).

An initial listing of potential ARARs was included in the Initial Screening of Alternatives (ISA) for Operable Unit 4 (Task 12 Report, October 1990). A comprehensive listing of potential ARARs and TBCs was jointly developed by U.S. Department of Energy (DOE), EPA, and the Ohio Environmental Protection Agency (OEPA) in October 1990. The ISA listing was refined using the comprehensive listing, the Remedial Investigation (RI) data and alternative descriptions to produce the ARAR/TBC tables presented in Appendix F of the Operable Unit 4 Feasibility Study Report (DOE 1994a). Included in these tables were ARARs and TBCs for a remedial alternative that identified vitrification of Silo 3 residues with final disposition at the NTS. This alternative is identified as 3B.1 in the Appendix F tables and was selected as the preferred alternative for remediation of Silo 3 residues in the Operable Unit 4 Record of Decision (DOE 1994c).

The ARARs identified in the OU4 ROD for vitrification of Silo 3 residues are also pertinent to stabilization of Silo 3 residues. Therefore, modifications to the ARARs and TBCs would not be expected as a result of changing the preferred alternative for Silo 3 residues from vitrification to stabilization followed by transport for final disposition at either the NTS or a RPCDF. The ARARs

and TBCs identified for remediation of Silo 3 residues are presented in Tables A.2-1a through A.2-1c.

ARARs identified in the OU1 ROD for excavation and thermal drying of waste pit material followed by disposal at a RPCDF would also be pertinent to blending of Silo 3 residues with material from OU1 Waste Pit 5. The ARARs as they pertain to silo 3 residues are presented in the tables of this Appendix. Modifications to the ARARs and TBCs would not be expected, unless the blended material failed the toxicity characteristic under RCRA.

However, modifications to the ARARs and TBCs would be expected for changing the preferred alternative to off-site remediation of Silo 3 residues at a RPCDF by stabilization prior to final disposal. The modifications mainly concern implementation of additional requirements of the Resource Conservation and Recovery Act (RCRA). These modifications to the ARAR tables have been shaded for ease of identification. A discussion of these modifications is presented in Section A.4.0 of this Appendix.

The requirement(s) of the ARARs or TBC material, as well as the rationale for implementation and the affected alternatives, are presented in Tables A.2-1a through A.2-1c. Where two or more standards that cover the same regulatory area were identified, the more stringent or prescriptive standard was selected for inclusion in the tables. Other non-ARAR, non-TBC requirements, which are critical to the remedial actions, are described in Section A.3.4, and presented in Table A.2-1d.

EPA guidance directs the identification of three types of ARARs: chemical-specific, location-specific, and action-specific. The identification of potential ARARs is discussed by type in the subsections that follow. Tables A.2-1a through A.2-1d segregate the potential ARARs and TBCs into three separate tables by ARAR type. Table A.2-1a contains Chemical-Specific ARARs/TBCs; Table A.2-1b, Location-Specific ARARs/TBCs; and Table A.2-1c, the Action-Specific ARARs/TBCs. Table A.2-1a, Chemical-Specific ARARs, further classifies potential ARARs on the basis of media affected. Only alternatives that passed the initial screening and are described in detail in this document are listed in these tables. The ARARs in each table are arranged within each ARAR type by the legislative act that establishes the requirements. The major acts listed in the comprehensive Table A.2-1 include the Atomic Energy Act (AEA), Clean Water Act (CWA), Clean Air Act (CAA), RCRA, National Environmental Policy Act (NEPA), and Uranium Mill Tailings Radiation Control

Act (UMTRCA). Where only a single regulatory citation appears for an ARAR in these tables, the citation or reference is more stringent than it's state or federal counterpart, or has no counterpart.

Compliance evaluations for each alternative, subjected to detailed analysis relative to the identified ARARs, are presented in Table A.2-2. Compliance is indicated when the standard would be met, or where the remedial activities associated with that alternative will not violate the requirement. In cases of potential noncompliance, a brief explanation of the expected reason for noncompliance is provided.

If a requirement is determined to be an ARAR, it must be complied with unless a condition addressed by the CERCLA criteria for a waiver is encountered. Under Section 121(d)(4) of CERCLA, EPA may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only an interim measure and will become part of a total remedial action that will attain the ARAR level or standard of control when completed.
- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.
- Compliance with the requirement is technically impracticable from an engineering perspective.
- The remedial action selected will attain a standard of performance that is equivalent to that required by the ARAR through the use of another method or approach.
- The state has not consistently applied (or demonstrated an intention to consistently apply) the promulgated requirement in similar circumstances at other remedial actions.
- Attainment of the ARAR would not provide a balance between the need for protection of public health or welfare and the environment at this site, and the availability of Superfund monies to respond to other sites that may present a threat to public health or the environment. [Because the Fernald Environmental Management Project (FEMP) is not being cleaned up with Superfund money, this last waiver condition is not directly applicable to the project. However, cost is still a criterion for the evaluation of identified alternatives].

No waivers are being requested for the proposed alternatives evaluated in this document.

A.3.0 ARAR DEVELOPMENT

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Investigation activities have been ongoing for a number of years at the FEMP, providing considerable information about site contamination and waste characterization. This background material has allowed for the preliminary selection and continued development of the ARARs identified for Silo 3 residues. Proposed ARARs were developed based on discussions held with EPA and OEPA during the preparation of the CRU4 FS and OU4 ROD, however, the ARARs would be revised if an alternative other than the selected remedy is chosen for remediation of Silo 3 residues.

A.3.1 CHEMICAL-SPECIFIC REQUIREMENTS

Chemical-specific ARARs are usually health- or risk-derived numerical values that establish an acceptable level or concentration of chemical or radionuclide that may remain in specific environmental media after remediation is complete. These levels are deemed to be protective of human health and are used to help establish remedial cleanup goals.

The development of chemical-specific ARARs was limited to the constituents of concern (COCs) identified in Appendix D of the RI Report for Operable Unit 4 (DOE 1993b). Chemical-specific ARARs and TBCs for Silo 3 residues have been identified for radionuclide, organic, and inorganic chemicals in drinking water. In accordance with the NCP at 40 CFR § 300.430(e)(2)(i), the maximum contaminant level goals (MCLGs) established under the SDWA that are set at levels above zero shall be attained by the remedial action for groundwater or surface waters that are current or potential sources of drinking water, where the MCLGs are "relevant and appropriate" to the circumstances of the release, as determined by the factors in 40 CFR § 300.400(g)(2). If an MCLG is not determined to be "relevant and appropriate," the corresponding maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release. When both MCLs and MCLGs exist for a COC, the numerical limits selected for these ARARs are the lower of the non-zero values that are promulgated. Since the source of the waste would be removed to an off-site disposal facility, the standards associated with meeting SDWA MCLs and MCLGs would not be ARARs for the five alternatives being evaluated for remediation of Silo 3 residues.

Chemical-specific requirements for Silo 3 residues include regulations of the AEA, CAA, CWA, and RCRA or their state counterpart.

A.3.2 LOCATION-SPECIFIC REQUIREMENTS

Location-specific ARARs generally restrict certain activities, or restrict or require where certain activities may be conducted, solely because of geographical, hydrologic, or land use concerns.

The location-specific requirements included in this document address those requirements that prevent the selection of an alternative or restrict or require certain activities due to special site characteristics. Location-specific requirements considered for the remedial alternatives include protection of wetlands, endangered species and habitat, and protection of the sole source aquifer.

A.3.3 ACTION-SPECIFIC REQUIREMENTS

Action-specific ARARs are usually restrictions on the conduct of certain activities or the operation of certain technologies at the site.

The action-specific requirements include both obligatory actions and action limitations. Action-specific requirements for Operable Unit 4 include waste management, unit design and operation, radiation protection, and mandated disposal actions and limitations specified under federal RCRA, CWA, CAA, UMTRCA, NEPA, and AEA regulations, or their state counterparts.

A.3.4 OTHER REQUIREMENTS

In addition to the types and classes of ARARs described, other requirements exist that are neither ARARs nor TBCs. These other requirements do not fit into the applicable, relevant and appropriate, or TBC categories either because they are not promulgated regulations or because they are not environmental requirements subject to waiver or negotiation. This latter category includes those requirements such as site worker protection standards under the Occupational Safety and Health Administration (OSHA), and off-site transportation requirements found in the United States Department of Transportation regulations. These other requirements are identified to facilitate a thorough evaluation and comprehensive comparison of the remedial alternatives.

An example of non-promulgated requirements includes the various DOE Orders. AEA requirements for DOE's waste management are incorporated into DOE Orders, developed and issued under DOE's AEA authority. The Orders are generally consistent with, and typically include, technical requirements similar or equivalent to those in Nuclear Regulatory Commission (NRC) regulations and that are appropriate for DOE facilities. DOE Order substantive environmental requirements that pertain to an alternative are TBC requirements, which, when included in a CERCLA ROD, are

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enforceable cleanup standards under CERCLA. Although not specifically targeted for DOE facilities, substantive technical portions of promulgated and non-promulgated NRC requirements may be "relevant and appropriate" or TBCs, respectively, for various alternatives to ensure protection of human health and the environment.

In this document DOE Orders are identified as TBCs only when no promulgated ARAR exists, to ensure adequate protection of human health and the environment. Parts of these Orders that are considered potential TBCs are included in Tables A.2-1a through A.2-1c. When an ARAR was identified that offered equivalent protectiveness to an existing Order, the promulgated requirement was selected for inclusion in the tables instead of the DOE Order. For the alternatives described in this document, portions of DOE Order 5400.5 were selected as TBCs to ensure adequate protection of the public during and following remediation. Other DOE Orders which pertain to worker protection and safety, NEPA implementation, and quality assurance during remediation of Operable Unit 4 are considered "other requirements" and are included in Table A.2-1d. Also included in this table are other non-environmental promulgated requirements with which the FEMP must comply during remediation of OU4.

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A.4.0 CRITICAL ARAR DETERMINATIONS

Some ARAR determinations warrant a more detailed discussion. Detailed discussions of the principal hazardous waste, radioactive waste, and state ARAR determinations that were identified as potential ARARs are presented in this section.

A.4.1 HAZARDOUS WASTE - RCRA

The material contained in Silo 3 is 11(e)(2) byproduct material resulting from the processing of uranium ore concentrates and is specifically exempt, as defined, from regulation as solid waste under RCRA 40 CFR § 261.4(a)(4). The referenced exclusion applies to "... source, special nuclear or byproduct material as defined in the Atomic Energy Act of 1954 as amended, 42 U.S.C. 2011 *et seq.*" The AEA defines byproduct material as: "(1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content" [AEA Section 11(e)(1) and (2)]. Since a material must first be a solid waste in order to be a hazardous waste, and since the material is excluded from regulation as solid waste, the subject material cannot be considered hazardous waste. It should be noted that the words "any radioactive material" as used in the definition for 11(e)(1) byproduct material refers only to the actual radionuclides dispersed or suspended in the waste substance. Nonradioactive hazardous components of 11(e)(1) byproduct material are subject to the RCRA regulations for management as hazardous waste (10 CFR § 962 Byproduct Material).

By definition, Silo 3 residues are not 11(e)(1) byproduct material. The radioactive material in the Silo 3 residues was neither yielded in nor made radioactive during processing. The radioactive material in the Silo 3 residues is inherent to the ore from which the uranium was extracted. Silo 3 residues were not generated as a result of producing or utilizing special nuclear material. Special nuclear material is defined as "(1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of Section 51 [42 U.S.C. 2071], determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material" [AEA Section 11(aa)(1) and (2)]. Silo 3 residues were generated from the extraction of uranium not from the production of plutonium nor the enrichment of U-233 or U-235. In addition, special nuclear

material is utilized in nuclear reactors. Silo 3 residues were not generated in a nuclear reactor. Therefore, Silo 3 residues do not meet the definition of 11(e)(1) byproduct material.

Silo 3 residues fall under the 11(e)(2) classification of byproduct material. Silo 3 only contains residues from the chemical extraction (beneficiation) of uranium from ores; no other solid or hazardous wastes were added to the silos or to the residues. Therefore, the contents of Silo 3 are pure "byproduct materials" by definition, and not solid wastes or hazardous wastes subject to regulation under RCRA. The metals found in the material were present in the natural ore, and were unintentionally extracted from the parent ore along with the uranium during the process of beneficiation, becoming more concentrated in the residue after the uranium was removed. The presence of naturally occurring metals is expected in byproduct material, and does not invalidate either the definition or the exclusion. In addition, no metals from a non-ore source were added to the stream at any point in the beneficiation process, also, no hazardous waste or waste constituent was added or created at any time during the beneficiation process. The fact that several metals in the material fail the RCRA toxicity characteristic leaching procedure (TCLP) does not cause the material to become subject to RCRA regulation due to a hazardous waste characteristic, since the metals are not from an external source, but are associated with the parent material (whose residues, including any ancillary metals, are excluded from the definition of solid waste).

Because Silo 3 residues are classified as byproduct material as defined under the AEA of 1954 and is excluded from the definition of solid waste, requirements under RCRA are not applicable. However, based on Extraction Procedure Toxicity test results conducted and reported in the Operable Unit 4 Remedial Investigation, leachate from the Silo 3 residues exceed the toxicity characteristic limits for arsenic, cadmium, chromium, and selenium established for hazardous waste in 40 CFR § 261.24. Since metals in the residues have been demonstrated to be mobile by exhibiting the toxicity characteristic that RCRA is designed to control and pose a potential threat to impact groundwater that may be used for human consumption, the residues are sufficiently similar to hazardous waste regulated by RCRA and some RCRA requirements are relevant and appropriate for management of the Silo 3 residues.

As stated previously, relevant and appropriate requirements that are identified for alternatives involving off-site disposal activities must be met for only the <u>onsite portions</u> of those alternatives. In addition, onsite actions are required to comply only with the substantive parts of an ARAR.

Therefore, only the substantive parts of RCRA requirements identified as ARARs need to be met for the alternatives that identify onsite treatment of Silo 3 residues followed by off-site disposal.

Requirements under RCRA are considered "relevant and appropriate" for alternatives that identify onsite treatment followed by disposal at an off-site facility. However, these same RCRA requirements may become "applicable" for alternatives that identify off-site treatment at a RPCDF. If the RPCDF cannot receive the Silo 3 residues under their existing 11(e)(2) byproduct material license, the untreated Silo 3 residues would be shipped to them as low level radioactive waste (LLRW). By shipping the untreated Silo 3 residues to the RPCDF as LLRW, the Silo 3 residues would no longer be AEA 11(e)(2) byproduct material and the exemption under 40 CFR § 261.4(a)(4) would no longer apply. Therefore, under Alternative ALT3 involving off-site treatment at a RPCDF, untreated Silo 3 residues may be considered mixed waste under RCRA and the RCRA requirements may be considered "applicable" to the remediation of the Silo 3 residues. As "applicable" requirements, both administrative and substantive parts for both onsite and off-site remedial activities would have to be met.

In addition, soil and debris may also exhibit a hazardous waste characteristic due to contamination by the Silo materials that would require management as a hazardous waste under RCRA. Any other solid waste generated pursuant to remediation would require characterization in accordance with 40 CFR § 262.11 under RCRA prior to disposal.

Relevant and appropriate RCRA closure requirements are promulgated at 40 CFR § 264, Subpart G. These regulations contain the RCRA closure performance standard and incorporate the unit type closure requirements by reference. The silos in Operable Unit 4 are similar to tanks, as defined under the RCRA tank definition in 40 CFR 260.10. Thus, the closure requirements for tank units in 40 CFR 264.197 are potential ARARs.

Facilities regulated under Subtitle C of RCRA that are undergoing remedial or corrective action may designate specific areas of the facility property for the management of remediation waste. These remedial waste management areas, known as corrective action management units (CAMUs), are allowed under 40 CFR Part 264, Subpart S, in order to provide flexibility during the process of remediation. Remediation wastes include both solid and hazardous wastes, as well as media and debris which may be contaminated with a hazardous waste. The CAMU may be designated for functional purposes as long as protectiveness is assured; in the case of this document, by meeting the

threshold criteria of acceptable risk, and compliance with identified ARARs. Contaminated media and debris generated during the remediation of OU4 may be managed in the CAMU, or moved between CAMUs without triggering the applicability of the Land Disposal Restrictions (LDRs) which prohibit placement of hazardous wastes in land disposal units unless the waste has been treated to certain concentration levels or by using specified technologies.

DOE-FN does not intend to invoke the CAMU ARAR for the management of the residues from the Silos. Use of the CAMU would be relevant and appropriate to management of soil and debris waste from remediation and D&D activities for disposal in the OSDF.

A.4.1.1 Land Disposal Restrictions (LDRs)

As stated in Section A.4.1, Silo 3 residues are classified as 11(e)(2) byproduct material under the AEA of 1954. As byproduct material, Silo 3 residues are exempt from regulation under RCRA. However, the substantive parts of certain RCRA requirements were identified as "relevant and appropriate" requirements for onsite activities for alternative involving off-site disposal at either the NTS or a RPCDF. Not identified as "relevant and appropriate" requirements were LDRs for minimum treatment requirements for restricted waste prior to land disposal.

However, Alternative ALT3 may require the identification of the LDRs as an "applicable" requirement for remediation of Silo 3 residues. Alternative ALT3 identifies off-site treatment of the Silo 3 residues by stabilization at a RPCDF followed by disposal at the RPCDF as the preferred remedial alternative. The current operating permit for the RPCDF will not allow the acceptance of Silo 3 residues as AEA 11(e)(2) byproduct material at the RPCDF. The RPCDF could, however, receive the material as LLRW. Shipment of the material to the RPCDF under the classification as LLRW would negate the previous classification of Silo 3 residues as AEA 11(e)(2) byproduct material since a material cannot be both LLRW and AEA 11(e)(2) byproduct material.

As LLRW, Silo 3 residues that exhibited the toxicity characteristic would be subject to regulations under RCRA, including the LDRs. In addition, these requirements would be "applicable" to the remediation of the Silo 3 residues. Off-site remedial actions only require "applicable" requirements be met; however, both the administrative and substantive parts of the applicable requirements must be met by the remedial alternative. Therefore, both the administrative and substantive parts of identified RCRA requirements would have to be complied with for Alternative ALT3 for material that exhibited the toxicity characteristic.

Section 268.9(c) states "...no prohibited waste which exhibits a characteristic under 40 CFR part 261, subpart C may be land disposed unless the waste complies with the treatment standards under 40 CFR part 268, subpart D". Mixed waste is prohibited from land disposal effective May 8, 1992, as stated in 40 CFR § 268.35(d). To be land disposed, Silo 3 residues classified as LLRW would be required to be treated to the extent where an extract from the treated waste developed using Method 1311, the TCLP, would not exceed the levels presented in Table CCWE of 40 CFR § 268.41.

It should be noted that Silo 3 residues blended with material from Waste Pit 5, under Alternative ALT4, can no longer be classified as AEA 11(e)(2) byproduct material. Therefore, blended material would be considered LLRW and any batch of blended material that also exhibited the toxicity characteristic would also be considered a mixed waste subject to the above LDRs.

A.4.2 RADIOACTIVE WASTE - AEA, NRC, AND UMTRCA

The residues in Silo 3 are unique, concentrated uranium ore process byproducts. No single regulation exists that is both sufficiently adequate and appropriate to address the management and disposal of these residues. Therefore, several groups of regulations that contain management and disposal requirements for radioactive wastes have been identified as "relevant and appropriate," and parts of DOE Order 5400.5 have been identified as "TBC" criteria for remedial actions involving this material. Certain requirements within these regulations are considered "relevant" to Silo 3 residues on the basis of significantly similar wastes and "appropriate" because the appropriateness of the requirements' purpose to the overall goals of the remedial action. The protective requirements of the UMTRCA, the NRC regulations, and various other regulations including DOE Order 5400.5, are listed as potential ARARs or TBCs for this material.

A.4.3 MORE STRINGENT STATE REQUIREMENTS

Those state requirements considered to be ARARs are: (1) promulgated such that they are of general applicability and legally enforceable, (2) identified by the state in a timely manner, and (3) are more stringent than federal requirements [40 CFR § 300.400(g)(4)]. Several State of Ohio promulgated requirements were identified as more stringent than the federal requirements and are potential ARARs for Operable Unit 4; these potential state ARARs are discussed below.

A.4.3.1 Ohio Solid and Hazardous Waste Rules

The State of Ohio solid and hazardous waste rules vary from the federal RCRA regulations. The federal regulations define hazardous wastes as a subset of solid wastes with the AEA regulated

substances specifically excluded under 40 CFR § 261.4. Under the Ohio rules, this exclusion provided for AEA regulated substances is only from regulation as hazardous waste, defining solid waste to include the AEA regulated substance. Therefore, this Ohio regulation is more stringent than its federal counterpart.

A.4.3.2 Ohio Water Quality Standards

The State of Ohio regulations contain the following water quality standard that does not have a counterpart in the federal requirements:

- Ohio Administrative Code 3745-1-21 assigns use designations to sections of the Great Miami River and its tributaries. Based on these use designations, Ohio Administrative Code 3745-1-07 designates water quality standards for the section of the river that is subject to potential impact by discharges from the FEMP, both at the point of discharge and outside the mixing zone.

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REFERENCES

McCord, C., U.S. Environmental Protection Agency, October 1990, (Letter to A. Avel, Subject: Operable Unit 4 Screening Dispute Resolution).

U.S. Department of Energy, 1993a, "Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3," Fernald Environmental Management project, DOE, Fernald Office.

U.S. Department of Energy, 1993b, "Remedial Investigation Report for Operable Unit 4," Final, Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy, 1994a, "Feasibility Study Report for Operable Unit 4," Final, Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy, 1994b, "Proposed Plan for Remedial Actions at Operable Unit 4," Final, Fernald Environmental Management Project, DOE/EA-0953, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy, 1994c, "Record of Decision for Remedial Actions at Operable Unit 4," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

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TABLE A.2-1a

POTENTIAL ARARs FOR SILO 3 REMEDIAL ACTION ALTERNATIVES

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Air	Residual Radioactive Material DOE Order 5400.5 Chap. IV, 6.b (proposed 10 CFR 834)	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 and thorium bearing waste might result in the release of radon gas to the environment.	VIT ALT1 ALT2 ALT4
Air	Radiation Protection of the Public and the Environment (DOE Order 5400.5 Chap. III) (proposed 10 CFR 834)	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.). Derived Concentration Guide[a] (μCi/mL)	To be considered	Remediation of Silo 3 residues has the potential to release radionuclides that are contained in the waste materials.	VIT ALT1 ALT2 ALT4

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}

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TABLE A.2-1a
(Continued)

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
	DOE Order 5400.5 Chap. III (Cont'd) (proposed 10 CFR 834)	Derived Concentration Guide[a] (μCi/mL) Isotope / D / W / Y 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, 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}.			

Medium	CAA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Air	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 might cause any member of the public to receive in any year an EDE of 10 mrem per year. Monitoring is required at release points having potential to discharge radionuclides which could cause an EDE in excess of 1% of the standard (0.1 mrem/yr) to any member of the public.	Applicable	Radioactive materials within Silo 3 might contribute to the dose to members of the public from the air pathway during implementation of remedial actions (since NESHAPS applies to operating units).	VIT ALT1 ALT2 ALT3 ALT4
Air	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	Facilities such as Silo 3 might qualify as sources since it might contain radium-226 in sufficient concentrations to emit radon-222. This requirement is applicable only to storage and disposal of radium-bearing byproduct material.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1a
(C d)

Chemical-Specific

Medium	DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Radiation Protection of the Public and the Environment (DOE Order 5400.5 Chapter III) (proposed 10 CFR 834)	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 only if ingestion is the single pathway of exposure. Isotope — Ingested Water DCGs (μCi/mL) Actinium-227 — $1x10^{-8}$ Lead-210 — $3x10^{-8}$ Polonium-210 — $8x10^{-8}$ Protactinium-231 — $1x10^{-8}$ Radium-224 — $4x10^{-7}$ Radium-226 — $1x10^{-7}$ Radium-228 — $1x10^{-7}$ Technetium-99 — $1x10^{-4}$ Strontium-90 — $1x10^{-6}$ Thorium-228 — $4x10^{-7}$ Thorium-230 — $3x10^{-7}$ Thorium-232 — $5x10^{-8}$ Uranium-234 — $5x10^{-7}$ Uranium-235 — $6x10^{-7}$ Uranium-236 — $5x10^{-7}$ Uranium-238 — $6x10^{-7}$	To be considered	Remediation of Silo 3 residues has the potential to release radionuclides that are contained in the waste materials to environmental media.	VIT ALT1 ALT2 ALT4

Medium	CWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Ohio Water Quality Standards OAC 3745-1-04	"Five Freedoms" for surface water: All surface waters of the state shall be free from: • 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	Pertains to both discharges to surface waters as a result of remediation and any on-site surface waters affected by site conditions.	VIT ALT1 ALT2 ALT4

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TABLE A.2-1a
(Continued)

Chemical-Specific

Medium	CWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Ohio Water Quality Standards OAC 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 criteria concentrations outside the mixing zone as follows: Constituent — Criteria conc.[a] (ug/1) — 30-day average conc. (ug/1) 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	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. Chemical contaminants within Silo 3might be released during remediation such that they might contribute to contamination in these aquatic habitats. OAC 3745-1-21 (Water Use Designation for the Great Miami River) establishes the classification of the receiving waters for the FEMP.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1a
(Continued)

Chemical-Specific

Medium	CWA	Requirement			ARAR/TBC	Rationale for Implementation	Alternative Number
Water	Ohio Water Quality Standards OAC 3745-1-07 (continued)	Constituent	Criteria conc.[a] (ug/1)	30-day average conc. (ug/1)			
		2-butanone	160000	7100			
		4-nitrophenol	790	35			
		acetone	550000	78000			
		aldrin	----	0.01			
		bis(2-ethylhexyl) phthalate	1100	8.4			
		carbon tetrachloride	1800	280			
		DDT	----	0.001			
		dieldrin	----	0.005			
		di-n-butyl-phthalate	350	190			
		diethylphthalate	2600	120			
		dimethylphthalate	1700	73			
		endosulfan[d]	----	0.003			
		endrin	----	0.002			
		fluoranthene	200	8.9			
		methylene chloride	9700	430			
		PCBs	----	0.001			
		phenol	5300	370			
		tetrachloroethene	540	73			
		toluene	2400	1700			
		[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 each. The remaining COCs for OU4 will have criteria concentration levels based on calculated acute aquatic criteria (AAC), or chronic aquatic criteria (CAC).					

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TABLE A.2-1a
(Continued)

Chemical-Specific

Medium	RCRA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Soil	Land Disposal Restrictions Treatment Standards 40 CFR 268.41, Subpart D	Table CCWE identifies the restricted wastes and the concentration of their associated constituents which may not be exceeded in the extract of a waste or waste treatment residual extracted using Method 1311, the Toxicity Characteristic Leaching Procedure, for the allowable land disposal of such waste. Waste Code / Regulated Constituent / Treatment Level (mg/L) D004 / Arsenic / 5.0 D005 / Barium / 100 D006 / Cadmium / 1.0 D007 / Chromium / 5.0 D008 / Lead / 5.0 D009 / Mercury / 0.20 D010 / Selenium / 5.7 D011 / Silver / 5.0	Applicable to non-excluded solid wastes that exhibit a hazardous characteristic	Shipment of Silo 3 residues to a RPCDF as LLRW might result in classification of residues as mixed waste subject to RCRA and the LDRs. Silo 3 residues might need to be treated such that leachate from treated material would meet treatment levels established under the LDRs.	ALT3 ALT4

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TABLE A.2-1b

POTENTIAL ARARs FOR SILO 3 REMEDIAL ACTION ALTERNATIVES

Location-Specific

NEPA/EPA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Endangered Species Protection 50 CFR 402 (ORC 1518, 1513.25) (OAC 1501-18-1-01)	Federal agencies must not jeopardize the continued existence of any endangered or threatened species, or destroy or adversely modify critical habitat of such species.	Relevant and Appropriate	Although the FEMP is located within the range of the Indiana bat, a federally listed endangered species, no sighting has occurred on the FEMP. Therefore, this requirement is relevant and appropriate. Any potential impacts of the remedial actions on this species must be evaluated and appropriate action taken.	VIT ALT1 ALT2 ALT4
NEPA/DOE	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Compliance with Floodplain/Wetlands Environmental Review Requirements 10 CFR 1022 (Executive Order 11990)	DOE actions in a wetland must first evaluate the potential adverse effects those actions might have on the wetland and consider the natural and beneficial values served by the wetlands.	Applicable	This requirement is applicable because the FEMP is a DOE facility. Several alternatives might result in destruction or modification of wetland areas.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1c

POTENTIAL ARARs FOR SILO 3 REMEDIAL ACTION ALTERNATIVES

Action-Specific

AEA/DOE	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
10 CFR 1021.2	DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR 1500-1508	Applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.	VIT ALT1 ALT2 ALT3 ALT4
CWA	**Requirement**	**ARAR/TBC**	**Rationale for Implementation**	**Alternative Number**
Nationwide Permit Program 33 CFR 330	The U.S. Corps of Engineers can issue a Nationwide Permit (NWP) as a general permit for certain classes of actions that involve dredge or fill activities in wetlands or navigable waters. Discharges of dredged or fill material into wetlands may require a wetland delineation.	Applicable	Remediation activities may require construction of access roads and utility lines resulting 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 14 (Road Crossing), and Nationwide Permit 12 (Utility Line Backfill and Bedding). OEPA has been granted Section 401 State Water Quality Certification for NWPs 12 and 14.	VIT ALT1 ALT2 ALT3 ALT4
Discharge of Storm Water Runoff 40 CFR 122.26 (OAC 3745-38)	Storm water runoff from landfills, 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	Required of all industrial waste sites and construction sites of greater than 5 acres that discharge storm water runoff to the waters of the United States. Some remedial alternatives evaluated might disturb more than 5 acres of land.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1c
(Continued)

Action-Specific

CWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Discharge of Treatment System Effluent 40 CFR 125.100 40 CFR 125.104	Best Management Practices Develop and implement a BMP program to prevent the release of toxic or hazardous pollutants 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. The BMP program must: • Establish specific objectives for the control of toxic and hazardous pollutants • 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	All of the proposed actions have the potential for releases and runoff from this operable unit. The requirement is not applicable because BMP under the NPDES permit program applies only to ancillary facilities of manufacturing units that might have releases of toxic or hazardous pollutants. The purpose of the BMP program is relevant and appropriate to prevent releases from spills or runoff during the implementation of remedial actions. The FEMP has an approved Best Management Practices Plan.	VIT ALT1 ALT2 ALT4

SDWA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Ohio Water Well Standards OAC 3745-9-10	Abandonment of Test Holes and Wells 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 wells might be installed and/or closed as part of these remedial alternatives.	VIT ALT1 ALT2 ALT3 ALT4

UMTRCA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings 40 CFR 192 Subpart C	This subpart contains guidance, criteria, and supplemental standards for compliance with Subparts A and B of 40 CFR 192.	Relevant and Appropriate	Radioactive materials in this operable unit are primarily byproduct residues from uranium processing. Requirements for design of controls should be consistent with design of controls for other residual radioactive materials such as mill tailings.	VIT ALT1 ALT2 ALT4

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Action-Specific

RCRA Subtitle D	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Hazardous Waste Determinations 40 CFR 262.11 (OAC 3745-52-11)	Any generator of waste must determine whether or not the waste is hazardous. The procedures to be followed include: • To identify whether a particular material of concern is a "solid waste" • To identify whether a particular exclusion applies to the material eliminating it from definition as a "solid waste" • To identify whether a particular solid waste might be classified as a hazardous waste • To 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 that exhibit a hazardous characteristic).	These procedures are established to determine whether wastes are subject to the requirements of RCRA. The residues in Silo 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, exhibit the characteristics of hazardous waste, or are otherwise similar to RCRA hazardous waste. The residues stored in the silos are sufficiently similar to hazardous wastes based on the TCLP results. Silo 3 contains residues which must be treated, stored, and disposed in accordance with RCRA. Other wastes, such as debris generated during decontamination (e.g., concrete scabbling), will also require a hazardous waste determination to be made.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Empty Containers 40 CFR 261.7 (OAC 3745-51-7)	Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if one or more of the following are met: • No more than 2.5 cm (1 inch) of residue remains on bottom of inner liner • Less than 3% by weight of total capacity remains (less than or equal to 110 gallon container) • Less than 0.3% by weight of total capacity remains (greater than 110 gallon container) Containers that have held acutely hazardous ("P" listed) wastes are "empty" and exempt from further RCRA regulation if: • They or their inner liners have been triple rinsed with an adequate solvent or the inner liner has been removed from the container	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Containers used to treat or store the contents of Silo 3 might contain residues which exhibit hazardous waste characteristics which must be removed before the containers might be reused or disposed.	VIT ALT1 ALT2 ALT3 ALT4
Generators Who Transport Hazardous Waste for Off-Site Treatment, Storage, or Disposal 40 CFR 262.20 - 262.33 and 263.20-.31 (OAC 3745-52-20 through 33 and OAC 3745-53-20 through 31)	Any generator who transports hazardous waste for off-site treatment, storage or disposal must originate and follow-up the manifest for off-site shipments.	Applicable	Any residues determined to be RCRA hazardous waste removed from this operable unit for off-site treatment, storage, or disposal might be subject to the manifest requirements.	VIT ALT1 ALT2 ALT3 ALT4

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Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Treatment, Storage, or Disposal Facility Standards 40 CFR 264, Subpart B (OAC 3745-54-13 through 16)	General Standards • 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 prior to treatment, storage, or disposal • 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 • 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 remedy defects, and maintain an inspection log • 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 positions including emergency response training	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Residues, which exhibit a characteristic similar to RCRA hazardous waste, removed from this operable unit might be treated, stored, and disposed in accordance with TSD facility standards. These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1c
(Continued)

Action-Specific

Treatment, Storage, or Disposal Facility Preparedness and Prevention 40 CFR 264, Subpart C 40 CFR 264.31 (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 nonsudden release of hazardous waste to air, soil, or surface water which might threaten human health or the environment.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Residues removed from this operable unit might be treated, stored, and disposed in accordance with TSD facility standards. These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste.	ALT1 ALT2 ALT3 ALT4
40 CFR 264.32 (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.			
40 CFR 264.33 (OAC 3745-54-33)	All fire protection and spill-control and decontamination equipment and communication and alarm systems must be tested and maintained as necessary to assure proper emergency operation.			
40 CFR 264.34 (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.			
40 CFR 264.35 (OAC 3745-54-35)	Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment.			
40 CFR 264.37 (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.			

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Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
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.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Residues removed from this operable unit must be treated, stored, and disposed in accordance with TSD facility standards. These requirements are relevant and appropriate because the residues in Silo 3 are sufficiently similar to hazardous waste.	VIT ALT1 ALT2 ALT3 ALT4
40 CFR 264.52 (OAC 3745-54-52)	Contingency plans should address procedures to implement a response to incidents involving hazardous waste, and provide for 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.			
40 CFR 264.55 and 56 (OAC 3745-54-55 through 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.			

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TABLE A.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Closure 40 CFR 264, Subpart G 40 CFR 264.111 (OAC 3745-55-11) 40 CFR 264.114 (OAC 3745-55-14) 40 CFR 264.116 (OAC 3745-55-16)	Operator must close facility in a manner that: • Minimizes the need for further maintenance • Minimizes post-closure escape of hazardous constituents • Complies with specific unit type closure requirements All contaminated equipment, structures and soils must be properly disposed or decontaminated. Following closure, a survey plot showing the location of hazardous waste disposal units with respect to surveyed benchmarks must be filed with the legal total zoning authority.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	These requirements are relevant and appropriate because the residues are sufficiently similar to hazardous waste and some remedial alternatives might require closure as outlined in this standard. (The requirement for submittal of survey plot will not pertain to the off-site alternatives unless on-site residuals require management as a land fill).	VIT ALT1 ALT2 ALT3 ALT4

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Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Container Storage 40 CFR Subpart I 264.171 - 178 (OAC 3745-55-71 through -78)	Containers of RCRA hazardous waste must be: • 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. Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide a containment system with a capacity of 10 percent of the volume of the largest container of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all containers, liners, bases, and soils.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	These requirements are relevant and appropriate for alternatives utilizing containers for temporary storage or storage before disposal. The requirements are relevant and appropriate because the residues in the silos are sufficiently similar to hazardous waste.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Tank Systems 40 CFR 264, Subpart J (OAC 3745-55-91 through 96)	Design, operating standards, and inspection requirements for tank units within which hazardous waste is stored or treated. • 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 liquids to the environment.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Design criteria, operating standards, and inspections for tank treatment units might be relevant and appropriate for alternatives utilizing treatment or storage in a tank prior to disposal. These requirements are relevant and appropriate because the residues in the silos are sufficiently similar to hazardous waste.	VIT ALT1 ALT2 ALT3 ALT4
Closure Requirements for Tanks 40 CFR 264.197 (OAC 3745-55-97)	At closure, the facility owner must do the following: • Remove all waste residues • Remove or decontaminate all tank system components • Remove or decontaminate all contaminated soils and structures • Manage all of the above as hazardous wastes • If all contaminated soils cannot be removed, the landfill requirements of 40 CFR 264.310 apply	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Silo 3 is a tank, according to the definitions of 40 CFR 264.10, which contain wastes sufficiently similar to hazardous waste. These requirements are relevant and appropriate because the circumstances and wastes subject to potential release are similar to those RCRA is designed to address. These standards will also pertain to closure of any tanks and appurtances used to store or treat these residues during remediation.	VIT ALT1 ALT2 ALT3 ALT4
Miscellaneous Units 40 CFR 264, Subpart X (40 CFR 264.601 and .602) (OAC 3745-57-91 and 92)	Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined in 40 CFR 260.10.	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	Miscellaneous units might be utilized under various alternatives to remediate waste that is sufficiently similar to hazardous wastes. These units might include mixers, vitrifiers, or other units.	VIT ALT1 ALT2 ALT3 ALT4

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Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Corrective Action for SWMUs 40 CFR Subpart S 40 CFR 264.552,.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 and Appropriate (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	During the process of remediation, waste materials might require temporary management in containment buildings, temporary units, stockpiles or, other land based units for the purpose of staging, treating or disposing the material. All of the materials generated from remediation of Silo 3 are considered remediation wastes. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.	VIT ALT1 ALT2 ALT3 ALT4
Containment Buildings 40 CFR 264 Subpart DD 40 CFR 264.1101 and .1102	Hazardous waste and debris might be placed in units known as containment buildings for the purpose of interim storage or treatment. 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 (This requirement will be applicable to non-excluded solid wastes that exhibit a hazardous characteristic).	During the process of remediation, waste materials might require temporary management for the purpose of staging or treating the material. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1c
(Continued)

Action-Specific

RCRA Subtitle C	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Waste Analysis and Recordkeeping 40 CFR 268.7(a)	Except as specified in §268.32, if a generator's waste exhibits one or more of the characteristics set out at 40 CFR part 261, subpart C, the generator must test an extract using the Extraction Procedure Toxicity Test, Method 1310,..., or use process knowledge of the waste to determine if the waste is restricted from land disposal under this part.	Applicable to non-excluded solid wastes that exhibit a hazardous characteristic.	Method 1310, Extraction Procedure Toxicity Test would be used to determine compliance with this requirement.	ALT3 ALT4
Special Rules Regarding Wastes that Exhibit a Characteristic 40 CFR 268.9(c)	In addition to any applicable standards determined from the initial point of generation, no prohibited waste which exhibits a characteristic under 40 CFR part 261, subpart C may be land disposed unless the waste complies with the treatment standards under 40 CFR part 268, subpart D.	Applicable to non-excluded solid wastes that exhibit a hazardous characteristic.	Shipment of Silo 3 residues to a RPCDF as LLRW may result in classification of residues as mixed waste. 40 CFR 268.35(d) prohibits such mixed waste from land disposal effective May 8, 1992. For Silo 3 residues to be land disposed as LLRW at the RPCDF the treatment standards under 40 CFR 268 Subpart D would have to be met.	ALT3 ALT4
Applicability of Treatment Standards 40 CFR 268.40(a)	A restricted waste identified in §268.41 may be land disposed only if an extract of the waste or of the treatment residue of the waste...does not exceed the value shown in Table CCWE of §268.41.	Applicable to non-excluded solid wastes that exhibit a hazardous characteristic.	Method 1311, Toxicity Characteristic Leaching Procedure would be used to determine compliance with this requirement.	ALT3 ALT4

DOE Order	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Radiation Dose Limit (All Pathways) DOE Order 5400.5, Chapter II, Section 1.a (proposed 10 CFR 834)	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	Radiation sources within this operable unit might contribute to the total dose to members of the public from this DOE facility.	VIT ALT1 ALT2 ALT4

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Action-Specific

CAA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
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	The implementation of remedial action alternatives will require the movement of dirt and other material likely to result in fugitive dust emissions. This requirement is relevant and appropriate because the FEMP is not located in an area subject to this regulation.	VIT ALT1 ALT2 ALT4
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	During the remediation process some potential exists for emissions of radionuclides and toxic chemicals to the air, which might endanger individuals or damage property.	VIT ALT1 ALT2 ALT3 ALT4
Control of Visible Particulate Emissions from Stationary Sources OAC 3745-17-07	Discharge of particulate emissions into ambient air from any stack of a shade or density greater than 20 percent opacity is prohibited. Transient exceedance limits are included in this regulation.	Applicable	Treatment operations for various alternatives might result in the release of particulate material.	VIT ALT1 ALT2 ALT3 ALT4
Permit to Install OAC 3745-31-05(A)(3)	The director shall issue a permit to install if he determines that the installation or modification and operation of the air contaminant source will employ the best available technology.	Relevant and Appropriate	Although an administrative Permit to Install is not required for alternatives involving treatment, the substantive requirements of this section must be met by employing Best Available Technology (BAT) for treating particulate and off-gas emissions.	VIT ALT1 ALT2 ALT4

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TABLE A.2-1c
(Continued)

Action-Specific

CAA	Requirement	ARAR/TBC	Rationale for Implementation	Alternative Number
Restrictions on Particulate Emissions from Industrial Processes OAC 3745-17-11	This requirement establishes numerical emission release limits for particulate material from industrial sources. 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	Treatment operations for various alternatives might result in release of particulate material which might exceed these standards.	VIT ALT1 ALT2 ALT3 ALT4

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TABLE A.2-1d[a]

OTHER REQUIREMENTS FOR SILO 3
REMEDIAL ACTION ALTERNATIVES

Title	Requirement	Rationale for Implementation
OSHA Worker Protection Requirements 29 CFR 1904 and 1910	These regulations establish requirements to protect workers who could be exposed to radiation, noise, hazardous wastes, or other contaminants or hazards at the remediation site.	This operable unit is a remediation site under CERCLA. Compliance with 29 CFR 1910.120 is required for all sites undergoing remediation by 40 CFR 300.150.
DOT Requirements for Transportation of Hazardous Materials 49 CFR 171-173, 177, 178	No one may transport hazardous materials on public highways except in accordance with these regulations: Part 171 General requirements Part 172 This part establishes shipping papers, marking, labeling, placarding, and emergency response information requirements. Part 173 This part establishes packaging and other shipping requirements for hazardous materials, including radioactive materials. Part 177 Requirements of the transporter Part 178 Specifications for shipping containers	Applicable to those alternatives which involve transportation of the waste materials off-site. Radioactive materials and materials sufficiently similar to hazardous wastes might be shipped off site.

[a]These other requirements are not technically ARARs or TBCs since they are not environmental regulations or guidance subject to waiver, but must be complied with whenever they pertain to the location or activity.

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TABLE A.2-1d[a]
(Continued)

Title	Requirement	Rationale for Implementation
Highway Improvement Act of 1982 23 USC 127	Establishes vehicle weight limits for interstate highways.	Applicable to those alternatives which involve transportation of the waste materials offsite.
Hazardous Materials Transportation Act 49 USC 1801-1812	Establishes requirements for minimizing environmental impacts of spills or releases of hazardous materials.	Applicable to those alternatives which involve transportation of the waste materials off-site. Radioactive materials and materials sufficiently similar to hazardous wastes might be shipped off site.
NTS Waste Acceptance Criteria	Establishes the wastes that can be disposed at the facility.	NTS's acceptance criteria would be applicable to disposal at the NTS. NTS operates under DOE Order 5820.2A, "Radioactive Waste Management."
Envirocare Waste Acceptance Criteria	Establishes the wastes that can be disposed at the facility.	Envirocare's acceptance criteria would be applicable to disposal at Envirocare.
National Historic Preservation Act 16 USC 470 et seq.	Protection of sites listed or eligible for listing in the National Register of Historic Places.	Required as a matter of law for the alternatives affected.
Archaeological and Historic Preservation Act 16 USC 469	Preservation of artifacts and data associated with archaeological finds.	Required as a matter of law for the alternatives affected.

[a]These other requirements are not technically ARARs or TBCs since they are not environmental regulations or guidance subject to waiver, but must be complied with whenever they pertain to the location or activity.

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TAB -1d[a]
(Continued)

Title	Requirement	Rationale for Implementation
American Indian Religious Freedom Act 42 USC 1996	Provides for tribal access by native peoples to grave sites and sites of cultural, symbolic, or religious significance.	Required as a matter of law for the alternatives affected.
Native American Graves Protection and Repatriation Act 25 USC 3001	Provides for return of human remains and cultural objects from Native American graves to affiliated tribes.	Required as a matter of law for the alternatives affected.
Executive Order 11593 - Protection and Enhancement of Cultural Environment	Requires inventory of site for potential historic places for eligibility in the National Register of Historic Places.	Required as a matter of law for the alternatives affected.
Fish and Wildlife Coordination Act 16 USC 66 et seq.	Requires consultation with other state agencies for any activities which might affect any body of water for the purpose of conserving fish and wildlife resources.	Required as a matter of law for the alternatives affected.
Archaeological Resources Protection Act 16 USC 470 (a)	Requires permit for removal of any archaeological resources from federal lands.	Required as a matter of law for the alternatives affected.
Antiquities Act and Historic Sites Act 16 USC 431-433 and 16 USC 461-467	Requires identification and preservation of cultural resources on federal lands. Includes natural landmarks.	Required as a matter of law for the alternatives affected.

[a]These other requirements are not technically ARARs or TBCs since they are not environmental regulations or guidance subject to waiver, but must be complied with whenever they pertain to the location or activity.

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TABLE A.2-1d[a]
(Continued)

Title	Requirement	Rationale for Implementation
Farmland Protection Policy Act 7 USC 4201 et. seq.	Requires protection and maintenance of farmland for its beneficial use as national resource.	Required as a matter of law for the alternatives affected.
Occupational Radiation Protection 10 CFR 835	Standards for occupational radiation protection of workers at DOE facilities	Required as a matter of law for safety and worker protection at DOE facilities. Replaces former DOE Order 5480.11.

[a]These other requirements are not technically ARARs or TBCs since they are not environmental regulations or guidance subject to waiver, but must be complied with whenever they pertain to the location or activity.

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TAB[illegible]2-1d[a]
(Continued)

DOE Order	Title	Rationale for Implementation
5400.3	Hazardous and Mixed Waste Program	Contractual obligation for activities at DOE facilities
5400.5	Radiation Protection of the Public and the Environment	Contractual obligation for activities at DOE facilities
5440.1E	NEPA Compliance Program	Contractual obligation for activities at DOE facilities
5480.1B	Environmental, Safety, and Health Program for DOE Operations	Contractual obligation for activities at DOE facilities
5480.3A	Hazardous Materials Packaging and Transportation Safety	Contractual obligation for activities at DOE facilities
5480.4	Environmental Protection, Safety, and Health Protection Standards	Contractual obligation for activities at DOE facilities
5483.1A	Occupational Safety and Health Programs for DOE Employees at Government-Owned, Contractor-Operated Facilities	Contractual obligation for activities at DOE facilities
5820.2A	Radioactive Waste Management	Contractual obligation for activities at DOE facilities
5700.6C	Quality Assurance	Contractual obligation for activities at DOE facilities
6430.1A	General Design Criteria	Contractual obligation for activities at DOE facilities

[a]These other requirements are not technically ARARs or TBCs since they are not environmental regulations or guidance subject to waiver, but must be complied with whenever they pertain to the location or activity.

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TABLE A.2-2

DOCUMENTATION OF COMPLIANCE WITH ARARs FOR SILO 3 RESIDUES[1]

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
CHEMICAL-SPECIFIC:			
40 CFR 61 Subpart H Radionuclide Emissions (Except Airborne Radon-222)	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.	The effective dose 10 mrem standard for air emissions would be met at the nearest off-site receptor.
40 CFR 61 Subpart Q Radon Emissions	The radon-222 flux rate standard of 20 pCi/m^2/s would be met during storage.	The radon-222 flux rate standard of 20 pCi/m^2/s would be met during storage.	The radon-222 flux rate standard of 20 pCi/m^2/s would be met during storage.
OAC 3745-1-04 Ohio Water Quality Standards (Five Freedoms)	This alternative would prevent releases that impact surface water during removal and treatment.	NA[2]	This alternative would prevent releases that impact surface water during removal and blending.
OAC 3745-1-07 Ohio Water Quality Standards	Discharges during treatment of silo material would be monitored and treated to comply with these standards.	Discharges during removal of silo material would not cause water quality standards to be exceeded outside the mixing zone.	Discharges would not cause the water quality standards to be exceeded outside the mixing zone.
40 CFR 268.41(a) Treatment Standards expressed as concentrations in waste extract	NA[2]	Cement stabilization of the Silo 3 residues will meet the treatment levels for RCRA metals.	Blended material that exhibits the toxicity characteristic will be stabilized at the RPCDF to meet the treatment levels for RCRA metals.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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TABLE A.2-2[1]
(Continued)

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
LOCATION-SPECIFIC:			
50 CFR 402 Protection of Endangered Species	The on-site portions of this alternative would not impact an endangered or threatened specie or habitat.	NA[2]	The on-site portions of this alternative would not impact an endangered or threatened specie or habitat.
10 CFR 1022 Compliance with Floodplain/Wetlands Environmental Review Requirements	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.	This alternative would comply with all NEPA documentation requirements.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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TABLE A.2-2[1]
(Continued)

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
ACTION-SPECIFIC:			
10 CFR 1021.2 NEPA Implementation	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.	This alternative would comply with the NEPA documentation requirements.
33 CFR 330 Nationwide Permit Program	This alternative would comply with the dredge and fill requirements.	This alternative would comply with the dredge and fill requirements.	This alternative would comply with the dredge and fill requirements.
40 CFR 122.26 Discharge of Storm Water Runoff	This alternative would monitor and control storm water runoff during removal and treatment.	This alternative would monitor and control storm water runoff during removal.	This alternative would monitor and control storm water runoff during removal and blending.
40 CFR 125.100 and 125.104 Discharge of Treatment System Effluent (Best Management Practices)	This alternative would implement BMPs during removal and treatment of waste material.	NA[2]	This alternative would implement BMPs during removal and blending of waste material.
OAC 3745-9-10 Ohio Water Well Standards	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.	This alternative would comply with the well abandonment standards.
40 CFR 192 Subpart C Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings	This alternative would comply with this requirement.	NA[2]	This alternative would comply with this requirement.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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TABLE A.2-2[1]
(Continued)

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
40 CFR 262.11 Hazardous Waste Determinations	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.	This alternative would comply with the waste determination requirements.
40 CFR 261.7 Empty Containers	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.	This alternative would comply with the empty container requirements.
40 CFR 262.20-.33 and 263.20-.31 Transport of Hazardous Waste	This alternative would comply with the hazardous waste transport requirements.	This alternative would comply with the hazardous waste transport requirements.	This alternative would comply with the hazardous waste transport requirements.
40 CFR 264 Subpart B TSDF General Standards	This alternative would comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.	This alternative would comply with the TSDF general standards.
40 CFR 264 Subpart C TSDF Preparedness and Prevention	This alternative would comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.	This alternative would comply with the TSDF preparedness and prevention requirements.
40 CFR 264 Subpart D TSDF Contingency Plan and Emergency Procedures	This alternative would comply with the TDSF emergency/ contingency plan requirements.	This alternative would comply with the TDSF emergency/ contingency plan requirements.	This alternative would comply with the TDSF emergency/ contingency plan requirements.
40 CFR 264.111, .114 and, .116 Closure Requirements	This alternative would comply with the closure requirements for units involved in treatment.	This alternative would comply with the closure requirements for units involved in preparing material for shipment.	This alternative would comply with closure requirements for the blending facility.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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TABLE A.2-2[1]
(Continued)

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
40 CFR 264 Subpart I Container Storage	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.	This alternative would comply with the hazardous waste container storage requirements.
40 CFR 264 Subpart J Tank Systems	This alternative would comply with the RCRA tank requirements for units involved in treatment.	This alternative would comply with the RCRA tank requirements.	This alternative would comply with the RCRA tank requirements for units involved with blending.
40 CFR 264.197 Closure Requirements for Tank Systems	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.	This alternative would comply with the RCRA tank closure requirements for unit operations involving tanks.
40 CFR 264 Subpart X Miscellaneous Units	This alternative would comply with the miscellaneous units requirements.	This alternative would comply with the miscellaneous units requirements.	This alternative would comply with the miscellaneous units requirements.
40 CFR 264.552 and .553 Subpart S Corrective Action for SWMUs	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.	This alternative would comply with the CAMU and TU requirements.
40 CFR Subpart DD Containment Buildings	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.	This alternative would comply with the requirements for containment buildings.
40 CFR 268.7(a) Waste Analysis and Recordkeeping	NA[2]	This alternative would comply with the analysis and recordkeeping requirements.	Blended material that exhibits the toxicity characteristic would comply with the analysis and recordkeeping requirements.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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TABLE A.2-2[1]
(Continued)

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
40 CFR 268.9(c) Special Rules Regarding Wastes that Exhibit a Characteristic	NA[2]	Cement stabilization of Silo 3 residues would ensure compliance with this requirement.	Blended material that exhibits the toxicity characteristic will be stabilized at the RPCDF to meet the treatment levels for RCRA metals.
40 CFR 268.40(a) Applicability of Treatment Standards	NA[2]	Cement stabilization of Silo 3 residues would ensure compliance with this requirement.	Blended material that exhibits the toxicity characteristic will be stabilized at the RPCDF to meet the treatment levels for RCRA metals.
OAC 3745-17-08 Control of Fugitive Dust	This alternative would control any construction or demolition activities that would create fugitive dust.	NA[2]	This alternative would control any construction or demolition activities that would create fugitive dust.
ORC 3704.01-.05 OAC 3745-15-07 Prohibition of Violations and Prevention of Air Pollution Nuisance	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.	This alternative would not create an air pollution nuisance.
OAC 3745-17-07 Control of Particulate Emissions from Stationary Sources	This alternative would comply with the requirement.	This alternative would comply with the requirement.	This alternative would comply with the requirement.
OAC 3745-31-05(a)(3) Permit to Install	This alternative would employ BAT for treating particulate and off-gas emissions.	NA[2]	This alternative would employ BAT for treating particulate and off-gas emissions.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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TABLE A.2-2[1]
(Continued)

Requirement	VIT, ALT1, & ALT2 Removal, Onsite Stabilization, Off-site Disposal	ALT3 Removal, Off-site Treatment, Off-site Disposal	ALT4 Removal, Onsite Blend with Waste Pit 5 Material, Off-site Disposal
OAC 3745-17-11 Restrictions on Particulate Emissions from Industrial Processes	This alternative would comply with the requirement.	This alternative would comply with the requirement.	This alternative would comply with the requirement.

[1]Five alternatives are proposed for remediation of Silo 3 residues: VIT, ALT1, ALT2, ALT3, and ALT4. Since compliance with ARARs is identified for alternatives involving onsite treatment followed by off-site disposal, they have been consolidated into one column on this table. Any difference in compliance with ARARs between the vitrification and cementation alternative will be noted in the table.
[2]"NA" indicates identified requirements is not an ARAR for this alternative.

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APPENDIX B

Summary of Screening Evaluation of Silo 3 Alternatives

(March 15, 1996)

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B.1.0 INTRODUCTION

B.1.1 Background

The Record of Decision (ROD) for Operable Unit 4 (OU4) identified vitrification and disposal at the Nevada Test Site (NTS) as the selected remedy for the contents of Silos 1, 2, and 3. During implementation of the ROD, development of improved technical, schedule, and cost data have made it appropriate to reevaluate vitrification and consider other alternatives for the Silo 3 material. The purpose of this reevaluation is to determine whether any alternatives could simplify the technical requirements, accelerate the schedule, and save money while providing the same level of human health and environmental protection.

One recommendation from the January 1996 Value Engineering Study was that alternative methods of dispositioning Silo 3 material would simplify vitrification of Silos 1 and 2 material, significantly shorten the remediation schedule, and reduce the overall costs. A joint DOE/FERMCO team was asked to evaluate the four leading alternatives to vitrification. Table B.1-1 lists the team members.

- Direct Disposal with Off-Site Treatment
- Cementation (Stabilization)
- Vacuum Extrusion (Including stabilization)
- Blending with OU1 Material

These four alternatives were selected as potentially viable. It was determined that only conventional and proven treatment methods stood a strong likelihood of success. Any change to the chosen OU4 ROD remedial action will proceed through the CERCLA process, which requires a detailed analysis of alternatives prior to implementation of a selected remedy and the solicitation of proposals for performing the actual work. A technology must be identified in the ROD that will meet the remediation objectives. The market place can be used to find the best way to implement the technology.

Due to the time constraints on performing this initial evaluation, only existing data and information was used in the analysis. The limitations of the information and the need for additional information is documented.

Cost estimates are rough order of magnitude and are presented as ranges for each alternative. These cost figures do not represent the total cost of a project because they do not include some of the cost elements common to each alternative. The costs should be used to provide input to the viability of an option not to specifically compare one alternative to another alternative except for evaluating relative cost magnitudes.

Table B.1-1. SILO 3 ALTERNATIVES EVALUATION TEAM

DOE

John Sattler	Waste Management	Cementation (Lead)
Nina Akgunduz	OU4	(Lead)
John Hall	OU1	Blending
David Rast	Waste Management	Direct Disposal
Doug Maynor	Ohio Field Office	Vacuum Extrusion

FERMCO

John Smets	OU4	(Project Management)
Ken Alkema	Materials Disposition	Direct Disposal (Technical Lead)
Karen Wintz	Waste Management	Cementation
Keith Hampton	OU4	Vacuum Extrusion
Diane Zdelar-Bush	OU1	Blending
Mike West	Waste Management	
Mike Skriba	OU4	(Project Director)
Robert Frost	OU4	(Regulatory)
Mike Smith	OU4	(Transportation)

B.1.2 Approach

The following steps were used by the evaluation team in developing the evaluation:

- A set of evaluation criteria was developed and is presented in Section B.4.0 for each alternative.
- A DOE/FERMCO team, identified for each alternative, collected and summarized the available information for each alternative
  Common assumptions, background information, regulatory positions, waste acceptance criteria, stakeholder and regulator concerns, and analytical data information were assembled and are presented in Section B.6.0.
- A common cost and schedule evaluation process was established to assist in consistency among the alternatives.
- All of the individual information was evaluated and normalized for consistency and presentation.

This evaluation is the first step in determining whether an alternative to vitrification would better meet the CERCLA evaluation criteria and remediation effort for the Silo 3 material. The next step will be to develop, by April 30, 1996, a more detailed Silo 3 Alternatives Evaluation that will

provide a comprehensive and detailed evaluation of Silo 3 alternatives, including vitrification. The vitrification alternative for Silo 3 material will be updated with any additional information that has become available since the OU4 ROD approval.

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B.2.0 SUMMARY

B.2.1 Results

Table B.2-1 summarizes the results of this evaluation. Details of the evaluation for each alternative are presented in Section B.5.0.

Section B.3.1 presents a description of each alternative. A discussion of the screening criteria used in this evaluation is found in Section B.4.0. Section B.6.0 describes the assumptions and bases used in this evaluation.

B.2.2 Conclusions

Cost was not found to be a discriminator in this evaluation. The cost estimates for the alternatives were very rough orders of magnitude since they were not based on detailed designs, layouts, or vendor quotes. All four estimate ranges overlapped each other, making none a clear winner.

The blending alternative does not allow for early Silo 3 disposition as the other alternatives do and presents significant programmatic risk to the project. This alternative relies on dilution (approximately 20 percent Silo 3 material and 80 percent Pit 5 material) to meet the mobility and toxicity requirements for TCLP metals contained in Silo 3. There is a chance that some batches of the blended material may not meet the requirements. In that case the entire batch will have to be stabilized by a process such as cementation at the disposal site or vitrification at Fernald. Any batches of blended Silo 3 material and waste pit material that fail the Toxicity Characteristic Leaching Procedure (TCLP) become mixed waste, and must then be treated to meet the Land Disposal Restrictions (LDRs) applicable as ARARs for the project. The proposed Universal Treatment Standards (UTSs) would require treatment to meet much lower leaching rates than the current TCLP limits.

Direct disposal with off-site treatment and cementation provide two viable alternatives to compare to vitrification. Using either of these methods, remediation could begin within 12-18 months and be completed within 18-30 months. It should be noted that these estimates do not include time to modify the regulatory enforcement documents and perform treatability studies. The cost ranges merit additional consideration and may compare favorably to vitrification costs. It is expected that off-site treatment will be cementation which will be performed at the commercial disposal facility. These alternatives are both variations of cementation, which was identified as a feasible alternative within the OU4 FS. The only difference between direct disposal with off-site treatment and cementation is the location of the treatment facility.

The vacuum extrusion alternative is similar in most respects to the cementation alternative. Both alternatives will treat the Silo 3 materials and produce a waste form that is expected to meet disposal requirements. Facility sizes and costs will be nearly the same. Equipment costs for vacuum extrusion will be a little more than cementation since it requires, in essence, a full cement

plant plus the extruder, which is currently available as government excess at DOE's Mound Facility but is contaminated with transuranics. The processing schedules will be similar. The volume of waste to be disposed of, and its associated costs, may be less than cementation since vacuum extrusion is primarily a volume reduction process; however, it's uncertain how much volume reduction can be obtained with wet cement.

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TABLE B.2-1 Silo 3 Remediation Alternatives - Summary of Screening Evaluation

CRITERIA	DIRECT DISPOSAL (Commercial Facility Only)	CEMENTATION	VACUUM EXTRUSION	BLENDING WITH PIT 5 (OU1)
Institutional Implementability				
Impacts on OU4 ROD	Not considered in FS. Contains basic ROD elements. Provides treatment and off-site disposal at a commercial disposal facility. ROD amendment likely.	Alternative included in FS. Slight potential to handle as ESD. Most likely ROD amendment.	Not considered in FS. Similar to cementation.	Not considered in FS. OU4 ROD change similar to cementation. Unlikely change to OU1 ROD needed.
Licensing/Permitting/Special Approvals	Requires exemption to prohibition on commercial disposal of low-level waste, unless sent as mixed waste (DOE Order 5820.2A). Modification of 11.(e)(2) license if not sent as low-level waste.	Exemption to DOE Order 5820.2A required for disposal at a commercial disposal facility. NTS requires PA modification.	Exemption to DOE Order 5820.2A required for disposal at commercial disposal facility. NTS requires PA modification.	Modification of the exemption to DOE Order 5820.2A for OU1 material may be required for disposal at a commercial disposal facility. Silo 3 loses 11.(e)(2) classification upon blending with OU1 - becomes LLRW. Must meet TCLP limits, or else be treated to meet the RCRA LDRs.
EPA/Stakeholder Concerns	Transport of powdery material. Quality of treatment at disposal facility.	Waste is in stable form prior to shipment similar to existing ROD.	Waste is in stable form prior to shipment similar to existing ROD.	No significant reduction in toxicity or mobility provided for Silo 3 material.
Technical Implementability				
Demonstrated Experience	Similar material has been treated and disposed successfully at the commercial disposal facility.	Proven and tested. Commonly used to stabilize RCRA wastes containing metals.	Proven successful for waste volume reduction. Use for mixed waste treatment being tested. Not currently in use for stabilization.	Proven technology. No metals treatment being performed.

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TABLE B.2-1 Silo 3 Remediation Alternatives - Summary of Screen Evaluation (Cont.)

CRITERIA	DIRECT DISPOSAL (Commercial Facility Only)	CEMENTATION	VACUUM EXTRUSION	BLENDING WITH PIT 5 (OU1)
Expected Success with Silo 3 Material	Should be able to blend, treat, and dispose Silo 3 material at a commercial disposal facility.	Proven and tested - requires formulation refinement.	Should be able to blend, treat, and dispose Silo 3 material. No data to support. Potential volume reduction uncertain. Need specific treatability information.	Introduction and blending of Silo 3 to OU1 process must be addressed. Expect drying process of blended waste to remain the
Ability to Meet WAC NTS Commercial Disposal Facility	NTS can not currently accept. Meets commercial disposal facility WAC for receipt. Requires blending to meet in-place radiological WAC.	NTS: Meets WAC after treatment. ENV: Meets RCRA standards, will require blending/averaging in cell for radionuclide WAC limits.	NTS: Meets WAC after treatment. ENV: Meets RCRA standards, will require blending/averaging in cell for radionuclide WAC limits.	Blend with Pit 5 - meets commercial disposal facility WAC for direct cell placement. Must be blended additionally at the commercial disposal facility, if mixed with Pits 1, 2, 4, or 6.
Secondary Wastes	Containers if not recycled, PPE, scrap equipment, spent carbon from radon reduction, decontamination materials, filtering cartridges.	Sampling materials, PPE, scrap equipment, spent carbon from radon reduction, decontamination materials, filters, and containers if not able to recycle.	Sampling materials, HEPA filters, spent carbon from radon reduction, PPE, scrap equipment, decontamination materials, wastewater from vacuum exhaust.	Silo 3 radionuclides not included in OU1 modeling. Sampling materials, filters, spent carbon from radon reduction, PPE, scrap equipment, decontamination materials, etc.
Environmental and Safety Issues	Careful control of dust and radon release during packaging.	Careful control of dust and radon release during removal, processing, and packaging.	Careful control of dust and radon release during removal, processing, and packaging. Treatment of vacuum exhaust required. Must decontaminate Mound equipment.	Careful control dust during removal, processing, and packaging.

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TABLE B.2-1 Silo 3 Remediation Alternatives - Summary of Screen Evaluation (Cont.)

CRITERIA	DIRECT DISPOSAL (Commercial Facility Only)	CEMENTATION	VACUUM EXTRUSION	BLENDING WITH PIT 5 (OU1)
Quantity of Material Produced	Disposal volume will increase. Cost impact included in pricing.	Estimated @ 7,886 cubic yards high end; 5,600 cubic yards low end.	Additional testing needed. May be able to achieve 15-30% reduction in cementation volumes.	Anticipate 3,915 tons of Silo 3 material. No significant increase in Silo 3 volume. Costs based on weight only after blending.
Material Transportation Requirements	Must be in approved IP-2 containers.	Must be in approved IP-2 containers.	Must be in approved IP-2 containers.	Blended material potentially meets LSA-I criteria.
Material Handling and Storage	Packaging will need to be carefully controlled for dust. Container exteriors require decontamination prior to shipment.	Storage required to complete 28-day cement hydration reaction. Containers will require decontamination prior to shipment.	Storage required to complete 28-day cement hydration reaction. Containers will require decontamination prior to shipment.	No interim storage planned for OU1 other than storing rail cars on lines to form unit train.
Schedule				
Anticipated Start and Completion	Premobilization 3-6 months Mobilization 3-6 months Operations 6 months	Premobilization 6 months Mobilization 6 months Operations 6 months	Premobilization 6-12 months. Mobilization 6 months. Operations 6 months.	Start construction of transfer - 1999. Begin blending with Pit 5 - after fiscal year 2000, unless other pit chosen.
Total Costs	Commercial Disposal Facility: $6-11$ Million.	Commercial Disposal Facility: $9-$15 Million. NTS: $13-$19 Million.	Commercial Disposal Facility: $8-$16 Million. NTS: $12-$19 Million.	Commercial Disposal Facility: $4-$10 Million

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B.2.3 Recommendations

The cementation alternative should be retained for full evaluation. Since direct disposal with off-site treatment (cementation) is exactly the same process as cementation but with different economics due to the location of the treatment facility (a commercial plant rather than a government plant), it should be evaluated as a subset of the cementation alternative.

Since vacuum extrusion is nearly the same process as cementation and has similar economics, it should be considered as a potential cost savings opportunity if cementation is selected over vitrification. Additional treatability work on vacuum extrusion would not be necessary as part of the Silo 3 evaluation process until cementation is chosen as the selected alternative. This exclusion would significantly simplify the evaluation process without loss of a potential cost savings opportunity.
Because there is no schedule advantage associated with blending and because of the programmatic risk involved, the blending alternative should be dropped from further evaluation.

Shipment by rail should be deleted as part of the alternative considerations. Truck transport was in the original feasibility study, is currently successful with other material, can be done more quickly, and is cost effective. Rail transport would require additional facilities that off-set the transportation savings. Also, the ability of the containers required for train transport to meet the IP-2 requirement is questionable.

B.2.4 Path Forward

The next step is to develop a more detailed analysis of the two recommended alternatives by April 30, 1996. Based on the analysis in the screening evaluation, the following recommendations for the full evaluation should be considered:

1. FERMCO should establish a specific team with a designated team leader reporting to CRU4 to perform the evaluation of Silo 3 alternatives. The alternatives to be evaluated are:
   - Vitrification with disposal at NTS
   - Cement stabilization on-site with disposal at NTS
   - Cement stabilization on-site with disposal at the commercial disposal facility
   - Cement stabilization and disposal at the commercial disposal facility
2. DOE counterparts should continue to be involved throughout the evaluation.
3. U.S. EPA and Ohio EPA should be involved on a regular basis with the development of the evaluation.

4. Stakeholders should be regularly involved with the evaluation through supplemental public involvement activities such as public meetings, post cards, fact sheets, etc..

5. Scope, schedule, and budget should be developed and reviewed with DOE to assure alignment with expectations of the product for the next phase.

6. The team should have the responsibility and capacity to develop the design basis for estimates to ensure consistency in level of equipment complexity, cost estimates, regulatory issues, etc.

7. The scope of the evaluation must be kept within reason. Additional alternatives cannot be considered if the schedule is to be maintained.

8. Treatability considerations must be developed immediately and kept to those that can be done within a two-three month window. Treatability studies that are essential to making a decision on the alternatives should be addressed in the follow-on evaluation. During the preliminary design phase, additional studies can be performed if one of the alternatives other than vitrification is chosen. Ohio EPA and U.S. EPA should be involved in deciding what treatability studies are needed and in reviewing and approving the work.

9. The vitrification alternative analysis is key to the evaluation of Silo 3 alternatives. A key person with responsibility needs to be assigned to the team to provide the appropriate focus to vitrification.

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B.3.0 DESCRIPTION OF ALTERNATIVES

B.3.1 Direct Disposal with Off-Site Treatment

Silo 3 material would be introduced through the removal system currently under design for the vitrification process, transferred to appropriate shipping containers, and shipped to a commercial disposal facility. The commercial disposal facility would off-load and treat (cement stabilize) the waste to meet the specific requirements of the disposal facility.

The facility requirements for this alternative are minimal, consisting of only a container loading station with appropriate dust control facilities.

B.3.2 Cementation

Silo 3 material would be introduced through the removal system currently under design for the vitrification process; transferred to treatment equipment located near Silo 3; treated by blending with water, cement, and/or other additives to achieve the desired material characteristics; packaged and transported via railroad and/or truck to either Envirocare or the NTS for final disposal.

This alternative will require construction of a cementation facility near Silo 3. This new facility will require electrical power, water, air, and possibly sewer connections. It will need to contain a control room, an HVAC system with HEPA filtered exhaust, change rooms, bulk material storage and transfer systems, and a liquid radwaste collection and transfer system, in addition to the cementation processing equipment.

B.3.3 Vacuum Extrusion

Silo 3 material would be introduced through the removal system currently under design for the vitrification process; transferred to treatment equipment near Silo 3; treated by blending with water, clay, lime and/or other additives and extruded to achieve the desired waste characteristics; packaged and transported via railroad and/or truck to either Envirocare or the NTS for final disposal.

The facility requirements for this alternative are similar to the cementation alternative.

B.3.4 Blend With OU1 Material

Silo 3 material would be introduced through the removal system currently under design for the vitrification process and transferred to a storage container. After Waste Pit 5 material had been excavated, the two waste streams would be mixed at the entrance of the OU1 drying process in

appropriate proportions (estimated to be approximately 20 percent Silo 3 material and 80 percent Pit 5 material) to meet Waste Acceptance Criteria for either the NTS or Envirocare. The waste would then be transferred to shipping containers for disposal.

The facility requirements for this alternative are similar to the direct disposal alternative.

draft

B.4.0 EVALUATION CRITERIA

B.4.1 Institutional Implementability

B.4.1.1 Impacts on OU4 ROD

This criterion attempts to present some basis to determine the effort and time required to change the OU4 CERCLA documentation for each alternative. Those alternatives that are closer to the ROD alternatives or are more specifically presented in the FS may require less processing to receive regulatory approval. The actual impact on schedule is difficult to determine. It depends, in significant measure, on the U.S. EPA, Ohio EPA, and stakeholder acceptance of an alternative. Schedule impacts from the CERCLA process are discussed in Section B.4.3.

All of the alternatives differ from the alternative chosen in the ROD. All alternatives provide off-site disposal and, with the exception of Pit 5 Blending, provide treatment to reduce mobility and toxicity similar to the purpose of vitrification. Additional analysis is needed to ensure that the blending of Silo 3 with Pit 5 does meet TCLP limitations.

B.4.1.2 Licensing/Permitting/Special Approvals

This criterion presents potential administrative roadblocks in implementing an alternative. The items listed under this section are not seen as onerous obstacles to implementation of any alternative. Exemptions to DOE Order 5820.2A are being approved within time periods that would not put them on the critical path.

B.4.1.3 EPA/Stakeholder Concerns

The need for changing the ROD is a major issue under this evaluation criterion. To be successful, an alternative must be demonstrably better than the vitrification alternative. This screening alternative evaluation does not attempt to make this comparison.

B.4.2 Technical Implementability

B.4.2.1 Demonstrated Experience/Expected Success with Silo 3 Material

Given the current concerns among regulators and stakeholders over Fernald's ability to successfully process remediation wastes, it is essential for any alternative considered to have proven demonstrated experience and success. There must also be a strong indication that the alternative can be used to successfully remediate the Silo 3 material.

B.4.2.2 Ability to Me Waste Accept e Criteria (WAC)

Nevada Test Site (NTS - To be viable, an alternative must provide a waste that can be disposed. AEA 11(e)2 wastes are required to be treated to remove any hazardous waste characteristic prior to disposal at the NTS. Any other classification of Silo 3 waste that exhibits a characteristic would require treatment to meet the RCRA LDRs (for acceptance at the NTS; and for disposal at the commercial facility).

Commercial Disposal Facility - The WAC for the commercial disposal facility can be met through treatment at either Fernald or at the site to remove the hazardous characteristic. The commercial facility's license allows blending at the facility to ensure radioactive WAC can be met. Mixed waste sent to a commercial facility must be treated to RCRA LDRs prior to land disposal.

B.4.2.3 Secondary Waste

Secondary waste generation is an important factor in considering waste minimization and costs. Costs and concerns for secondary waste generation and decommissioning are proportional to the complexity of the equipment and operations used for that alternative.

B.4.2.4 Environmental and Safety Issues

The powdery nature and the presence of thorium-230 presents the most difficult environmental and health and safety issues for handling the Silo 3 material. Engineering and administrative controls must be carefully considered to ensure protection of worker and public health and safety.

Although the radium content of Silo 3 is low compared to Silos 1 and 2, protection for radon release is an important design consideration. The ability to protect workers from exposure to radiation from radon and thorium exposures is essential.

B.4.2.5 Quantity of Materials Produced

The cost implications of this element are obvious. Increased quantities of waste will result in higher transport and disposal costs. Removing the Silo 3 material from the silo will increase the volume of waste to be disposed.

Direct disposal assumes that the original volume can be achieved. The uncertainty as shown in the cost range for direct disposal is in part due to this assumption being incorrect. Treatment at the commercial disposal facility will increase the volume and is included in the cost estimate.

Cementation will increase the density of the material significantly but will also add some bulking. The cost estimate for cementation provides for bulking from 10 to 55 percent.

Vacuum extrusion may provide benefits through volume reduction. Information on the volume reduction potential of vacuum extrusion for treatment through some form of cementation or stabilization is not available. There are expectations that the volume reduction should be in the 15 to 30 percent range. Specific treatability tests are needed to determine the volume reduction possible with the Silo 3 material. The cost range attempts to account for this uncertainty. If vacuum reduction performs at its best, it will provide a cost savings; but if it does not provide a volume reduction benefit it will be a more expensive alternative. For the commercial disposal facility, the impact on vacuum extrusion for volume reduction is more complicated. Because of the compactibility requirement at the commercial disposal facility, vacuum extruded material must be shredded to provide a more compactible material. The shredding increases the volume and reduces the benefit of the initial volume reduction.

Blending costs after the Silo 3 material is blended with Pit 5 material are based on weight and not impacted by volume.

B.4.2.6 Material Transport Requirements

Raw and treated Silo 3 material with the exception of Silo 3 material blended with Pit 5 can be shipped as LSA-II in containers that meet Industrial Package-Type 2 (IP-2) criteria. Blended material can potentially meet LSA-I criteria that will allow use of a less stringent IP-1 container.

B.4.2.7 Material Handling and Storage

Additional handling of dry material adds to costs and complexity. Interim storage would be required for cementation and vacuum extrusion alternatives.

B.4.3 Schedule

The schedule is based on the time for implementation after regulatory approval to begin activities on an alternative. Time is given in months for planning, construction, and operation.

The current schedule for the Fernald Residues Vitrification Plant Project is to begin treatment operations October 2000 and complete operations in October 2003.

Time frames for the regulatory process are not shown in the table or included in the individual alternative discussion. These time frames vary depending on the regulatory and stakeholder acceptance of an alternative. Further, they are impacted by the ability to perform some of the

work simultaneously. Approval of changes to the ROD can take from six months to a year, including the time for this current evaluation, depending on the level of regulator and stakeholder support. If there is significant agreement on an alternative, Remedial Design and Remedial Action (RD/RA) work plan development can proceed with an acceptable DOE and FERMCO risk that the ROD changes will result in approval. With parallel review, construction could begin after a ROD amendment or other appropriate CERCLA action is completed (i.e., within six months to a year from now).

The blending alternative does not allow for Silo 3 remediation to begin until fiscal year 2000 because Pit 5 material is not available for blending until that date.

Rail upgrades are scheduled to be completed prior to July 1998. The transport of material, by rail, ready to leave the site before that time would be delayed.

Completion of the system to remove Silo 3 material is currently scheduled for Fall 1998. This schedule must be accelerated to allow Silo 3 remediation to proceed ahead of vitrification.

B.4.4 Costs

The costs presented are very preliminary and rough. Although the cost estimates need to be more carefully developed for the April 30, 1996 deliverable, they provide a basis for screening of the alternatives.

Costs for each alternative is shown as a range to account for uncertainty in pricing, estimate bases, technical performance, and the level of design. Costs were developed based on current data regarding an alternative. These bases need to be more completely reviewed and the estimates modified and expanded as necessary for the comparison with vitrification during the full Evaluation of Silo 3 alternatives. Cost should be one of the factors considered in the viability of an alternative.

The cost ranges do not account for all costs common to all of the alternatives, such as the costs of removing the material from Silo 3 or regulatory costs associated with changing the ROD.

The direct disposal cost range, $6-$11 million, is based on the pricing range submitted by the commercial disposal facility, volume uncertainties, and the sophistication of the equipment needed to package the dry material.

The cementation range of $9-$15 million for the commercial disposal facility is a result of uncertainties in bulking complexity of structures and equipment needed for processing. The range of $13-$19 million for NTS disposal is based on the same uncertainties. The major factors in the increased cost between the commercial disposal facility and NTS are disposal costs and the cost of disposing of containers. The costs for NTS do not include any of the costs to NTS not covered by the disposal fee paid by Fernald.

The vacuum extrusion cost ranges for the commercial disposal facility are a little lower at the low end and a little higher at the high end for cementation. If vacuum extrusion can reduce volume without causing compaction problems at the commercial disposal facility, it would save money over cementation without vacuum extrusion. If compaction is impacted, the cost could be higher. Therange is greater because of greater uncertainty. It should also be noted that the cost of the vacuum extruder is not included. It is assumed that the extruder from Mound would be used.

The vacuum extrusion cost ranges for NTS are lower at the low end and the same at the high end compared to cementation. Volume reduction for NTS is not as uncertain because extruded material would be placed directly into containers that would be transported and disposed in a cell at NTS. Without the compaction concern, costs should not exceed the cementation range. However, uncertainties on how well vacuum extrusion will serve as a treatment device remain and the cost upper cost range is the same as for cementation.

The cost range for blending takes into account the uncertainty in getting the Silo 3 material to the Pit 5 material and the range in complexity of equipment and structures needed for blending the material. While some treatability information on blending is needed, additional engineering effort should narrow the cost range for blending.

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B.5.0 EVALUATION OF ALTERNATIVES

The objective of these criteria is to provide a framework for evaluating nonvitrification alternatives for Silo 3 material, rather than make comparisons between vitrification and nonvitrification alternatives. Section B.5.1 describes Direct Disposal/Treatment Off-Site. Section B.5.2 describes Cementation. Section B.5.3 describes Vacuum Extrusion. Section B.5.4 describes the Blend with OU1 Material alternative.

B.5.1 Direct Disposal / Treatment Off-Site

B.5.1.1 Institutional Implementability

B.5.1.1.1 Degree of compatibility and impacts to the OU4 ROD and other RODs

Direct disposal at an off-site facility was not considered in the OU4 FS. However, direct disposal at the commercial facility as mixed waste requires treatment to meet the RCRA LDRs. This alternative contains the basic elements considered in the FS and the ROD, treatment and off-site disposal. Transport of untreated material represents a deviation from the ROD. It is expected that the ROD would require an amendment.

B.5.1.1.2 Permitting/Regulatory/DOE Requirements

a. DOE exemption requirements for off-site/commercial disposal

If shipped as LLRW, an exemption to DOE Order 5820.2A will be required. If shipped as mixed waste, an exemption exists.

b. Requirement for 11(e)(2) vs. LLRW classification for implementing the alternative.

There is disagreement between Fernald's current 11(e)(2) classification of the Silo 3 material and the regulatory agency's (agency that regulates the commercial disposal facility) preliminary classification that the Silo 3 material is an 11(e)(1) and, therefore, a LLRW. Whereas, the untreated Silo 3 material cannot be accepted at the commercial facility under the terms of the 11(e)2 license, it may be accepted as LLW or mixed waste.

There is a regulatory path to disposing of Silo 3 material at the commercial facility. Careful consideration will be employed to ensure that the most cost-effective regulatory pathway is found. For disposal at the commercial facility,

the hazardous waste characteristic would need to be eliminated prior to disposal. The commercial facility has a current license and permit to perform the treatment and disposal.

c. Mixed Waste Issues

Depending on the input from the regulators here and at the commercial disposal facility location and because the metals toxicity will be eliminated before disposal, the material could be declared either a mixed waste or a 11(e)(1) by-product material, depending on which provides the most benefit. In either case, the same treatment will be applied. Mixed wastes already have an exemption to 5820.2A for disposal at a commercial disposal facility. A by-product material would not require the administrative or potential cost implications of a mixed waste. It is best if possible to avoid a mixed waste designation. Ohio EPA and U.S. EPA have accepted the FEMP designation of 11(e)(2).

B.5.1.1.3 Potential EPA and stakeholder concerns

- Transportation of powdery untreated material.
- Capability of the commercial disposal facility to treat the Silo 3 material successfully.
- Handling of the dry silo material at Fernald and the disposal site.
- Ability of the material to meet the disposal WAC.

B.5.1.1.4 Waste Acceptance Criteria

Under the current interpretation of 5820.2A, the NTS cannot receive the Silo 3 material without prior treatment. Silo 3 material does meet the WAC for receipt of the material at the commercial disposal facility, but would require blending and treatment prior to actual disposal. The facility is licensed to blend and treat the material.

B.5.1.2 Technical Implementability

B.5.1.2.1 Degree to which the technologies and processes are proven through demonstrated previous experience.

The cementation/stabilization process used by the disposal facility is proven successful. Dry handling of the material will take additional engineering controls and attention. It has been safely dry handled, but requires additional cost.

Blending and stabilization on similar material by treatment of a radioactively contaminated flue dust from a steel mill have been performed at the commercial disposal facility.

Packaging and transportation are proven processes.

B.5.1.2.2 The ability of the alternative to operate successfully with expected Silo 3 waste characteristics.

As noted, the major concern is the dry handling of the material.

Treatability of the material must be confirmed at the commercial facility.

B.5.1.2.3 Ability of the alternative to produce wastes that meet WAC for available final disposal sites.

The material will meet the commercial disposal site's WAC for receipt and disposal after treatment for metals.

B.5.1.2.4 Secondary effluents/emission generated by the alternative and the availability of the alternative to manage them.

Air emissions during packaging must be controlled. Cost estimates include control of particulate material and protection of worker health.

B.5.1.2.5 Environmental and worker safety (radiological/chemical/process) issues associated with operation of the proposed system/process.

Potential air emissions must be controlled during dry handling.

Package integrity must be ensured. IP-2 containers with an internal super sack would provide protection.

B.5.1.2.6 Requirements for removing material from Silo for introduction into system/process.

Does not differ from other alternatives.

B.5.1.2.7 Degree to which special operator skills/experience will be necessary.

Dry handling of material may require special skills. These same skills will be required for all alternatives.

B.5.1.2.8 Quantity of waste produced

This screening evaluation assumes that the volume of Silo 3 material to be shipped would be the volume currently in Silo 3. This assumption creates uncertainty in the cost estimate because handling of the material tends to cause "fluffing."

The volume of waste for actual disposal will increase from 10 to 20 percent. Pricing is based on "as received" volume. The "as received" price considers actual disposal volume in its development.

B.5.1.2.9 Transportation requirements for disposal

Material will be transported in IP-2 containers. An internal super sack may facilitate the shipment and the removal. Transport containers and off-loading activities will need to be amenable to treatment operations at the commercial disposal facility. This need may preclude the use of gondola cars for this option.

B.5.1.2.10 Waste handling and storage requirements before final disposal

Dry handling will be an issue at the disposal facility. Blending and treatment will be required prior to disposal. Material can be stored in transport containers.

B.5.1.3 Schedule

B.5.1.3.1 Ability of the alternative to complete the remediation of Silo 3 in a timely fashion, well ahead of the current ROD schedule.

a. Availability of transport and disposal services off-the-shelf

Currently available.

b. Availability of equipment and materials off-the-shelf

Currently available.

c. Availability of labor (FEMP or subcontractor "turn key" service)

Turn key service available.

d. Requirement for additional laboratory testing prior to scale-up

Treatability of the material at the commercial site may be beneficial depending on an evaluation of similar material already treated at the facility.

e. Impacts to current vitrification schedule for conducting required evaluations

Significant improvement in the remediation schedule of Silo 3 can be achieved.

B.5.1.3.2 Anticipated schedule for project preparation, planning, operations, and D&D.

Pre-mobilization	- six - nine months
Construction	- six months
Operation	- six months (Only limited by the time to remove and ship)

B.5.1.4 Cost

These cost estimates are a rough order of magnitude and are given in ranges to demonstrate their uncertainty. They provide an indication of the cost viability of an alternative and a general trend of the relative cost of the alternatives. These costs do not include common costs for all of the alternatives, such as removal of the Silo 3 material from the silo and regulatory approval.

For direct disposal at the commercial disposal facility, the cost range is $6 - $11 million. Uncertainties in disposal and treatment costs at the commercial disposal facility and the equipment required at Fernald to perform the packaging and loading are the major contributors to the cost range.

The capital costs for a train almost offset the transportation cost savings.

B.5.1.4.1 Order of magnitude capital cost of the proposed system

The estimated cost range considering the use of gondola cars for train and WMBs for truck is $1 - $3 million.

B.5.' .2 Operating c for life c stem in net present val e

The e mated cost range for operation and maintenance is $0.2 - $0.4 million.

B.5.1.4.3 Waste disposal costs

The cost range for treatment and disposal at the commercial disposal facility is $2.5 - $4.5 million.

B.5.1.4.4 Waste shipping costs

The cost range for packaging and transportation to a commercial disposal facility have been estimated for two scenarios, truck and train. The range is $0.5 - $2.5 million.

B.5.1.4.5 Decommissioning costs

Decommissioning cost, estimated on the complexity of the equipment at Fernald is $0.2 - $0.4 million.

B.5.2 Cementation

B.5.2.1 Institutional Implementability

B.5.2.1.1 Degree of Compatibility and Impacts with OU4 ROD and other RODs.

Substituting cementation for vitrification may require a modification of the ROD. The degree of modification will be somewhat greater for a commercial disposal facility because it was not considered in the FS. The retention of on-site treatment (cementation in place of vitrification) and shipment to the NTS provides the best option for using an Explanation of Significant Difference (ESD) to make the ROD change. Depending on regulator and stakeholder input, a ROD amendment even for this alternative is still likely.

B.5.2.1.2 Permitting/Regulatory/DOE Requirements

The final material produced using cementation would be disposed as a LLRW and would be compatible with disposal at either the NTS or a commercial disposal facility.

a. DOE exemption requirements for off-site/commercial disposal

In order to send OU4 material to a commercial dis osal facility, an exemption from the requirements of DOE Order 5820.2A would be required.

b. Requirement for 11(e)(2) vs. LLRW classification for implementing the alternative

The commercial disposal facility cannot receive the material as 11(e)(2) by-product material without a license amendment. The NTS can receive either classification of material [11(e)(2) under an exemption]. Regardless of whether the NTS receives the material as 11(e)(2), or as low-level radioactive waste (LLRW), the material must be treated to remove the hazardous characteristic prior to shipment.

c. Mixed waste issues

A commercial disposal facility can receive the material as mixed waste or as LLRW. If the waste is treated at the FEMP to remove the hazardous characteristic prior to disposal, it can be disposed at either the NTS or a commercial disposal facility as a LLRW. The option also exists to condition the waste at the FEMP to remove the dusting problem, ship as LLRW, 11(e)(1) (preferable to mixed waste designation) to a commercial disposal facility, and allow that disposal facility to perform treatment to remove the TCLP characteristic and meet the LDRs. The NTS cannot receive the material with a mixed waste characteristic.

d. Performance Assessment - NTS

Shipment of the material to the NTS will require modification of the source term for the NTS Performance Assessment (PA) but should not require complete revision. The PA for the vitrified material from Silos 1 and 2 would have to consider the elimination of Silo 3 as well.

B.5.2.1.3 Potential EPA/Stakeholder Concerns

Cementation provides sufficient waste immobilization for safe handling and transportation. The vitrified waste form will provide a greater degree of waste immobilization over long time periods and may be more desirable to the EPA. However, the radiological properties of the Silo 3 material do not dictate the use of an immobilization method such as vitrification.

B.5.2.1.4 Waste Acceptance Criteria

The final material produced using cementation will be a LLRW acceptable for disposal at either the NTS or a commercial disposal facility. Cemented material will have to meet compaction requirements at the commercial facility. Blending will be necessary to meet the commercial disposal facility WAC and are included in the costs.

B.5.2.2 Technical Implementability

B.5.2.2.1 Degree to which the technologies and processes are proven through demonstrated previous experience

Cementation, for immobilization of metals and other contaminants, is widespread. There are hundreds of sites in the United States where stabilization, using pozzolanic materials such as cement and fly ash, has been successfully implemented. A large portion of all RCRA waste containing metals is stabilized with cement and other materials prior to final placement in a landfill.

B.5.2.2.2 The ability of the alternative to operate successfully with expected Silo 3 waste characteristics

The Silo 3 material has been proven through treatability testing to be amenable to cementation to immobilize the contaminants of concern prior to placement in a final disposal site. The Silo 3 material has some pozzolanic properties by itself that are enhanced by blending with additional pozzolanic material.

B.5.2.2.3 Ability of the alternative to produce wastes that meet waste acceptance criteria for available final disposal sites (identify final disposal sites considered)

Based on the OU4 FS Treatability Study data, the final waste form using cementation will be acceptable for final disposal at the NTS and a commercial disposal facility. The radiological components of Silo 3 material will meet the commercial disposal facility's WAC with blending.

B.5.2.2.4 Secondary effluents/emissions generated by the alternative and the availability of alternatives for managing them

The evolution of radon gas and the airborne release of radioactive particulate matter are the primary emissions of concern. Equipment for processing, storage vessels, and handling dry Silo 3 material will be subject to ventilation controls, including HEPA filtration and a radon absorption unit to prevent airborne releases.

B.5.2.2.5 Environmental and worker safety (radiological/chemical/process) issues associated with operation of the proposed system/process

The most significant safety issue would be the potential for airborne radioactive materials and internal dose due to radon. In an area where materials may become airborne, respiratory protection using supplied air is anticipated to be used. Except for airborne particulate concerns, Silo 3 materials can be contact-handled because of their

low external dose rate. Cement stabilization of hazardous wastes is a commonly used technology that does not present unusual hazards.

B.5.2.2.6 Requirements for removing material from Silo 3 for introduction into system/process

The removal method is assumed to be the same for all processes.

B.5.2.2.7 Degree to which special operator skills/experience will be necessary

Experienced operators will enhance the ability to produce a high quality waste form. However, operators can be trained to operate the equipment.

B.5.2.2.8 Quantity of waste produced

Treatability testing of aggressive cement formulations containing large proportions of stabilization materials showed a volume increase of 55.6 percent with a final volume of cemented material of 7,886 cubic yards. With additional testing, however, it is reasonable to expect the loading of Silo 3 material, given its pozzolanic properties, to be in the range of 80 to 90 percent on a dry-weight basis for a total cemented volume of 5,600 cubic yards.

B.5.2.2.9 Transportation requirements for disposal

Containers of stabilized waste can be transported via truck to either disposal site. A commercial disposal facility would offer the additional advantage of accepting bulk wastes via truck or rail assuming the container meets IP-2 criteria.

B.5.2.2.10 Waste handling and storage requirements before final disposition

The waste mixture will need to remain at the FEMP in storage for a period of up to 28 days for curing before it can be shipped off-site. A staging area will be required for this purpose. This duration may be reduced if it is determined that the hydration reactions can be allowed to continue during transport.

B.5.2.3 Schedule

B.5.2.3.1 Ability of the alternative to complete the remediation of Silo 3 in a timely fashion, well ahead of ROD

Cementation of the Silo 3 material would allow remediation to occur prior to vitrification.

a. Availability of transport and disposal services off-the-shelf

Transport via truck is currently used for waste shipments from the FEMP to both a commercial disposal facility or the NTS. Shipment via rail requires upgrade of the existing rail siding consistent with the OU1 schedule or an acceleration of this schedule.

b. Availability of equipment and materials off-the-shelf

Cement stabilization equipment and materials can be purchased off-the-shelf. This equipment is used industry-wide for hazardous waste treatment.

c. Availability of labor (FEMP or subcontractor "turn key" service)

Subcontractors with extensive experience in cement stabilization are available to perform this work. FERMCO labor can be provided for support as necessary.

d. Requirement for additional laboratory testing prior to scale-up

Additional treatability work prior to full-scale operations is required to refine and optimize the formulation for cement/waste ratios.

e. Impacts to current vitrification schedule for conducting required evaluations

Accelerating Silo 3 remediation using cement stabilization would shorten the total time required for disposing of the Silo 1, 2, and 3 materials. If difficulties arise during vitrification of the Silo 1 and 2 materials, the additional time available resulting from the removal of Silo 3 material from the vitrification feed stream could be used to maintain the ROD schedule.

B.5.2.3.2 Anticipated schedule for project preparation, planning, operations, and D&D

The cementation system could be designed, constructed, and commence operations within approximately one year following authorization to proceed. The period of operation necessary to complete the processing of Silo 3 material is approximately six months.

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B.5.2.4 Cost

These cost estimates are a rough order of magnitude and are given in ranges to demonstrate their uncertainty. They provide an indication of the cost viability of an alternative and a general trend of the relative cost of the alternatives. These costs do not include common costs for all alternatives, such as removal of the Silo 3 material from the silo and regulatory approval.

The cost range for cementation with disposal at the commercial disposal facility is $9 - $15 million. The cost range for disposal at the NTS is $13 - $19 million. The major uncertainty is in the complexity of equipment and structures needed and the amount of bulking that will occur. Disposal costs are the major difference between the commercial disposal facility and the NTS.

B.5.2.4.1 Order of magnitude (rough) capital cost of proposed system

The cost range for cementation capital costs with disposal at the commercial disposal facility is $3 - $7 million. The cost range for disposal at the NTS is $3 - $7 million. The range is based on the complexity of the equipment and structures needed.

B.5.2.4.2 Operating costs for life of system in net present value

The estimated cost range for operation and maintenance of the conceptual system is $0.4 - $0.8 million. The estimated cost range for disposal at the NTS is $0.4 - $0.8 million. Based on the uncertainty in equipment operation.

B.5.2.4.3 Waste disposal costs

The estimated cost range is $2 - $3 million for the commercial disposal facility option. The estimated cost range is $4 - $6 million for disposal at the NTS. Based on uncertainty mainly in bulking.

B.5.2.4.4 Waste Shipping and Packaging Costs

The estimated cost range is $3 - $4 million for packaging and shipping to the commercial disposal facility. The cost range is $4 - $5 million for shipment to the NTS. Cost range based mainly on uncertainties in bulking.

B.5.2.4.5 Decommissioning costs for proposed option

The estimated cost range based on the complexity of the structure necessary is $0.2 - $0.4 million. Decommissioning is a function of equipment and structure size and complexity.

B.5.3 Vacuum Extrusion

B.5.3.1 Institutional Implementability

B.5.3.1.1 Degree of compatibility and impacts to the OU4 ROD and other RODs

Off-site shipment of vacuum extruded Silo 3 material may require a ROD modification. The degree of modification would be somewhat greater for disposal at a commercial disposal facility because it was not considered in the FS. However, vacuum extrusion is a technology for stabilizing the waste and cement stabilization was considered in the FS.

B.5.3.1.2 Permitting/Regulatory/DOE Requirements

a. DOE exemption requirements for off-site/commercial disposal

To send OU4 material to a commercial disposal facility, an exemption from the requirements from DOE Order 5820.2A would be required.

b. Requirement for 11(e)(2) vs. LLRW classification for implementing the alternative

The commercial disposal facility cannot receive the material as 11.(e)(2) by-product material. The NTS can receive either classification. Regardless of whether the NTS receives the material as either 11.(e)(2) or as LLRW, the material must be treated to remove the hazardous characteristic.

c. Mixed waste issues

The vacuum extrusion alternative assumes that treatment to eliminate the TCLP characteristic would be part of the treatment at Fernald. There would be no mixed waste issues after treatment.

d. Performance Assessment - NTS

Shipment of the material to the NTS will required modification of the source term for the NTS Performance Assessment (PA) but should not require complete revision. Removal of Silo 3 material from vitrification requires a change in the NTS process anyway.

B.5.3.1.3 Potential EPA and stakeholder concerns

Any plan to ship vacuum extruded material off-site must be presented to the stakeholders to determine public concerns, gain stakeholder acceptance, and provide a subsequent response. The vacuum extruded waste would be a stabilized waste form that provides sufficient waste immobilization for safe handling and transportation. If existing extrusion equipment at Mound is used, a concern also may exist regarding processing FEMP material through equipment contaminated with low levels of plutonium - 238. The equipment must be decontaminated prior to use at Fernald.

B.5.3.1.4 Waste Acceptance Criteria

The final material produced after vacuum extrusion must be a LLRW that passes TCLP. This waste would be acceptable for disposal at the NTS or a commercial disposal facility. The specific application of a commercial disposal facility's definition of compactible and noncompactible debris must be further examined. Blending at the commercial disposal facility would be necessary to meet their average WAC for disposal.

B.5.3.2 Technical Implementability

B.5.3.2.1 Degree to which the technologies and processes are proven through demonstrated previous experience

Vacuum extrusion has been employed in the brick making industry for years to volume reduce solid waste residues prior to disposal. It has also been used at the DOE Mound facility to densify soil for shipment. Use of the vacuum extrusion equipment is being tested for treatment of wastes exhibiting hazardous characteristics. TCLP results of the final waste form are not available.

B.5.3.2.2 The ability of the alternative to operate successfully with expected Silo 3 waste characteristics

A material needs to have some degree of plasticity to be successfully extruded. Since Silo 3 material is non-plastic, it would need to be mixed with clay (bentonite) to improve its plasticity. Lime or other chemical additives such as Portland cement would be necessary to chemically stabilize the material to pass TCLP. Non-scientific tests using surrogate flash to simulate the Silo 3 material produced material at 70% waste loading. Further tests would need to be conducted to determine the amount of additives necessary to pass TCLP requirements and the potential impact on compactibility at the commercial disposal facility.

B.5.3.2.3 Ability of the alternative to produce wastes that meet waste acceptance criteria for available final disposal sites (identify final disposal sites considered)

Tests previously performed on surrogate Silo 3 material have not been tested for TCLP reduction. Further tests are required to determine the proper formulation and equipment requirements.

B.5.3.2.4 Secondary effluents/emissions generated by the alternative and the availability of alternatives for managing them

Emissions from the vacuum extrusion unit come from the vacuum exhaust at a flow rate of approximately 20 cfm. A moisture trap and pre-filter/HEPA unit has been developed to handle the moisture and particulate in the exhaust. A radon adsorption unit may be needed to control radon emissions.

B.5.3.2.5 Environmental and worker safety (radiological/chemical/process) issues associated with operation of the proposed system/process

The most significant safety issue would be the potential for airborne radioactive materials and internal dose due to radon. Respiratory protection using supplied air is anticipated for work in this area. Normally, Silo 3 materials can be contact-handled because of their low external dose rate. Cement stabilization of hazardous wastes is a commonly-used technology that does not present unusual hazards. The requirements and issues for accepting plutonium-contaminated equipment at the FEMP have not yet been resolved. The equipment must be decontaminated prior to use at Fernald.

B.5.3.2.6 Requirements for removing material from Silo for introduction into system/process

Removal method is the same for all alternatives.

B.5.3.2.7 Degree to which special operator skills/experience will be necessary

No special skills are necessary to operate the extruder. Further skills would be required for controlling the chemical processes. Use of experienced operators will improve reliable quality of waste product.

B.5.3.2.8 Quantity of waste produced

The unit at Mound has a design rate of 10 tons/hour. Using the waste loading described above (71% waste loading), the rate of the actual waste processed is 7 tons/hour. The volume reduction for this mix was not measured during the surrogate tests that were conducted, but it is estimated to be between 15% and 30%. Additional testing is required to define the actual volume reduction that could be obtained with Silo 3 material. Significant uncertainty exists concerning the ability of vacuum extrusion to stabilize and volume reduce Silo 3 material.

B.5.3.2.9 Transportation requirements for disposal

As LSA-II solid material, containers of extruded Silo 3 material would be shipped in containers that, at a minimum, meet DOT design requirements for Industrial Package-Type 2 (IP-2) containers. These containers can be shipped via truck to either disposal site. Materials can also be shipped to a commercial disposal facility by rail.

B.5.3.2.10 Waste handling and storage requirements before final disposal

On-site storage requirements are dependent on the rate of extrusion processing, and filling containers for off-site transport. Additional space should be allocated for staging or holding areas for supply of empty and backlog containers, and for material pending characterization or rework. Processing rates may be affected by storage limitations on- and off-site. It is assumed that pellets will be used, which would require that standard bulk material handling equipment be used.

B.5.3.3 Schedule

B.5.3.3.1 Ability of the alternative to complete the remediation of Silo 3 in a timely fashion, well ahead of ROD

a. Availability of transport and disposal services off-the-shelf

Transport via truck is currently used for waste shipments from the FEMP to both a commercial disposal facility and the NTS. Shipment via rail requires upgrade of the existing rail siding consistent with the OU1 schedule or an acceleration of this schedule.

b. Availability of equipment and materials off-the-shelf

Additional support equipment is common and can be purchased off-the-shelf. The vacuum extruder is currently located at the DOE Mound facility and is available for

use at the FEMP. The equipment is skid-mounted and can be lifted by standard crane. The vacuum extrusion equipment must be decontaminated, packaged, transported, and reassembled at the FEMP.

c. Availability of labor (FEMP or subcontractor "turn key" service)

FERMCO operators are available and can be trained to operate this equipment. Since the vacuum extrusion equipment is owned by DOE, it would not be feasible to subcontract operation of the system.

d. Requirement for additional laboratory testing prior to scale-up

Additional treatability work prior to full-scale operations is required to develop the required formulations for stabilizing the waste for RCRA purposes and vacuum extrusion.

e. Impacts to current vitrification schedule for conducting required evaluations

Silo 3 remediation using vacuum extrusion would shorten the total time required for disposing of the Silo 1, 2, and 3 materials. If difficulties arise during vitrification of the Silo 1 and 2 materials, the additional time available resulting from the removal of Silo 3 material from the vitrification feed stream could be used to maintain the ROD schedule.

B.5.3.3.2 Anticipated schedule for project preparation, planning, operations, and D&D

Upon completion of the regulatory process, it is estimated to take approximately 1 year to design and construct the system and another 6 months to operate.

B.5.3.4 Cost

These cost estimates are a rough order of magnitude and are given in ranges to demonstrate their uncertainty. Ranges for individual parts of the total cost cannot simply be added because they may represent conflicting conditions. For example, capital costs are at the low end because of truck transportation. The low end of shipping is based on rail. These costs provide an indication of the viability of an alternative and a general trend of the relative cost of the alternatives. These costs do not include costs that are common for all alternatives, such as removal of the Silo 3 material from the silo and regulatory approval.

The cost range for the commercial disposal option is $8 - $16 million. The cost range for the NTS option is $12 - $19 million, based on the uncertainty in bulking from cementation of the

Silo 3 material. The difference in cost ranges between the commercial disposal option and the NTS is mostly from differences in disposal costs.

The cost range for vacuum extrusion is similar to the cost range for cementation. This is not surprising since the vacuum extrusion alternative is a cementation option with potential for volume reduction. Without treatability studies, significant uncertainty exists regarding the amount of volume reduction that could occur using vacuum extrusion at the commercial disposal facility. There are no results on volume reduction from surrogate material. There is no information on the compactibility of the material after extrusion. Additionally, there is no information on the volume increase that will occur if the material must be "shredded" to meet the commercial facility's compaction requirement.

The cost range for the commercial facility is both a little lower and a little higher than cementation. The potential exists for some cost savings. However, the potential also exists for cost increases.

For the NTS option, the range is the same at the upper end as for cementation, but lower at the lower end. There remains significant uncertainty based on inadequate information.

Costs were considered for both train and truck transport to the commercial disposal facility. Increased capital costs almost offset the disposal and transportation savings.

B.5.3.4.1 Order of magnitude (rough) capital cost of proposed system

The cost range for the commercial disposal facility is $2 - $6 million. The cost range for the NTS option is $2 - $5 million. The lower capital cost for the NTS is the elimination of rail infrastructure. The ranges result from uncertainties in the complexity of equipment and structures and level of design information available.

B.5.3.4.2 Operating costs for life of system in net present value

The estimated cost range for the commercial and the NTS options is $0.4 - $0.8 million.

B.5.3.4.3 Waste disposal costs

The estimated cost range for the commercial disposal facility is $2 - $4 million. The estimated range for the NTS option is $3 - $6 million. The major difference between the commercial facility and the NTS is the unit disposal cost. Also, bulk rail shipment lowers the potential disposal costs at the commercial disposal facility.

B.5.3.4.4 Waste shipping costs

The cost estimate range for waste packaging and shipping for the commercial disposal facility is $1 - $5 million and for NTS is $3 - $5 million. The uncertainties of "shredding" on volume reduction influence the upper value in the commercial disposal facility range.

B.5.3.4.5 Decommissioning costs for proposed option

The estimated cost range for decommissioning for the commercial disposal facility and the NTS is $0.2 - $0.4 million.

B.5.4 Blend with OU1 Material

B.5.4.1 Institutional Implementability

B.5.4.1.1 Degree of compatibility and impacts to the OU4 ROD and other RODs

OU4 ROD changes are provided in regulatory discussion for all alternatives. Most conservative impact to OU1 ROD would be an Explanation of Significant Differences (ESD), but may not be necessary.

B.5.4.1.2 Permitting/regulatory/DOE requirements

a. DOE exemption requirements for off-site/commercial disposal

OU1 5820.2A exemption covers OU1 material only. The exemption would have to be amended to include Silo 3 material. Time period for OU1 to obtain exemption was approximately 18-24 months. Currently, exemptions are taking two to three months.

b. Requirement for 11(e)(2) vs. LLRW classification for implementing the alternative

OU1 would assume Silo 3 waste was 11(e)(2) and therefore excluded as a solid waste. Once blended with OU1 material, Silo 3 would lose its exclusion and all waste would be treated as LLRW. Characterization sampling at the end of the OU1 treatment process, as planned, would include TCLP characterization.

c. Mixed waste issues

Level of metal concentrations in both Silo 3 and Pit 5 show potential to exceed TCLP levels. Additional work would be needed to ensure there would not be a mixed waste problem.

d. Performance Assessment - NTS

The NTS is not being considered as the primary disposal option for OU1 waste meeting Permitted Commercial Disposal Facility (PCDF) WAC. In the event blended OU1 material is not acceptable for shipment to a commercial disposal facility due to high radionuclide content, while passing TCLP tests, the material will be shipped to the NTS as LLRW. The cost analysis for the blending alternative does not consider shipment to the NTS.

B.5.4.1.3 Potential EPA and stakeholder concerns

Regulatory and stakeholder concerns addressed in regulatory discussion. No additional concerns specific to this option have been identified. No significant reduction in toxicity or mobility is provided by this alternative.

B.5.4.1.4 Waste Acceptance Criteria

The WAC for a commercial disposal facility's disposal license were used for this evaluation.

B.5.4.2 Technical Implementability

B.5.4.2.1 Degree to which the technologies and processes are proven through demonstrated previous experience

Components of the OU1 remedial design are proven technologies used by other DOE and commercial facilities. No significant reduction in toxicity or mobility is provided by this alternative.

B.5.4.2.2 The ability of the alternative to operate successfully with expected Silo 3 waste characteristics

The OU1 facility is designed to blend and dry waste to meet WAC for the PCDF. The addition of Silo 3 material to pit wastes is not expected to cause a change in operation of the facility. Material handling of the Silo 3 material itself would have to be addressed.

B.5.4.2.3 Ability of the alternative to produce wastes that meet waste acceptance criteria for available final disposal sites (identify final disposal sites considered)

NTS: Assumption for this evaluation is that blended OU1 and Silo 3 material would be considered LLRW and could be disposed at the NTS as such.

Commercial Disposal Facility:

(1) If treated waste must meet LLRW radiologic limits prior to shipment, Silo 3 must be blended with Pit 5 to meet this requirement.

(2) If treated waste may exceed LLRW placed radiologic limits by up to 10 times provided "as disposed" is appropriately blended, Silo 3 may be able to be blended with any waste pit to meet this requirement. Because of the volume of blended Silo 3 and Pit 5 material, the disposal fee at the PCDF would most likely be higher.

B.5.4.2.4 Secondary effluents/emissions generated by the alternative and the availability of alternatives for managing them

The introduction of Silo 3 material into the OU1 process does add radionuclides that were not considered during air modeling for off-gas treatment, hazard category classification, transportation risk, etc. Additional modeling or evaluation would be required to identify the quantity of additional emissions generated and the impact of that quantity on off-gas treatment, shipping, hazard category, etc.

B.5.4.2.5 Environmental and worker safety (radiological/chemical/process) issues associated with operation of the proposed system/process

The introduction of Silo 3 material into the OU1 process does add radionuclides that were not considered during air modeling for off-gas treatment, hazard category classification, transportation risk, etc. Additional modeling or evaluation would be required to identify the quantity of additional emissions generated and the impact of that quantity on off-gas treatment, shipping, hazard category, etc.

B.5.4.2.6 Requirements for removing material from Silo for introduction into system/process

Assume removal method is the same for all alternatives.

B.5.4.2.7 Degree to which special operator skills/experience will be necessary

No additional skills/experience required in addition to those required for OU1 remedial action.

B.5.4.2.8 Quantity of waste produced

3,915 tons.

B.5.4.2.9 Transportation requirements for disposal

OU1 material meets the DOT requirements for LSA-I. Blended Silo 3 and Pit 5 material has the potential to meet LSA-I requirements. As LSA-I, blended material, could be transported in a gondola car in coordination with other OU1 material.

B.5.4.2.10 Waste handling and storage requirements before final disposal

Interim storage of gondola cars as a unit train is part of the OU1 process.

B.5.4.3 Schedule

B.5.4.3.1 Ability of the alternative to complete the remediation of Silo 3 in a timely fashion, well ahead of ROD

a. Availability of transport and disposal services off-the-shelf

b. Availability of equipment and materials off-the-shelf

c. Availability of labor (FEMP or subcontractor "turn key" service)

d. Requirement for additional laboratory testing prior to scale-up

e. Impacts to current vitrification schedule for conducting required evaluations

The same schedule for OU1 would apply to Silo 3 material. OU1 is scheduled to start shipping Waste Pits 1 and 2 in July 1998. Waste Pit 5 is scheduled for excavation in fiscal year 2000.

B.5.4.3.2 Anticipated schedule for project preparation, planning, operations and D&D

Operation of OU1 facilities is currently scheduled to start 1998 and finish 2004. D&D of facilities is scheduled for 2005.

B.5.4.4 Cost

These cost estimates are a rough order of magnitude and are given in ranges to demonstrate their uncertainty. They provide an indication of the cost viability of an alternative and a general trend of the relative cost of the alternatives. These costs do not include common costs for all alternatives, such as removal of the Silo 3 material from the silo and regulatory approval.

The estimated cost range for this alternative is $4 - $10 million. The major uncertainty in cost is the complexity of equipment and structures needed to move the Silo 3 material to the Pit 5 material and blend the two materials. Engineering attention and agreement on the design basis for the estimate should reduce the range significantly.

Costs for excavation, drying, loading, shipping, and disposal of OU1 pit material is $528 per ton. If the Silo 3 material could be transferred to the pit material, blended, shipped, and disposed at the same cost as the pit material, the cost would be $2.1 million. The equipment and building, operating, and decommissioning costs necessary to transfer and blend the Silo 3 material range from $2 - $8 million. This uncertainty needs to be reduced.

B.6.0 ASSUMPTIONS AND CRITERIA

A number of assumptions must be made in order to evaluate the alternatives for treatment of Silo 3 material. Assumptions and criteria that are common to all 4 alternatives are discussed in the sections that follow.

B.6.1 Silo 3 Material Characteristics

B.6.1.1 Physical Characteristics

Information on the characteristics of the Silo 3 material is available from the treatability testing performed on the samples collected during the 1989 sampling activity. The laboratory notes describe the appearance of the material as a red powder with "talc-like" consistency. The moisture content was measured in an infrared drying oven at approximately 0.3 wt. percent and in a conventional 105° C drying oven at approximately 2.3 wt. percent. Silo 3 contains 5,088 yd^3 of material estimated to weigh 7,830,000 pounds based on an assumed in-situ density of 57 lb/ft^3. A density of 40 lb/ft^3 is assumed for the Silo 3 material as it is removed from the silo and handled.

Based on analytical results, Silo 3 contains inorganic materials. Aluminum, calcium, iron, magnesium, potassium, and sodium were all present at concentrations exceeding 10,000 ppm. Based on process knowledge and the low moisture content of the material, it would be expected that these materials are all present in an oxide form. Other metals including chromium, lead, cobalt, and nickel were also found.

A determination of the inorganic composition found that the material contained 15 wt. percent sulfate, 14 wt. percent silica, 10 wt. percent magnesium oxide, and other oxides in lesser quantities, including carbonate and calcium oxide.

The total uranium concentration in the Silo 3 material was found with a maximum concentration of 4,554 ppm. U-238 was present at a maximum of 2,043 pCi/g, U-235/236 at 158 pCi/g, and U-234 at 1,935 pCi/g. Ra-226 was present at a maximum of 6,435 pCi/g. Thorium-230 was present at a maximum of 71,650 pCi/g.

Calculations and direct measurements indicate that Silo 3 materials can be contact-handled (i.e., low external dose rate). For example, calculated external dose rates (Microshield) at contact with a white metal box and a gondola railroad car containing Silo 3 material were 0.9 and 1.3 mR/hr, respectively. However, Silo 3 material must be contained during handling and storage because of its dispersable form (dry powder) and the risk of worker exposure through inhalation of airborne particles. Radon emanation from Silo 3 material is only moderate as a result of the relatively low concentration of Ra-226. However, closed vessels that contain untreated Silo 3 material will accumulate concentrations of Rn-222. The head space in Silo 3 contains approximately 200,000 pCi of Rn-222 per liter of air.

B.6.1.2 Hazardous Waste Characteristics

There are limited data available to describe leaching of RCRA heavy metals from untreated Silo 3 material. The Silo 3 material is considered an AEA 11(e)(2) by-product material, excluded from regulation under RCRA. During the RI/FS, three cores of Silo 3 material were taken from three manways of Silo 3, sampled for Extraction Procedure Toxicity (EP Toxicity), and sectioned for archive. It is believed that the cores are representative of the Silo 3 material. EP Toxicity data from 1989 are presented in the OU4 RI/FS and represent the most comprehensive sampling event (eleven samples were taken). Subsequent analyses of archived sample material were conducted on samples taken from the core sections (from which the EP Toxicity samples were taken) on at least three occasions:

1) A single Toxicity Characteristic Leaching Procedure (TCLP) sample to support the OU4 cementation treatability study (March 1993);

2) A single TCLP sample in April 1993; and,

3) Three TCLP samples in 1995.

Although there is good agreement between the TCLP data and the EP Toxicity data, the RI/FS data are statistically more useful. The EP Toxicity data fail for As, Cd, Cr, and Se; their TCLP limits are 5.0, 1.0, 5.0, and 1.0 mg/l respectively. The arsenic data range over two orders of magnitude, from 0.018 to 41.5 mg/l. The cadmium data are all below EP limits except for one data point, which is an order of magnitude above the others; cadmium ranged from 0.108 to 6.32 mg/l. Chromium ranged from 0.336 to 11.9 mg/l, and exceeded the limit in about half the samples. Most of the selenium data just exceeded the EP limit of 1.0 mg/l; range was 0.92 to 11.7 mg/l.

The first TCLP sample to support the cementation treatability study exceeded the TCLP limit only for arsenic (5.3 mg/l); chromium (4.6 mg/l) and selenium (0.92 mg/l) were just below the limit. The second sample was in close agreement to the first, but in this case, chromium (6.0 mg/l), as well as arsenic (6.4 mg/l), exceeded the limit. Selenium was again just below the limit at 0.98 mg/l.

The third sampling event provided three TCLP data points. Arsenic consistently exceeded the TCLP limit (range 16.9 to 60.3 mg/l); cadmium just exceeded (range 1.1 to 3.3 mg/l); chromium again averaged around the limit (range 3.1 to 8.6 mg/l); and selenium at 0.9 mg/l was just below the limit.

Care should be taken in the use of numerical data to draw conclusions for these four heavy metals. The EP Toxicity data represent the most analytical data points. Due to the wide range of data for arsenic, the chromium levels floating around the limit in both the EP and TCLP, and the outlying data points for cadmium and selenium, it cannot be assumed that a single sample of Silo 3 material would fail for any one (or all) of the four metals. Based on this information, it

is currently assumed that the Silo 3 material exceeds the TCLP limits for at least one of the four metals, and therefore will be considered to exhibit a hazardous waste characteristic.

It has been suggested that it is unlikely that this calcined stabilized material could leach sufficiently to fail the TCLP characteristic and that false positive TCLP and EP Toxicity results may have occurred due to interference from thorium and highly concentrated inorganics in the waste described previously. Because management of the material would be significantly simplified if it did not have a hazardous characteristic, this issue should be carefully evaluated.

It is also necessary to ensure that the blended Silo 3 and Pit 5 material does not exceed TCLP limits.

B.6.2 Packaging Options

Both raw and treated Silo 3 material can be classified as low specific activity-II (LSA-II) solid material, defined as "material in which the activity is distributed throughout and the estimated average specific activity does not exceed $10^{-4}A_2/g$ for solids" 49 CFR § 173.403. As LSA-II, Silo 3 material must be shipped in containers that meet or exceed DOT design requirements for Industrial Package-Type 2 (IP-2) containers.

The exception to the above classification is Silo 3 material blended with Pit 5 material. Pit 5 material is classified as LSA-I, defined as "mill tailings, contaminated earth, concrete, rubble, other debris, and activated material in which the Class 7 material is essentially uniformly distributed and the average specific activity does not exceed $10^{-6}A_2/g$." Blending Pit 5 material with Silo 3 material at a ratio of 20:1, respectively, would result in a solid material that exceeds the LSA-I limit slightly. It is believed that a strong case could be made to allow the shipment of this blended material as LSA-I in coordination with shipment with other OU1 material. As LSA-I material, blended material can be packaged in containers that meet or exceed DOT design requirements for IP-1 containers. In addition, DOT regulations allow LSA-I material to be packaged in bulk (i.e., gondola cars), where the package is a strong tight packaging that is shipped under exclusive use conditions in a closed transport vehicle.

For planning purposes, three types of packages are assumed to be available for the transport and disposal of Silo 3 materials. These packages are rail gondola cars (bulk rail shipments to a commercial disposal facility only), full-height, and half-height white metal boxes (shipment to NTS or a commercial disposal facility by truck).

It has not yet been determined that gondola cars can be certified as IP-2 containers; however, gondola cars would meet specifications for shipping blended Pit 5 material and Silo 3 material as LSA-I. Gondola cars used for transport of bulk Silo 3 material would be lined with a synthetic material liner, loaded from the top, then closed with a secured hard cover. The liner would to prevent external contamination of the rail car during loading, prevent release of material during transport, prevent infiltration of water during shipment, and minimize contamination of the rail car internal surfaces. The

hard cover is designed to prevent human intrusion, infiltration of precipitation, and inadvertent release of material during transport. The design specifications of the representative gondola car, also envisioned for use in transporting OU1 wastes (FERMCO 1995), are shown below:

- Inside length 52 feet 6 inches
- Inside width 9 feet 7.5 inches
- Inside height 5 feet 6 inches
- Cargo capacity 107 tons/103 cubic yards
- Empty weight 36 tons
- Outside length 57 feet 1.5 inches (coupler-to-coupler)

The FEMP's full-height and half-height White Metal Boxes (WMB) purchased under FERMCO subcontract No. 95MKB004830 are strong-tight containers that currently meet the IP-2 criteria. Both WMBs are a standard FEMP container used for transport and disposal of wastes. The half- and full-height WMBs have volumetric capacities of 43 ft^3 and 94 ft^3 respectively, while the weight limit on both boxes is 9,000 lbs. Full-height boxes would be used for materials with densities less than 100 lb/ft^3 in order to achieve volumetric fill-rates of at least 90 percent of container capacity. Half-height boxes would be used for materials with densities greater than 100 lb/ft^3.

B.6.3 Transportation Options

In the event that a commercial disposal facility is selected, truck or rail transport can be used for the entire transportation process. Only truck transport will be considered for the NTS disposal option.

B.6.3.1 Rail Transport

A major upgrade of facilities at the FEMP will be required in order to support rail transportation operations. These upgrades include construction of waste loading facilities and installation of new tracks. In addition, three trestles within the CSX track system will need to be replaced or rebuilt in order to support the FEMP's requirements. These improvements and maintenance activities are described in the Site Improvement Plan component of the OU1 remedial design, and are scheduled for completion in 1998. If rail is chosen as the means of transport, the schedule for implementing the Silo 3 remediation must be delayed until 1998 or the railroad upgrades must be accelerated.

Rail cars destined for the commercial disposal facility would depart from the FEMP and travel on CSX tracks to St. Louis. In St. Louis the trains would switch to Union Pacific track for the remainder of the route to Clive, UT. The total distance by rail to a commercial disposal facility is approximately 3,100 km.

In the event that gondola rail cars are used as containers to transport the material in bulk form to a commercial disposal facility, shipments from the FEMP could consist of individual cars, or

a "unit" train of at least 40 gondola cars. A unit train is a train that makes a direct run between point of origin and the destination point. It receives priority right-of-way and expedited switching, and stays intact along the whole route. Unit trains offer the advantages of lower transport costs, shorter transit times, improved safety and security, and immediate return of empty cars.

B.6.3.2 Truck Transport

The distance by truck to a commercial disposal facility is approximately 2,900 km, while the distance by truck to the NTS is approximately 3,300 km resulting in an approximate 30 percent savings. In the event that WMBs are used as containers to transport the material to either the NTS or a commercial disposal facility, four WMBs would be placed directly onto the truck bed. Bulk transport by truck is not a consideration for NTS.

B.6.4 Disposal Facility Options

A commercial disposal facility is licensed to accept for disposal: (a) specific low concentrations of radionuclides within the classification LLRW, (b) Naturally Occurring Radioactive Material (NORM), c) mixed waste, and (d) 11.(e)(2) by-product materials (uranium and thorium mill tailings). However, due to license restrictions, a commercial disposal facility can only receive the Silo 3 material as LLRW or as mixed waste. The commercial disposal facility's 11.(e)(2) license would have to be modified to receive the material as 11.(e)(2). Before waste shipment, a commercial disposal facility normally requires submittal of a waste profile with five 2-pound or 1-liter analytic samples and one large (50 lb) physical sample to establish a baseline for future shipments. The physical sample is used to establish compaction ratios. The five analytical samples will be analyzed at a commercial disposal facility's on-site laboratory to establish acceptance parameters.

A commercial disposal facility has facilities for receiving wastes transported by either rail car or truck. Incoming gondola rail cars are pushed one at a time into the facility's rail car roll-over device. This unit straddles the rail spur and effects a controlled "drop" of the waste material into an adjacent concrete pit. The material is then loaded into dump trucks, transported to the disposal cell, placed in one-foot "lifts" (or levels), compacted, and covered. Waste packages (i.e., WMB or intermodal 20-ton containers) are shipped to the commercial disposal facility by rail or truck, are removed from the transport vehicles, emptied for bulk transfer of the wastes to the disposal cell, then returned to the generator for disposal or reuse.

A commercial disposal facility defines "debris" as anything other than soil and soil-like material. Any debris more than 10 percent of the volume affects the price. Noncompactible debris in the form of concrete, stone or metal may be placed within a lift up to 25 percent by volume.

The NTS serves as a major LLRW disposal facility for several DOE sites and has accepted significant quantities of LLRW generated at the FEMP. The NTS cannot receive mixed waste or LLRW that exhibit a hazardous waste characteristic. Even if the Silo 3 material is considered to be AEA 11.(e)(2)

by-product material, it is the position of the NTS that DOE Order 5820.2A allows the receipt by exception of small quantities of 11.(e)(2) material as LLRW which cannot contain material with a hazardous waste characteristic.

Current FEMP procedures for the shipment of LLRW to the NTS specify the use of disposable metal containers. Use of loaded containers weighing over 5,000 pounds require explicit prior notification of and approval by the NTS. There are no specific limitations for fine particles when materials are packaged in steel containers for disposal.

B.6.5 Cost Assumptions

The following assumptions and factors are used for the purpose of estimating costs associated with each of the Silo 3 remediation alternatives:

- Package Costs — $700/WMB
- Handling Costs — Handling costs are based on handling as a powder without prior wetting.
- Transportation Costs — Costs for railroad upgrades already planned by OU1 have not been included in the cost estimates. The following shipment costs have been assumed.
  - $3,200/truck shipment to NTS
  - $2,400/truck shipment to a commercial disposal facility
  - $10,000 round trip rail to commercial disposal facility
- Commercial Facility Disposal Costs
  - $8.50 - $12.50/ft^3 depending on compactibility for disposal of LLRW not requiring treatment
  - $24(20-30 range)/ft^3 for disposal of wastes requiring treatment (i.e., wastes requiring metals stabilization)
- NTS Disposal Costs
  - $20/ft^3 for packaged LLRW - does not include cost incurred at NTS Burial size for WMB is 112 cubic feet with 90 cubic feet of material in the box.

APPENDIX C

DETAILED COST ESTIMATES

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C.4-3 Life-Cycle and Present Worth Cost Analyses C-4-3

LIST OF ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
cm	centimeter
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ft	feet
ft^2	square feet
ft^3	cubic feet
HEPA	High Efficiency Particulate Air
in.	inch
kg	kilogram
km	kilometer
lb	pound
m	meter
m^3	cubic meters
mi	mile
min.	minute
NTS	Nevada Test Site
O&M	operation and maintenance
RTS	Radon Treatment System
yd^3	cubic yard

C.1.0 INTRODUCTION -- 8050

Cost estimates are used in the feasibility study process under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to eliminate those remediation alternatives which are significantly more expensive than competing alternatives but do not offer commensurate performance or health protectiveness. These estimates are required to be order-of-magnitude level accuracy, as defined by the American Association of Cost Engineers.

The cost estimates contained herein were based on a variety of cost-estimating data such as cost curves, generic unit costs, vendor information, conventional cost-estimating guides, commercial remedial costs, and previous similar estimates as modified by site-specific information. The categories of costs considered were: (1) capital costs; (2) operation and maintenance (O&M) costs; (3) waste packaging, transportation, and disposal costs; and (4) decontamination and decommissioning costs.

The cost estimates presented are order-of-magnitude estimates with an intended accuracy range of ± 40 percent. Estimates are considered to be order-of-magnitude because of the uncertainties in the information used to develop the alternatives. Final remediation costs will depend on the actual detailed design used, actual labor and material costs, actual site conditions, productivity, competitive market conditions, final scope, final schedule, final engineering design, and other variables. As a result, final remediation costs will vary from the estimates presented here. Because of these factors, funding needs should be carefully reviewed before specific financial decisions are made or final remedial action budgets are established.

A present worth analysis was conducted for all of the Silo 3 residues alternatives so that alternatives with costs incurred over differing time periods could be compared on an equivalent basis. A discount rate of 7 percent was used in the present worth analysis.

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C.2.0 BASIS OF ESTIMATE - 8050

C.2.1 Capital Costs

Capital costs are expenditures required to construct a facility to perform a remedial action. Capital costs consist of direct and indirect costs. Direct costs are those expenditures necessary for the actual installation of the remedial action. These include equipment, labor, and materials. Indirect costs include expenditures for engineering, financial, supervision, and other services necessary to carry out a remedial action (see Attachments C.I through C.VI for Alternative Cost Summary Details).

C.2.1.1 Site Preparation

Site preparation is applicable to all the Silo 3 alternatives. Each alternative includes site preparation components such as clearing and grubbing vegetated areas required for the material processing area, the staging area for the shipment of containerized waste, the material slurry transfer trench, utilities, and the roads and equipment staging areas.

C.2.1.2 Residue Removal/Transfer System

The residues removal/transfer system is a fundamental component of all the alternatives. This cost component includes the site preparation, at grade structure construction, auger, filter/receiver, and the pneumatic retrieval equipment. Assumptions used for the cost estimate include:

- Site preparation clearing of the area for construction of the environmental enclosures (EEs), area excavation for the foundations and equipment pads;
- Two EEs identical and separate removal facilities will be approximately 300 ft^2 structures, located within 300 feet of Silo 3;
- A backing plate seal would be installed at the interface of the pneumatic removal system and the silo dome. Reinforcing and tensioning of the Silo 3 walls;
- The air suctioned from the silo would be separated in a filter/receiver adjacent to the facility. Air handling/exhaust treatment equipment include HEPA filters, blowers, air inlet dampers, CCTV equipment and controls, and isokinetic stack sampler; and
- The pneumatic removal equipment would consist of an auger, vacuum, and pump.

C.2.1.3 Vitrification

This cost component includes the incremental cost to process Silo 3 residues. The reference plant is assumed to exist which will retrieve and vitrify the residues from Silos 1 and 2 regardless of the method selected for processing Silo 3 residues. The reference plant is rated at 25 tonnes of glass per

day. A capital cost estimate was prepared for the reference vitrification plant and includes the following major systems:

- Feed Preparation System;
- Melter System;
- Melter Off-gas System, including radon removal;
- Gem Production and Packaging System;
- Heating, Ventilating, and Air Conditioning;
- Distributed Control System; and
- Health Physics System.

A second cost estimate was prepared for a modified plant designed to vitrify the residues from all three silos. Two alternative plant design assumptions were available. The first assumes that the processing rate is the same (25 tonnes per day) and the additional residues are processed by operating the plant for a longer period of time. The second alternative assumes that the plant capacity is increased to allow processing in the same length of time. The first assumption was used in this study to minimize the amount of new design and cost estimating work that had to be done. If the vitrification alternatives is selected, the actual plant capacity must be evaluated in detail.

Since the production capacity of the modified plant is the same as that of the reference plant (25 tonnes per day), most systems, and therefore their costs, are the same. The only two systems that must be modified are the Feed Preparation System and the Melter System, as discussed in detail in Section 3.2 of this report. An additional bin and feeder were added to the Feed Preparation system to hold Silo 3 residues and the melter size was reduced because of increased processing efficiency when vitrifying Silo 3 residues. Because of the reduced melter size and related cost savings there was a net reduction in vitrification plant costs of $700,000. When the cost of the Silo 3 Retrieval System was added ($2.3 million) the total cost of modifying the reference plant was $1.6 million.

C.2.1.4 Stabilization

Stabilization is a component of Alternatives ALT1, ALT2, and ALT3. This cost item includes the cost of the stabilization process and support equipment and was based on the following:

- ALT1 stabilization formula is assumed to be a mix consisting, by weight, 45 percent Silo 3 residues, 9 percent cement, 37 percent water, 9 percent blast furnace slag;
- The ALT 1 stabilization equipment would operate at a rate of 6 operational processing hours/day. Batch size of the mixer is 3 cy, producing 8,000 pounds of stabilized material

containing approximately 2,900 pounds of Silo 3 residues. A total of 2,152 batches would be required to stabilize Silo 3 residues. A total of 650 processing hours or 108 days;

- ALT1 stabilization equipment includes a surge tank, screw feeder, stabilization mixers, blast furnace slag cement, and storage/feed facilities, process piping, pumps, and mixers;

- The ALT2 stabilization formula is assumed to be a mix consisting of, by weight, 52 percent Silo 3 residues, 11 percent cement, 26 percent water, and 11 percent blast furnace slag. A batch size of 2.7 cy would produce approximately 6,000 pounds of stabilized waste containing approximately 3,135 pounds of Silo 3 residues. A total of 2,500 batches would be required to stabilize all of the residues. Processing per batches would be approximately 30 minutes. A total of 1,250 processing hours would be required to stabilize all of the Silo 3 residues, (assuming 6 operational processing hours/day) a total of 208 calendar days would be required to process all of the Silo 3 residues;

- ALT3 stabilization equipment would be similar to ALT2 except that cement and blast furnace slag would be replaced by a sodium silicate feed tank system; and

- ALT3 conditioning would use a formulation mix consisting, by weight, 83 percent Silo 3 residues, 13 percent water, and 4 percent sodium silicate. Batch size of the mixer is 2.7 cy, producing 4,330 pounds of conditioned waste containing approximately 3,580 pounds of Silo 3 residues. A total of 2,190 batches would be required to condition all of Silo 3 residues. A total of 729 processing hours (6 hr/day) or 122 calendar days would be required to process all the Silo 3 residues.

C.2.1.5 Indirect Costs

Indirect costs are those costs required to support the design, construction, and management of the treatment facilities. Costs incurred to support the construction activities include those required for the purchase of small tools and consumable items (welding machines, welding rods, grinding wheels, etc.,); the use of temporary facilities and utilities during the construction phase only; initial safety training and ongoing safety meetings; health physics support during construction; the general contractor's markup, overhead, and profit; and the payroll burden and benefits of the construction force. The payroll burden and benefits include health insurance, unemployment benefits, Social Security, and worker's compensation insurance. Additional indirect costs are those incurred in the engineering, design, and construction management.

Sales tax and risk budget (contingency) are added as a percentage of the overall costs of the remedial action alternative. A sales tax of 5.5 percent has been applied to all capital equipment purchases and services. Although sales tax is not typically applicable to CERCLA remediation activities, the State of Ohio requires that sales tax be charged on all equipment purchased. The risk budget was used to account for the uncertainties in the actual cost values to cover a statistical probability of a ± 40 percent accuracy range.

Escalation which would account for the increase in labor and material costs during the construction period, was not considered in the present worth analysis per EPA's costing guidance manual.

C.2.2 Operations and Maintenance Costs

O&M costs include all costs necessary to operate the plant. The components of O&M costs include:

- Labor: This component includes wages, salaries, training, overhead, and benefits associated with the labor needed to run the plant. This includes plant operations, maintenance crafts, security, engineering support, analytical services, health physics support, and plant management;

- Replacement Equipment: This component considers routine preventive maintenance and expected equipment failures;

- Materials and Chemicals: This component includes glass-formers, cement, fly ash, flocculents, and all miscellaneous chemicals required to operate the plant; and

- Electricity: This is a major cost component for the vitrification alternative because of the joule-heated melter. It is relatively minimal for the other three alternatives.

C.2.3 Waste Packaging, Transportation, and Disposal Costs

C.2.3.1 Packaging

Packaging is a cost component of all Alternatives. Packaging costs include the cost of purchasing the containers and the labor associated with handling, filling, and documentation (see Attachment 1 for Cost Summary details). Estimated costs are based on the following:

- Vitrified material will consist of a formula blending K-65 and Silo 3 residues. Packagings would be U.S. Department of Transportation (DOT) Specification 7A-Type A containers with exterior dimensions of approximately 1.4 m (4.5 ft) wide by 1.8 m (6 ft) long by 1.5 m (5 ft) depth. Interior dimensions would be approximately 1.1 m (3.5 ft) width by 1.5 m (5 ft) length by 1.1 m (3.5 ft) depth, providing approximately 1.7 m^3 (61 ft^3) of packaging volume;

- The number of packagings for ALT VIT was based on a maximum container payload weight of approximately 4,100 kg (9,000 lbs), and a maximum payload volume of approximately 1.7 m^3 (61 ft^3), assuming a material density of approximately 2,790 kg/m^3 (174 lb/ft^3), and a bulk packaging density of approximately 2,250 kg/m^3 (140 lb/ft^3);

- Packaging for stabilized material and raw Silo 3 residues would be Industrial Packaging-Type 2 containers with exterior dimensions of approximately 1.2 m (4 ft) width by 2.1 m (7 ft) length by 1.2 m (4 ft) depth. Interior dimensions would be approximately 1.1 m (3.6 ft) width by 2 m (6.6 ft) length by 1.1 m (3.6 ft) depth, providing approximately 2.5 m^3 (84 ft^3) of packaging volume;

- The number of packagings for ALT1, ALT2, and ALT3 material was based on a maximum payload weight of approximately 4,100 kg (9,000 lb) and a maximum payload volume of approximately 2.4 m^3 (84 ft^3) assuming a bulk packaging density of 1,610 kg/m^3 (100 lb/ft^3)

for ALT1 material; a bulk packaging density of 1,410 kg/m^3 (88 lb/ft^3) for ALT2 material; and a bulk packaging density of 1,030 kg/m^3 (64 lb/ft^3) for ALT3 material;

- Disposal volumes for VIT and ALT1 were estimated by multiplying the number of containers presented in Table C.2-1 by the external volume of the container used for the shipment of the material, 3.8 m^3 (131 ft^3) for VIT material and 3.2 m^3 (112 ft^3) for ALT 1 material;

- Disposal volume for ALT3 was estimated by assuming a ten percent increase in volume of Silo 3 residues shipped to a Representative Permitted Commercial Disposal Facility (RPCDF) for treatment, 4,140 m^3 (146,200 ft^3) shipped to the RPCDF;

- Total packaging cost was estimated assuming the number of containers indicated in Table C-2-1 for VIT and ALT1. For ALT2 and ALT3 it was assumed that containers could be recycled three times for shipment of material to the RPCDF. Therefore, packaging cost estimates assumed one-third the number of containers indicated in Table C.2-1 for ALT 2 and ALT3 would be purchased;

- A unit cost of $4,746 per VIT container was determined based on a material cost of $3,500 per unit, a 5.5 percent sales tax applied to the purchase of each container, a labor cost of $545 per unit for handling and documentation, and a 12 percent risk budget; and

- A unit cost of $1,556 per ALT1, ALT2, and ALT3 container was determined based on a material cost of $800 per unit, a 5.5 percent sales tax applied to the purchase of each container, a labor cost of $545 per unit for handling and documentation, and a 12 percent risk budget.

TABLE C.2-1

SILO 3 ALTERNATIVE MATERIAL VOLUMES AND DISPOSAL QUANTITY ESTIMATES

Alternative	Volume of Silo 3 Residues m^3 (yd^3)	Volume Increase Due to Treatment Percent	Volume of Waste to be Disposed m^3 (yd^3)	No. of Packages
VIT	3890 (5088)	37[1]	5333 (6972)	1437
ALT1	3890 (5088)	76[2]	6850 (8960)	2160
ALT2	3890 (5088)	24	4830 (6320)	2520
ALT3	3890 (5088)	17	4555 (5960)	2190

[1]Volume of Silo 3 residues is actually reduced by approximately 55 percent due to vitrification. Disposal volume increase is due to volume of the disposal container.

[2]Volume of Silo 3 residues increases by approximately 20 percent due to cement stabilization. Additional volume increase is due to volume of the disposal containers.

C.2.3.2 Transportation

Transportation is a cost component of all the alternatives. This cost item includes transportation of the packaged material and is based on the following assumptions:

- For all alternatives packages would be transported by truck;
- Costs were estimated using a unit rate of $3,584 per truck shipment to the NTS and a unit rate of $3,524 per truck shipment to the RPCDF based on current average shipping costs to the respective facilities and a 12 percent risk budget; and
- It was assumed that truck shipments returning recycled containers from the RPCDF for ALT2 and ALT3 would also cost $3,524 per truck shipment.

C.2.3.3 Disposal

Alternatives VIT and ALT1 include disposal at NTS, and Alternatives ALT2 and ALT3 include disposal at the RPCDF. Costs were estimated based on the following:

- Disposal costs for packaged material that would be disposed at NTS were estimated assuming a unit disposal cost of $790.70/m^3 ($22.40/ft^3), based on projected disposal costs for fiscal 1998 and a 12 percent risk budget;
- Disposal costs for ALT 2 material that would be disposed at the RPCDF were estimated assuming a unit disposal cost of $494/m^3 ($14/ft^3), based on current disposal costs and a 12 percent risk budget;
- Treatment costs for ALT3 material at the RPCDF were estimated assuming a unit treatment cost of $1,186/m^3 ($33.60/ft^3), based on current treatment costs for material requiring special handling and a 12 percent risk budget;
- Disposal costs for ALT3 material at the RPCDF were estimated assuming a unit disposal cost of $33.35/m^3 ($9.50/ft^3). This is based on the assumption that the treatment facility will generate treated residues amenable to compaction at its own disposal facility. A 12 percent risk budget is also included in the unit cost; and
- To reuse containers used for shipment of material to the RPCDF, under ALT2 and ALT3, a unit decontamination and reconditioning cost of $112/container was assumed, which includes a 12 percent risk budget. It is assumed that containers will be reconditioned after the third use and sent back to the FEMP for use in other onsite projects.

C.2.4 Decontamination and Decommissioning

At the end of production, 0.5 to 3 years depending on the alternative, the facilities will have to be cleaned of all radioactive contamination (decontamination) and placed in a safe shutdown condition (decommissioning). Safe shutdown is defined as all fluids drained, all electrical deenergized (with some exceptions), etc. After decommissioning, the Facilities D&D Project will remove the equipment

and demolish the buildings and silos. Upon completion of demolition, the Soil Remediation Project will remediate the soil as required.

The D&D of silo structures and remediation of OU4 soils were not part of this evaluation. Therefore, the costs of work to be performed by silo structure D&D and remediation of soils are not included here.

D&D costs are estimated at $83 per square foot of building, plus 180 labor hours per piece of equipment at $23.35 per hour.

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C.3.0 Sensitivity Analysis

A sensitivity analysis was performed upon the cost impacts of the final waste volume of stabilized material generated under Alternative ALT2 (see Attachment C.VII for Cost Summary details). In the "*Summary of Screening Evaluation of Silo 3 Alternatives*," included as Appendix B of this document, a technique known as vacuum extrusion was identified as a potential method of offering some volume reduction capabilities for the treated Silo 3 residues.

This sensitivity analysis in Section 3.4 looks at the potential cost impacts of implementing vacuum extrusion as a process option to reduce waste volume and; therefore, minimize packaging, transportation, and disposal costs associated with implementing ALT2. The sensitivity analysis did not consider stabilized material from ALT1 since material would be poured directly into the transport and disposal containers and allowed to solidify into a monolith in the container. The sensitivity analysis also did not consider material from ALT3. Since the Silo 3 residues would be treated by the RPCDF under this alternative, actual volume reduction capabilities would be controlled by the RPCDF treatment process.

The sensitivity analysis assumes that vacuum extrusion will utilize the same formulation as the stabilization process discussed in ALT2 in order to meet the RPCDF waste acceptance criteria. The formulation presented in ALT2 results in an estimated 24 percent increase in waste disposal volume compared to untreated Silo 3 residues. The sensitivity analysis considered potential waste volume reductions of zero, ten, twenty, and thirty percent compared to the estimated waste disposal volume of 4,830 m^3 (120,550 ft^3) for ALT2 treated Silo 3 residues. In addition to the impacts on packaging, transportation, and disposal costs resulting from vacuum extrusion, the sensitivity analysis also considered capital costs associated with implementation, operation, and maintenance of vacuum extrusion in comparison to the alternative evaluated in the discussion of ALT2.

In addition to the packaging, transportation, and disposal cost assumptions already discussed. The following assumptions were used in the sensitivity analysis:

- The total weight of stabilized material remained constant at 6,828,970 kg (15,008,720 lb);
- The void fraction associated with stabilized particles remained constant at 20 percent;
- Assuming no reduction in stabilized material volume results in an effective packaging and disposal volume of approximately 4,830 m^3 (170,550 ft^3) and a bulk packaging density of 1,410 kg/m^3 (88 lb/ft^3);

- Assuming a 10 percent reduction in stabilized material volume results in an effective packaging and disposal volume of approximat 4,430 m^3 (156,340 ft^3) and a bulk packaging density of 1,5 kg/m^3 (96 lb/ft^3); and

- Assuming a 20 percent reduction in stabilized aterial volume results in an effective packaging and disposal volume of approximately 3,800 m^3 (134,010 ft^3) and a bulk packaging density of 1,800 kg/m^3 (112 lb/ft^3).

- Assuming a 30 percent reduction in stabilized material volume results in an effective packaging and disposal volume of approximately 3,320 m^3 (117,260 ft^3) and a bulk packaging density of 2,060 kg/m^3 (128 lb/ft^3).

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C.4.0 PRESENT WORTH ANALYSIS

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Present worth analysis provides a method of evaluating and comparing costs that occur over different time periods by discounting all future expenditures to the present year. The costs for different remedial action alternatives can be compared on the basis of a single figure. From a financial standpoint, the objective of the present worth calculation is to determine those funds needed today to capitalize the remedial action over its duration, given the discount rate. To determine present worth costs, the following equations were used:

$$P=A[1-(1+i)^{-n})/i] \qquad \text{(Eq. 1)}$$

Where:

P = Present Worth ($).
A = uniform annual payment during years 1 through n ($).
i = discount rate.
n = number of periods (years) of operation.

Equation 1 is used to convert annual expenses to present worth dollars (i.e., O&M costs); and

$$P=F(1+i)^{-n} \qquad \text{(Eq 2)}$$

Where:

P = present worth ($).
F = single payment in year n ($).
i = discount rate.
n = number of periods (years) of operation

Equation 2 is used to convert a one-time future expenses to present worth dollars (i.e., D&D costs).

In order to perform the present worth calculation the following implementing and simplifying assumptions were made.

- All capital costs for engineering, procurement, and construction were assumed to occur at year 0. Their actual costs are therefore equal to their present worth costs;
- The plant is assumed to begin operation at year 0 and continue for n years;
- Annual costs for O&M and for packaging, transportation, and disposal occur at the end of the

year or at the end of the period if less than one year to complete;

- D&D costs are assumed to occur at the end of operation, or year n;
- Costs are discounted on an annual basis, rather than monthly, daily, or continuously; and
- The discount rate used for the present worth calculations is seven percent per CERCLA guidance (EPA 1988), as revised by correspondence from EPA's Office of Emergency and Remedial Response (EPA 1993) for sites which have a Record of Decision targeted for fiscal year 1994 and thereafter. Present worth costs are summarized in Table C.4-1.

In order to compute the present worth of the vitrification alternative's annual costs, which occur between years 2.17 and 2.95, the total present worth cost of the reference plant must be subtracted from the total present worth cost of the modified plant. This is shown in Table C.4-1.

TABLE C.4-1

PRESENT WORTH COST ANALYSIS - VITRIFICATION ALTERNATIVE
($ Millions)

CASE	INITIAL CAPITAL COST	ANNUAL PACKAGING TRANSPORTATION & DISPOSAL COSTS	ANNUAL O&M COSTS	END OF LIFE D&D COSTS	OPERATING LIFE (years)[1]	TOTAL PRESENT WORTH COST
Reference VIT Plant	$104.9	$17.6	$11.5	$5.6	2.17	$166.5
Modified VIT Plant	$106.5	$17.6	$11.7	$5.6	2.95	$186.8
Net Cost of Silo 3 Vitrification	$1.6	$0.0	$0.2	$0.0	0.78	$20.4

[1]Operating life taken from Table 3.2-2

In order to compute the present worth of annual costs that occur for less than one year; as do those for ALT1, ALT2, and ALT3; the annual costs must be calculated as if they continue occurring for the remainder of the year, then discounted for the actual partial year. For example, if the operating expenses of an alternative were $1,000 per month and the length of operation was only 3 months, "A" in equation 1 would be $12,000 and "n" would be 0.25 (3 months). This is shown in Table C.4-2.

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TABLE C.4-2

PRESENT WORTH COST ANALYSIS - SILO 3 ALTERNATIVE
($ Millions)

Case	Initial Capital Costs	Equivalent Annual Packaging Transportation & Disposal Costs	Equivalent Annual O&M Costs	End of Life D&D Costs	Operating Life (years)	Total Present Worth Cost
ALT1 - Onsite Treatment Disposal at NTS	$6.7	$31.0	$3.5	$0.8	0.345	$18.8
ALT2 - Onsite Treatment Disposal at Envirocare	$6.8	$10.8	$2.0	$0.8	0.798	$17.1
ALT3 - Treatment and Disposal at Envirocare	$6.7	$24.1	$3.0	$0.8	0.468	$19.5

Table C.4-3 presents the total life-cycle and present worth cost analyses for all four alternatives. Life-cycle cost is total dollars spent during the life of the project and includes capital, annual, and D&D costs. Total present worth costs are from Tables C.4-1 and C.4-2.

TABLE C.4-3

LIFE-CYCLE AND PRESENT WORTH COST ANALYSES
($ Millions)

Case	Initial Capital Cost	Total Packaging Transportation & Disposal Costs	Total O&M Costs	End of Life D&D Costs	Total Life-Cycle Cost	Operating Life (years)	Total Present Worth Cost
Vitrification Alternative	$1.6	$13.6	$9.6	$0.0	$24.8	0.78	$20.4
ALT1 Onsite Treatment Disposal at NTS	$6.7	$10.7	$1.2	$0.9	$19.5	0.35	$18.8
ALT2 Onsite Treatment Disposal at Envirocare	$6.8	$8.6	$1.6	$0.9	$17.9	0.80	$17.1
ALT3 Treatment and Disposal at Envirocare	$6.7	$11.3	$1.4	$0.9	$20.3	0.47	$19.5

The two items of interest are the initial capital costs and total present worth costs. From a purely economics point of view only total present worth costs are important. However, due to the annual nature of U.S. Government funding, initial capital costs are an important discrimination.

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REFERENCES

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U.S. Environmental Protection Agency, 1988, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," EPA/540/G-89/004, EPA, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency, 1993, Memorandum from Office of Emergency and Remedial Response to EPA Regional Directors, OWSER Directive No. 9355.3-20, June 25.

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ATTACHMENT C.I

PACKAGING, TRANSPORTATION, AND DISPOSAL COST DETAILS

SUMMARY SHEET

FILE #:	C4-95-03-01	DATE:	23-Apr-96
CLIENT:	DOE	ESTIMATOR:	M.L. SMITH
PROJECT:	VITRIFIED SILO3 BY TRUCK TO NTS	LOCATION:	FERNALD
	FERMCO ESTIMATING SERVICES	TASK#:	4CBAV

ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS						
SUPERVISION - CONTRACTOR						
SM TOOLS/CONSM'BLS						
EQUIPMENT RENTAL						
TEMP. FACILITIES						
TEMP UTL'S HOOK-UP						
JOB CLEAN-UP						
Y						
H PHYSICS S/C						
CLA $800 PER PERSON						
PAYRL BRD.&BENFT.						
OVERHEAD & PROFIT						
BOND						
INDIRECT FIELD COSTS						
DIRECT & INDIRECT FIELD COSTS						

	QTY	$				
WASTE CONTAINERS	1,437	$3,500			$5,029,500	$5,029,500
CERTIFICATION	1,437	$545	$783,200			$783,200
TRANSPORTATION	719	$3,200		$2,300,800		$2,300,800
BURIAL	188,247	$20		$3,764,900		$3,764,900
RECYCLING						
STORAGE						
WASTE MANAGEMENT COSTS			$783,200	$6,065,700	$5,029,500	$11,878,400
PROJ.MGMT-FERMCO						
CONSTR MGMT-FERMCO						
FERMCO FIELD SUPPORT COSTS						
ENGINEERING/DESIGN/INSPECTION	A/E		FERMCO			
ENGINEERING COSTS						
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$276,600		$276,600
SUB-TOTAL (BASE ESTIMATE)						$12,155,000
RISK BUDGET	12.0%					$1,458,600
G&A-FERMCO	(SEE EXCLUSION COMMENTS)					
ESCALATION	(SEE EXCLUSION COMMENTS)					
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)						**$13,613,600**

FY 96 DOLLARS

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 1 BY TRUCK TO NTS

FERMCO
ESTIMATING SERVICES

DATE: 23-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
DRY							
HEALTH PHYSICS S/C							
CERCLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							
	QTY / $						
WASTE CONTAINERS	2,160 / $800					$1,728,000	$1,728,000
CERTIFICATION	2,160 / $545			$1,177,200			$1,177,200
TRANSPORTATION	540 / $3,200				$1,728,000		$1,728,000
BURIAL	241,920 / $20				$4,838,400		$4,838,400
RECYCLING							
STORAGE							
WASTE MANAGEMENT COSTS				$1,177,200	$6,566,400	$1,728,000	$9,471,600
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTIO	A/E			FERMCO			
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$95,000			$95,000
SUB-TOTAL (BASE ESTIMATE)							$9,566,600
RISK BUDGET	12.0%						$1,148,000
G&A-FERMCO	(SEE EXCLUSION COMMENTS)						
ESCALATION	(SEE EXCLUSION COMMENTS)						
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)							**$10,714,600**

FY 96 DOLLARS

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 2 BY TRUCK TO THE RPCDF

FERMCO ESTIMATING SERVICES

DATE: 22-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
TY							
TH PHYSICS S/C							
ERCLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							

	QTY	$					
WASTE CONTAINERS(*)	840	$800				$672,000	$672,000
CERTIFICATION	2,520	$545		$1,373,400			$1,373,400
TRANSPORTATION							
TO ENVIROCARE	504	$3,150			$1,587,600		$1,587,600
TO FEMP	504	$3,150			$1,587,600		$1,587,600
BURIAL	170,550	$12.50			$2,131,900		$2,131,900
RECYCLING	2,520	$100			$252,000		$252,000
STORAGE							
WASTE MANAGEMENT COSTS				$1,373,400	$5,559,100	$672,000	$7,604,500
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTION		A/E		FERMCO			
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$37,000			$37,000
SUB-TOTAL (BASE ESTIMATE)							$7,641,500
RISK BUDGET	12.0%						$917,000
G&A-FERMCO (SEE EXCLUSION COMMENTS)							
ESCALATION (SEE EXCLUSION COMMENTS)							

TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET) $8,558,500

ste containers would be reconditioned at the RPCDF for reuse at the FEMP for either OU4 remedial operations or use in other projects.

FY 96 DOLLARS

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 3 BY TRUCK TO THE RPCDF

FERMCO
ESTIMATING SERVICES

DATE: 22-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
Y							
TH PHYSICS S/C							
CLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							
	QTY	$					
WASTE CONTAINERS(*)	730	$800				$584,000	$584,000
CERTIFICATION	2,190	$545		$1,193,600			$1,193,600
TRANSPORTATION							
TO ENVIROCARE	365	$3,150			$1,149,800		$1,149,800
TO FEMP	365	$3,150			$1,149,800		$1,149,800
TREATMENT	146,200	$30			$4,386,000		$4,386,000
BURIAL	160,820	$8.50			$1,367,000		$1,367,000
RECYCLING	2,190	$100			$219,000		$219,000
STORAGE							
WASTE MANAGEMENT COSTS				$1,193,600	$8,271,600	$584,000	$10,049,200
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTION		A/E			FERMCO		
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$32,100			$32,100
SUB-TOTAL (BASE ESTIMATE)							**$10,081,300**
RISK BUDGET	12.0%						$1,209,800
G&A-FERMCO (SEE EXCLUSION COMMENTS)							
ESCALATION (SEE EXCLUSION COMMENTS)							

RGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET) $11,291,100

ste containers would be reconditioned at the RPCDF for reuse at the FEMP for either OU4 remedial operations or use in other projects.

FY 96 DOLLARS

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ATTACHMENT C.II

SILO 3 RESIDUES RETRIEVAL SYSTEM COST DETAILS

SUMMARY SHEET

FILE #:	C4-96-03-01	DATE:	19-Apr-96
CLIENT:	DOE	ESTIMATOR:	G.D.Walters
PROJECT:	SILO 3 WASTE RETRIEVAL EQUIPMENT	LOCATION:	FERNALD
WBS #:	1.1.1.1.4.3.2	TASK#:	4CBAV

FERMCO ESTIMATING SERVICES

ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
CIVIL & EXCAVATION	1,921		$39,100		$700	$39,800
CONCRETE	831		$15,800		$5,900	$21,700
BUILDINGS				$65,500		$65,500
MACHINERY & EQUIPMENT Factored Equipment Estimate	1,200		$25,900	$22,000	$314,200	$362,100
PIPING	1,969	22.09	$43,500		$29,000	$72,500
ELECTRICAL	2,447	18.51	$45,300		$45,300	$90,600
INSTRUMENTATION	978	18.51	$18,100		$54,300	$72,400
PAINTING ALLOWANCE	227	20.68	$4,700		$2,500	$7,200
INSULATION ALLOWANCE	242	19.39	$4,700		$2,500	$7,200
DIRECT FIELD COSTS	**9,815**		**$197,100**	**$87,500**	**$454,400**	**$739,000**
SUPERVISION - CONTRACTOR	1,669		$33,500			$33,500
SM TOOLS/CONSM'BLS					$11,800	$11,800
EQUIPMENT RENTAL					$34,400	$34,400
TEMP. FACILITIES	589		$5,900		$5,900	$11,800
TEMP UTL'S HOOK-UP	294		$3,800		$2,100	$5,900
CLEAN-UP	589		$8,900		$3,000	$11,900
SAFETY	294		$3,800		$2,100	$5,900
HEALTH PHYSICS S/C	196		$5,100		$500	$5,600
CERCLA $800 PER PERSON			$4,300			$4,300
PAYRL BRD.&BENFT.			$149,600			$149,600
OVERHEAD & PROFIT				$185,200		$185,200
BOND				$12,000		$12,000
INDIRECT FIELD COSTS	**3,632**	**59.20**	**$214,900**	**$197,200**	**$59,800**	**$471,900**
DIRECT & INDIRECT FIELD COSTS	**13,447**	**30.60**	**$412,000**	**$284,700**	**$514,200**	**$1,210,900**

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		
WASTE MANAGEMENT COSTS		

PROJ.MGMT-FERMCO	$96,900	$96,900
CONSTR MGMT-FERMCO	$242,200	$242,200
FERMCO FIELD SUPPORT COSTS	**$339,100**	**$339,100**
E/D/I	A/E FERMCO	$510,000
ENGINEERING COSTS		**$510,000**

SALES TAX - SUBCONTRACT	$28,300		SALES TAX - FERMCO			$28,300
SUB-TOTAL (BASE ESTIMATE)						**$2,088,300**

RISK BUDGET	9.5%	$198,000
G&A-FERMCO	(SEE EXCLUSION COMMENTS)	
ESCALATION	(SEE EXCLUSION COMMENTS)	

TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET) $2,286,300

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OFFICIAL USE ONLY

INDEPENDENT GOVERNMENT ESTIMATE

FY1995

ROM SILO3 ALTERNATIVE

19-Apr-96 — 8050

LABOR	HOURS	COST
SENIOR MANAGEMENT		
ENGINEERING MANAGEMENT		
FINANCE		
HUMAN RESOURCES		
PERSONNEL DEVEL.		
LEGAL		
PROJECT MANAGEMENT	92	
ADMIN/EDITING		
PROJECT ENGINEER	870	
DOCUMENT CONTROL		
CIVIL ENGINEER	388	
GEOLOGY/GEOTECH		
ARCHITECTURAL ENGINEER	234	
CADD SYSTEMS	3000	
ENVIRONMENTAL ENGINEER		
STRUCTURAL ENGINEER	388	
MECHANICAL ENGINEER	476	
PROCESS ENGINEER	518	
PIPING ENGINEER	304	
INSTRUMENTATION ENGINEER	444	
HVAC ENGINEER	252	
ELECTRICAL ENGINEER	468	
COMMUNITY RELATIONS		
HEALTH & SAFETY	8	
FIELD ENGINEER SERVICES	600	
QUALITY ASSURANCE		
TECHNICAL SPECIALIST		
NUCLEAR/SYSTEMS SAFETY	128	
PURCHASING		
CONTRACT ADMINISTRATION		
SUBCONTRACT ADMINISTRATION		
MATERIAL HANDLING	518	
COST ENGINEER		
ESTIMATING	120	
PLANNING/SCHEDULING	16	
MGT. INFORMATION SYSTEMS		
ENGINEERING COORDINATION		
SECRETARIAL		
CLERICAL		
WORD PROCESSING	204	
FACILITIES ADMINISTRATION		
LIBRARY		
SYSTEMS ENGINEER		
VALUE ENGINEER		
ENGR. COMPLIANCE & QC	112	
GENERAL ENGINEER		
ALL ENGINEERING DESIGNERS		
TOTAL LABOR	9,140	$244,300
OVERHEAD	89.02%	$217,500
OTHER DIRECT COSTS		
SUBCONTRACT-1		
SUBCONTRACT-2		
SUBCONTRACT-3		
SUBCONTRACT-4		
FCCM	0.23%	$600
FEE ($5.20/DPLH)	$5.20	$47,500
TOTAL ODC'S	0	$48,100
TOTAL HOURS	9,140	
TOTAL COST		$510,000

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CLIENT- U.S. [redacted]F ENERGY
PROJECT- SIL[redacted]RIEVAL EQUIPMENT ROOMS
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDG[redacted]MATE DETAILS

W.B.S.#: [redacted]1.1.4.3.2
EST. N[redacted]C4-96-3-1
ESTIM[redacted]G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	Civil and Excavation												
	Site Prep Machine Excavation/Load & Haul	744	cy		1309					$24,200		$600	$24,800
	Machine Trenching	200	cy		612					$11,300			$11,300
	SUB TOTAL (Civil & Excavation)	944	cy							$35,500		$600	$36,100
	TAKE - OFF ALLOWANCE 10%									$3,600		$100	$3,700
	TOTAL (Civil & Excavation)	944	cy		1,921.0					$39,100		$700	$39,800

000382

-8050

CLIENT- U.S. DEPT. OF ENERGY
PROJECT- SILO3 RETRIEVAL EQUIPMENT ROOMS
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDGET ESTIMATE DETAILS

W.B.S.#: 1.1.1.1.4.3.2
EST. NO. C4-96-3-1
ESTIMATOR: G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	Site Prep (Area of Silo3 and Silo4 Line)												
	(All work preformed in Level C PPE 2.5 Productivity Factor)												
	Clear and Grub Area For ER 1	133	sy	0.3	40.0	18.56				$700			$700
	Clear and Grub Area For ER 2	133	sy	0.3	40.0	18.56				$700			$700
	Excavate For Equipment Rooms to be Place at Silo3 Wall	256	cy	0.3	77.0	18.56				$1,400			$1,400
	Footers For Equipment Room	19	cy	3.8	73.0	18.56				$1,400			$1,400
	Ecavate Equip. Pads / Spash Blocks & stack Foundation	78	cy	2.5	195.0	18.56				$3,600			$3,600
	Excavate & Contour Berm Areas &Silo 4 Line	320	cy	2.5	800.0	18.56				$14,800			$14,800
	Load and Haul Spoils to Queing area	744	cy	0.1	74.0	18.56				$1,400			$1,400
	Assume 20% swell												
	Crusting Agent	1	ls	10.0	10.0	18.56			$600	$200		$600	$800
	Sub-total (Site Prep)	744	cy		1309.0					$24,200		$600	$24,800
	Relocate 3" Process Water Lines												
	Machine Trench	89	cy	1.0	86.0	18.56				$1,600			$1,600
	Assume 400 lf 2" wide 36 deep												
	Demo 3" TW Line	400	lf	0.1	40.0	18.56				$700			$700
	Backfill & Compaction	120	cy	1.4	168.0	18.56				$3,100			$3,100
	Machine Trench												
	Relocate 3" TW Line	111	cy	1.0	108.0	18.56				$2,000			$2,000
	Assume 500 lf 6" wide 36 deep												
	Backfill & Compaction	150	cy	1.4	210.0	18.56				$3,900			$3,900
	Sub-Total(Machine Trench)	200	cy		612.0					$11,300			$11,300

000383

CLIENT- U.S. [redacted] F ENERGY
PROJECT- SIL[redacted] RIEVAL EQUIPMENT ROOMS
LOCATION- SILO [redacted]
PROJ.CTL.- VERN STULTZ

BUDG[redacted] MATE DETAILS

W.B.S.#: 1.1.1.1.4.3.2
EST. N[redacted] C4-96-3-1
ESTIM[redacted] G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	Concrete Summary												
	Equipment Room (ER) Foundations	40	cy		557					$10,600		$4,400	$15,000
	Equipment Pads	11	cy		198					$3,800		1000	$4,800
	SUB TOTAL (Concrete)	51	cy		755.0					$14,400		$5,400	$19,800
	TAKE - OFF ALLOWANCE 10%				76.0					$1,400		$500	$1,900
	TOTAL (Concrete)	51	cy		831.0					$15,800		$5,900	$21,700

000384

I-8050

CLIENT- U.S. DEPT. OF ENERGY
PROJECT- SILO3 RETRIEVAL EQUIPMENT ROOMS
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDGET ESTIMATE DETAILS

W.B.S.#: 1.1.1.[illegible].3.2
EST. NO. C4-96-3-1
ESTIMATOR: G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	Cast - in - Place												
	Equipment Room Fountdations & Stack												
	With Retaining wall												
	Equipment Room 1	17	cy	15.4	262.0	19.03			$115	$5,000		$2,000	$7,000
	Equipment Room 2	17	cy	15.4	262.0	19.03			$115	$5,000		$2,000	$7,000
	Stack Foundation	2	cy	12.9	26.0	19.03			$85	$500		$200	$700
	OverPour Allowance	4	cy	2.0	7.0	19.03			$50	$100		$200	$300
	Sub-total (Equipment Room Foundations & Stack)	40	cy		557.0					$10,600		$4,400	$15,000
	Equipment Pads												
	PDCU Pad	5	cy	18.7	94.0	19.03			$85	$1,800		$400	$2,200
	Air Compressor Pad	5	cy	18.7	94.0	19.03			$85	$1,800		$400	$2,200
	Spash Blocks Pre-Cast (Install Only)	2	ea	4.0	8.0	19.03			$50	$200		$100	$300
	OverPour Allowance	1	cy	2.0	2.0	19.03			$50			$100	$100
	Sub-Total (Equipment Pads)	11	cy		198.0					$3,800		$1,000	$4,800

000385

CLIENT- U.S. [redacted] F ENERGY
PROJECT- SIL[redacted] RIEVAL EQUIPMENT ROOMS
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDG[redacted] MATE DETAILS

W.B.S.#: 1.1.1.1.4.3.2
EST. N[redacted] C4-96-3-1
ESTIM[redacted] G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	BUILDING SUMMARY												
	SILO 3 RETRIEVAL EQUIPMENT ROOMS 1 & 2	700	sf								$59,500		$59,500
	SUB TOTAL (EQUIPMENT ROOMS)	700	sf								$59,500		$59,500
	TAKE - OFF ALLOWANCE 10%										$6,000		$6,000
	TOTAL (EQUIPMENT ROOMS)	700	sf								$65,500		$65,500

000386

F-8050

CLIENT- U.S. DEPT. OF ENERGY
PROJECT- SILO3 RETRIEVAL EQUIPMENT ROOMS
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDGET ESTIMATE DETAILS

W.B.S.#: 1.1.1.1.4.3.2
EST. NO. C4-96-3-1
ESTIMATOR: G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS			COST/UNIT			LABOR	SUB CONTRACT	MATERIAL	TOTAL
				UNIT	TOTAL	RATE	LABOR	SUB	MAT'L				
	SILO3 RETRIEVAL EQUIPMENT ROOMS												
	Install and Set Custom Engineered Equipment Room I	350	sf					$85			$29,750		$29,750
	Install and Set Custom Engineered Equipment Room 2	350	sf					$85			$29,750		$29,750
	Sub-Total(Silo3 Retrieval Equipment Rooms)	700	sf								$59,500		$59,500

000387

CLIENT- U.S[illegible] OF ENERGY
PROJECT- SI[illegible] RIEVAL EQUIPMENT
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDG[illegible] ATE DETAILS

W.B.S.#: 1.1.1.4.3.2
EST. NO[illegible] 4-96-3-1
ESTIMA[illegible] WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	RESIDUE RETRIEVAL EQUIPMENT	55	ea		1,100					$23,500	$20,000	$285,600	$329,100
	SUB-TOTAL	1	LOT		1,099.5					$23,500	$20,000	$285,600	$329,100
	TAKE - OFF ALLOWANCE 10%				100.0					$2,400	$2,000	$28,600	$33,000
	TOTAL (SILO 3 RESIDUE RETRIEVAL EQUIPMENT)	1	LOT		1,199.5					$25,900	$22,000	$314,200	$362,100

000388

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CLIENT- U.S. DEPT. OF ENERGY
PROJECT- SILO3 RETRIEVAL EQUIPMENT
LOCATION- SILO 3
PROJ.CTL.- VERN STULTZ

BUDGET ESTIMATE DETAILS

W.B.S.#: 1.1.1.1.4.3.2
EST. NO. C4[illegible]1
ESTIMATOR: G. WALTERS
DATE: 04/19/96
TASK: 4CBAV

COST CATEG.	DESCRIPTION	QUAN	UNIT	MANHOURS UNIT	MANHOURS TOTAL	MANHOURS RATE	COST/UNIT LABOR	COST/UNIT SUB	COST/UNIT MAT'L	LABOR	SUB CONTRACT	MATERIAL	TOTAL
	MATERIAL HANDLING / PROCESSING AND MISCELLANEOUS RESIDUE RETRIEVALEQUIPMENT												
	6" Dia Auger Conveyor Screw Conveyer	2	ea	40.0	80.0	$21.31			$15,000	$1,700		$30,000	$31,700
	12"x 12" Carbon Steel Delumper/Crusher	2	ea	20.0	40.0	$21.31			$9,500	$900		$19,000	$19,900
	(Budgetary cost provided by Franklin Miller Livingston Inc. New Jersey)												
	Rotary AirLock 7X7	2	ea	10.0	20.0	$21.31			$5,400	$400		$10,800	$11,200
	(Budgetary cost provided by MAC)												
	10" Knife Valve w/ Boltups & Flanges	2	ea	4.0	8.0	$22.09			$1,380	$200		$2,800	$3,000
	(Budgetary cost provided by McMaster Carr)												
	Pneumatic Retrieval Pipe 4" Dia Screwed Sections CS Sch 40	100	lf	0.3	30.0	$22.09			$6	$700		$600	$1,300
	(Budgetary cost provided Richardsons)												
	Pneumatic Hose 4" Dia	40	lf	0.1	4.0	$22.09			$100	$100		$4,000	$4,100
	Air Hose 1" Dia 100 psi	100	lf	0.0	3.5	$22.09			$0.65	$100		$100	$200
	Air Hose Reel	2	ea	2.0	4.0	$22.09			$25	$100		$100	$200
	Electric Winch 1/4 Ton	2	ea	4.0	8.0	$21.31			$1,250	$200		$2,500	$2,700
	8" 2-Ton MonoRail Hoist & Trolley	4	ea	20.0	80.0	$21.31			$3,250	$1,700		$13,000	$14,700
	Silo Wall Drill	1	ea						$6,500			$6,500	$6,500
	Drill Enclosure	1	ea						$1,200			$1,200	$1,200
	Core Bit	2	ea						$1,100			$2,200	$2,200
	Concrete Saw & Blades	1	ea						$900			$900	$900
	Silo Wall Coring -Drill 8" Dia Hole 8" deep	2	ea	25.0	50.0	$18.56				$900			$900
	Silo Wall Cutting Widen 8" Dia -4'x3' Opening 2 Ea 8" Thick	28	lf	1.5	42.0	$18.56				$800			$800
	Silo Banding & Post Tensioning -cover w/Shotcrete	1	ls	80.0	80.0	$21.31			$3,500	$1,700		$3,500	$5,200
	Shop Fab Field Fit Align & Install Silo Backing Plate 11'-0 w x 9'-0 h x 1/4" Thk Plate w/vertical sliding door	2	ea	100.0	200.0	$21.31		10,000		$4,300	$20,000		$24,300
	HEPA Filters 1000 CFM	6	ea	8.0	48.0	$21.31			$2,600	$1,000		$15,600	$16,600
	Exhaust Fans 1000 CFM	6	ea	8.0	48.0	$21.31			$1,600	$1,000		$9,600	$10,600
	Stack 15"Dia PVC- 40' Guy Wires	1	ea	60	60.0	$21.31			$3,500	$1,300		$3,500	$4,800
	15" Airinlet Motorized	2	ea	6	12.0	$21.31			$650	$300		$1,300	$1,600
	15" Airinlet Manual	2	ea	2	4.0	$21.31			$65	$100		$100	$200
	CCTV Pan & Tilt Install in Silo3 to FRVP Control Room	6	ea	10	60.0	$21.31			$5,000	$1,300		$30,000	$31,300
	Sump & Pump	2	ea	20	40.0	$22.09			$3,000	$900		$6,000	$6,900
	AirCompressor 100 psi, 200 CFM	2	ea	24	48.0	$21.31			$28,000	$1,000		$56,000	$57,000
	Filter Receiver	1	ea	40.0	40.0	$21.31			$25,000	$900		$25,000	$25,900
	(Budgetary cost provided by Letter Report)												
	Rotary AirLock	1	ea	10.0	10.0	$21.31			$3,000	$200		$3,000	$3,200
	(Budgetary cost provided by Letter Report)												
	Turbo Exhauster 10 hp	1	ea	20.0	20.0	$21.31			$35,000	$400		$35,000	$35,400
	(Budgetary cost provided by Letter Report)												
	Access Ramps for Houdini	1	ea	40.0	40.0	$21.31			$1,500	$900		$1,500	$2,400
	Caged Ladder	2	ea	10.0	20.0	$21.31			$900	$400		$1,800	$2,200
	Sub-Total (RESIDUE RETRIEVAL EQUIPMENT)	55	ea		1,099.5					$23,500	$20,000	$285,600	$329,100

000389

ATTACHMENT C.III

VITRIFICATION ALTERNATIVE COST DETAILS

8050

SUMMARY SHEET

FILE #: C4-96-03-01
CLIENT: DOE
PROJECT: SILO 3 ALTERNATIVE-GEMS
WBS #: 1.1.1.1.4.3.2

FERMCO
ESTIMATING SERVICES

DATE: 19-Apr-96
ESTIMATOR: G.D.Walters
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	11,040		$204,800		$1,600	$206,400
	CONCRETE	68,152		$1,331,000		$662,250	$1,993,250
	STRUCTURAL STEEL	6,136		$129,000		$328,700	$457,700
	BUILDINGS	32,091		$648,400		$790,900	$1,439,300
	MACHINERY & EQUIPMENT	64,330		$1,331,000		$27,564,300	$28,895,300
	PIPING	23,848		$526,800		$790,100	$1,316,900
	ELECTRICAL	54,635		$1,011,300		$1,878,200	$2,889,500
	INSTRUMENTATION	20,427		$378,100		$1,134,300	$1,512,400
	PAINTING / INSULATION ALLOWANCE	14,628		$302,500		$201,600	$504,100
DIRECT FIELD COSTS		295,287		$5,862,900		$33,351,950	$39,214,850
SUPERVISION - CONTRACTOR		50,199		$996,700			$996,700
SM TOOLS/CONSM'BLS						$351,800	$351,800
EQUIPMENT RENTAL						$1,033,500	$1,033,500
TEMP. FACILITIES		17,717		$175,900		$175,900	$351,800
'P UTL'S HOOK-UP		8,859		$114,300		$61,600	$175,900
CLEAN-UP		17,717		$263,800		$87,900	$351,700
ETY		8,859		$114,300		$61,600	$175,900
EALTH PHYSICS S/C		5,906		$150,600		$14,800	$165,400
CERCLA $800 PER PERSON				$130,300			$130,300
PAYRL BRD.&BENFT.				$4,451,000			$4,451,000
OVERHEAD & PROFIT					$9,479,800		$9,479,800
BOND					$568,800		$568,800
INDIRECT FIELD COSTS		109,256	58.50	$6,396,900	$10,048,600	$1,787,100	$18,232,600
DIRECT & INDIRECT FIELD COSTS		404,543	30.30	$12,259,800	$10,048,600	$35,139,050	$57,447,450

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		
WASTE MANAGEMENT COSTS		

PROJ.MGMT-FERMCO				$3,676,640	$919,160	$4,595,800
CONSTR MGMT-FERMCO				$11,489,500		$11,489,500
FERMCO FIELD SUPPORT COSTS				$15,166,100	$919,200	$16,085,300
E/D/I	A/E			FERMCO		$20,681,000
ENGINEERING COSTS						$20,681,000
SALES TAX - SUBCONTRACT	$1,932,600		SALES TAX - FERMCO	$50,600		$1,983,200
SUB-TOTAL (BASE ESTIMATE)						$96,196,950
RISK BUDGET 9.0%						$8,658,000
G&A-FERMCO (SEE EXCLUSION COMMENTS)						
ESCALATION (SEE EXCLUSION COMMENTS)						
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)						$104,854,950

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	38,026	CY	11,040	204,800	0	1,600	0	206,400		
	1	CONCRETE	4,793	CY	68,152	1,331,000	0	662,250	0	1,993,250		
	2	STEEL	150	TONS	6,136	129,000	0	328,710	0	457,710		
	3	BLDGS	1	LOT	32,091	648,400	0	790,915	0	1,439,315		
		SUBTOTAL 0 THRU 3			117,419	2,313,200	0	1,783,475	0	4,096,675		
	4	EQUIPMENT	349	PCS	64,330	1,331,000	0	284,000	27,280,300	28,895,300		
	5	PIPING	FACTO	RED	23,848	526,800	0	0	790,100	1,316,900		
	6	ELECTRICAL	FACTO	RED	54,635	1,011,300	0	0	1,878,200	2,889,500		
	7	INSTRUMENTATION	FACTO	RED	20,427	378,100	0	0	1,134,300	1,512,400		
	8	PAINTING/INSULATION	FACTO	RED	14,628	302,500	0	0	201,600	504,100		
		SUBTOTAL 5 THRU 8			113,538	2,218,700	0	0	4,004,200	6,222,900		
		TOTAL DFC			295,287	5,862,900	0	2,067,475	31,284,500	39,214,875		

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00093

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM SUMMARY ACCTS 0-3
FILENAME: F:\LOTUS94\SILO3ALT\GEMS\SUMM.V

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		SUMMARY OF ACCOUNTS TOTAL										
		CIVIL	38,026	CY	11,040	$204,800		$1,600				$206,400
		CONCRETE	4,793	CY	68,152	$1,331,000		$662,250				$1,993,250
		STRUCTURAL STEEL	150	TN	6,136	$129,000		$328,710				$457,710
		ARCHITECTURAL / BUILDINGS / FINISHES	1	LOT	32,091	$648,400		$790,915				$1,439,315
		TOTAL			117,419	$2,313,200		$1,783,475				$4,096,675

000394

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS34\SILO3ALT\DEMB\MATPAD

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	100	CY	84	$1,600		$0				
		EXCAVATION HAND	10	CY	32	$600		$0				
		BACKFILL MACHINE	145	CY	37	$700		$0				
		BACKFILL HAND	15	CY	23	$400		$0				
		HAUL & DUMP	25	CY	16	$300		$0				
		SUB-TOTAL	295	CY	192	$3,600		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	295	CY	192	$3,600		$0				
		TOTAL	295	CY	192	$3,600		$0				$3,600

000395

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\EXHSTK

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	160	CY	31	$600		$0				
		EXCAVATION HAND	10	CY	19	$400		$0				
		BACKFILL MACHINE	125	CY	32	$600		$0				
		BACKFILL HAND	5	CY	6	$100		$0				
		HAUL & DUMP	70	CY	9	$200		$0				
		SUB-TOTAL	370	CY	97	$1,800		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	370	CY	97	$1,800		$0				
		TOTAL	370	CY	97	$1,800		$0				$1,800

000396

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS94\SILO3ALT\GEM6\BLDG2.'

TOTAL DIRECT COST

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	11,740	CY	2,272	$42,200						
		EXCAVATION HAND	615	CY	1,191	$22,100						
		BACKFILL MACHINE	11,150	CY	2,677	$53,400						
		BACKFILL HAND	585	CY	755	$14,000						
		HAUL & DUMP	2,510	CY	324	$6,000						
		SUB-TOTAL	26,600	CY	7,419	$137,700						
		MATERIAL TAKE-OFF 0.0%	0		0	$0						
		SUB-TOTAL	26,600	CY	7,419	$137,700						
		TOTAL	26,600	CY	7,419	$137,700		$0				$137,700

000397

F-8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM8\EQUPYRD.WK3

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	400	CY	77	$1,400		$0				
		EXCAVATION HAND	20	CY	39	$700		$0				
		BACKFILL MACHINE	280	CY	72	$1,300		$0				
		BACKFILL HAND	15	CY	19	$400		$0				
		HAUL & DUMP	195	CY	26	$500		$0				
		FENCING & GATE	110	LF	67	$1,200		$1,600				
		SUB-TOTAL	910	CY	300	$5,500		$1,600				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	910	CY	300	$5,500		$1,600				
		TOTAL	**910**	**CY**	**300**	**$5,500**		**$1,600**				**$7,100**

000398

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM6\BLDG2.'

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	1,290	CY	250	$4,600		$0				
		EXCAVATION HAND	65	CY	126	$2,300		$0				
		BACKFILL MACHINE	355	CY	92	$1,700		$0				
		BACKFILL HAND	20	CY	26	$500		$0				
		HAUL & DUMP	1,190	CY	154	$2,900		$0				
		BERM	5,565	CY	2,039	$37,800		$0				
		SUB-TOTAL	8,485	CY	2,687	$49,800		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8,485	CY	2,687	$49,800		$0				
		TOTAL	8,485	CY	2,687	$49,800		$0				$49,800

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM5\BLD1.W

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	633	CY	119	$2,200		$0				
		EXCAVATION HAND	6	CY	58	$1,100		$0				
		BACKFILL MACHINE	362	CY	98	$1,800		$0				
		BACKFILL HAND	4	CY	26	$500		$0				
		HAUL & DUMP	362	CY	44	$800		$0				
		SUB-TOTAL	1,366	CY	345	$6,400		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	1,366	CY	345	$6,400		$0				
		TOTAL	1,366	CY	345	$6,400		$0				$6,400

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\MATPAD

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	66	CY	341	$6,700		$5,610				
		WASTE & SPILLAGE	7	CY	10	$200		$330				
		SUB-TOTAL	73	CY	351	$6,900		$5,940				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	73	CY	351	$6,900		$5,940				
		TOTAL	73	CY	351	$6,900		$5,940				$12,840

000401

F-8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\9\LO3ALT\GEMB\EXHSTK

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		STACK FOUNDATION	60	CY	506	$9,900		$6,100				
		SUB-TOTAL	60	CY	506	$9,900		$6,100				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	60	CY	506	$9,900		$6,100				
		TOTAL	60	CY	506	$9,900		$6,100				$16,000

000402

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\B\LO3ALT\GEMB\BLDG3.1

TOTAL DIRECT COST

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	220	CY	1,574	$30,700		$21,500				
		WALLS	540	CY	11,146	$217,700		$81,800				
		FOOTINGS	170	CY	2,986	$58,300		$20,650				
		ELEVATED SLABES	295	CY	5,328	$104,100		$63,100				
		FOUNDATIONS	120	CY	1,013	$19,800		$11,400				
		SPILLAGE & WASTE	30	CY	77	$1,500		$1,500				
		SUB-TOTAL	1,375	CY	22,124	$432,100		$199,950				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	1,375	CY	22,124	$432,100		$199,950				
		TOTAL	1,375	CY	22,124	$432,100		$199,950				$632,050

000403

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM8\BLDG2.'

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	805	CY	5,753	$112,400		$78,600				
		COLUMN D\FOUNDATIONS	20	CY	452	$8,800		$2,570				
		FOOTINGS	210	CY	3,689	$72,000		$25,500				
		WALLS	725	CY	14,964	$292,200		$109,900				
		ELEVATED SLABS	740	CY	13,364	$261,000		$158,300				
		EQUIP. FOUNDATIONS	255	CY	2,154	$42,100		$24,100				
		WASTE & SPILLAGE	55	CY	142	$2,800		$2,750				
		SUB-TOTAL	2,810	CY	40,518	$791,300		$401,720				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	2,810	CY	40,518	$791,300		$401,720				
		TOTAL	**2,810**	**CY**	**40,518**	**$791,300**		**$401,720**				**$1,193,020**

000404

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\V8\LO3ALT\GEM8\EQUPYRD.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		TANK & EQUIPMENT FOUNDATIONS	110	CY	929	$18,100		$10,400				
		COLUMN & FOOTINGS	40	CY	703	$13,700		$4,900				
		DUCTBANK	5	CY	55	$1,100		$400				
		SUBSTATION PAD	20	CY	143	$2,800		$2,000				
		WASTE & SPILLAGE	4	CY	10	$200		$400				
		SUB-TOTAL	179	CY	1,840	$35,900		$18,100				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	179	CY	1,840	$35,900		$18,100				
		TOTAL	**179**	**CY**	**1,840**	**$35,900**		**$18,100**				**$54,000**

000405

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMB\BLD1.W

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	246	CY	1,789	$34,900		$24,410				
		COLUMN D\FOUNDATIONS	45	CY	1,011	$19,700		$5,780				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	296	CY	2,813	$54,900		$30,440				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	296	CY	2,813	$54,900		$30,440				
		TOTAL	296	CY	2,813	54,900		$30,440				$85,340

000406

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS94\BILO3ALT\OEMB\MATPAC

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	0.5	TN	155	$3,300		$2,500				
		SUB-TOTAL	0.5	TN	155	$3,300		$2,500				
		0.0%	0.0		0	$0		$0				
		MATERIAL TAKE-OFF						$2,500				
		SUB-TOTAL	0.5	TN	155	$3,300						$5,800
		TOTAL	0.5	TN	155	$3,300		$2,500				

8050

000407

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\EXHSTK

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		PLATFORMS	3	TN	123	$2,600		$5,250				
		LADDERS	120	VLF	93	$2,000		$2,900				
		GRATING	210	SF	54	$1,100		$1,900				
		HANDRAIL	150	LF	26	$500		$1,650				
		DAVITS	3	EA	58	$1,200		$1,800				
		SUB-TOTAL	3	TN	354	$7,400		$13,500				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	3	TN	354	$7,400		$13,500				
		TOTAL	3	TN	354	$7,400		$13,500				$20,900

000408

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM8\BLDG2.'

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	7	TN	190	$4,000		$10,500				
		STAIRS	64	RSR	191	$4,000		$12,200				
		SUB-TOTAL	7	TN	381	$8,000		$22,700				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	7	TN	381	$8,000		$22,700				
		TOTAL	7	TN	381	$8,000		$22,700				$30,700

000409

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VERIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\EQUPYRD.WK3

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	19	TN	515	$10,800		$28,500				
		STAIRS	64	RSR	191	$4,000		$12,200				
		CHECKER PLATE	750	SF	213	$4,500		$8,400				
		HANDRAIL	125	LF	53	$1,100		$1,500				
		SUB-TOTAL	19	TN	972	$20,400		$50,600				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	19	TN	972	$20,400		$50,600				
		TOTAL	19	TN	972	$20,400		$50,600				$71,000

000410

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTU824\BILO3ALT\GEM8\BLDG2.'

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	24	TN	504	$10,600		$36,000				
		METAL ROOFING	1,890	SF	69	$1,500		$2,500				
		CHECKER PLATE	1,320	SF	290	$8,100		$14,850				
		STAIRS	152	RSR	351	$7,400		$29,000				
		SUB-TOTAL	24	TN	1,214	$25,600		$82,350				
		0.0%	0		0	$0		$0				
		MATERIAL TAKE-OFF						$82,350				
		SUB-TOTAL	24	TN	1,214	$25,600						$107,950
		TOTAL	24	TN	1,214	$25,600		$82,350				

000411

8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS94\SILO3ALT\GEM5\BLD1.W

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	96	TN	2,601	$54,700		$144,000				
		METAL ROOFING	9,000	SF	424	$8,900		$11,960				
		LADDERS	45	LF	35	$700		$1,100				
		SUB-TOTAL	96	TN	3,060	$64,300		$157,060				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	96	TN	3,060	$64,300		$157,060				
		TOTAL	96	TN	3,060	$64,300		$157,060				$221,360

000412

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS34\9\SILO3ALT\QEMB\MATPAD

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		DOWNSPOUT & GUTTERS	340	LF	52	$1,000		$800				
		LIGHTING	5,400	SF	135	$2,700		$4,100				
		SUB-TOTAL	5,400	SF	187	$3,700		$4,900				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	5,400	SF	187	$3,700		$4,900				
		TOTAL	5,400	SF	187	$3,700		$4,900				$8,600

000313

80150

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT	U.S. DEPT OF ENERGY
PROJECT	SILO 3 ALTERNATIVE
LOCATION	SILO AREA
DESCRIPTION	VITRIFICATION GEM
FILENAME	F:\LOTUS34\SILO3ALT\GEMS\EXHSTK

PREPARED BY	G. WALTERS
DATE	04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		EXHAUST STACK	1	EA	2,815	$56,900		$280,000				
		EXHAUST STACK DUCKWORK	25	LF	188	$3,800		$13,375				
		SEALERS/HARDNER	345	SF	3	$100		$55				
		PAINT STACK & DUCT	26,125	SF	1,011	$20,400		$2,900				
		PAINT PLATFORMS	700	SF	27	$500		$100				
		SUB-TOTAL	1	LOT	4,044	$81,700		$296,430				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	1	LOT	4,044	$81,700		$296,430				
		TOTAL	1	LOT	4,044	$81,700		$296,430				$378,130

000414

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM8\BLDG3.'

TOTAL DIRECT COST

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		SEALERS & HARDNER	16,230	SF	125	$2,500		$2,600				
		3'x7' HM DOORS	3	EA	31	$600		$1,500				
		3'x7' HM DOORS	2	PR	41	$800		$2,440				
		DOWNSPOUT & GUTTERS	1	LOT	181	$3,700		$1,440				
		PLUMBING	8,300	SF	226	$4,600		$14,600				
		SPRINKLERS	8,600	SF	277	$5,600		$12,900				
		LIGHTING	8,600	SF	1,941	$39,200		$13,400				
		COMMUNICATIONS	8,600	SF	277	$5,600		$4,900				
		SUB-TOTAL	8,600	SF	2,974	$60,100		$51,180				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8,600	SF	2,974	$60,100		$51,180				
		TOTAL	**8,600**	**SF**	**2,974**	**$60,100**		**$51,180**				**$111,280**

000415

8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEM8\EQUPYRD.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		PAINT STEEL	6,285	SF	243	$4,900		$900				
		SEALER /HARDNER	1,195	SF	5	$100		$100				
		FIREPROOF PIPEWAY	2,200	SF	355	$7,200		$1,800				
		LIGHTING	7,700	SF	869	$17,600		$11,700				
		PAINT TANKS	3,030	SF	117	$2,400		$450				
		SUB-TOTAL	20,390	SF	1,589	$32,200		$14,950				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	20,390	SF	1,589	$32,200		$14,950				
		TOTAL	**20,390**	**SFT**	**1,589**	**$32,200**		**$14,950**				**$47,150**

000416

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS24\8\LO3ALT\GEM8\BLDG2.*

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		SIDING	8,250	SF	1,173	$23,700		$39,350				
		MEMBRANE ROOFING	1,890	SF	48	$1,000		$2,765				
		ROOF INSULATION	1,890	SF	36	$700		$2,260				
		DOWNSPOUT & GUTTERS	1	LOT	129	$2,600		$1,000				
		DOORS	9	EA	52	$1,100		$8,500				
		PLUMBING	19,100	SF	352	$7,100		$23,565				
		SPRINKLERS	19,100	SF	433	$8,800		$20,100				
		LIGHTING	19,100	SF	5,279	$106,700		$31,200				
		COMMUNICATIONS	19,100	SF	528	$10,700		$10,800				
		PAINT STEEL	7,010	SF	271	$5,500		$1,050				
		EPOXY WALLS	46,300	SF	903	$18,200		$7,200				
		EPOXY STEEL	1,540	SF	106	$2,100		$850				
		EPOXY FLOORS	8,250	SF	710	$14,300		$5,000				
		EPOXY CEILING	8,250	SF	779	$15,700		$5,000				
		PAINT CEILING	3,210	SF	129	$2,600		$500				
		PAINT BINS	3,230	SF	125	$2,500		$460				
		EPOXY TANKS	5,610	SF	383	$7,700		$3,000				
		SEALER/HARDENER	27,350	SF	159	$3,200		$5,200				
		SUB-TOTAL	19,100	SF	11,595	$234,200		$167,800				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	19,100	SF	11,595	$234,200		$167,800				
		TOTAL	19,100	SFT	11,595	$234,200		$167,800				$402,000

000417

80950

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\BLD1.W

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		SIDING	8,800	SF	1,201	$24,300		$43,570				
		MEMBRANE ROOFING	9,100	SF	295	$6,000		$17,110				
		ROOF INSULATION	9,100	SF	223	$4,500		$13,970				
		DOWNSPOUT & GUTTERS	550	LF	178	$3,600		$1,380				
		BATTEN INSULATION	10,450	SF	81	$1,600		$780				
		CONSTRUCTION JOINT	200	LF	90	$1,800		$1,375				
		DOORS	34	EA	383	$7,700		$23,450				
		CHANGE ROOM ACCESSORIES	1	LOT	129	$2,600		$4,000				
		TOILET ACCESSORIES	1	LOT	194	$3,900		$7,500				
		COMPUTER FLOOR	1	LOT	97	$2,000		$3,000				
		LAB FURNISHINGS	1	LOT	77	$1,600		$10,000				
		LUNCH / CONFERANCE ROOM	1	LOT	97	$2,000		$6,500				
		CERMAIC TILE	3,210	SF	414	$8,400		$7,060				
		RUBBER TOPSET	1,950	LF	188	$3,800		$1,365				
		VINYL TILE	7,730	SF	599	$12,100		$4,640				
		SUSPENDED CEILINGS	9,100	SF	637	$12,900		$24,595				
		METAL STUDS & SHEET ROCK	10,450	SF	809	$16,300		$13,060				
		PLUMBING	9,100	SF	299	$6,000		$19,310				
		SPRINKLERS	9,100	SF	353	$7,100		$16,455				
		LIGHTING	9,100	SF	3,538	$71,500		$21,610				
		COMMUNICATIONS	9,100	SF	353	$7,100		$7,295				
		SEALERS & HARDNER	9,100	SF	85	$1,700		$1,770				
		PAINT WALLS	19,920	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB-TOTAL	9,100	SF	11,702	$236,500		$255,655				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	9,100	SF	11,702	$236,500		$255,655				
		TOTAL	9,100	SF	11,702	$236,500		$255,655				$492,155

000418

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SOS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	117,419	2,313,200	0	1,783,475	0	4,096,675		
	10	SYSTEM 03	CHILLED WATER	10	EA	3,100	66,000	0	0	1,261,000	1,327,000		
	35	SYSTEM 05	HVAC	35	EA	25,460	504,700	0	284,000	1,026,800	1,815,500		
		SYSTEM 06	SHOP EQUIP	1	LOT	730	15,500	0	0	181,000	196,500		
	21	SYSTEM 12	FEED PREPARATION	21	EA	2,020	43,200	0	0	297,700	340,900		
	1	SYSTEM 13	MELTER	1	EA	3,870	82,500	0	0	10,000,000	10,082,500		
	53	SYSTEM 14	MELTER OFF GAS	53	EA	3,400	72,000	0	0	885,600	957,600		
	7	SYSTEM 15	VESSEL OFF GAS	7	EA	330	7,000	0	0	10,000	17,000		
	20	SYSTEM 20	RADIOACTIVE LIQ WASTE	20	EA	1,010	21,400	0	0	94,200	115,600		
	5	SYSTEM 21	SHIELD DOORS	5	EA	1,510	32,100	0	0	96,200	128,300		
	5	SYSTEM 24	GEM PRODUCTION	5	EA	1,410	30,100	0	0	1,232,800	1,262,900		
	102	SYSTEM 25	GEM PACKAGING	102	EA	1,210	25,700	0	0	342,500	368,200		
	9	SYSTEM 30	ELECTRICAL	9	EA	2,940	62,600	0	0	521,900	584,500		
	38	SYSTEM 41	COMPRESSED AIR	38	EA	1,520	32,400	0	0	72,400	104,800		
		SYSTEM 46	MELTER COOLING WATER	1	LOT	260	5,500	0	0	91,200	96,700		
	6	SYSTEM 53	NON RADIOACTIVE LIQ WASTE	6	EA	240	5,200	0	0	46,900	52,100		
	10	SYSTEM 54	COLD CHEMICALS	10	EA	280	5,900	0	0	10,200	16,100		
		SYSTEM 55	BULK CHEMICALS VENT SYSTEM	1	LOT	150	3,200	0	0	4,000	7,200		
	23	SYSTEM 58	GLASS FORMER & FEED	23	EA	1,180	25,300	0	0	331,400	356,700		
		SYSTEM 61	DCS	1	LOT	650	13,900	0	0	3,457,500	3,471,400		
	4	SYSTEM 62	HPS	4	EA	3,380	72,000	0	0	4,535,700	4,607,700		
		SYSTEM 63/64	PROCESS SAMPLING/ANALYT LAB	1	LOT	9,160	195,200	0	0	1,585,000	1,780,200		
		SYSTEM 66	MIS	1	LOT	520	9,600	0	0	1,196,300	1,205,900		
	349		TOTAL EQUIPMENT			64,330	1,331,000	0	284,000	27,280,300	28,895,300		
			PIPING	1	LOT	23,848	526,800	0	0	790,100	1,316,900		
			ELECTRICAL	1	LOT	54,635	1,011,300	0	0	1,878,200	2,889,500		
			INSTRUMENTATION	1	LOT	20,427	378,100	0	0	1,134,300	1,512,400		
			PAINTING & INSULATION	1	LOT	14,628	302,500	0	0	201,600	504,100		
			TOTAL BULKS			113,538	2,218,700	0	0	4,004,200	6,222,900		
			TOTAL DFC			295,287	5,862,900	0	2,067,475	31,284,500	39,214,875		

0004419

8050

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 03	CHILLED WATER										
	3	03-CH-1A/B/C	CENTRIFUGAL WATER CHILLERS	3	EA	930	19,800			660,000	679,800		
			550 TON CAPACITY										
			SKID MOUNTED										
	3	03-P-1A/B/C	CHILLED WATER PUMPS	3	EA	310	6,600			57,000	63,600		
			900 GPM										
	3	03-P-2A/B/C	COOLING TOWER WATER PUMPS	3	EA	310	6,600			75,000	81,600		
			1100 GPM										
	3	03-CT-1	COOLING TOWER	1	EA	1,290	27,500			269,000	296,500		
			3300 GPM										
			FIELD ERRECTED										
	3	03-F-1 THRU 40	HIGH EFF FILTER BOXES	40	EA	260	5,500			200,000	205,500		
			TOTAL 03	10	EA	3,100	66,000	0	0	1,261,000	1,327,000		

000420

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: Q. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05	HVAC										
	5	05-F-01A/B	HEPA FILTER PLENUMS	2	EA	410	8,700			450,000	458,700		
			18,000 CFM										
	5	05-F-02	HEPA FILTER PLENUM	1	EA	100	2,100			110,000	112,100		
			9,000 CFM										
	5	05-B-01A/B	CENTRIFUGAL FANS	2	EA	190	4,000			59,000	63,000		
			30,000 CFM										
			75 HP										
	5	05-B-02	CENTRIFUGAL FANS	1	EA	80	1,700			18,000	19,700		
			20,000 CFM										
			30 HP										
	5	05-AH-01A/B	AIR HANDLING UNITS WITH	2	EA	410	8,700			90,000	98,700		
			COOLING COIL, ELECTRIC HEATER										
			AND FILTERS										
			350 KW, 25,000 CFM										
	5	05-F-03A/B	CENTRIFUGAL SUPPLY FANS	2	EA	150	3,200			59,000	62,200		
			30,000 CFM										
			40 HP										
	5	05-F-04A/B	CENTRIFUGAL TRANSFER FANS	2	EA	150	3,200			59,000	62,200		
			30,000 CFM										
			40 HP										

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	5	05-AH-02	AIR HANDLING UNITS WITH	1	EA	210	4,500			45,000	49,500		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			30 KW, 25,000 CFM										
	5	05-AH-03	AIR HANDLING UNITS WITH	1	EA	150	3,200			27,000	30,200		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			20 KW, 15,000 CFM										
	5	05-AH-04	AIR HANDLING UNITS WITH	1	EA	100	2,100			18,000	20,100		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			10 KW, 11,000 CFM										
	5	05-EX-01A/B	CENTRIFUGAL EXHAST FANS	2	EA	100	2,100			28,000	30,100		
			10 HP										
			15000 CFM										
	5	05-EX-02	CENTRIFUGAL EXHAST FANS	2	EA	130	2,800			18,000	20,800		
			20 HP										
			20000 CFM										
	5	05-EH-1 THRU 4	ELECTRIC UNIT HEATERS	4	EA	50	1,100			2,400	3,500		
			20 KW										
			DUCTING SYSTEM			20,640	402,100		270,000		672,100		
			HVAC FOR M & E BLDG	12	EA	[illegible],240	26,400			43,400	69,800		
		INCLUDES:05-AH-05 ,05-AH-06, 05-EX-03,											

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		DUCTING SYSTEM			1,350	28,800		14,000		42,800		
		TOTAL 05	35	EA	25,460	504,700	0	284,000	1,026,800	1,815,500		

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000423

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06	SHOP EQUIPMENT										
	6	06-SH-01	MACHINE SHOP EQUIP	1	LOT	260	5,500			90,000	95,500		
			MILL, LATHE, GRINDER,										
			BAND SAW AND										
			5 TON OVHD CRANE, 20' SPAN										
	6	06-SH-02	WELDING SHOP EQUIP	1	LOT	90	1,900			22,000	23,900		
			STD ARC WELDER, TIG WELDER,										
			FUME HOOD, GRINDER,										
			METAL SHEAR, BENDER AND										
			WELDING TABLE										
	6	06-SH-03	ELECT TEST & REPAIR SHOP	1	LOT	80	1,700			12,000	13,700		
			MISC TEST EQUIP, DEGREASER/										
			CLEANER CONDUIT BENDER,										
			THREAD CUTTER & GRINDER										
	6	06-SH-04	PIPE FAB SHOP EQUIP	1	LOT	40	900			7,000	7,900		
			PIPE BENDER, PIPE THRD CUTTER										
			AND SMALL WELDER										
	6	06-MR-1 THRU 5	MONORAILS	5	EA	260	5,500			50,000	55,500		
			5 TONS										
			TOTAL 06	1	LOT	730	15,500	0		181,000	196,500		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12	FEED PREPARATION										
	12	12-TK-1	SLURRY THICKENER	1	EA	270	5,800			71,400	77,200		
			9,875 GALLON										
			13'-6" ID X 9'CENTER DEPTH X 8' WALL										
			EPOXY COATED STEEL										
	12	12-TK-2	THICKENER WET WELL	1	EA	270	5,800			41,000	46,800		
			9,500 GALLON										
			13'-6" ID X 9'H										
			EPOXY COATED STEEL										
	12	12-S-1	KNOCK OUT DRUM	1	EA	60	1,300			800	2,100		
			12' ID X 6'H										
			20 SCFM										
			C.S.										
	12	12-TK-3A/B/C	FEED MAKE-UP TANKS	3	EA	810	17,300			107,100	124,400		
			9,500 GALLON										
			EPOXY COATED STEEL										
	12	12-MM-1	THICKENER RAKE MECHANISM	1	EA	100	2,100			W/TK-2	2,100		
			1.5 HP										
			C.S.										
	12	12-MM-2	WET WELL AGITATOR	1	EA	30	600			8,400	9,000		
			3 HP										
			C.S.										
	12	12-MM-3A/B/C	FEED MAKE-UP TANK	3	EA	80	1,700			41,000	42,700		

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0060

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
			C.S.										
	12	12-P-1A/B	THICKENER UNDERFLOW PUMPS	2	EA	80	1,700			3,100	4,800		
			3 GPM										
			HDPE										
	12	12-P-2A/B	WET WELL RECYCLE PUMPS	2	EA	80	1,700			8,200	9,900		
			10 GPM										
			7.5 HP										
			C.S.										
	12	12-P-3	SLURRY THICKENER SUMP PUMP	1	EA	40	900			3,400	4,300		
			10 GPM										
			0.50 HP										
			C.S.										
	12	12-P-4A/B	WET WELL OVERFLOW PUMPS	2	EA	80	1,700			6,800	8,500		
			10 GPM										
			0.75 HP										
			C.S.										
	12	12-P-5A/B	MELTER FEED PUMPS	2	EA	80	1,700			3,100	4,800		
			3.3 GPM										
			HDPE										
	12	12-P-6	SLURRY STORAGE SUMP PUMP	1	EA	40	900			3,400	4,300		
			10 GPM										
			1 HP										
			C.S.										
			TOTAL 12	21	EA	020	43,200	0	0	297,700	340,900		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 13	MELTER										
	13	13-EM-1	CERAMIC MELTER	1	EA	3,870	82,500			10,000,000	10,082,500		
			25 METRIC T/D										
			3500 KW										
		TOTAL 13		1	EA	3,870	82,500	0	0	10,000,000	10,082,500		

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E-8050

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 14	MELTER OFFGAS										
	14	14-FC-1	FILM COOLER	1	EA	100	2,100			113,000	115,100		
			304LSS										
	14	14-FC-2	BACKUP FILM COOLER	1	EA	100	2,100			113,000	115,100		
			304LSS										
	14	14-VS-1	VENTURI SCRUBBER	1	EA	210	4,500			12,800	17,300		
			304LSS										
	14	14-TK-1	QUENCH SOLUTION TANK	1	EA	50	1,100			28,000	29,100		
			12'ID X 6'H										
			EPOXY COATED STEEL										
	14	14-MM-1	QUENCH SOLUTION TANK	1	EA	30	600			15,000	15,600		
			AGITATOR										
			304LSS										
	14	14-P-1A/B	QUENCH SOLUTION TANK PUMPS	2	EA	100	2,100			16,200	18,300		
			100 HP										
			C.S.										
	14	14-T-1	OFFGAS SCRUB COLUMN	1	EA	30	600			12,000	12,600		
			3'-8"ID X 16' T/T										
			EPOXY COATED STEEL										
	14	14-EC-1	QUENCH WATER COOLER	1	EA	40	900			35,000	35,900		
			3.1 mm BTU/HR , 1,248 FT AREA										
			24"O.D. 24' OVERALL LENGTH										
			C.S.										

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-F-1	QUENCH WATER FILTER EPOXY COATED STEEL	1	EA	50	1,100			5,200	6,300		
	14	14-E-1	OFFGAS FILTERATION PREHEATER 52,873 BTU/HR 12" O.D. X 8' LONG ELECTRIC	1	EA	30	600			10,000	10,600		
	14	14-F-2A/B	OFFGAS FILTERS 1,898 ACFM	2	EA	100	2,100			39,000	41,100		
	14	14-MB-1A/B	EXHAUST BLOWERS 1,898 ACFM 100 HP	2	EA	210	4,500			48,000	52,500		
	14	14-EC-2	EXHAUST DSCHRG AFTER COOLER 272,818 BTU/HR 374 SF 24"O.D. X 10' LONG C.S.	1	EA	100	2,100			53,000	55,100		
	14	14-V-1	EXHAUST DISCHARGE K.O. DRUM 24"O.D. X 10' T/T EPOXY COATED STEEL	1	EA	30	600			8,200	8,800		
	14	14-T-2	SO2/CO2 ABSORBER 18"O.D. X 42' T/T EPOXY COATED STEEL	1	EA	100	2,100			15,000	17,100		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY Q. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-P-2A/B	SPENT ABSORBENT PUMPS	2	EA	80	1,700			3,700	5,400		
			1 HP										
			24 GPM										
			C.S.										
	14	14-F-3A/B	SPENT ABSORBENT FILTERS	2	EA	100	2,100			3,200	5,300		
			24 GPM										
			EPOXY COATED STEEL										
	14	14-TK-2A/B	SPENT ABSORBENT TANKS	2	EA	180	3,800			74,000	77,800		
			11,400 GALLONS										
			12' ID X 17' H										
			EPOXY COATED STEEL										
	14	14-TK-3A/B	SPENT ABSORBENT MAKE-UP	2	EA	180	3,800			74,000	77,800		
			TANKS										
			11,400 GALLONS										
			12' ID X 17' H										
			EPOXY COATED STEEL										
	14	14-P-3A/B	SPENT ABSORBENT TRANSFER	2	EA	80	1,700			5,700	7,400		
			PUMPS 200 GPM 10 HP C.S.										
	14	14-MM-2A/B	SPENT ABSORBENT TANK	2	EA	100	2,100			2,800	4,900		
			AGITATORS 10 HP C.S.										
	14	14-P-4A/B	FRESH ABSORBENT PUMPS	2	EA	80	1,700			4,200	5,900		
			23 GPM 1 HP C.S.										

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SWS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-MM-3A/B	FRESH ABSORBENT TANK	2	EA	100	2,100			2,800	4,900		
			AGITATORS 10 HP C.S.										
	14	14-EC-3	FRESH ABSORBENT COOLER	1	EA	100	2,100			4,000	6,100		
			316,000 BTU/HR C.S.										
	14	14-E-2	GAS/GAS HEAT EXCHANGER	1	EA	50	1,100			2,900	4,000		
			DOUBLE PIPE										
			100,220 BTU/HR										
			12" DIA. X 12' T/T										
			28.3 SF										
			S.S.										
	14	14-E-3	NOX REACTOR PREHEATER	1	EA	50	1,100			5,000	6,100		
			ELECTRIC										
			100,220 BTU/HR										
			29.4 KW										
			S.S.										
	14	14-R-1 THRU 4	NOX REACTOR #1 THRU #4	4	EA	410	8,700			130,200	138,900		
			1,000#/HR AIR										
			2'X2'X2'										
			S.S.										
	14	14-EC-4	NOX REACTOR #3 EFFLUENT	1	EA	30	600			1,200	1,800		
			COOLER										
			DOUBLE PIPE										
			50,350 BTU/HR										
			8" DIA. X 6' T/T										
			7.1 SF										
			S.S.										

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/93

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-EC-5	NOX REACTOR #4 EFFLUENT	1	EA	30	600			5,000	5,600		
			COOLER										
			240,058 BTU/HR										
			6" DIA. X 12' LONG										
			60 SF										
			S.S.										
	14	14-EC-6	NOX REACTOR #4 EFFLUENT	1	EA	30	600			5,000	5,600		
			COOLER										
			44,430 BTU/HR										
			8" DIA. X 10' LONG										
			61 SF										
			S.S.										
	14	14-V-2	CHILLED OFFGAS K.O. DRUM	1	EA	50	1,100			2,500	3,600		
			10"DIA X 8'T/T										
			EPOXY COATED STEEL										
	14	14-V-3A/B	MOLECULAR SIEVE VESSELS	2	EA	100	2,100			9,000	11,100		
			CONE BOTTOM										
			20" O.D. X 11'T/T										
			EPOXY COATED STEEL										
	14	14-EC-7	DRIED OFFGAS CHILLER	1	EA	50	1,100			2,200	3,300		
			13,500 BTU/HR										
			C.S.										
	14	14-E-4	DESSICANT REGENERATE HEATER	1	EA	30	600			4,000	4,600		
			66,000 BTU/HR										
			19.3 KW										
			ELECTRIC										
			C.S.										

000432

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-MB-2	REGENERATION BLOWER	1	EA	30	600			1,100	1,700		
			123 ACFM										
			0.5 HP										
			C.S.										
	14	14-F-4	REGENERATION AIR EXHAUST FILTE	1	EA	50	1,100			2,600	3,700		
			250 ACFM										
	14	14-F-4A/B	RADON REMOVAL VESSELS	2	EA	210	4,500			17,100	21,600		
			192 ACFM										
			8' ID X 17-4" T/T										
			845 CF										
			C.S.										
			TOTAL 14	53	EA	3,400	72,000	0	0	885,600	957,600		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 15	VESSEL OFFGAS										
	15	15-E-2	VESSEL VENT FILTER PREHTR	1	EA	50	1,100			0	1,100		
			2,866 BTU/HR										
			100 SCFM										
			ELECTRIC										
			0.84 KW										
			S.S.										
	15	15-MB-4A/B	VESSEL VENT EXHAUSTERS	2	EA	100	2,100			0	2,100		
			100 SCFM										
	15	15-V-1	VESSEL VENT K.O. DRUM	1	EA	30	600			0	600		
			100 SCFM										
			8"DIA X 8'T/T										
			C.S.										
	15	15-EC-2	VESSEL VENT AFTERCOOLER	1	EA	50	1,100			0	1,100		
			100 SCFM										
			25,000 BTU/HR										
			C.S.										
	15	15-FH-3A/B	VESSEL VENT FILTERS	2	EA	100	2,100			0	2,100		
			100 SCFM										
			12"DIA X 6'H										
			C.S.										
			TOTAL 15	7	EA	330	7,000	0	0	10,000	17,000		

000634

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/98

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 20	RADIOACTIVE LIQUID WASTE										
	20	20-TK-1	PH ADJUSTMENT TANK	1	EA	30	600			900	1,500		
			500 GALLON										
			PLASTIC										
	20	20-TK-2	PRECIPITATION TANK	1	EA	30	600			800	1,400		
			500 GALLON										
			PLASTIC										
	20	20-TK-3	SURGE/RECYCLE TANK	1	EA	30	600			800	1,400		
			500 GALLON										
			PLASTIC										
	20	20-TK-4	RECYCLE SUMP TANK	1	EA	30	600			500	1,100		
			200 GALLON										
			PLASTIC										
	20	20-MM-1	PH ADJUSTMENT AGITATOR	1	EA	10	200			1,600	1,800		
			0.25 HP										
			C.S.										
	20	20-P-1	PRECIPITATION PUMP	1	EA	40	900			2,900	3,800		
			16 GPM										
			3 HP										
			C.S.										
	20	20-P-2A/B	RECYCLE PUMPS	2	EA	80	1,700			5,800	7,500		
			40 GPM										
			1.5 HP										
			C.S.										

000435

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	20	20-P-3A/B	ION EXCHANGE PUMPS	2	EA	80	1,700			6,800	8,500		
			4 GPM										
			0.25 HP										
			C.S.										
	20	20-P-4A/B	BACKWASH PUMPS	2	EA	80	1,700			5,800	7,500		
			20 GPM										
			0.75 HP										
			C.S.										
	20	20-P-5A/B	RECYCLE SUMP PUMPS	2	EA	80	1,700			6,800	8,500		
			4 GPM										
			0.75 HP										
			C.S.										
	20	20-F-1A/B	MULTIMEDIA FILTERS	2	EA	210	4,500			56,700	61,200		
			10 MICRON										
			C.S.										
	20	20-F-2A/B	CARTRIDGE FILTERS	2	EA	100	2,100			1,200	3,300		
			3 MICRON										
			4 GPM										
			S.S.										
	20	20-F-3A/B	ION EXCHANGE UNITS	2	EA	210	4,500			3,600	8,100		
			EPOXY COATED STEEL										
			TOTAL 20	20	EA	1,010	21,400	0	0	94,200	115,600		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 21	SHIELD DOORS										
	21	21-RA-1A/B	MELTER ROOM SLIDING DOORS	2	EA	340	7,200			15,000	22,200		
			5' X 5' X 4"										
	21	21-RA-2	FILLING ROOM SHIELD DOOR	1	EA	340	7,200			31,500	38,700		
			5' X 20' X 4"										
	21	21-RA-3	MONORAIL MAINT ACCESS SHLD	1	EA	390	8,300			7,700	16,000		
			4' X 5' X 4"										
	21	21-RA-4	LOADING AREA SHIELD DOOR	1	EA	440	9,400			42,000	51,400		
			8' X 20' X 4"										
			TOTAL 21	5	EA	1,510	32,100	0	0	96,200	128,300		

CONSTRUCTION COSTS
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CLIENT U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

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DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 24	GEM PRODUCTION										
	24	24-MD-1	25 M-T/DAY	1	EA	880	18,800			1,214,000	1,232,800		
			GLOB CUTTER/BELT CONVEYOR										
			CHUT w/SLIDING VALVE,BELT										
			COOLING SYSTEM										
	24	24-HD-1	FILLED CONTAINER GRAVITY	1	EA	310	6,600			9,000	15,600		
			ROLLER CONVEYOR										
	24	24-TV-1A/B	MELTER ROOM CCTV	2	EA	120	2,600			6,800	9,400		
	24	24-TV-2	MELTER ROOM CCTV CONTROLS	1	EA	100	2,100			3,000	5,100		
			TOTAL 24	5	EA	1,410	30,100	0	0	1,232,800	1,262,900		

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CONSTRUCTION COSTS
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CLIENT U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 25	GEM PACKAGING SYSTEM										
	25	25-HD-1A-G	FILLED GRVTY ROLLER CONVEYOR	7	EA	180	3,800			119,000	122,800		
			5,000# CAPICITY										
	25	25-HD-2	EMPTY CONTAINER POWERED	1	EA	230	4,900			24,000	28,900		
			ROLLER CONVEYOR 1,000# CAP										
	25	25-MR-1A&B	MONORAIL w/HOIST LIFTING DEVICE	2	EA	210	4,500			30,000	34,500		
			5 TON CAP.15'LIFT										
	25	25-HD-3	EMPTY CONTAINER GRAVITY	1	EA	80	1,700			21,500	23,200		
			ROLLER CONVEYOR 1,000# CAP										
	25	25-TV-1A-D	COOLING ROOM CCTV CAMERA	4	EA	100	2,100			13,600	15,700		
	25	25-TV-2	CCTV MONITOR & CONTROLS	1	EA	100	2,100			3,000	5,100		
	25	25-HD-3	SEG CONTAINER LID LIFT DEVICE	1	EA	210	4,500			3,000	7,500		
			LIFTING DEVICE TO REMOVE AND										
			LID ON THE SEG CONTAINER										
	25	25-CD-1	GEM TRANSFER CONTAINER	84	CNTRS		0			92,400	92,400		
			C.S.										
	25	25-SX-1	LOADING AREA SHIELDING WINDOW	1	EA	100	2,100			36,000	38,100		
			24" W X 30" L X 6" THK										
			TOTAL 25	102	EA	1,210	25,700	0	0	342,500	368,200		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
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	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30-US-1	UNIT SUBSTATION #1, INCLUDES	1	EA	900	19,200			219,200	238,400		
			DOUBLE ENDED 13.8 KV TO4160 KV										
			HVAC										
			600A KVA FUSED DISCONN SWITCH	2	EA								
			1500KVA TRANSFORMERS DRY TYPE	2	EA								
			1200 AMP MAIN BREAKERS	2	EA								
			1200 AMP TIE BREAKERS	1	EA								
			1200 AMP FEED BREAKER BREAKER	1	EA								
			EQUIPPED SPASE	2	EA								
			1200 AMP VERTICAL SECTIONS	5	EA								
			PT'S	2	EA								
			CT'S	6	EA								
			METERS & RELAYS	1	LOT								
	30	30-US-2	UNIT SUBSTATION #2, INCLUDES	1	EA	900	19,200			128,400	147,600		
			DOUBLE ENDED 13.8 KV TO 480 KV										
			HVAC /PROCESS/ELECT										
			600A KVA FUSED DISCONN SWITCH	2	EA								
			1500KVA TRANSFORMERS DRY TYPE	2	EA								
			2000 AMP MAIN BREAKERS	2	EA								
			2000 AMP TIE BREAKERS	1	EA								
			800 AMP FEED BREAKER BREAKER	1	EA								
			EQUIPPED SPASE	1	EA								
			2000 AMP VERTICAL SECTIONS	5	EA								
			PT'S	2	EA								
			CT'S	2	EA								
			METERS & RELAYS	1	LOT								

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	30	30-US-3	UNIT SUBSTATION #3,INCLUDES	1	EA	390	8,300			84,600	92,900		
			SINGLE ENDED 13.8 KV TO 4160 KV										
			600A KVA FUSED DISCONN SWITCH	1	EA								
			3750KVA TRANSFORMER DRY TYPE	1	EA								
			1200 AMP CIRCUIT BREAKER	1	EA								
			NEMA 3R										
			VERTICAL SECTION	1	EA								
	30	30-MC-1	PROCESS MCC #1,INCLUDES	1	EA	180	3,800			14,200	18,000		
			VERTICAL SECTION 600A	5	EA								
			SIZE #1	23	EA								
			SIZE #2	1	EA								
			225A CB	4	EA								
			LUGS	1	EA								
	30	30-MC-2	PROCESS MCC #2, INCLUDES	1	EA	180	3,800			14,700	18,500		
			VERTICAL SECTION 600A	5	EA								
			SIZE #1	22	EA								
			SIZE #2	1	EA								
			SIZE #4	1	EA								
			225A CB	4	EA								
			LUGS	1	EA								
	30	30-MC-3/4	HVAC MCC #1, INCLUDES	2	EA	130	2,800			17,800	20,600		
			VERTICAL SECTION 600A	4	EA								
			SIZE #1	4	EA								
			SIZE #2	2	EA								
			SIZE #3	6	EA								
			SIZE #4	1	EA								
			225A CB	2	EA								
			LUGS	1	EA								

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	30	30-MC-3/4	TANK PREP MCC, INCLUDES	1	EA	80	1,700			5,000	6,700		
			VERTICAL SECTIONS	2	EA								
			SIZE #1	10	EA								
			100A CB	2	EA								
			LUGS	1	EA								
	30	30-UP-1	UPS, INCLUDES	1	EA	180	3,800			38,000	41,800		
			50KVA, 480V TO 208V	1	EA								
			MAIN BYPASS	1	EA								
			BATTERY	1	EA								
			TOTAL 30	9	EA	2,940	62,600	0	0	521,900	584,500		

000442

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 41	COMPRESSED AIR										
	41	41-C-1A/B	AIR COMPRESSORS(PLANT AIR)	2	EA	210	4,500			21,000	25,500		
			60 SCFM @ 120 PSIG										
			20 HP										
			C.S.										
	41	41-F-2	AIR INTAKE FILTER	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-F-3	COALESCING OIL FILTER	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-DY-1	DESICANT AIR DRYER	1	EA	50	1,100			4,200	5,300		
			60 SCFM @ 120 PSIG										
			5 HP										
			C.S.										
	41	41-F-1	PREFILTER , AIR	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-V-1	AIR COMPRESSORS RECEIVER	1	EA	50	1,100			1,200	2,300		
			150 GALLON										
			C.S.										
	41	41-F-4	AFTER FILTER , AIR	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-C-2	COMPRESSOR AIR PACKAGE	1	EA	260	5,500			33,600	39,100		
			(BREATHING AIR)										
			240 SCFM @ 120 PSIG										
			60 HP										

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SØS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	41	41-F-5	AIR INTAKE FILTER	1	EA	50	1,100			W/C-2A/B	1,100		
			240 SCFM										
			C.S.										
	41	41-PU-1A/B	BREATHING AIR PURIFIER	2	EA	210	4,500			W/C-2A/B	4,500		
			240 SCFM @120 PSIG										
			C.S.										
	41	41-V-2	BREATHING AIR RESERVOIR	1	EA	50	1,100			10,500	11,600		
			60"ID X 12' LONG										
			C.S.										
	41	41-F-6 THRU 29	FILTER CARTRIDGES	24	EA	310	6,600			1,900	8,500		
			180 SCFM @ 105 PSIG										
			C.S.										
	41		BREATHING AIR BACK-UP	1	EA	210	4,500			W/C-2A/B	4,500		
			C.S.										
			TOTAL 41	38	EA	1,520	32,400	0		72,400	104,800		

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CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

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	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 46 MELTER COOLING WATER										
		ALLOWANCE	1	LOT	260	5,500			91,200	96,700		
		TOTAL 46	1	LOT	260	5,500	0	0	91,200	96,700		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 55 BULK COLD CHEMICAL VENT SYS										
		ALLOWANCE	1	LOT	150	3,200			4,000	7,200		
		TOTAL 55	1	LOT	150	3,200	0	0	4,000	7,200		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

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DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 53	NON RAD.ACTIVE LIQ WASTE										
	53	53-TK-1 THRU 3	CATCH TANKS #1 THRU #3	3	EA	120	2,600			40,300	42,900		
			3,300 GALLONS										
			7-6' DIA X 12'H										
			C.S.										
	53	53-P-1 THRU 3	CATCH TANKS TRANSFER PUMPS	3	EA	120	2,600			6,600	9,200		
			50 GPM @ 30 PSI										
			1.5 HP										
			C.S.										
		TOTAL 53		6	EA	240	5,200	0	0	46,900	52,100		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
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	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 54	COLD CHEMICALS										
	54	54-TK-1	CAUSTIC DAY TANK	1	EA	10	200			500	700		
			100 GALLON										
			PLASTIC										
	54	54-TK-2	ACID STORAGE DRUM	1	EA	10	200			300	500		
			50 GALLON										
			PLASTIC										
	54	54-TK-3	FLOCCULANT STORGE TANK	1	EA	10	200			500	700		
			100 GALLON										
			PLASTIC										
	54	54-MM-1	FLOCCULANT AGITATOR	1	EA	10	200			1,600	1,800		
			0.25 HP										
			C.S.										
	54	54-P-1A/B	CAUSTIC METERING PUMPS	2	EA	80	1,700			2,500	4,200		
			0.25 HP										
			304LSS										
	54	54-P-2A/B	ACID METERING PUMPS	2	EA	80	1,700			2,500	4,200		
			0.25 HP										
			316LSS										
	54	54-P-3A/B	FLOCCULANT METERING PUMPS	2	EA	80	1,700			2,300	4,000		
			0.25 HP										
			C.S.										

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 58	GLASS FORMER PREP & FEED										
	58	58-B-1	IRON OXIDE STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-2	CALCIUM OXIDE STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-3	SILICA STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-4	ALUMINA STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-5	BORAX STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-6	COAL STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-7	SODIUM CARBONATE STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										

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TOTAL DIRECT COST

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	58	58-M-1 THRU 7	ROTARY VALVE	7	EA	180	3,800			36,800	40,600		
			8" X 6"										
			0.75 HP										
			C.S.										
	58	58-XE-1	PNEUMATIC CONVEYOR	1	EA	260	5,500			130,000	135,500		
			C.S.										
	58	58-B-8	ADDETIVE BIN	1	EA	30	600			10,500	11,100		
			5' ID X 12' HIGH										
			C.S.										
	58	58-F-1 THRU 7	BIN DUST COLLECTORS	7	EA	360	7,700			21,800	29,500		
			C.S.										
			TOTAL 58	23	EA	1,180	25,300	0		331,400	356,700		

000550

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		HARDWARE			650	13,900			1,532,500	1,546,400		
		SOFTWARE							1,345,000	1,345,000		
		VENDOR REP							580,000	580,000		
		TOTAL 61	1	LOT	650	13,900	0	0	3,457,500	3,471,400		

000451

T-80550

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 62	HPS										
			HARDWARE			3,230	68,800			2,315,300	2,384,100		
			SOFTWARE							1,995,000	1,995,000		
			VENDOR REP							215,500	215,500		
	62	62-MB-1A/B	HPS VACUUM BLOWERS	2	EA	100	2,100			7,800	9,900		
			55 ACFM @5 PSIG										
			3 HP										
	62	62-FH-1A/B	HPS VACUUM EXH HEPA FILTERS	2	EA	50	1,100			2,100	3,200		
			TOTAL 62	4	EA	3,380	72,000	0	0	4,535,700	4,607,700		

000452

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 66 MIS										
		HARDWARE			520	9,600			741,300	750,900		
		SOFTWARE							265,000	265,000		
		VENDOR REP							190,000	190,000		
		TOTAL 66	1	LOT	520	9,600	0	0	1,196,300	1,205,900		

000453

7-8059

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "A" GEM MACHINE
F:\LOTUS34\SILO3ALT\GEMS\EQPGEMS.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64	ANALYTICAL LAB/PROCESS SAMPLING ALLOWANCE	1	LOT	9,160	195,200			1,585,000	1,780,200		
		TOTAL 63/64		1	LOT	160	195,200	0	0	1,585,000	1,780,200		

000654

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SUMMARY SHEET

FILE #: C4-96-03-01
CLIENT: DOE
PROJECT: SILO 3 ALTERNATIVE-GEMS - SERIES D MELTER
WBS #: 1.1.1.1.4.3.2

FERMCO
ESTIMATING SERVICES

DATE: 19-Apr-96
ESTIMATOR: G.D.Walters
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	11,040		$204,800		$1,600	$206,400
	CONCRETE	68,152		$1,331,000		$662,250	$1,993,250
	STRUCTURAL STEEL	6,136		$129,000		$328,700	$457,700
	BUILDINGS	32,091		$648,400		$790,900	$1,439,300
	MACHINERY & EQUIPMENT	64,430		$1,333,200		$27,371,300	$28,704,500
	PIPING	23,785		$525,400		$788,000	$1,313,400
	ELECTRICAL	54,279		$1,004,700		$1,865,800	$2,870,500
	INSTRUMENTATION	19,811		$366,700		$1,100,200	$1,466,900
	PAINTING / INSULATION ALLOWANCE	14,188		$293,400		$195,600	$489,000
DIRECT FIELD COSTS		293,912		$5,836,600		$33,104,350	$38,940,950
SUPERVISION - CONTRACTOR		49,965		$992,200			$992,200
SM TOOLS/CONSM'BLS						$350,200	$350,200
EQUIPMENT RENTAL						$1,028,700	$1,028,700
TEMP. FACILITIES		17,635		$175,100		$175,100	$350,200
'P UTL'S HOOK-UP		8,817		$113,800		$61,300	$175,100
:LEAN-UP		17,635		$262,600		$87,500	$350,100
LTY		8,817		$113,800		$61,300	$175,100
ALTH PHYSICS S/C		5,878		$149,900		$14,700	$164,600
CERCLA	$800 PER PERSON			$129,700			$129,700
PAYRL BRD.&BENFT.				$4,431,000			$4,431,000
OVERHEAD & PROFIT					$9,417,600		$9,417,600
BOND					$565,100		$565,100
INDIRECT FIELD COSTS		108,747	58.60	$6,368,100	$9,982,700	$1,778,800	$18,129,600
DIRECT & INDIRECT FIELD COSTS		402,659	30.30	$12,204,700	$9,982,700	$34,883,150	$57,070,550

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		
WASTE MANAGEMENT COSTS		

PROJ.MGMT-FERMCO				$3,652,480		$913,120	$4,565,600
CONSTR MGMT-FERMCO				$11,414,100			$11,414,100
FERMCO FIELD SUPPORT COSTS				$15,066,600		$913,100	$15,979,700
E/D/I		A/E		FERMCO			$20,545,400
ENGINEERING COSTS							$20,545,400
SALES TAX - SUBCONTRACT	$1,918,600		SALES TAX - FERMCO	$50,200			$1,968,800
SUB-TOTAL (BASE ESTIMATE)							$95,564,450
RISK BUDGET	9.0%						$8,601,000
G&A-FERMCO	(SEE EXCLUSION COMMENTS)						
ESCALATION	(SEE EXCLUSION COMMENTS)						
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)							$104,165,450

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000455

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES 'D' MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	38,026	CY	11,040	204,800	0	1,600	0	206,400		
	1	CONCRETE	4,793	CY	68,152	1,331,000	0	662,250	0	1,993,250		
	2	STEEL	150	TONS	6,136	129,000	0	328,710	0	457,710		
	3	BLDGS	1	LOT	32,091	648,400	0	790,915	0	1,439,315		
		SUBTOTAL 0 THRU 3			117,419	2,313,200	0	1,783,475	0	4,096,675		
	4	EQUIPMENT	350	PCS	64,430	1,333,200	0	284,000	27,087,300	28,704,500		
	5	PIPING	FACTO	RED	23,785	525,400	0	0	788,000	1,313,400		
	6	ELECTRICAL	FACTO	RED	54,279	1,004,700	0	0	1,865,800	2,870,500		
	7	INSTRUMENTATION	FACTO	RED	19,811	366,700	0	0	1,100,200	1,466,900		
	8	PAINTING/INSULATION	FACTO	RED	14,188	293,400	0	0	195,600	489,000		
		SUBTOTAL 5 THRU 8			112,063	2,190,200	0	0	3,949,600	6,139,800		
		TOTAL DFC			293,912	5,836,600	0	2,067,475	31,036,900	38,940,975		

000457

- 80950

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM SUMMARY ACCTS 0-3
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\SUMM.V

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		SUMMARY OF ACCOUNTS TOTAL										
		CIVIL	38,026	CY	11,040	$204,800		$1,600				$206,400
		CONCRETE	4,793	CY	68,152	$1,331,000		$662,250				$1,993,250
		STRUCTURAL STEEL	150	TN	6,136	$129,000		$328,710				$457,710
		ARCHITECTURAL / BUILDINGS / FINISHES	1	LOT	32,091	$648,400		$790,915				$1,439,315
		TOTAL			117,419	$2,313,200		$1,783,475				$4,096,675

000458

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS34\SILO3ALT\CEMS\MATPAD

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	100	CY	84	$1,600		$0				
		EXCAVATION HAND	10	CY	32	$600		$0				
		BACKFILL MACHINE	145	CY	37	$700		$0				
		BACKFILL HAND	15	CY	23	$400		$0				
		HAUL & DUMP	25	CY	16	$300		$0				
		SUB-TOTAL	295	CY	192	$3,600		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	295	CY	192	$3,600		$0				
		TOTAL	**295**	**CY**	**192**	**$3,600**		**$0**				**$3,600**

000459

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMB\EXHSTK

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	160	CY	31	$600		$0				
		EXCAVATION HAND	10	CY	19	$400		$0				
		BACKFILL MACHINE	125	CY	32	$600		$0				
		BACKFILL HAND	5	CY	6	$100		$0				
		HAUL & DUMP	70	CY	9	$200		$0				
		SUB-TOTAL	370	CY	97	$1,800		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	370	CY	97	$1,800		$0				
		TOTAL	370	CY	97	$1,800		$0				$1,800

000460

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMB\BLDG3.'

TOTAL DIRECT COST

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	11,740	CY	2,272	$42,200						
		EXCAVATION HAND	615	CY	1,191	$22,100						
		BACKFILL MACHINE	11,150	CY	2,877	$53,400						
		BACKFILL HAND	585	CY	755	$14,000						
		HAUL & DUMP	2,510	CY	324	$6,000						
		SUB-TOTAL	26,600	CY	7,419	$137,700						
		MATERIAL TAKE-OFF 0.0%	0		0	$0						
		SUB-TOTAL	26,600	CY	7,419	$137,700						
		TOTAL	**26,600**	**CY**	**7,419**	**$137,700**		**$0**				**$137,700**

000461

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS24\SILO3ALT\GEMS\EQUPYRD.WK3

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	400	CY	77	$1,400		$0				
		EXCAVATION HAND	20	CY	39	$700		$0				
		BACKFILL MACHINE	280	CY	72	$1,300		$0				
		BACKFILL HAND	15	CY	19	$400		$0				
		HAUL & DUMP	195	CY	26	$500		$0				
		FENCING & GATE	110	LF	67	$1,200		$1,600				
		SUB-TOTAL	910	CY	300	$5,500		$1,600				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	910	CY	300	$5,500		$1,600				
		TOTAL	**910**	**CY**	**300**	**$5,500**		**$1,600**				**$7,100**

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\BLDG2.'

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	1,290	CY	250	$4,600		$0				
		EXCAVATION HAND	65	CY	126	$2,300		$0				
		BACKFILL MACHINE	355	CY	92	$1,700		$0				
		BACKFILL HAND	20	CY	26	$500		$0				
		HAUL & DUMP	1,190	CY	154	$2,900		$0				
		BERM	5,565	CY	2,039	$37,800		$0				
		SUB-TOTAL	8,485	CY	2,687	$49,800		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8,485	CY	2,687	$49,800		$0				
		TOTAL	8,485	CY	2,687	$49,800		$0				$49,800

000463

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\BILO3ALT\GEMB\BLD1.W

PREPARED BY: G.WA
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		EXCAVATION MACHINE	633	CY	119	$2,200		$0				
		EXCAVATION HAND	6	CY	58	$1,100		$0				
		BACKFILL MACHINE	362	CY	98	$1,800		$0				
		BACKFILL HAND	4	CY	26	$500		$0				
		HAUL & DUMP	362	CY	44	$800		$0				
		SUB-TOTAL	1,366	CY	345	$6,400		$0				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	1,366	CY	345	$6,400		$0				
		TOTAL	1,366	CY	345	$6,400		$0				$6,400

000464

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS34\SILO3ALT\QEM8\MATPAD

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	66	CY	341	$6,700		$5,610				
		WASTE & SPILLAGE	7	CY	10	$200		$330				
		SUB-TOTAL	73	CY	351	$6,900		$5,940				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	73	CY	351	$6,900		$5,940				
		TOTAL	73	CY	351	$6,900		$5,940				$12,840

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\EXHST.K

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		STACK FOUNDATION	60	CY	506	$9,900		$6,100				
		SUB-TOTAL	60	CY	506	$9,900		$6,100				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	60	CY	506	$9,900		$6,100				
		TOTAL	60	CY	506	$9,900		$6,100				$16,000

000466

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO2ALT\GEMS\BLOG2.'

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	220	CY	1,574	$30,700		$21,500				
		WALLS	540	CY	11,146	$217,700		$81,800				
		FOOTINGS	170	CY	2,986	$58,300		$20,650				
		ELEVATED SLABES	295	CY	5,328	$104,100		$63,100				
		FOUNDATIONS	120	CY	1,013	$19,800		$11,400				
		SPILLAGE & WASTE	30	CY	77	$1,500		$1,500				
		SUB-TOTAL	1,375	CY	22,124	$432,100		$199,950				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	1,375	CY	22,124	$432,100		$199,950				
		TOTAL	**1,375**	**CY**	**22,124**	**$432,100**		**$199,950**				**$632,050**

000467

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\BLDG2.'

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	805	CY	5,753	$112,400		$78,600				
		COLUMN D\FOUNDATIONS	20	CY	452	$8,800		$2,570				
		FOOTINGS	210	CY	3,689	$72,000		$25,500				
		WALLS	725	CY	14,964	$292,200		$109,900				
		ELEVATED SLABS	740	CY	13,364	$261,000		$158,300				
		EQUIP. FOUNDATIONS	255	CY	2,154	$42,100		$24,100				
		WASTE & SPILLAGE	55	CY	142	$2,800		$2,750				
		SUB-TOTAL	2,810	CY	40,518	$791,300		$401,720				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	2,810	CY	40,518	$791,300		$401,720				
		TOTAL	2,810	CY	40,518	$791,300		$401,720				$1,193,020

000468

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS3\(8)LO3ALT\GEM8\EQUPYRD.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		TANK & EQUIPMENT FOUNDATIONS	110	CY	929	$18,100		$10,400				
		COLUMN & FOOTINGS	40	CY	703	$13,700		$4,900				
		DUCTBANK	5	CY	55	$1,100		$400				
		SUBSTATION PAD	20	CY	143	$2,800		$2,000				
		WASTE & SPILLAGE	4	CY	10	$200		$400				
		SUB-TOTAL	179	CY	1,840	$35,900		$18,100				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	179	CY	1,840	$35,900		$18,100				
		TOTAL	179	CY	1,840	$35,900		$18,100				$54,000

000469

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\BLD1.W

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	246	CY	1,789	$34,900		$24,410				
		COLUMN D\FOUNDATIONS	45	CY	1,011	$19,700		$5,780				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	296	CY	2,813	$54,900		$30,440				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	296	CY	2,813	$54,900		$30,440				
		TOTAL	296	CY	2,813	54,900		$30,440				$85,340

000470

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS94\SILO3ALT\GEMS\MATPAC

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	0.5	TN	155	$3,300		$2,500				
		SUB-TOTAL	0.5	TN	155	$3,300		$2,500				
		MATERIAL TAKE-OFF 0.0%	0.0		0	$0		$0				
		SUB-TOTAL	0.5	TN	155	$3,300		$2,500				
		TOTAL	0.5	TN	155	$3,300		$2,500				$5,800

000571

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS24\SILO3ALT\GEMS\EXHSTK

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		PLATFORMS	3	TN	123	$2,600		$5,250				
		LADDERS	120	VLF	93	$2,000		$2,900				
		GRATING	210	SF	54	$1,100		$1,900				
		HANDRAIL	150	LF	26	$500		$1,650				
		DAVITS	3	EA	58	$1,200		$1,800				
		SUB-TOTAL	3	TN	354	$7,400		$13,500				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	3	TN	354	$7,400		$13,500				
		TOTAL	3	TN	354	$7,400		$13,500				$20,900

000472

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION VITRIFICATION GEM
FILENAME F:\LOTUS34\SILO3ALT\GEMS\BLDG3.'

TOTAL DIRECT COST

PREPARED BY G. Walters
DATE 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	7	TN	190	$4,000		$10,500				
		STAIRS	64	RSR	191	$4,000		$12,200				
		SUB-TOTAL	7	TN	381	$8,000		$22,700				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	7	TN	381	$8,000		$22,700				
		TOTAL	7	TN	381	$8,000		$22,700				$30,700

000473

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT	U.S. DEPT. OFENERGY
PROJECT	SILO 3 ALTERNATIVE
LOCATION	SILO AREA
DESCRIPTION	VITRIFICATION GEM
FILENAME	F:\LOTUS34\SILO3ALT\GEMS\EQUPYRD.WK3

PREPARED BY	G.WALTERS
DATE	04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	19	TN	515	$10,800		$28,500				
		STAIRS	64	RSR	191	$4,000		$12,200				
		CHECKER PLATE	750	SF	213	$4,500		$8,400				
		HANDRAIL	125	LF	53	$1,100		$1,500				
		SUB-TOTAL	19	TN	972	$20,400		$50,600				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	19	TN	972	$20,400		$50,600				
		TOTAL	19	TN	972	$20,400		$50,600				$71,000

000474

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION VITRIFICATION GEM
FILENAME F:\LOTUS24\SILO3ALT\GEMS\BLDG2.

TOTAL DIRECT COST

PREPARED BY G.WALTERS
DATE 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	24	TN	504	$10,600		$36,000				
		METAL ROOFING	1,890	SF	69	$1,500		$2,500				
		CHECKER PLATE	1,320	SF	290	$6,100		$14,850				
		STAIRS	152	RSR	351	$7,400		$29,000				
		SUB-TOTAL	24	TN	1,214	$25,600		$82,350				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	24	TN	1,214	$25,600		$82,350				
		TOTAL	**24**	**TN**	**1,214**	**$25,600**		**$82,350**				**$107,950**

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\BLD1.W

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		STRUCTURAL STEEL	96	TN	2,601	$54,700		$144,000				
		METAL ROOFING	9,000	SF	424	$8,900		$11,960				
		LADDERS	45	LF	35	$700		$1,100				
		SUB-TOTAL	96	TN	3,060	$64,300		$157,060				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	96	TN	3,060	$64,300		$157,060				
		TOTAL	96	TN	3,060	$64,300		$157,060				$221,360

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNAITIVE
LOCATION: SILO AREA
DESCRIPTION: COVERED STORAGE PAD
FILENAME: F:\LOTUS34\8\LO3ALT\GEM8\MATPAD

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		DOWNSPOUT & GUTTERS	340	LF	52	$1,000		$800				
		LIGHTING	5,400	SF	135	$2,700		$4,100				
		SUB-TOTAL	5,400	SF	187	$3,700		$4,900				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	5,400	SF	187	$3,700		$4,900				
		TOTAL	5,400	SF	187	$3,700		$4,900				$8,600

8050

000477

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\EXHBTK

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		EXHAUST STACK	1	EA	2,815	$56,900		$280,000				
		EXHAUST STACK DUCKWORK	25	LF	188	$3,800		$13,375				
		SEALERS/HARDNER	345	SF	3	$100		$55				
		PAINT STACK & DUCT	26,125	SF	1,011	$20,400		$2,900				
		PAINT PLATFORMS	700	SF	27	$500		$100				
		SUB-TOTAL	1	LOT	4,044	$81,700		$296,430				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	1	LOT	4,044	$81,700		$296,430				
		TOTAL	1	LOT	4,044	$81,700		$296,430				$378,130

000478

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\OEM8\BLDG3.'

TOTAL DIRECT COST

PREPARED BY: G. Walters
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		SEALERS & HARDNER	16,230	SF	125	$2,500		$2,600				
		3'x7' HM DOORS	3	EA	31	$600		$1,500				
		3'x7' HM DOORS	2	PR	41	$800		$2,440				
		DOWNSPOUT & GUTTERS	1	LOT	181	$3,700		$1,440				
		PLUMBING	8,300	SF	226	$4,600		$14,600				
		SPRINKLERS	8,600	SF	277	$5,600		$12,900				
		LIGHTING	8,600	SF	1,941	$39,200		$13,400				
		COMMUNICATIONS	8,600	SF	277	$5,600		$4,900				
		SUB-TOTAL	8,600	SF	2,974	$60,100		$51,180				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8,600	SF	2,974	$60,100		$51,180				
		TOTAL	**8,600**	SF	**2,974**	**$60,100**		**$51,180**				**$111,280**

000479

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OFENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS94\SILO3ALT\GEMS\EQUPYRD.WK3

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		PAINT STEEL	6,265	SF	243	$4,900		$900				
		SEALER /HARDNER	1,195	SF	5	$100		$100				
		FIREPROOF PIPEWAY	2,200	SF	355	$7,200		$1,800				
		LIGHTING	7,700	SF	869	$17,600		$11,700				
		PAINT TANKS	3,030	SF	117	$2,400		$450				
		SUB-TOTAL	20,390	SF	1,589	$32,200		$14,950				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	20,390	SF	1,589	$32,200		$14,950				
		TOTAL	20,390	SFT	1,589	$32,200		$14,950				$47,150

000480

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS3\RSLO3ALT\GEMS\BLDG2.'

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		SIDING	8,250	SF	1,173	$23,700		$39,350				
		MEMBRANE ROOFING	1,890	SF	48	$1,000		$2,765				
		ROOF INSULATION	1,890	SF	36	$700		$2,260				
		DOWNSPOUT & GUTTERS	1	LOT	129	$2,600		$1,000				
		DOORS	9	EA	52	$1,100		$8,500				
		PLUMBING	19,100	SF	352	$7,100		$23,565				
		SPRINKLERS	19,100	SF	433	$8,800		$20,100				
		LIGHTING	19,100	SF	5,279	$106,700		$31,200				
		COMMUNICATIONS	19,100	SF	528	$10,700		$10,800				
		PAINT STEEL	7,010	SF	271	$5,500		$1,050				
		EPOXY WALLS	46,300	SF	903	$18,200		$7,200				
		EPOXY STEEL	1,540	SF	106	$2,100		$850				
		EPOXY FLOORS	8,250	SF	710	$14,300		$5,000				
		EPOXY CEILING	8,250	SF	779	$15,700		$5,000				
		PAINT CEILING	3,210	SF	129	$2,600		$500				
		PAINT BINS	3,230	SF	125	$2,500		$460				
		EPOXY TANKS	5,610	SF	383	$7,700		$3,000				
		SEALER/HARDENER	27,350	SF	159	$3,200		$5,200				
		SUB-TOTAL	19,100	SF	11,595	$234,200		$167,800				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	19,100	SF	11,595	$234,200		$167,800				
		TOTAL	**19,100**	**SFT**	**11,595**	**$234,200**		**$167,800**				**$402,000**

000481

1-8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: VITRIFICATION GEM
FILENAME: F:\LOTUS34\SILO3ALT\GEMS\BLD1.W

PREPARED BY: G.WALTERS
DATE: 04/19/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		SIDING	8,800	SF	1,201	$24,300		$43,570				
		MEMBRANE ROOFING	9,100	SF	295	$6,000		$17,110				
		ROOF INSULATION	9,100	SF	223	$4,500		$13,970				
		DOWNSPOUT & GUTTERS	550	LF	178	$3,600		$1,380				
		BATTEN INSULATION	10,450	SF	81	$1,600		$780				
		CONSTRUCTION JOINT	200	LF	90	$1,800		$1,375				
		DOORS	34	EA	383	$7,700		$23,450				
		CHANGE ROOM ACCESSORIES	1	LOT	129	$2,600		$4,000				
		TOILET ACCESSORIES	1	LOT	194	$3,900		$7,500				
		COMPUTER FLOOR	1	LOT	97	$2,000		$3,000				
		LAB FURNISHINGS	1	LOT	77	$1,600		$10,000				
		LUNCH / CONFERANCE ROOM	1	LOT	97	$2,000		$6,500				
		CERMAIC TILE	3,210	SF	414	$8,400		$7,060				
		RUBBER TOPSET	1,950	LF	188	$3,800		$1,365				
		VINYL TILE	7,730	SF	599	$12,100		$4,640				
		SUSPENDED CEILINGS	9,100	SF	637	$12,900		$24,595				
		METAL STUDS & SHEET ROCK	10,450	SF	809	$16,300		$13,060				
		PLUMBING	9,100	SF	299	$6,000		$19,310				
		SPRINKLERS	9,100	SF	353	$7,100		$16,455				
		LIGHTING	9,100	SF	3,538	$71,500		$21,610				
		COMMUNICATIONS	9,100	SF	353	$7,100		$7,295				
		SEALERS & HARDNER	9,100	SF	85	$1,700		$1,770				
		PAINT WALLS	19,920	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB-TOTAL	9,100	SF	11,702	$236,500		$255,655				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	9,100	SF	11,702	$236,500		$255,655				
		TOTAL	9,100	SF	11,702	$236,500		$255,655				$492,155

000482

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	117,419	2,313,200	0	1,783,475	0	4,096,675		
	10	SYSTEM 03	CHILLED WATER	10	EA	3,100	66,000	0	0	1,261,000	1,327,000		
	36	SYSTEM 05	HVAC	36	EA	25,560	506,900	0	284,000	1,136,800	1,927,700		
		SYSTEM 06	SHOP EQUIP	1	LOT	730	15,500	0	0	181,000	196,500		
	21	SYSTEM 12	FEED PREPARATION	21	EA	2,020	43,200	0	0	297,700	340,900		
	1	SYSTEM 13	MELTER	1	EA	3,870	82,500	0	0	9,697,000	9,779,500		
	53	SYSTEM 14	MELTER OFF GAS	53	EA	3,400	72,000	0	0	885,600	957,600		
	7	SYSTEM 15	VESSEL OFF GAS	7	EA	330	7,000	0	0	10,000	17,000		
	20	SYSTEM 20	RADIOACTIVE LIQ WASTE	20	EA	1,010	21,400	0	0	94,200	115,600		
	5	SYSTEM 21	SHIELD DOORS	5	EA	1,510	32,100	0	0	96,200	128,300		
	5	SYSTEM 24	GEM PRODUCTION	5	EA	1,410	30,100	0	0	1,232,800	1,262,900		
	102	SYSTEM 25	GEM PACKAGING	102	EA	1,210	25,700	0	0	342,500	368,200		
	9	SYSTEM 30	ELECTRICAL	9	EA	2,940	62,600	0	0	521,900	584,500		
	38	SYSTEM 41	COMPRESSED AIR	38	EA	1,520	32,400	0	0	72,400	104,800		
		SYSTEM 46	MELTER COOLING WATER	1	LOT	260	5,500	0	0	91,200	96,700		
	6	SYSTEM 53	NON RADIOACTIVE LIQ WASTE	6	EA	240	5,200	0	0	46,900	52,100		
	10	SYSTEM 54	COLD CHEMICALS	10	EA	280	5,900	0	0	10,200	16,100		
		SYSTEM 55	BULK CHEMICALS VENT SYSTEM	1	LOT	150	3,200	0	0	4,000	7,200		
	23	SYSTEM 58	GLASS FORMER & FEED	23	EA	1,180	25,300	0	0	331,400	356,700		
		SYSTEM 61	DCS	1	LOT	650	13,900	0	0	3,457,500	3,471,400		
	4	SYSTEM 62	HPS	4	EA	3,380	72,000	0	0	4,535,700	4,607,700		
		SYSTEM 63/64	PROCESS SAMPLING/ANALYT LAB	1	LOT	9,160	195,200	0	0	1,585,000	1,780,200		
		SYSTEM 66	MIS	1	LOT	520	9,600	0	0	1,196,300	1,205,900		
	350		TOTAL EQUIPMENT			64,430	1,333,200	0	284,000	27,087,300	28,704,500		
			PIPING	1	LOT	23,785	525,400	0	0	788,000	1,313,400		
			ELECTRICAL	1	LOT	54,279	1,004,700	0	0	1,865,800	2,870,500		
			INSTRUMENTATION	1	LOT	19,811	366,700	0	0	1,100,200	1,466,900		
			PAINTING & INSULATION	1	LOT	14,188	293,400	0	0	195,600	489,000		
			TOTAL BULKS			112,063	2,190,200	0	0	3,949,600	6,139,800		
			TOTAL DFC			293,912	5,836,600	0	2,067,475	31,036,900	38,940,975		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 03	CHILLED WATER										
	3	03-CH-1A/B/C	CENTRIFUGAL WATER CHILLERS	3	EA	930	19,800			660,000	679,800		
			550 TON CAPACITY										
			SKID MOUNTED										
	3	03-P-1A/B/C	CHILLED WATER PUMPS	3	EA	310	6,600			57,000	63,600		
			900 GPM										
	3	03-P-2A/B/C	COOLING TOWER WATER PUMPS	3	EA	310	6,600			75,000	81,600		
			1100 GPM										
	3	03-CT-1	COOLING TOWER	1	EA	1,290	27,500			269,000	296,500		
			3300 GPM										
			FIELD ERRECTED										
	3	03-F-1 THRU 40	HIGH EFF FILTER BOXES	40	EA	260	5,500			200,000	205,500		
			TOTAL 03	10	EA	3,100	66,000	0	0	1,261,000	1,327,000		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
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LOCATION: SILO AREA
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05	HVAC										
	5	05-F-01A/B	HEPA FILTER PLENUMS	2	EA	410	8,700			450,000	458,700		
			18,000 CFM										
	5	05-F-02	HEPA FILTER PLENUM	2	EA	200	4,300			220,000	224,300		
			9,000 CFM										
	5	05-B-01A/B	CENTRIFUGAL FANS	2	EA	190	4,000			59,000	63,000		
			30,000 CFM										
			75 HP										
	5	05-B-02	CENTRIFUGAL FANS	1	EA	80	1,700			18,000	19,700		
			20,000 CFM										
			30 HP										
	5	05-AH-01A/B	AIR HANDLING UNITS WITH	2	EA	410	8,700			90,000	98,700		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			350 KW, 25,000 CFM										
	5	05-F-03A/B	CENTRIFUGAL SUPPLY FANS	2	EA	150	3,200			59,000	62,200		
			30,000 CFM										
			40 HP										
	5	05-F-04A/B	CENTRIFUGAL TRANSFER FANS	2	EA	150	3,200			59,000	62,200		
			30,000 CFM										
			40 HP										

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	5	05-AH-02	AIR HANDLING UNITS WITH	1	EA	210	4,500			45,000	49,500		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			30 KW, 25,000 CFM										
	5	05-AH-03	AIR HANDLING UNITS WITH	1	EA	150	3,200			27,000	30,200		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			20 KW, 15,000 CFM										
	5	05-AH-04	AIR HANDLING UNITS WITH	1	EA	100	2,100			18,000	20,100		
			COOLING COIL , ELECTRIC HEATER										
			AND FILTERS										
			10 KW, 11,000 CFM										
	5	05-EX-01A/B	CENTRIFUGAL EXHAST FANS	2	EA	100	2,100			28,000	30,100		
			10 HP										
			15000 CFM										
	5	05-EX-02	CENTRIFUGAL EXHAST FANS	2	EA	130	2,800			18,000	20,800		
			20 HP										
			20000 CFM										
	5	05-EH-1 THRU 4	ELECTRIC UNIT HEATERS	4	EA	50	1,100			2,400	3,500		
			20 KW										
			DUCTING SYSTEM			20,640	402,100		270,000		672,100		
			HVAC FOR M & E BLDG	12	EA	240	26,400			43,400	69,800		
		INCLUDES:05-AH-05	,05-AH-06, 05-EX-03,										

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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DATE 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		DUCTING SYSTEM			1,350	28,800		14,000		42,800		
		TOTAL 05	36	EA	25,560	506,900	0	284,000	1,136,800	1,927,700		

CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06	SHOP EQUIPMENT										
	6	06-SH-01	MACHINE SHOP EQUIP	1	LOT	260	5,500			90,000	95,500		
			MILL, LATHE, GRINDER,										
			BAND SAW AND										
			5 TON OVHD CRANE, 20' SPAN										
	6	06-SH-02	WELDING SHOP EQUIP	1	LOT	90	1,900			22,000	23,900		
			STD ARC WELDER, TIG WELDER,										
			FUME HOOD, GRINDER,										
			METAL SHEAR, BENDER AND										
			WELDING TABLE										
	6	06-SH-03	ELECT TEST & REPAIR SHOP	1	LOT	80	1,700			12,000	13,700		
			MISC TEST EQUIP, DEGREASER/										
			CLEANER CONDUIT BENDER,										
			THREAD CUTTER & GRINDER										
	6	06-SH-04	PIPE FAB SHOP EQUIP	1	LOT	40	900			7,000	7,900		
			PIPE BENDER, PIPE THRD CUTTER										
			AND SMALL WELDER										
	6	06-MR-1 THRU 5	MONORAILS	5	EA	260	5,500			50,000	55,500		
			5 TONS										
			TOTAL 06	1	LOT	730	15,500	0		181,000	196,500		

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CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12	FEED PREPARATION										
	12	12-TK-1	SLURRY THICKENER	1	EA	270	5,800			71,400	77,200		
			9,875 GALLON										
			13'-6" ID X 9'CENTER DEPTH X 8' WALL										
			EPOXY COATED STEEL										
	12	12-TK-2	THICKENER WET WELL	1	EA	270	5,800			41,000	46,800		
			9,500 GALLON										
			13'-6" ID X 9'H										
			EPOXY COATED STEEL										
	12	12-S-1	KNOCK OUT DRUM	1	EA	60	1,300			800	2,100		
			12' ID X 6'H										
			20 SCFM										
			C.S.										
	12	12-TK-3A/B/C	FEED MAKE-UP TANKS	3	EA	810	17,300			107,100	124,400		
			9,500 GALLON										
			EPOXY COATED STEEL										
	12	12-MM-1	THICKENER RAKE MECHANISM	1	EA	100	2,100			W/TK-2	2,100		
			1.5 HP										
			C.S.										
	12	12-MM-2	WET WELL AGITATOR	1	EA	30	600			8,400	9,000		
			3 HP										
			C.S.										

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CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
			3 HP										
			C.S.										
	12	12-P-1A/B	THICKENER UNDERFLOW PUMPS	2	EA	80	1,700			3,100	4,800		
			3 GPM										
			HDPE										
	12	12-P-2A/B	WET WELL RECYCLE PUMPS	2	EA	80	1,700			8,200	9,900		
			10 GPM										
			7.5 HP										
			C.S.										
	12	12-P-3	SLURRY THICKENER SUMP PUMP	1	EA	40	900			3,400	4,300		
			10 GPM										
			0.50 HP										
			C.S.										
	12	12-P-4A/B	WET WELL OVERFLOW PUMPS	2	EA	80	1,700			6,800	8,500		
			10 GPM										
			0.75 HP										
			C.S.										
	12	12-P-5A/B	MELTER FEED PUMPS	2	EA	80	1,700			3,100	4,800		
			3.3 GPM										
			HDPE										
	12	12-P-6	SLURRY STORAGE SUMP PUMP	1	EA	40	900			3,400	4,300		
			10 GPM										
			1 HP										
			C.S.										

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CONSTRUCTION COSTS
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CLIENT U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 13	MELTER										
	13	13-EM-1	CERAMIC MELTER - SERIES D	1	EA	3,870	82,500			9,697,000	9,779,500		
			25 METRIC T/D										
			3500 KW										
		TOTAL 13		1	EA	3,870	82,500	0	0	9,697,000	9,779,500		

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Series A Glass 25 Ton / Day Joule Heated Melter	$10,000,000
Series D Glass 25 Ton / Day Joule Heated Melter	
.95^.6($10,000,000) =	$9,697,000
Savings	$303,000

Assumptions: This type of melter produces a glass gem approximately .749 the size of the Series A Glass.
The structural design of this melter is such that it is approximately 75% of the length of the Series A Melter with the same Height and Width dimensions. Therefore any savings will be in the structural materials and refactory brick. The expensive peripheral equipment will still be required.

000492

CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 14	MELTER OFFGAS										
	14	14-FC-1	FILM COOLER	1	EA	100	2,100			113,000	115,100		
			304LSS										
	14	14-FC-2	BACKUP FILM COOLER	1	EA	100	2,100			113,000	115,100		
			304LSS										
	14	14-VS-1	VENTURI SCRUBBER	1	EA	210	4,500			12,800	17,300		
			304LSS										
	14	14-TK-1	QUENCH SOLUTION TANK	1	EA	50	1,100			28,000	29,100		
			12'ID X 6'H										
			EPOXY COATED STEEL										
	14	14-MM-1	QUENCH SOLUTION TANK	1	EA	30	600			15,000	15,600		
			AGITATOR										
			304LSS										
	14	14-P-1A/B	QUENCH SOLUTION TANK PUMPS	2	EA	100	2,100			16,200	18,300		
			100 HP										
			C.S.										
	14	14-T-1	OFFGAS SCRUB COLUMN	1	EA	30	600			12,000	12,600		
			3'-8"ID X 16' T/T										
			EPOXY COATED STEEL										
	14	14-EC-1	QUENCH WATER COOLER	1	EA	40	900			35,000	35,900		
			3.1 mm BTU/HR , 1,248 FT AREA										
			24"O.D. 24' OVERALL LENGTH										
			C.S.										

000493

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CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

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DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-F-1	QUENCH WATER FILTER	1	EA	50	1,100			5,200	6,300		
			EPOXY COATED STEEL										
	14	14-E-1	OFFGAS FILTERATION PREHEATER	1	EA	30	600			10,000	10,600		
			52,873 BTU/HR										
			12" O.D. X 8' LONG										
			ELECTRIC										
	14	14-F-2A/B	OFFGAS FILTERS	2	EA	100	2,100			39,000	41,100		
			1,898 ACFM										
	14	14-MB-1A/B	EXHAUST BLOWERS	2	EA	210	4,500			48,000	52,500		
			1,898 ACFM										
			100 HP										
	14	14-EC-2	EXHAUST DSCHRG AFTER COOLER	1	EA	100	2,100			53,000	55,100		
			272,818 BTU/HR										
			374 SF										
			24"O.D. X 10' LONG										
			C.S.										
	14	14-V-1	EXHAUST DISCHARGE K.O. DRUM	1	EA	30	600			8,200	8,800		
			24"O.D. X 10' T/T										
			EPOXY COATED STEEL										
	14	14-T-2	SO2/CO2 ABSORBER	1	EA	100	2,100			15,000	17,100		
			18"O.D. X 42' T/T										
			EPOXY COATED STEEL										

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-P-2A/B	SPENT ABSORBENT PUMPS	2	EA	80	1,700			3,700	5,400		
			1 HP										
			24 GPM										
			C.S.										
	14	14-F-3A/B	SPENT ABSORBENT FILTERS	2	EA	100	2,100			3,200	5,300		
			24 GPM										
			EPOXY COATED STEEL										
	14	14-TK-2A/B	SPENT ABSORBENT TANKS	2	EA	180	3,800			74,000	77,800		
			11,400 GALLONS										
			12' ID X 17' H										
			EPOXY COATED STEEL										
	14	14-TK-3A/B	SPENT ABSORBENT MAKE-UP	2	EA	180	3,800			74,000	77,800		
			TANKS										
			11,400 GALLONS										
			12' ID X 17' H										
			EPOXY COATED STEEL										
	14	14-P-3A/B	SPENT ABSORBENT TRANSFER	2	EA	80	1,700			5,700	7,400		
			PUMPS 200 GPM 10 HP C.S.										
	14	14-MM-2A/B	SPENT ABSORBENT TANK	2	EA	100	2,100			2,800	4,900		
			AGITATORS 10 HP C.S.										
	14	14-P-4A/B	FRESH ABSORBENT PUMPS	2	EA	80	1,700			4,200	5,900		
			23 GPM 1 HP C.S.										

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-MM-3A/B	FRESH ABSORBENT TANK	2	EA	100	2,100			2,800	4,900		
			AGITATORS 10 HP C.S.										
	14	14-EC-3	FRESH ABSORBENT COOLER	1	EA	100	2,100			4,000	6,100		
			316,000 BTU/HR C.S.										
	14	14-E-2	GAS/GAS HEAT EXCHANGER	1	EA	50	1,100			2,900	4,000		
			DOUBLE PIPE										
			100,220 BTU/HR										
			12" DIA. X 12' T/T										
			28.3 SF										
			S.S.										
	14	14-E-3	NOX REACTOR PREHEATER	1	EA	50	1,100			5,000	6,100		
			ELECTRIC										
			100,220 BTU/HR										
			29.4 KW										
			S.S.										
	14	14-R-1 THRU 4	NOX REACTOR #1 THRU #4	4	EA	410	8,700			130,200	138,900		
			1,000#/HR AIR										
			2'X2'X2'										
			S.S.										
	14	14-EC-4	NOX REACTOR #3 EFFLUENT	1	EA	30	600			1,200	1,800		
			COOLER										
			DOUBLE PIPE										
			50,350 BTU/HR										
			8" DIA. X 6' T/T										
			7.1 SF										
			S.S.										

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CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

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DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-EC-5	NOX REACTOR #4 EFFLUENT	1	EA	30	600			5,000	5,600		
			COOLER										
			240,058 BTU/HR										
			6" DIA. X 12' LONG										
			60 SF										
			S.S.										
	14	14-EC-6	NOX REACTOR #4 EFFLUENT	1	EA	30	600			5,000	5,600		
			COOLER										
			44,430 BTU/HR										
			8" DIA. X 10' LONG										
			61 SF										
			S.S.										
	14	14-V-2	CHILLED OFFGAS K.O. DRUM	1	EA	50	1,100			2,500	3,600		
			10"DIA X 8'T/T										
			EPOXY COATED STEEL										
	14	14-V-3A/B	MOLECULAR SIEVE VESSELS	2	EA	100	2,100			9,000	11,100		
			CONE BOTTOM										
			20" O.D. X 11'T/T										
			EPOXY COATED STEEL										
	14	14-EC-7	DRIED OFFGAS CHILLER	1	EA	50	1,100			2,200	3,300		
			13,500 BTU/HR										
			C.S.										
	14	14-E-4	DESSICANT REGENERATE HEATER	1	EA	30	600			4,000	4,600		
			66,000 BTU/HR										
			19.3 KW										
			ELECTRIC										
			C.S.										

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CONSTRUCTION COSTS
DETAILS

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PROJECT SILO 3 ALTERNATIVE
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	14	14-MB-2	REGENERATION BLOWER	1	EA	30	600			1,100	1,700		
			123 ACFM										
			0.5 HP										
			C.S.										
	14	14-F-4	REGENERATION AIR EXHAUST FILTE	1	EA	50	1,100			2,600	3,700		
			250 ACFM										
	14	14-F-4A/B	RADON REMOVAL VESSELS	2	EA	210	4,500			17,100	21,600		
			192 ACFM										
			8' ID X 17-4" T/T										
			845 CF										
			C.S.										
			TOTAL 14	53	EA	3,400	72,000	0	0	885,600	957,600		

000698

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY: Q. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 15	VESSEL OFFGAS										
	15	15-E-2	VESSEL VENT FILTER PREHTR	1	EA	50	1,100			0	1,100		
			2,866 BTU/HR										
			100 SCFM										
			ELECTRIC										
			0.84 KW										
			S.S.										
	15	15-MB-4A/B	VESSEL VENT EXHAUSTERS	2	EA	100	2,100			0	2,100		
			100 SCFM										
	15	15-V-1	VESSEL VENT K.O. DRUM	1	EA	30	600			0	600		
			100 SCFM										
			8"DIA X 8'T/T										
			C.S.										
	15	15-EC-2	VESSEL VENT AFTERCOOLER	1	EA	50	1,100			0	1,100		
			100 SCFM										
			25,000 BTU/HR										
			C.S.										
	15	15-FH-3A/B	VESSEL VENT FILTERS	2	EA	100	2,100			0	2,100		
			100 SCFM										
			12"DIA X 6'H										
			C.S.										
			TOTAL 15	7	EA	330	7,000	0	0	10,000	17,000		

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CONSTRUCTION COSTS
DETAILS

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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 20	RADIOACTIVE LIQUID WASTE										
	20	20-TK-1	PH ADJUSTMENT TANK	1	EA	30	600			900	1,500		
			500 GALLON										
			PLASTIC										
	20	20-TK-2	PRECIPITATION TANK	1	EA	30	600			800	1,400		
			500 GALLON										
			PLASTIC										
	20	20-TK-3	SURGE/RECYCLE TANK	1	EA	30	600			800	1,400		
			500 GALLON										
			PLASTIC										
	20	20-TK-4	RECYCLE SUMP TANK	1	EA	30	600			500	1,100		
			200 GALLON										
			PLASTIC										
	20	20-MM-1	PH ADJUSTMENT AGITATOR	1	EA	10	200			1,600	1,800		
			0.25 HP										
			C.S.										
	20	20-P-1	PRECIPITATION PUMP	1	EA	40	900			2,900	3,800		
			16 GPM										
			3 HP										
			C.S.										
	20	20-P-2A/B	RECYCLE PUMPS	2	EA	80	1,700			5,800	7,500		
			40 GPM										
			1.5 HP										
			C.S.										

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	20	20-P-3A/B	ION EXCHANGE PUMPS	2	EA	80	1,700			6,800	8,500		
			4 GPM										
			0.25 HP										
			C.S.										
	20	20-P-4A/B	BACKWASH PUMPS	2	EA	80	1,700			5,800	7,500		
			20 GPM										
			0.75 HP										
			C.S.										
	20	20-P-5A/B	RECYCLE SUMP PUMPS	2	EA	80	1,700			6,800	8,500		
			4 GPM										
			0.75 HP										
			C.S.										
	20	20-F-1A/B	MULTIMEDIA FILTERS	2	EA	210	4,500			56,700	61,200		
			10 MICRON										
			C.S.										
	20	20-F-2A/B	CARTRIDGE FILTERS	2	EA	100	2,100			1,200	3,300		
			3 MICRON										
			4 GPM										
			S.S.										
	20	20-F-3A/B	ION EXCHANGE UNITS	2	EA	210	4,500			3,600	8,100		
			EPOXY COATED STEEL										
			TOTAL 20	20	EA	1,010	21,400	0	0	94,200	115,600		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 21	SHIELD DOORS										
	21	21-RA-1A/B	MELTER ROOM SLIDING DOORS	2	EA	340	7,200			15,000	22,200		
			5' X 5' X 4"										
	21	21-RA-2	FILLING ROOM SHIELD DOOR	1	EA	340	7,200			31,500	38,700		
			5' X 20' X 4"										
	21	21-RA-3	MONORAIL MAINT ACCESS SHLD	1	EA	390	8,300			7,700	16,000		
			4' X 5' X 4"										
	21	21-RA-4	LOADING AREA SHIELD DOOR	1	EA	440	9,400			42,000	51,400		
			8' X 20' X 4"										
			TOTAL 21	5	EA	1,510	32,100	0	0	96,200	128,300		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 24	GEM PRODUCTION										
	24	24-MD-1	25 M-T/DAY	1	EA	880	18,800			1,214,000	1,232,800		
			GLOB CUTTER/BELT CONVEYOR										
			CHUT w/SLIDING VALVE,BELT										
			COOLING SYSTEM										
	24	24-HD-1	FILLED CONTAINER GRAVITY	1	EA	310	6,600			9,000	15,600		
			ROLLER CONVEYOR										
	24	24-TV-1A/B	MELTER ROOM CCTV	2	EA	120	2,600			6,800	9,400		
	24	24-TV-2	MELTER ROOM CCTV CONTROLS	1	EA	100	2,100			3,000	5,100		
			TOTAL 24	5	EA	1,410	30,100	0	0	1,232,800	1,262,900		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 25	GEM PACKAGING SYSTEM										
	25	25-HD-1A-G	FILLED GRVTY ROLLER CONVEYOR 5,000# CAPICITY	7	EA	180	3,800			119,000	122,800		
	25	25-HD-2	EMPTY CONTAINER POWERED ROLLER CONVEYOR 1,000# CAP	1	EA	230	4,900			24,000	28,900		
	25	25-MR-1A&B	MONORAIL w/HOIST LIFTING DEVICE 5 TON CAP.15'LIFT	2	EA	210	4,500			30,000	34,500		
	25	25-HD-3	EMPTY CONTAINER GRAVITY ROLLER CONVEYOR 1,000# CAP	1	EA	80	1,700			21,500	23,200		
	25	25-TV-1A-D	COOLING ROOM CCTV CAMERA	4	EA	100	2,100			13,600	15,700		
	25	25-TV-2	CCTV MONITOR & CONTROLS	1	EA	100	2,100			3,000	5,100		
	25	25-HD-3	SEG CONTAINER LID LIFT.DEVICE LIFTING DEVICE TO REMOVE AND LID ON THE SEG CONTAINER	1	EA	210	4,500			3,000	7,500		
	25	25-CD-1	GEM TRANSFER CONTAINER C.S.	84	CNTRS		0			92,400	92,400		
	25	25-SX-1	LOADING AREA SHIELDING WINDOW 24" W X 30" L X 6" THK	1	EA	100	2,100			36,000	38,100		
			TOTAL 25	102	EA	210	25,700	0	0	342,500	368,200		

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TOTAL DIRECT COST

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30-US-1	UNIT SUBSTATION #1, INCLUDES	1	EA	900	19,200			219,200	238,400		
			DOUBLE ENDED 13.8 KV TO4160 KV										
			HVAC										
			600A KVA FUSED DISCONN SWITCH	2	EA								
			1500KVA TRANSFORMERS DRY TYPE	2	EA								
			1200 AMP MAIN BREAKERS	2	EA								
			1200 AMP TIE BREAKERS	1	EA								
			1200 AMP FEED BREAKER BREAKER	1	EA								
			EQUIPPED SPASE	2	EA								
			1200 AMP VERTICAL SECTIONS	5	EA								
			PT'S	2	EA								
			CT'S	6	EA								
			METERS & RELAYS	1	LOT								
	30	30-US-2	UNIT SUBSTATION #2, INCLUDES	1	EA	900	19,200			128,400	147,600		
			DOUBLE ENDED 13.8 KV TO 480 KV										
			HVAC /PROCESS/ELECT										
			600A KVA FUSED DISCONN SWITCH	2	EA								
			1500KVA TRANSFORMERS DRY TYPE	2	EA								
			2000 AMP MAIN BREAKERS	2	EA								
			2000 AMP TIE BREAKERS	1	EA								
			800 AMP FEED BREAKER BREAKER	1	EA								
			EQUIPPED SPASE	1	EA								
			2000 AMP VERTICAL SECTIONS	5	EA								
			PT'S	2	EA								
			CT'S	2	EA								
			METERS & RELAYS	1	LOT								

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	30	30-US-3	UNIT SUBSTATION #3,INCLUDES	1	EA	390	8,300			84,600	92,900		
			SINGLE ENDED 13.8 KV TO 4160 KV										
			600A KVA FUSED DISCONN SWITCH	1	EA								
			3750KVA TRANSFORMER DRY TYPE	1	EA								
			1200 AMP CIRCUIT BREAKER	1	EA								
			NEMA 3R										
			VERTICAL SECTION	1	EA								
	30	30-MC-1	PROCESS MCC #1,INCLUDES	1	EA	180	3,800			14,200	18,000		
			VERTICAL SECTION 600A	5	EA								
			SIZE #1	23	EA								
			SIZE #2	1	EA								
			225A CB	4	EA								
			LUGS	1	EA								
	30	30-MC-2	PROCESS MCC #2, INCLUDES	1	EA	180	3,800			14,700	18,500		
			VERTICAL SECTION 600A	5	EA								
			SIZE #1	22	EA								
			SIZE #2	1	EA								
			SIZE #4	1	EA								
			225A CB	4	EA								
			LUGS	1	EA								
	30	30-MC-3/4	HVAC MCC #1, INCLUDES	2	EA	130	2,800			17,800	20,600		
			VERTICAL SECTION 600A	4	EA								
			SIZE #1	4	EA								
			SIZE #2	2	EA								
			SIZE #3	6	EA								
			SIZE #4	1	EA								
			225A CB	2	EA								
			LUGS	1	EA								

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	30	30-MC-3/4	TANK PREP MCC, INCLUDES	1	EA	80	1,700			5,000	6,700		
			VERTICAL SECTIONS	2	EA								
			SIZE #1	10	EA								
			100A CB	2	EA								
			LUGS	1	EA								
	30	30-UP-1	UPS, INCLUDES	1	EA	180	3,800			38,000	41,800		
			50KVA, 480V TO 208V	1	EA								
			MAIN BYPASS	1	EA								
			BATTERY	1	EA								
			TOTAL 30	9	EA	2,940	62,600	0	0	521,900	584,500		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 41	COMPRESSED AIR										
	41	41-C-1A/B	AIR COMPRESSORS(PLANT AIR)	2	EA	210	4,500			21,000	25,500		
			60 SCFM @ 120 PSIG										
			20 HP										
			C.S.										
	41	41-F-2	AIR INTAKE FILTER	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-F-3	COALESCING OIL FILTER	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-DY-1	DESICANT AIR DRYER	1	EA	50	1,100			4,200	5,300		
			60 SCFM @ 120 PSIG										
			5 HP										
			C.S.										
	41	41-F-1	PREFILTER , AIR	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-V-1	AIR COMPRESSORS RECEIVER	1	EA	50	1,100			1,200	2,300		
			150 GALLON										
			C.S.										
	41	41-F-4	AFTER FILTER , AIR	1	EA	30	600			W/C-1A/B	600		
			C.S.										
	41	41-C-2	COMPRESSOR AIR PACKAGE	1	EA	260	5,500			33,600	39,100		
			(BREATHING AIR)										
			240 SCFM @ 120 PSIG										
			60 HP										

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	41	41-F-5	AIR INTAKE FILTER	1	EA	50	1,100			W/C-2A/B	1,100		
			240 SCFM										
			C.S.										
	41	41-PU-1A/B	BREATHING AIR PURIFIER	2	EA	210	4,500			W/C-2A/B	4,500		
			240 SCFM @120 PSIG										
			C.S.										
	41	41-V-2	BREATHING AIR RESERVOIR	1	EA	50	1,100			10,500	11,600		
			60"ID X 12' LONG										
			C.S.										
	41	41-F-6 THRU 29	FILTER CARTRIDGES	24	EA	310	6,600			1,900	8,500		
			180 SCFM @ 105 PSIG										
			C.S.										
	41		BREATHING AIR BACK-UP	1	EA	210	4,500			W/C-2A/B	4,500		
			C.S.										
			TOTAL 41	38	EA	1,520	32,400	0		72,400	104,800		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 46 MELTER COOLING WATER										
		ALLOWANCE	1	LOT	260	5,500			91,200	96,700		
		TOTAL 46	1	LOT	260	5,500	0	0	91,200	96,700		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 55 BULK COLD CHEMICAL VENT SYS										
		ALLOWANCE	1	LOT	150	3,200			4,000	7,200		
		TOTAL 55	1	LOT	150	3,200	0	0	4,000	7,200		

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TOTAL DIRECT COST

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 53	NON RAD.ACTIVE LIQ WASTE										
	53	53-TK-1 THRU 3	CATCH TANKS #1 THRU #3	3	EA	120	2,600			40,300	42,900		
			3,300 GALLONS										
			7-6" DIA X 12'H										
			C.S.										
	53	53-P-1 THRU 3	CATCH TANKS TRANSFER PUMPS	3	EA	120	2,600			6,600	9,200		
			50 GPM @ 30 PSI										
			1.5 HP										
			C.S.										
		TOTAL 53		6	EA	240	5,200	0	0	46,900	52,100		

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CONSTRUCTION COSTS
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TOTAL DIRECT COST

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 54	COLD CHEMICALS										
	54	54-TK-1	CAUSTIC DAY TANK	1	EA	10	200			500	700		
			100 GALLON										
			PLASTIC										
	54	54-TK-2	ACID STORAGE DRUM	1	EA	10	200			300	500		
			50 GALLON										
			PLASTIC										
	54	54-TK-3	FLOCCULANT STORGE TANK	1	EA	10	200			500	700		
			100 GALLON										
			PLASTIC										
	54	54-MM-1	FLOCCULANT AGITATOR	1	EA	10	200			1,600	1,800		
			0.25 HP										
			C.S.										
	54	54-P-1A/B	CAUSTIC METERING PUMPS	2	EA	80	1,700			2,500	4,200		
			0.25 HP										
			304LSS										
	54	54-P-2A/B	ACID METERING PUMPS	2	EA	80	1,700			2,500	4,200		
			0.25 HP										
			316LSS										
	54	54-P-3A/B	FLOCCULANT METERING PUMPS	2	EA	80	1,700			2,300	4,000		
			0.25 HP										
			C.S.										

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	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 58	GLASS FORMER PREP & FEED										
	58	58-B-1	IRON OXIDE STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-2	CALCIUM OXIDE STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-3	SILICA STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-4	ALUMINA STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-5	BORAX STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-6	COAL STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										
	58	58-B-7	SODIUM CARBONATE STORAGE BIN	1	EA	50	1,100			18,900	20,000		
			9'ID X 15' HIGH										
			C.S.										

000514

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
	58	58-M-1 THRU 7	ROTARY VALVE	7	EA	180	3,800			36,800	40,600		
			8" X 6"										
			0.75 HP										
			C.S.										
	58	58-XE-1	PNEUMATIC CONVEYOR	1	EA	260	5,500			130,000	135,500		
			C.S.										
	58	58-B-8	ADDETIVE BIN	1	EA	30	600			10,500	11,100		
			5' ID X 12' HIGH										
			C.S.										
	58	58-F-1 THRU 7	BIN DUST COLLECTORS	7	EA	360	7,700			21,800	29,500		
			C.S.										
			TOTAL 58	23	EA	1,180	25,300	0		331,400	356,700		

000515

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		HARDWARE			650	13,900			1,532,500	1,546,400		
		SOFTWARE							1,345,000	1,345,000		
		VENDOR REP							580,000	580,000		
		TOTAL 61	1	LOT	650	13,900	0	0	3,457,500	3,471,400		

000516

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO AREA
DESCRIPTION: EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS		DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 62	HPS										
			HARDWARE			3,230	68,800			2,315,300	2,384,100		
			SOFTWARE							1,995,000	1,995,000		
			VENDOR REP							215,500	215,500		
	62	62-MB-1A/B	HPS VACUUM BLOWERS	2	EA	100	2,100			7,800	9,900		
			55 ACFM @5 PSIG										
			3 HP										
	62	62-FH-1A/B	HPS VACUUM EXH HEPA FILTERS	2	EA	50	1,100			2,100	3,200		
			TOTAL 62	4	EA	3,380	72,000	0	0	4,535,700	4,607,700		

000547

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 66 MIS										
		HARDWARE			520	9,600			741,300	750,900		
		SOFTWARE							265,000	265,000		
		VENDOR REP							190,000	190,000		
		TOTAL 66	1	LOT	520	9,600	0	0	1,196,300	1,205,900		

000548

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO AREA
DESCRIPTION EQUIPMENT SERIES "D" MELTER
F:\LOTUS34\SILO3ALT\GEMS\DMLTREQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64 ANALYTICAL LAB/PROCESS SAMPLING ALLOWANCE	1	LOT	9,160	195,200			1,585,000	1,780,200		
		TOTAL 63/64	1	LOT	9,160	195,200	0	0	1,585,000	1,780,200		

000519

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ATTACHMENT C.IV

ALTERNATIVE 1 COST DETAILS

SUMMARY SHEET

FILE #:	C4-96-03-01	DATE:	19-Apr-96
CLIENT:	DOE	ESTIMATOR:	G.D.Walters
PROJECT:	SILO 3 ALTERNATIVE- CEMENT(POURABLE)	LOCATION:	FERNALD
WBS #:	1.1.1.1.4.3.2	TASK#:	4CBAV

FERMCO ESTIMATING SERVICES

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	1,449		$26,900		$9,200	$36,100
	CONCRETE	1,231		$24,100		$14,850	$38,950
	STRUCTURAL STEEL	1,215		$25,500		$41,100	$66,600
	BUILDINGS	2,986		$60,200		$178,000	$238,200
	MACHINERY & EQUIPMENT	3,466		$73,900		$1,089,400	$1,163,300
	PIPING	842		$18,600		$27,900	$46,500
	ELECTRICAL	551		$10,200		$18,900	$29,100
	INSTRUMENTATION	470		$8,700		$26,200	$34,900
	PAINTING / INSULATION ALLOWANCE	169		$3,500		$2,300	$5,800
DIRECT FIELD COSTS		**12,379**		**$251,600**		**$1,407,850**	**$1,659,450**
SUPERVISION - CONTRACTOR		2,104		$42,800			$42,800
SM TOOLS/CONSM'BLS						$15,100	$15,100
EQUIPMENT RENTAL						$43,300	$43,300
TEMP. FACILITIES		743		$7,500		$7,500	$15,000
P UTL'S HOOK-UP		371		$4,900		$2,600	$7,500
CLEAN-UP		743		$11,300		$3,800	$15,100
ETY		371		$4,900		$2,600	$7,500
ALTH PHYSICS S/C		248		$6,500		$600	$7,100
CERCLA	$800 PER PERSON			$5,500			$5,500
PAYRL BRD.&BENFT.				$191,000			$191,000
OVERHEAD & PROFIT					$401,900		$401,900
BOND					$24,100		$24,100
INDIRECT FIELD COSTS		**4,580**	**59.90**	**$274,400**	**$426,000**	**$75,500**	**$775,900**
DIRECT & INDIRECT FIELD COSTS		**16,959**	**31.00**	**$526,000**	**$426,000**	**$1,483,350**	**$2,435,350**

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		

WASTE MANAGEMENT COSTS			
PROJ.MGMT-FERMCO	$155,840	$38,960	$194,800
CONSTR MGMT-FERMCO	$487,100		$487,100
FERMCO FIELD SUPPORT COSTS	**$642,900**	**$39,000**	**$681,900**
E/D/I	A/E	FERMCO	$876,700
ENGINEERING COSTS			**$876,700**

SALES TAX - SUBCONTRACT	$81,600		SALES TAX - FERMCO	$2,100		$83,700
SUB-TOTAL (BASE ESTIMATE)						**$4,077,650**

RISK BUDGET	9.0%	$367,000
G&A-FERMCO	(SEE EXCLUSION COMMENTS)	
ESCALATION	(SEE EXCLUSION COMMENTS)	
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)		**$4,444,650**

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	669	CY	1,449	26,900		9,200		36,100		
	1	CONCRETE	108	CY	1,231	24,100		14,850		38,950		
	2	STEEL	8	TN	1,215	25,500		41,060		66,560		
	3	BLDGS	3,371	SF	2,986	60,200	0	178,020		238,220		
		SUBTOTAL 0 THRU 3	1	LOT	6,881	136,700		243,130		379,830		
	4	EQUIPMENT	38	EA	3,466	73,900		9,500	1,079,900	1,163,300		
	5	PIPING	FACTO	RED	842	18,600		0	27,900	46,500		
	6	ELECTRICAL	FACTO	RED	551	10,200		0	18,900	29,100		
	7	INSTRUMENTATION	FACTO	RED	470	8,700		0	26,200	34,900		
	8	PAINTING/INSULATION	FACTO	RED	169	3,500		0	2,300	5,800		
		SUBTOTAL 5 THRU 8			2,032	41,000		0	75,300	116,300		
		TOTAL DFC			12,379	251,600	0	252,630	1,155,200	1,659,430		

000524

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – POURABLE
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
		CIVIL & EXCAVATION	669	CY	1,449	26,900		9,200				36,100
		CONCRETE	108	CY	1,231	24,100		14,850				38,950
		STEEL	8	TN	1,215	25,500		41,060				66,560
		ARCHITECTURAL / BUILDINGS / FINISHES	3,371	SF	2,986	60,200		178,020				238,220
		TOTAL	1	LOT	6,881	136,700		243,130				379,830

000525

CONSTRUCTION COSTS
DETAILS

CLIENT U.S.DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION CEMENTATION FACILITY – POURABLE
FILENAME F:\LOTUS24\8\LO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY G.WALTERS
DATE 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		CLEAR AND GRUB AREA	0.2	ACRE	26	$500		$0				
		EXCAVATION MACHINE	110	CY	119	$2,200		$0				
		EXCAVATION HAND	10	CY	58	$1,100		$0				
		BACKFILL MACHINE	100	CY	98	$1,800		$0				
		BACKFILL HAND	5	CY	26	$500		$0				
		GRAVEL ROADS	162	CY	200	$3,700		$4,300				
		PAVEMENT	111	SY	60	$1,100		$900				
		GRAVEL ROADS	150	CY	200	$3,700		$4,000				
		HAUL & DUMP STOCKPILE	132	CY	662	$12,300		$0				
		SUB-TOTAL	669	CY	1,449	$26,900		$9,200				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	669	CY	1,449	$26,900		$9,200				
		TOTAL	669	CY	1,449	$26,900		$9,200				$36,100

000526

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – POURABLE
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	83	CY	993	$19,400		$10,300				
		COLUMNS\FOUNDATIONS\EQUIPMENT PADS	20	CY	225	$4,400		$4,300				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		TOTAL	108	CY	1,231	24,100		$14,850				$38,950

000527

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – POURABLE
FILENAME: F:\LOTUS94\B\LO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		GRATING\STARIS\TOEPLATE\PLATFORMS	8	TN	960	$20,200		$28,000				
		METAL ROOFING	3,371	SF	220	$4,600		$11,960				
		EQUIPMENT LADDERS	50	LF	35	$700		$1,100				
		SUB–TOTAL	8	TN	1,215	$25,500		$41,060				
		MATERIAL TAKE–OFF 0.0%	0		0	$0		$0				
		SUB–TOTAL	8	TN	1,215	$25,500		$41,060				
		TOTAL	8	TN	1,215	$25,500		$41,060				$66,560

000528

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S.DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION CEMENTATION FACILITY – POURABLE
FILENAME F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY G.WALTERS
DATE 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		CONFINEMENT CELL 25x26x23	650	SF	232	$4,700		$13,000				
		SIDING	7,135	SF	155	$3,100		$18,500				
		MEMBRANE ROOFING	3,371	SF	181	$3,700		$9,500				
		ROOF INSULATION	3,371	SF	155	$3,100		$6,500				
		DOWNSPOUT & GUTTERS	376	LF	116	$2,300		$1,380				
		BATTEN INSULATION	3,371	SF	81	$1,600		$780				
		DOORS	7	EA	48	$1,000		$4,000				
		MOTOR OPERATED ROOL UP DOOR	2	EA	50	$1,000		$4,000				
		TRAILERS 42x10	2	EA	120	$2,400		$94,000				
		FURNISHINGS	1	LOT	80	$1,600		$10,000				
		METAL STUDS & SHEET ROCK	10,450	SF	258	$5,200		$6,500				
		LIGHTING PROTECTION	1	LOT	60	$1,200		$4,500				
		LIGHTING	3,371	SF	155	$3,100		$5,300				
		COMMUNICATIONS	3,371	SF	60	$1,200		$3,700				
		SEALERS & HARDNER	3,371	SF	85	$1,700		$3,500				
		PAINT WALLS	15,000	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB-TOTAL	3,371	SF	2,986	$60,200		$178,020				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	3,371	SF	2,986	$60,200		$178,020				
		TOTAL	**3,371**	**SF**	**2,986**	**$60,200**		**$178,020**				**$238,220**

000329

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	6,881	136,700		243,130		379,830		
	5	SYSTEM 05	HVAC	13	EA	554	11,700		9,500	156,900	178,100		
	6	SYSTEM 06	OTHER EQUIPMENT	1	SYS	230	4,900			98,900	103,800		
	12	SYSTEM 12	PROCESS SYSTEMS	16	EA	802	17,200			377,300	394,500		
	30	SYSTEM 30	ELECTRICAL EQUIPMENT	3	EA	1,260	26,800			225,000	251,800		
	61	SYSTEM 61	DCS	1	SYS	40	900			40,000	40,900		
	62	SYSTEM 62	HPS	4	EA	320	6,800			175,000	181,800		
	63/64	SYSTEM 63/64	ANALYTICAL LAB/PROCEESS	3	LOT	260	5,600			6,800	12,400		
	176		TOTAL EQUIPMENT	38	EA	3,466	73,900		9,500	1,079,900	1,163,300		
			PIPING	1	LOT	842	18,600	0	0	27,900	46,500		
			ELECTRICAL	1	LOT	551	10,200	0	0	18,900	29,100		
			INSTRUMENTATION	1	LOT	470	8,700	0	0	26,200	34,900		
			PAINTING & INSULATION	1	LOT	169	3,500	0	0	2,300	5,800		
			TOTAL BULKS			2,032	41,000	0	0	75,300	116,300		
			TOTAL DFC			12,379	251,600	0	252,630	1,155,200	1,659,430		

000530

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05	HVAC										
	5	05-HF-01	MODULAR AIR FLTR SYS 2000CFM	1	EA	90	1,900			80,000	81,900		
			HEPA INLET AIR	3	EA	60	1,300			10,200	11,500		
	5	05-EH-1 THRU 4	WALL MOUNTED AC	1	EA	10	200			1,600	1,800		
	5	05-C-01	30 TON COOLING SYSTEM	1	EA	80	1,700			18,500	20,200		
			DUCTING SYSTEM	1	LOT	60	1,200		9,500		10,700		
	5	05-STK-01	EXHAUST STACK	1	EA	40	900			3,500	4,400		
	5		AIR TREATMENT SYSTEM INCLUDES										
		300 GALLON TANK W/VENTURI SCRUBBER		1	EA	100	2,100			24,600	26,700		
		50 GAL LOW-HEAD PROGESSIVE PUMP		1	EA	20	400			6,600	7,000		
		2" 3-PORT ELE. ACTUATOR BALL VALVE		1	EA	4	100			2,800	2,900		
		200 CFM AIR DRYER		1	EA	60	1,300			4,500	5,800		
		200 CFM AIR GEAR PUMP		1	EA	10	200			4,000	4,200		
		200 CFM BLOWER		1	EA	20	400			600	1,000		
			TOTAL 05	13	EA	554	11,700	0	9,500	156,900	178,100		

000531

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION POURABLE MIX

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06	OTHER EQUIPMENT										
	6	06-SH-01	5TON BRIDGE CRANE/MONORAILS	1	SYS	160	3,400			48,000	51,400		
	6	06-LD-01	LIFTING FRAME	1	EA	20	400			3,500	3,900		
	6	06-TRK-01	FLATBED TRUCK	1	EA					13,000	13,000		
	6	06-IB-01	CEILING MNTD I-BEAM10TON HOIST	1	EA	50	1,100			34,400	35,500		
			TOTAL 06	1	SYS	230	4,900	0	0	98,900	103,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12	PROCESS SYSTEMS										
	12	12-SL-01	4,200 CUFT SILO3 w/ROTARY VANE	1	EA	155	3,300			36,000	39,300		
			VAR. SPEED FEEDER,CYCLONE										
	12	12-SL-3&4	2,100CFT SILOw/RTRY VANE	2	EA	80	1,700			50,000	51,700		
	12	12-SL-02	1,400 CUFT SILO3 w/ROTARY VANE	2	EA	210	4,500			43,000	47,500		
			VAR. SPEED FEEDER,CYCLONE										
	12	12-AU-01	18" DIA AUGER FEEDER 40' LONG	1	EA	40	900			35,000	35,900		
			w/CUSTOM ENCLOSURE SYSTEM										
	12	12-TK-01	FRESH WATER FEED SYS w/100 GAL	1	EA	60	1,300			5,200	6,500		
			ISOLATION TANK,50 GPM 100 PSI										
			CENTRIFUGAL PUMP										
	12	12-MX-01	3.28 CUYD HIGH INTENSITY MIXER	1	EA	60	1,300			173,000	174,300		
	12	12-TK-02	400 GAL RECYCLE WATER TANK	1	EA	20	400			6,600	7,000		
		ELECTRIC ACUTATOR BALL VALVE LL SENSOR INSTR.											
	12	12-PMP-01	50 GPM DIAPHRAM PUMP	1	EA	13	300			2,000	2,300		
	12	12-AG-01	TOP ENTERING 1/2HP AGITATOR	1	EA	10	200			2,000	2,200		
	12	12-WMB-01	WMB CHARGING SYSTEM	1	EA	120	2,600			17,000	19,600		
			includes:WMB elevator,5tn lift,track										
			cell charging door, sealed vestibule										
			mix system and drip pan										
			CUSTOM DRAIN	1	EA	10	200			2,000	2,200		
			CUSTOM SPLASH FUNNEL	1	EA	4	100			500	600		
			CUSTOM TITABLE CHUTE	1	EA	10	200			3,000	3,200		
			CUSTOM SLIDING DRIP PAN	1	EA	10	200			2,000	2,200		
			TOTAL 12	16	EA	[illegible]02	17,200	0	0	377,300	394,500		

000533

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30-US-1	UNIT SUBSTATION #1	1	EA	900	19,200			185,000	204,200		
	30	30-MC-1	MCC #1	1	EA	180	3,800			25,000	28,800		
	30	30-UP-1	UPS	1	EA	180	3,800			15,000	18,800		
			TOTAL 30	3	EA	1,260	26,800			225,000	251,800		

000534

8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		CONTROL/MONITOR MIX OPERATIONS	1	SYS	40	900			40,000	40,900		
		TOTAL 61	1	SYS	40	900	0	0	40,000	40,900		

000535

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 62 HPS ALLOWANCE										
		HARDWARE			320	6,800			125,000	131,800		
		SOFTWARE							50,000	50,000		
		TOTAL 62	4	EA	320	6,800	0	0	175,000	181,800		

000536

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: POURABLE MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64 ANALYTICAL LAB/PROCESS										
		SAMPLING HOLDING & INSPECTION										
		ALLOWANCE	1	LOT	220	4,700			3,000	7,700		
		GLOVE BOXES	2	EA	40	900			3,800	4,700		
		TOTAL 63/64	3	LOT	260	5,600	0	0	6,800	12,400		

000537

ATTACHMENT C.V

ALTERNATIVE 2 COST DETAILS

SUMMARY SHEET

EST FILE #:	C4-96-03-01	DATE:	19-Apr-96
CLIENT:	DOE	ESTIMATOR:	G.D.Walters
PROJECT:	SILO 3 ALTERNATIVE- CEMENT(GRANULAR)	LOCATION:	FERNALD
WBS #:	1.1.1.1.4.3.2	TASK#:	4CBAV

FERMCO ESTIMATING SERVICES

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	1,449		$26,900		$9,200	$36,100
	CONCRETE	1,231		$24,100		$14,850	$38,950
	STRUCTURAL STEEL	1,215		$25,500		$41,100	$66,600
	BUILDINGS	2,986		$60,200		$178,000	$238,200
	MACHINERY & EQUIPMENT	3,442		$73,400		$1,108,900	$1,182,300
	PIPING	856		$18,900		$28,400	$47,300
	ELECTRICAL	562		$10,400		$19,200	$29,600
	INSTRUMENTATION	481		$8,900		$26,600	$35,500
	PAINTING / INSULATION ALLOWANCE	169		$3,500		$2,400	$5,900
DIRECT FIELD COSTS		12,391		$251,800		$1,428,650	$1,680,450
SUPERVISION - CONTRACTOR		2,106		$42,800			$42,800
SM TOOLS/CONSM'BLS						$15,100	$15,100
EQUIPMENT RENTAL						$43,400	$43,400
TEMP. FACILITIES		743		$7,600		$7,600	$15,200
'P UTL'S HOOK-UP		372		$4,900		$2,600	$7,500
CLEAN-UP		743		$11,300		$3,800	$15,100
-ETY		372		$4,900		$2,600	$7,500
HEALTH PHYSICS S/C		248		$6,500		$600	$7,100
CERCLA	$800 PER PERSON			$5,500			$5,500
PAYRL BRD.&BENFT.				$191,100			$191,100
OVERHEAD & PROFIT					$406,200		$406,200
BOND					$24,400		$24,400
INDIRECT FIELD COSTS		4,585	59.90	$274,600	$430,600	$75,700	$780,900
DIRECT & INDIRECT FIELD COSTS		16,976	31.00	$526,400	$430,600	$1,504,350	$2,461,350

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		
WASTE MANAGEMENT COSTS		

PROJ.MGMT-FERMCO			$157,520	$39,380	$196,900
CONSTR MGMT-FERMCO			$492,300		$492,300
FERMCO FIELD SUPPORT COSTS			$649,800	$39,400	$689,200
E/D/I	A/E		FERMCO		$886,100
ENGINEERING COSTS					$886,100
SALES TAX - SUBCONTRACT	$82,700	SALES TAX - FERMCO	$2,200		$84,900
SUB-TOTAL (BASE ESTIMATE)					$4,121,550
RISK BUDGET	9.0%				$371,000
G&A-FERMCO (SEE EXCLUSION COMMENTS)					
ESCALATION (SEE EXCLUSION COMMENTS)					
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)					$4,492,550

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	669	CY	1,449	26,900		9,200		36,100		
	1	CONCRETE	108	CY	1,231	24,100		14,850		38,950		
	2	STEEL	8	TN	1,215	25,500		41,060		66,560		
	3	BLDGS	3,368	SF	2,986	60,200		178,020		238,220		
		SUBTOTAL 0 THRU 3	1	LOT	6,881	136,700		243,130		379,830		
	4	EQUIPMENT	34	EA	3,442	73,400		9,500	1,099,400	1,182,300		
	5	PIPING	FACTO	RED	856	18,900		0	28,400	47,300		
	6	ELECTRICAL	FACTO	RED	562	10,400		0	19,200	29,600		
	7	INSTRUMENTATION	FACTO	RED	481	8,900		0	26,600	35,500		
	8	PAINTING/INSULATION	FACTO	RED	169	3,500		0	2,400	5,900		
		SUBTOTAL 5 THRU 8			2,068	41,700		0	76,600	118,300		
		TOTAL DFC			12,391	251,800	0	252,630	1,176,000	1,680,430		

000541

-8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		CLEAR AND GRUB AREA	0.2	ACRE	26	$500		$0				
		EXCAVATION MACHINE	110	CY	119	$2,200		$0				
		EXCAVATION HAND	10	CY	58	$1,100		$0				
		BACKFILL MACHINE	100	CY	98	$1,800		$0				
		BACKFILL HAND	5	CY	26	$500		$0				
		GRAVEL ROADS	162	CY	200	$3,700		$4,300				
		PAVEMENT	111	SY	60	$1,100		$900				
		GRAVEL ROADS	150	CY	200	$3,700		$4,000				
		HAUL & DUMP STOCKPILE	132	CY	662	$12,300		$0				
		SUB–TOTAL	669	CY	1,449	$26,900		$9,200				
		MATERIAL TAKE–OFF 0.0%	0		0	$0		$0				
		SUB–TOTAL	669	CY	1,449	$26,900		$9,200				
		TOTAL	669	CY	1,449	$26,900		$9,200				$36,100

0005542

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	83	CY	993	$19,400		$10,300				
		COLUMNS\FOUNDATIONS\EQUIPMENT PADS	20	CY	225	$4,400		$4,300				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		TOTAL	108	CY	1,231	24,100		$14,850				$38,950

000543

8050

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS94\SILO3ALT\CEMENT\BLDG

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		GRATING\STARIS\TOEPLATE\PLATFORMS	8	TN	960	$20,200		$28,000				
		METAL ROOFING	3,368	SF	220	$4,600		$11,960				
		EQUIPMENT LADDERS	50	LF	35	$700		$1,100				
		SUB-TOTAL	8	TN	1,215	$25,500		$41,060				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8	TN	1,215	$25,500		$41,060				
		TOTAL	8	TN	1,215	$25,500		$41,060				$66,560

000544

CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		CONFINEMENT CELL 25x26x23	650	SF	232	$4,700		$13,000				
		SIDING	7,135	SF	155	$3,100		$18,500				
		MEMBRANE ROOFING	3,368	SF	181	$3,700		$9,500				
		ROOF INSULATION	3,368	SF	155	$3,100		$6,500				
		DOWNSPOUT & GUTTERS	376	LF	116	$2,300		$1,380				
		BATTEN INSULATION	3,368	SF	81	$1,600		$780				
		DOORS	7	EA	48	$1,000		$4,000				
		MOTOR OPERATED ROOL UP DOOR	2	EA	50	$1,000		$4,000				
		TRAILERS 42x10	2	EA	120	$2,400		$94,000				
		FURNISHINGS	1	LOT	80	$1,600		$10,000				
		METAL STUDS & SHEET ROCK	10,450	SF	258	$5,200		$6,500				
		LIGHTING PROTECTION	1	LOT	60	$1,200		$4,500				
		LIGHTING	3,368	SF	155	$3,100		$5,300				
		COMMUNICATIONS	3,368	SF	60	$1,200		$3,700				
		SEALERS & HARDNER	3,368	SF	85	$1,700		$3,500				
		PAINT WALLS	15,000	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB–TOTAL	3,368	SF	2,986	$60,200		$178,020				
		MATERIAL TAKE–OFF 0.0%	0		0	$0		$0				
		SUB–TOTAL	3,368	SF	2,986	$60,200		$178,020				
		TOTAL	3,368	SF	2,986	$60,200		$178,020				$238,220

000545

8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	6,881	136,700		243,130		379,830		
	5	SYSTEM 05	HVAC	13	EA	564	11,900		9,500	196,900	218,300		
	6	SYSTEM 06	OTHER EQUIPMENT	1	SYS	230	4,900			85,900	90,800		
	12	SYSTEM 12	PROCESS SYSTEMS	12	EA	768	16,500			369,800	386,300		
	30	SYSTEM 30	ELECTRICAL EQUIPMENT	3	EA	1,260	26,800			225,000	251,800		
	61	SYSTEM 61	DCS	1	SYS	40	900			40,000	40,900		
	62	SYSTEM 62	HPS	4	EA	320	6,800			175,000	181,800		
	63/64	SYSTEM 63/64	ANALYTICAL LAB/PROCEESS	3	LOT	260	5,600			6,800	12,400		
	176		TOTAL EQUIPMENT	34	EA	3,442	73,400		9,500	1,099,400	1,182,300		
			PIPING	1	LOT	856	18,900	0	0	28,400	47,300		
			ELECTRICAL	1	LOT	562	10,400	0	0	19,200	29,600		
			INSTRUMENTATION	1	LOT	481	8,900	0	0	26,600	35,500		
			PAINTING & INSULATION	1	LOT	169	3,500	0	0	2,400	5,900		
			TOTAL BULKS			2,068	41,700	0	0	76,600	118,300		
			TOTAL DFC			12,391	251,800	0	252,630	1,176,000	1,680,430		

000546

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05	HVAC										
	5	05-HF-01	MODULAR AIR FLTR SYS 2000CFM	1	EA	100	2,100			120,000	122,100		
			HEPA INLET AIR	3	EA	60	1,300			10,200	11,500		
	5	05-EH-1 THRU 4	WALL MOUNTED AC	1	EA	10	200			1,600	1,800		
	5	05-C-01	30 TON COOLING SYSTEM	1	EA	80	1,700			18,500	20,200		
			DUCTING SYSTEM	1	LOT	60	1,200		9,500		10,700		
	5	05-STK-01	EXHAUST STACK	1	EA	40	900			3,500	4,400		
	5		AIR TREATMENT SYSTEM INCLUDES										
		300 GALLON TANK W/VENTURI SCRUBBER		1	EA	100	2,100			24,600	26,700		
		50 GAL LOW-HEAD PROGESSIVE PUMP		1	EA	20	400			6,600	7,000		
		2" 3-PORT ELE. ACTUATOR BALL VALVE		1	EA	4	100			2,800	2,900		
		200 CFM AIR DRYER		1	EA	60	1,300			4,500	5,800		
		200 CFM AIR GEAR PUMP		1	EA	10	200			4,000	4,200		
		200 CFM BLOWER		1	EA	20	400			600	1,000		
			TOTAL 05	13	EA	564	11,900	0	9,500	196,900	218,300		

000547

-8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO.3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06	OTHER EQUIPMENT										
	6	06-SH-01	5TON BRIDGE CRANE/MONORAILS	1	SYS	160	3,400			48,000	51,400		
	6	06-LD-01	LIFTING FRAME	1	EA	20	400			3,500	3,900		
	6	06-IB-01	CEILING MNTD I-BEAM10TON HOIST	1	EA	50	1,100			34,400	35,500		
			TOTAL 06	1	SYS	230	4,900	0	0	85,900	90,800		

000548

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12 PROCESS SYSTEMS										
	12	12-SL-01 4,200 CUFT SILO3 w/ROTARY VANE	1	EA	155	3,300			36,000	39,300		
		VAR. SPEED FEEDER,CYCLONE										
		12-SL-3&4 2,100 CUFT SILO3 w/ROTARY VANE	2	EA	80	1,700			50,000	51,700		
	12	12-SL-02 1,400 CUFT SILO3 w/ROTARY VANE	2	EA	210	4,500			43,000	47,500		
		VAR. SPEED FEEDER,CYCLONE										
	12	12-AU-01 18" DIA AUGER FEEDER 40' LONG	1	EA	40	900			35,000	35,900		
		w/CUSTOM ENCLOSURE SYSTEM										
	12	12-TK-01 FRESH WATER FEED SYS w/100 GAL	1	EA	60	1,300			5,200	6,500		
		ISOLATION TANK,50 GPM 100 PSI										
		CENTRIFUGAL PUMP										
	12	12-MX-01 3.28 CUYD HIGH INTENSITY MIXER	1	EA	60	1,300			173,000	174,300		
	12	12-TK-02 400 GAL RECYCLE WATER TANK	1	EA	20	400			6,600	7,000		
		ELECTRIC ACUTATOR BALL VALVE LL SENSOR INSTR.										
	12	12-PMP-01 50 GPM DIAPHRAM PUMP	1	EA	13	300			2,000	2,300		
	12	12-AG-01 TOP ENTERING 1/2HP AGITATOR	1	EA	10	200			2,000	2,200		
	12	12-WMB-01 WMB CHARGING SYSTEM	1	EA	120	2,600			17,000	19,600		
		Includes:WMB elevator,5tn lift,track										
		cell charging door, sealed vestibule										
		mix system and drip pan										
		TOTAL 12	12	EA	768	16,500	0	0	369,800	386,300		

000549

1-80 50

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30-US-1	UNIT SUBSTATION #1	1	EA	900	19,200			185,000	204,200		
	30	30-MC-1	MCC #1	1	EA	180	3,800			25,000	28,800		
	30	30-UP-1	UPS	1	EA	180	3,800			15,000	18,800		
			TOTAL 30	3	EA	1,260	26,800			225,000	251,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		CONTROL/MONITOR MIX OPERATIONS	1	SYS	40	900			40,000	40,900		
		TOTAL 61	1	SYS	40	900	0	0	40,000	40,900		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 62 HPS ALLOWANCE										
		HARDWARE			320	6,800			125,000	131,800		
		SOFTWARE							50,000	50,000		
		TOTAL 62	4	EA	320	6,800	0	0	175,000	181,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/19/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64 ANALYTICAL LAB/PROCESS										
		SAMPLING HOLDING & INSPECTION										
		ALLOWANCE	1	LOT	220	4,700			3,000	7,700		
		GLOVE BOXES	2	EA	40	900			3,800	4,700		
		TOTAL 63/64	3	LOT	260	5,600	0	0	6,800	12,400		

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ATTACHMENT C.VI

ALTERNATIVE 3 COST DETAILS

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SUMMARY SHEET

FILE #: C4-96-03-01
CLIENT: DOE
PROJECT: SILO 3 ALT.- SILO 3 MATERIAL GRANULAR
WBS #: 1.1.1.1.4.3.2

FERMCO
ESTIMATING SERVICES

DATE: 19-Apr-96
ESTIMATOR: G.D.Walters
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	1,389		$25,800		$8,300	$34,100
	CONCRETE	1,231		$24,100		$14,850	$38,950
	STRUCTURAL STEEL	1,215		$25,500		$41,100	$66,600
	BUILDINGS	2,986		$60,200		$178,000	$238,200
	MACHINERY & EQUIPMENT	3,352		$71,500		$1,070,400	$1,141,900
	PIPING	828		$18,300		$27,400	$45,700
	ELECTRICAL	540		$10,000		$18,500	$28,500
	INSTRUMENTATION	465		$8,600		$25,700	$34,300
	PAINTING / INSULATION ALLOWANCE	164		$3,400		$2,300	$5,700
DIRECT FIELD COSTS		12,170		$247,400		$1,386,550	$1,633,950
SUPERVISION - CONTRACTOR		2,069		$42,100			$42,100
SM TOOLS/CONSM'BLS						$14,800	$14,800
EQUIPMENT RENTAL						$42,600	$42,600
TEMP. FACILITIES		730		$7,400		$7,400	$14,800
'P UTL'S HOOK-UP		365		$4,800		$2,600	$7,400
CLEAN-UP		730		$11,100		$3,700	$14,800
LTY		365		$4,800		$2,600	$7,400
ALTH PHYSICS S/C		243		$6,400		$600	$7,000
CERCLA	$800 PER PERSON			$5,400			$5,400
PAYRL BRD.&BENFT.				$187,800			$187,800
OVERHEAD & PROFIT					$395,600		$395,600
BOND					$23,700		$23,700
INDIRECT FIELD COSTS		4,503	59.90	$269,800	$419,300	$74,300	$763,400
DIRECT & INDIRECT FIELD COSTS		16,673	31.00	$517,200	$419,300	$1,460,850	$2,397,350

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		
WASTE MANAGEMENT COSTS		

PROJ.MGMT-FERMCO				$153,440	$38,360	$191,800
CONSTR MGMT-FERMCO				$479,500		$479,500
FERMCO FIELD SUPPORT COSTS				$632,900	$38,400	$671,300
E/D/I	A/E			FERMCO		$863,000
ENGINEERING COSTS						$863,000
SALES TAX - SUBCONTRACT	$80,300		SALES TAX - FERMCO	$2,100		$82,400
SUB-TOTAL (BASE ESTIMATE)						$4,014,050
RISK BUDGET	9.0%					$361,000
G&A-FERMCO (SEE EXCLUSION COMMENTS)						
ESCALATION (SEE EXCLUSION COMMENTS)						
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)						$4,375,050

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	669	CY	1,389	25,800		8,300		34,100		
	1	CONCRETE	108	CY	1,231	24,100		14,850		38,950		
	2	STEEL	8	TN	1,215	25,500		41,060		66,560		
	3	BLDGS	3,371	SF	2,986	60,200		178,020		238,220		
		SUBTOTAL 0 THRU 3	1	LOT	6,821	135,600		242,230		377,830		
	4	EQUIPMENT	33	EA	3,352	71,500		9,500	1,060,900	1,141,900		
	5	PIPING	FACTO	RED	828	18,300		0	27,400	45,700		
	6	ELECTRICAL	FACTO	RED	540	10,000		0	18,500	28,500		
	7	INSTRUMENTATION	FACTO	RED	465	8,600		0	25,700	34,300		
	8	PAINTING/INSULATION	FACTO	RED	164	3,400		0	2,300	5,700		
		SUBTOTAL 5 THRU 8			1,997	40,300		0	73,900	114,200		
		TOTAL DFC			12,170	247,400	0	251,730	1,134,800	1,633,930		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FCLTY-SILO3 MATERIAL
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
		CIVIL & EXCAVATION	669	CY	1,389	25,800		8,300				34,100
		CONCRETE	108	CY	1,231	24,100		14,850				38,950
		STEEL	8	TN	1,215	25,500		41,060				66,560
		ARCHITECTURAL / BUILDINGS / FINISHES	3,371	SF	2,986	60,200		178,020				238,220
		TOTAL	1	LOT	6,821	135,600		242,230				377,830

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FCLTY-SILO3 MATERIAL
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		CLEAR AND GRUB AREA	0.2	ACRE	26	$500		$0				
		EXCAVATION MACHINE	110	CY	119	$2,200		$0				
		EXCAVATION HAND	10	CY	58	$1,100		$0				
		BACKFILL MACHINE	100	CY	98	$1,800		$0				
		BACKFILL HAND	5	CY	26	$500		$0				
		GRAVEL ROADS	162	CY	200	$3,700		$4,300				
		GRAVEL ROADS	150	CY	200	$3,700		$4,000				
		HAUL & DUMP STOCKPILE	132	CY	662	$12,300		$0				
		SUB-TOTAL	669	CY	1,389	$25,800		$8,300				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	669	CY	1,389	$25,800		$8,300				
		TOTAL	669	CY	1,389	$25,800		$8,300				$34,100

CONSTRUCTION COSTS
DETAILS

CLIENT U.S.DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION CEMENTATION FCLTY-SILO3 MATERIAL
FILENAME F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY G.WALTERS
DATE 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	83	CY	993	$19,400		$10,300				
		COLUMNS\FOUNDATIONS\EQUIPMENT PADS	20	CY	225	$4,400		$4,300				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		TOTAL	108	CY	1,231	24,100		$14,850				$38,950

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FCLTY-SILO3 MATERIAL
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		GRATING\STARIS\TOEPLATE\PLATFORMS	8	TN	960	$20,200		$28,000				
		METAL ROOFING	3,371	SF	220	$4,600		$11,960				
		EQUIPMENT LADDERS	50	LF	35	$700		$1,100				
		SUB-TOTAL	8	TN	1,215	$25,500		$41,060				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8	TN	1,215	$25,500		$41,060				
		TOTAL	8	TN	1,215	$25,500		$41,060				$66,560

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FCLTY-SILO3 MATERIAL
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 04/18/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		CONFINEMENT CELL 25x26x23	650	SF	232	$4,700		$13,000				
		SIDING	7,135	SF	155	$3,100		$18,500				
		MEMBRANE ROOFING	3,371	SF	181	$3,700		$9,500				
		ROOF INSULATION	3,371	SF	155	$3,100		$6,500				
		DOWNSPOUT & GUTTERS	376	LF	116	$2,300		$1,380				
		BATTEN INSULATION	3,371	SF	81	$1,600		$780				
		DOORS	7	EA	48	$1,000		$4,000				
		MOTOR OPERATED ROOL UP DOOR	2	EA	50	$1,000		$4,000				
		TRAILERS 42x10	2	EA	120	$2,400		$94,000				
		FURNISHINGS	1	LOT	80	$1,600		$10,000				
		METAL STUDS & SHEET ROCK	10,450	SF	258	$5,200		$6,500				
		LIGHTING PROTECTION	1	LOT	60	$1,200		$4,500				
		LIGHTING	3,371	SF	155	$3,100		$5,300				
		COMMUNICATIONS	3,371	SF	60	$1,200		$3,700				
		SEALERS & HARDNER	3,371	SF	85	$1,700		$3,500				
		PAINT WALLS	15,000	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB-TOTAL	3,371	SF	2,986	$60,200		$178,020				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	3,371	SF	2,986	$60,200		$178,020				
		TOTAL	3,371	SF	2,986	$60,200		$178,020				$238,220

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	6,821	135,600		242,230		377,830		
	5	SYSTEM 05	HVAC	13	EA	564	11,900		9,500	196,900	218,300		
	6	SYSTEM 06	OTHER EQUIPMENT	1	SYS	230	4,900			85,900	90,800		
	12	SYSTEM 12	PROCESS SYSTEMS	11	EA	678	14,600			331,300	345,900		
	30	SYSTEM 30	ELECTRICAL EQUIPMENT	3	EA	1,260	26,800			225,000	251,800		
	61	SYSTEM 61	DCS	1	SYS	40	900			40,000	40,900		
	62	SYSTEM 62	HPS	4	EA	320	6,800			175,000	181,800		
	63/64	SYSTEM 63/64	ANALYTICAL LAB/PROCEESS	3	LOT	260	5,600			6,800	12,400		
	176		TOTAL EQUIPMENT	33	EA	3,352	71,500		9,500	1,060,900	1,141,900		
			PIPING	1	LOT	828	18,300	0	0	27,400	45,700		
			ELECTRICAL	1	LOT	540	10,000	0	0	18,500	28,500		
			INSTRUMENTATION	1	LOT	465	8,600	0	0	25,700	34,300		
			PAINTING & INSULATION	1	LOT	164	3,400	0	0	2,300	5,700		
			TOTAL BULKS			1,997	40,300	0	0	73,900	114,200		
			TOTAL DFC			12,170	247,400	0	251,730	1,134,800	1,633,930		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05	HVAC										
	5	05-HF-01	MODULAR AIR FLTR SYS 2000CFM	1	EA	100	2,100			120,000	122,100		
			HEPA INLET AIR	3	EA	60	1,300			10,200	11,500		
	5	05-EH-1 THRU 4	WALL MOUNTED AC	1	EA	10	200			1,600	1,800		
	5	05-C-01	30 TON COOLING SYSTEM	1	EA	80	1,700			18,500	20,200		
			DUCTING SYSTEM	1	LOT	60	1,200		9,500		10,700		
	5	05-STK-01	EXHAUST STACK	1	EA	40	900			3,500	4,400		
	5		AIR TREATMENT SYSTEM INCLUDES										
		300 GALLON TANK W/VENTURI SCRUBBER		1	EA	100	2,100			24,600	26,700		
		50 GAL LOW-HEAD PROGESSIVE PUMP		1	EA	20	400			6,600	7,000		
		2" 3-PORT ELE. ACTUATOR BALL VALVE		1	EA	4	100			2,800	2,900		
		200 CFM AIR DRYER		1	EA	60	1,300			4,500	5,800		
		200 CFM AIR GEAR PUMP		1	EA	10	200			4,000	4,200		
		200 CFM BLOWER		1	EA	20	400			600	1,000		
			TOTAL 05	13	EA	564	11,900	0	9,500	196,900	218,300		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06	OTHER EQUIPMENT										
	6	06-SH-01	5TON BRIDGE CRANE/MONORAILS	1	SYS	160	3,400			48,000	51,400		
	6	06-LD-01	LIFTING FRAME	1	EA	20	400			3,500	3,900		
	6	06-IB-01	CEILING MNTD I-BEAM10TON HOIST	1	EA	50	1,100			34,400	35,500		
			TOTAL 06	1	SYS	230	4,900	0	0	85,900	90,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12	PROCESS SYSTEMS										
	12	12-SL-01	4,200 CUFT SILO3 w/ROTARY VANE	1	EA	155	3,300			36,000	39,300		
			VAR. SPEED FEEDER,CYCLONE										
	12	12-SL-2&3	2,100 CUFT SILO3 w/ROTARY VANE	2	EA	80	1,700			50,000	51,700		
	12	12-SST-01	SODIUM SILICATE 1,000 GAL TANK	1	EA	120	2,600			4,500	7,100		
			w/50GPM 100 PSI FEED PUMP&PIPE										
	12	12-AU-01	18" DIA AUGER FEEDER 40' LONG	1	EA	40	900			35,000	35,900		
			w/CUSTOM ENCLOSURE SYSTEM										
	12	12-TK-01	FRESH WATER FEED SYS w/100 GAL	1	EA	60	1,300			5,200	6,500		
			ISOLATION TANK,50 GPM 100 PSI										
			CENTRIFUGAL PUMP										
	12	12-MX-01	3.28 CUYD HIGH INTENSITY MIXER	1	EA	60	1,300			173,000	174,300		
	12	12-TK-02	400 GAL RECYCLE WATER TANK	1	EA	20	400			6,600	7,000		
		ELECTRIC ACUTATOR BALL VALVE LL SENSOR INSTR.											
	12	12-PMP-01	50 GPM DIAPHRAM PUMP	1	EA	13	300			2,000	2,300		
	12	12-AG-01	TOP ENTERING 1/2HP AGITATOR	1	EA	10	200			2,000	2,200		
	12	12-WMB-01	WMB CHARGING SYSTEM	1	EA	120	2,600			17,000	19,600		
			includes:WMB elevator,5tn lift,track										
			cell charging door, sealed vestibule										
			mix system and drip pan										
		TOTAL 12		11	EA	[illegible]78	14,600	0	0	331,300	345,900		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30-US-1	UNIT SUBSTATION #1	1	EA	900	19,200			185,000	204,200		
	30	30-MC-1	MCC #1	1	EA	180	3,800			25,000	28,800		
	30	30-UP-1	UPS	1	EA	180	3,800			15,000	18,800		
			TOTAL 30	3	EA	1,260	26,800			225,000	251,800		

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-8050

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		CONTROL/MONITOR MIX OPERATIONS	1	SYS	40	900			40,000	40,900		
		TOTAL 61	1	SYS	40	900	0	0	40,000	40,900		

000569

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 62 HPS ALLOWANCE										
		HARDWARE			320	6,800			125,000	131,800		
		SOFTWARE							50,000	50,000		
		TOTAL 62	4	EA	320	6,800	0	0	175,000	181,800		

000520

-8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR – SILO 3 MATERIAL
F:\LOTUS34\SILO3ALT\CEMENT\SL3MTEQ.WK3

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 04/18/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64 ANALYTICAL LAB/PROCESS										
		SAMPLING HOLDING & INSPECTION										
		ALLOWANCE	1	LOT	220	4,700			3,000	7,700		
		GLOVE BOXES	2	EA	40	900			3,800	4,700		
		TOTAL 63/64	3	LOT	260	5,600	0	0	6,800	12,400		

000571

ATTACHMENT C.VII

SENSITIVITY ANALYSIS FOR ALTERNATIVE 2 COST DETAILS

SUMMARY SHEET

FILE #:	C4-96-03-01	DATE:	24-Jun-96
CLIENT:	DOE	ESTIMATOR:	G.D.Walters
PROJECT:	SILO 3 ALT.- CEMENT(GRANULAR) w/oVACUUM EXTRUSION	LOCATION:	FERNALD
WBS #:	1.1.1.1.4.3.2	TASK#:	4CBAV

FERMCO ESTIMATING SERVICES

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	1,449		$26,900		$9,200	$36,100
	CONCRETE	1,231		$24,100		$14,850	$38,950
	STRUCTURAL STEEL	1,215		$25,500		$41,100	$66,600
	BUILDINGS	2,986		$60,200		$178,000	$238,200
	MACHINERY & EQUIPMENT	3,442		$73,400		$1,108,900	$1,182,300
	PIPING	856		$18,900		$28,400	$47,300
	ELECTRICAL	562		$10,400		$19,200	$29,600
	INSTRUMENTATION	481		$8,900		$26,600	$35,500
	PAINTING / INSULATION ALLOWANCE	169		$3,500		$2,400	$5,900
DIRECT FIELD COSTS		12,391		$251,800		$1,428,650	$1,680,450
SUPERVISION - CONTRACTOR		2,106		$42,800			$42,800
SM TOOLS/CONSM'BLS						$15,100	$15,100
EQUIPMENT RENTAL						$43,400	$43,400
TEMP. FACILITIES		743		$7,600		$7,600	$15,200
'P UTL'S HOOK-UP		372		$4,900		$2,600	$7,500
CLEAN-UP		743		$11,300		$3,800	$15,100
ETY		372		$4,900		$2,600	$7,500
HEALTH PHYSICS S/C		248		$6,500		$600	$7,100
CERCLA	$800 PER PERSON			$5,500			$5,500
PAYRL BRD.&BENFT.				$191,100			$191,100
OVERHEAD & PROFIT					$406,200		$406,200
BOND					$24,400		$24,400
INDIRECT FIELD COSTS		4,585	59.90	$274,600	$430,600	$75,700	$780,900
DIRECT & INDIRECT FIELD COSTS		16,976	31.00	$526,400	$430,600	$1,504,350	$2,461,350

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		
WASTE MANAGEMENT COSTS		

PROJ.MGMT-FERMCO	$157,520	$39,380	$196,900
CONSTR MGMT-FERMCO	$492,300		$492,300
FERMCO FIELD SUPPORT COSTS	$649,800	$39,400	$689,200
E/D/I A/E	FERMCO		$886,100
ENGINEERING COSTS			$886,100

SALES TAX - SUBCONTRACT	$82,700		SALES TAX - FERMCO	$2,200		$84,900
SUB-TOTAL (BASE ESTIMATE)						$4,121,550

RISK BUDGET	9.0%	$371,000
G&A-FERMCO	(SEE EXCLUSION COMMENTS)	
ESCALATION	(SEE EXCLUSION COMMENTS)	

TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET) $4,492,550

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	669	CY	1,449	26,900		9,200		36,100		
	1	CONCRETE	108	CY	1,231	24,100		14,850		38,950		
	2	STEEL	8	TN	1,215	25,500		41,060		66,560		
	3	BLDGS	3,368	SF	2,986	60,200		178,020		238,220		
		SUBTOTAL 0 THRU 3	1	LOT	6,881	136,700		243,130		379,830		
	4	EQUIPMENT	34	EA	3,442	73,400		9,500	1,099,400	1,182,300		
	5	PIPING	FACTO	RED	856	18,900		0	28,400	47,300		
	6	ELECTRICAL	FACTO	RED	562	10,400		0	19,200	29,600		
	7	INSTRUMENTATION	FACTO	RED	481	8,900		0	26,600	35,500		
	8	PAINTING/INSULATION	FACTO	RED	169	3,500		0	2,400	5,900		
		SUBTOTAL 5 THRU 8			2,068	41,700		0	76,600	118,300		
		TOTAL DFC			12,391	251,800	0	252,630	1,176,000	1,680,430		

000575

- 8050

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\BILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		CLEAR AND GRUB AREA	0.2	ACRE	26	$500		$0				
		EXCAVATION MACHINE	110	CY	119	$2,200		$0				
		EXCAVATION HAND	10	CY	58	$1,100		$0				
		BACKFILL MACHINE	100	CY	98	$1,800		$0				
		BACKFILL HAND	5	CY	26	$500		$0				
		GRAVEL ROADS	162	CY	200	$3,700		$4,300				
		PAVEMENT	111	SY	60	$1,100		$900				
		GRAVEL ROADS	150	CY	200	$3,700		$4,000				
		HAUL & DUMP STOCKPILE	132	CY	662	$12,300		$0				
		SUB-TOTAL	669	CY	1,449	$26,900		$9,200				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	669	CY	1,449	$26,900		$9,200				
		TOTAL	669	CY	1,449	$26,900		$9,200				$36,100

000576

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	83	CY	993	$19,400		$10,300				
		COLUMNS\FOUNDATIONS\EQUIPMENT PADS	20	CY	225	$4,400		$4,300				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		TOTAL	**108**	**CY**	**1,231**	**24,100**		**$14,850**				**$38,950**

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CONSTRUCTION COSTS
DETAILS

TOTAL DIRECT COST

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\B\LO3ALT\CEMENT\BLDG

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		GRATING\STARIS\TOEPLATE\PLATFORMS	8	TN	960	$20,200		$28,000				
		METAL ROOFING	3,368	SF	220	$4,600		$11,960				
		EQUIPMENT LADDERS	50	LF	35	$700		$1,100				
		SUB-TOTAL	8	TN	1,215	$25,500		$41,060				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	8	TN	1,215	$25,500		$41,060				
		TOTAL	8	TN	1,215	$25,500		$41,060				$66,560

000528

CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		CONFINEMENT CELL 25x26x23	650	SF	232	$4,700		$13,000				
		SIDING	7,135	SF	155	$3,100		$18,500				
		MEMBRANE ROOFING	3,368	SF	181	$3,700		$9,500				
		ROOF INSULATION	3,368	SF	155	$3,100		$6,500				
		DOWNSPOUT & GUTTERS	376	LF	116	$2,300		$1,380				
		BATTEN INSULATION	3,368	SF	81	$1,600		$780				
		DOORS	7	EA	48	$1,000		$4,000				
		MOTOR OPERATED ROOL UP DOOR	2	EA	50	$1,000		$4,000				
		TRAILERS 42x10	2	EA	120	$2,400		$94,000				
		FURNISHINGS	1	LOT	80	$1,600		$10,000				
		METAL STUDS & SHEET ROCK	10,450	SF	258	$5,200		$6,500				
		LIGHTING PROTECTION	1	LOT	60	$1,200		$4,500				
		LIGHTING	3,368	SF	155	$3,100		$5,300				
		COMMUNICATIONS	3,368	SF	60	$1,200		$3,700				
		SEALERS & HARDNER	3,368	SF	85	$1,700		$3,500				
		PAINT WALLS	15,000	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB-TOTAL	3,368	SF	2,986	$60,200		$178,020				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	3,368	SF	2,986	$60,200		$178,020				
		TOTAL	3,368	SF	2,986	$60,200		$178,020				$238,220

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	6,881	136,700		243,130		379,830		
	5	SYSTEM 05	HVAC	13	EA	564	11,900		9,500	196,900	218,300		
	6	SYSTEM 06	OTHER EQUIPMENT	1	SYS	230	4,900			85,900	90,800		
	12	SYSTEM 12	PROCESS SYSTEMS	12	EA	768	16,500			369,800	386,300		
	30	SYSTEM 30	ELECTRICAL EQUIPMENT	3	EA	1,260	26,800			225,000	251,800		
	61	SYSTEM 61	DCS	1	SYS	40	900			40,000	40,900		
	62	SYSTEM 62	HPS	4	EA	320	6,800			175,000	181,800		
	63/64	SYSTEM 63/64	ANALYTICAL LAB/PROCEESS	3	LOT	260	5,600			6,800	12,400		
	176		TOTAL EQUIPMENT	34	EA	3,442	73,400		9,500	1,099,400	1,182,300		
			PIPING	1	LOT	856	18,900	0	0	28,400	47,300		
			ELECTRICAL	1	LOT	562	10,400	0	0	19,200	29,600		
			INSTRUMENTATION	1	LOT	481	8,900	0	0	26,600	35,500		
			PAINTING & INSULATION	1	LOT	169	3,500	0	0	2,400	5,900		
			TOTAL BULKS			2,068	41,700	0	0	76,600	118,300		
			TOTAL DFC			12,391	251,800	0	252,630	1,176,000	1,680,430		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05 HVAC										
	5	05-HF-01 MODULAR AIR FLTR SYS 2000CFM	1	EA	100	2,100			120,000	122,100		
		HEPA INLET AIR	3	EA	60	1,300			10,200	11,500		
	5	05-EH-1 THRU 4 WALL MOUNTED AC	1	EA	10	200			1,600	1,800		
	5	05-C-01 30 TON COOLING SYSTEM	1	EA	80	1,700			18,500	20,200		
		DUCTING SYSTEM	1	LOT	60	1,200		9,500		10,700		
	5	05-STK-01 EXHAUST STACK	1	EA	40	900			3,500	4,400		
	5	AIR TREATMENT SYSTEM INCLUDES										
		300 GALLON TANK W/VENTURI SCRUBBER	1	EA	100	2,100			24,600	26,700		
		50 GAL LOW-HEAD PROGESSIVE PUMP	1	EA	20	400			6,600	7,000		
		2" 3-PORT ELE. ACTUATOR BALL VALVE	1	EA	4	100			2,800	2,900		
		200 CFM AIR DRYER	1	EA	60	1,300			4,500	5,800		
		200 CFM AIR GEAR PUMP	1	EA	10	200			4,000	4,200		
		200 CFM BLOWER	1	EA	20	400			600	1,000		
		TOTAL 05	13	EA	564	11,900	0	9,500	196,900	218,300		

000581

-8050

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06 OTHER EQUIPMENT										
	6	06-SH-01 5TON BRIDGE CRANE/MONORAILS	1	SYS	160	3,400			48,000	51,400		
	6	06-LD-01 LIFTING FRAME	1	EA	20	400			3,500	3,900		
	6	06-IB-01 CEILING MNTD I-BEAM10TON HOIST	1	EA	50	1,100			34,400	35,500		
		TOTAL 06	1	SYS	230	4,900	0	0	85,900	90,800		

000582

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12	PROCESS SYSTEMS										
	12	12-SL-01	4,200 CUFT SILO3 w/ROTARY VANE	1	EA	155	3,300			36,000	39,300		
			VAR. SPEED FEEDER,CYCLONE										
	12	12-SL-3&4	2,100CFT SILOw/RTRY VANE	2	EA	80	1,700			50,000	51,700		
	12	12-SL-02	1,400 CUFT SILO3 w/ROTARY VANE	2	EA	210	4,500			43,000	47,500		
			VAR. SPEED FEEDER,CYCLONE										
	12	12-AU-01	18" DIA AUGER FEEDER 40' LONG	1	EA	40	900			35,000	35,900		
			w/CUSTOM ENCLOSURE SYSTEM										
	12	12-TK-01	FRESH WATER FEED SYS w/100 GAL	1	EA	60	1,300			5,200	6,500		
			ISOLATION TANK,50 GPM 100 PSI										
			CENTRIFUGAL PUMP										
	12	12-MX-01	3.28 CUYD HIGH INTENSITY MIXER	1	EA	60	1,300			173,000	174,300		
	12	12-TK-02	400 GAL RECYCLE WATER TANK	1	EA	20	400			6,600	7,000		
		ELECTRIC ACUTATOR BALL VALVE LL SENSOR INSTR.											
	12	12-PMP-01	50 GPM DIAPHRAM PUMP	1	EA	13	300			2,000	2,300		
	12	12-AG-01	TOP ENTERING 1/2HP AGITATOR	1	EA	10	200			2,000	2,200		
	12	12-WMB-01	WMB CHARGING SYSTEM	1	EA	120	2,600			17,000	19,600		
			includes:WMB elevator,5tn lift,track										
			cell charging door, sealed vestibule										
			mix system and drip pan										
			TOTAL 12	12	EA	768	16,500	0	0	369,800	386,300		

000583

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30-US-1	UNIT SUBSTATION #1	1	EA	900	19,200			185,000	204,200		
	30	30-MC-1	MCC #1	1	EA	180	3,800			25,000	28,800		
	30	30-UP-1	UPS	1	EA	180	3,800			15,000	18,800		
			TOTAL 30	3	EA	1,260	26,800			225,000	251,800		

000584

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		CONTROL/MONITOR MIX OPERATIONS	1	SYS	40	900			40,000	40,900		
		TOTAL 61	1	SYS	40	900	0	0	40,000	40,900		

000585

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 62 HPS ALLOWANCE										
		HARDWARE			320	6,800			125,000	131,800		
		SOFTWARE							50,000	50,000		
		TOTAL 62	4	EA	320	6,800	0	0	175,000	181,800		

985000

000586

CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX w/o VACUUM EXTRUSION
F:\LOTUS34\SILO3ALT\CEMENT\CMTEQP.WK3

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64 ANALYTICAL LAB/PROCESS										
		SAMPLING HOLDING & INSPECTION										
		ALLOWANCE	1	LOT	220	4,700			3,000	7,700		
		GLOVE BOXES	2	EA	40	900			3,800	4,700		
		TOTAL 63/64	3	LOT	260	5,600	0	0	6,800	12,400		

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SUMMARY SHEET

FILE #: C4-96-03-01
CLIENT: DOE
PROJECT: SILO 3 ALT.- CEMENT(GRANULAR) w/VACUUM EXTRUSION
WBS #: 1.1.1.1.4.3.2

FERMCO ESTIMATING SERVICES

DATE: 24-Jun-96
ESTIMATOR: G.D.Walters
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
	CIVIL & EXCAVATION	1,449		$26,900		$9,200	$36,100
	CONCRETE	1,231		$24,100		$14,850	$38,950
	STRUCTURAL STEEL	1,215		$25,500		$41,100	$66,600
	BUILDINGS	2,986		$60,200		$178,000	$238,200
	MACHINERY & EQUIPMENT	3,442		$73,400		$935,900	$1,009,300
	PIPING	733		$16,200		$24,200	$40,400
	ELECTRICAL	475		$8,800		$16,400	$25,200
	INSTRUMENTATION	411		$7,600		$22,700	$30,300
	PAINTING / INSULATION ALLOWANCE	145		$3,000		$2,000	$5,000
DIRECT FIELD COSTS		12,087		$245,700		$1,244,350	$1,490,050
SUPERVISION - CONTRACTOR		2,055		$41,800			$41,800
SM TOOLS/CONSM'BLS						$14,700	$14,700
EQUIPMENT RENTAL						$42,300	$42,300
TEMP. FACILITIES		725		$7,400		$7,400	$14,800
MP UTL'S HOOK-UP		363		$4,800		$2,600	$7,400
CLEAN-UP		725		$11,100		$3,700	$14,800
ETY		363		$4,800		$2,600	$7,400
ALTH PHYSICS S/C		242		$6,300		$600	$6,900
CERCLA	$800 PER PERSON			$5,300			$5,300
PAYRL BRD.&BENFT.				$186,500			$186,500
OVERHEAD & PROFIT					$366,400		$366,400
BOND					$22,000		$22,000
INDIRECT FIELD COSTS		4,472	59.90	$268,000	$388,400	$73,900	$730,300
DIRECT & INDIRECT FIELD COSTS		16,559	31.00	$513,700	$388,400	$1,318,250	$2,220,350

	QTY	$
WASTE CONTAINERS		
CERTIFICATION		
TRANSPORTATION		
BURIAL		
RECYCLING		
STORAGE		

WASTE MANAGEMENT COSTS					
PROJ.MGMT-FERMCO			$142,080	$35,520	$177,600
CONSTR MGMT-FERMCO			$444,100		$444,100
FERMCO FIELD SUPPORT COSTS			$586,200	$35,500	$621,700
E/D/I	A/E		FERMCO		$799,300
ENGINEERING COSTS					$799,300
SALES TAX - SUBCONTRACT	$72,500		SALES TAX - FERMCO	$2,000	$74,500
SUB-TOTAL (BASE ESTIMATE)					$3,715,850
RISK BUDGET	9.0%				$334,000
G&A-FERMCO	(SEE EXCLUSION COMMENTS)				
ESCALATION	(SEE EXCLUSION COMMENTS)				
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)					$4,049,850

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX – VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		ACCOUNT SUMMARY										
	0	CIVIL	669	CY	1,449	26,900		9,200		36,100		
	1	CONCRETE	108	CY	1,231	24,100		14,850		38,950		
	2	STEEL	8	TN	1,215	25,500		41,060		66,560		
	3	BLDGS	3,368	SF	2,986	60,200		178,020		238,220		
		SUBTOTAL 0 THRU 3	1	LOT	6,881	136,700		243,130		379,830		
	4	EQUIPMENT	34	EA	3,442	73,400		9,500	926,400	1,009,300		
	5	PIPING	FACTO	RED	733	16,200		0	24,200	40,400		
	6	ELECTRICAL	FACTO	RED	475	8,800		0	16,400	25,200		
	7	INSTRUMENTATION	FACTO	RED	411	7,600		0	22,700	30,300		
	8	PAINTING/INSULATION	FACTO	RED	145	3,000		0	2,000	5,000		
		SUBTOTAL 5 THRU 8			1,764	35,600		0	65,300	100,900		
		TOTAL DFC			12,087	245,700	0	252,630	991,700	1,490,030		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\BLO3ALT\CEMENT\BLDG.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CIVIL & EXCAVATION										
		CLEAR AND GRUB AREA	0.2	ACRE	26	$500		$0				
		EXCAVATION MACHINE	110	CY	119	$2,200		$0				
		EXCAVATION HAND	10	CY	58	$1,100		$0				
		BACKFILL MACHINE	100	CY	98	$1,800		$0				
		BACKFILL HAND	5	CY	26	$500		$0				
		GRAVEL ROADS	162	CY	200	$3,700		$4,300				
		PAVEMENT	111	SY	60	$1,100		$900				
		GRAVEL ROADS	150	CY	200	$3,700		$4,000				
		HAUL & DUMP STOCKPILE	132	CY	662	$12,300		$0				
		SUB-TOTAL	669	CY	1,449	$26,900		$9,200				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	669	CY	1,449	$26,900		$9,200				
		TOTAL	**669**	**CY**	**1,449**	**$26,900**		**$9,200**				**$36,100**

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\93LO3ALT\CEMENT\BLDG.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		CONCRETE										
		SLAB ON GRADE	83	CY	993	$19,400		$10,300				
		COLUMNS\FOUNDATIONS\EQUIPMENT PADS	20	CY	225	$4,400		$4,300				
		WASTE & SPILLAGE	5	CY	13	$300		$250				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	108	CY	1,231	$24,100		$14,850				
		TOTAL	108	CY	1,231	24,100		$14,850				$38,950

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\B\LO3ALT\CEMENT\BLDG.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		STRUCTURAL STEEL										
		GRATING\STARIS\TOEPLATE\PLATFORMS	8	TN	960	$20,200		$28,000				
		METAL ROOFING	3,368	SF	220	$4,600		$11,960				
		EQUIPMENT LADDERS	50	LF	35	$700		$1,100				
		SUB–TOTAL	8	TN	1,215	$25,500		$41,060				
		MATERIAL TAKE–OFF 0.0%	0		0	$0		$0				
		SUB–TOTAL	8	TN	1,215	$25,500		$41,060				
		TOTAL	8	TN	1,215	$25,500		$41,060				$66,560

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S.DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: CEMENTATION FACILITY – GRANULAR
FILENAME: F:\LOTUS34\SILO3ALT\CEMENT\BLDG.WK3

TOTAL DIRECT COST

PREPARED BY: G.WALTERS
DATE: 06/24/96

WBS	SYS	DESCRIPTION	QTY	UNIT	LABOR MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $	OH / P B&I B&O TAX $	TOTAL DIRECT COST $
		ARCHITECTURAL / BUILDINGS / FINISHES										
		CONFINEMENT CELL 25x26x23	650	SF	232	$4,700		$13,000				
		SIDING	7,135	SF	155	$3,100		$18,500				
		MEMBRANE ROOFING	3,368	SF	181	$3,700		$9,500				
		ROOF INSULATION	3,368	SF	155	$3,100		$6,500				
		DOWNSPOUT & GUTTERS	376	LF	116	$2,300		$1,380				
		BATTEN INSULATION	3,368	SF	81	$1,600		$780				
		DOORS	7	EA	48	$1,000		$4,000				
		MOTOR OPERATED ROOL UP DOOR	2	EA	50	$1,000		$4,000				
		TRAILERS 42x10	2	EA	120	$2,400		$94,000				
		FURNISHINGS	1	LOT	80	$1,600		$10,000				
		METAL STUDS & SHEET ROCK	10,450	SF	258	$5,200		$6,500				
		LIGHTING PROTECTION	1	LOT	60	$1,200		$4,500				
		LIGHTING	3,368	SF	155	$3,100		$5,300				
		COMMUNICATIONS	3,368	SF	60	$1,200		$3,700				
		SEALERS & HARDNER	3,368	SF	85	$1,700		$3,500				
		PAINT WALLS	15,000	SF	642	$13,000		$2,990				
		PAINT STEEL	19,140	SF	740	$15,000		$2,870				
		SUB-TOTAL	3,368	SF	2,986	$60,200		$178,020				
		MATERIAL TAKE-OFF 0.0%	0		0	$0		$0				
		SUB-TOTAL	3,368	SF	2,986	$60,200		$178,020				
		TOTAL	3,368	SF	2,986	$60,200		$178,020				$238,220

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX – VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SUMMARY											
		SYSTEM 01	BLDGS(ACC. 0,1,2 & 3)	1	LOT	6,881	136,700		243,130		379,830		
	5	SYSTEM 05	HVAC	13	EA	564	11,900		9,500	196,900	218,300		
	6	SYSTEM 06	OTHER EQUIPMENT	1	SYS	230	4,900			85,900	90,800		
	12	SYSTEM 12	PROCESS SYSTEMS	12	EA	768	16,500			196,800	213,300		
	30	SYSTEM 30	ELECTRICAL EQUIPMENT	3	EA	1,260	26,800			225,000	251,800		
	61	SYSTEM 61	DCS	1	SYS	40	900			40,000	40,900		
	62	SYSTEM 62	HPS	4	EA	320	6,800			175,000	181,800		
	63/64	SYSTEM 63/64	ANALYTICAL LAB/PROCEESS	3	LOT	260	5,600			6,800	12,400		
	176		TOTAL EQUIPMENT	34	EA	3,442	73,400		9,500	926,400	1,009,300		
			PIPING	1	LOT	733	16,200	0	0	24,200	40,400		
			ELECTRICAL	1	LOT	475	8,800	0	0	16,400	25,200		
			INSTRUMENTATION	1	LOT	411	7,600	0	0	22,700	30,300		
			PAINTING & INSULATION	1	LOT	145	3,000	0	0	2,000	5,000		
			TOTAL BULKS			1,764	35,600	0	0	65,300	100,900		
			TOTAL DFC			12,087	245,700	0	252,630	991,700	1,490,030		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX -VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 05	HVAC										
	5	05-HF-01	MODULAR AIR FLTR SYS 2000CFM	1	EA	100	2,100			120,000	122,100		
			HEPA INLET AIR	3	EA	60	1,300			10,200	11,500		
	5	05-EH-1 THRU 4	WALL MOUNTED AC	1	EA	10	200			1,600	1,800		
	5	05-C-01	30 TON COOLING SYSTEM	1	EA	80	1,700			18,500	20,200		
			DUCTING SYSTEM	1	LOT	60	1,200		9,500		10,700		
	5	05-STK-01	EXHAUST STACK	1	EA	40	900			3,500	4,400		
	5		AIR TREATMENT SYSTEM INCLUDES										
		300 GALLON TANK W/VENTURI SCRUBBER		1	EA	100	2,100			24,600	26,700		
		50 GAL LOW-HEAD PROGESSIVE PUMP		1	EA	20	400			6,600	7,000		
		2" 3-PORT ELE. ACTUATOR BALL VALVE		1	EA	4	100			2,800	2,900		
		200 CFM AIR DRYER		1	EA	60	1,300			4,500	5,800		
		200 CFM AIR GEAR PUMP		1	EA	10	200			4,000	4,200		
		200 CFM BLOWER		1	EA	20	400			600	1,000		
			TOTAL 05	13	EA	564	11,900	0	9,500	196,900	218,300		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX – VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 06	OTHER EQUIPMENT										
	6	06-SH-01	5TON BRIDGE CRANE/MONORAILS	1	SYS	160	3,400			48,000	51,400		
	6	06-LD-01	LIFTING FRAME	1	EA	20	400			3,500	3,900		
	6	06-IB-01	CEILING MNTD I-BEAM10TON HOIST	1	EA	50	1,100			34,400	35,500		
			TOTAL 06	1	SYS	230	4,900	0	0	85,900	90,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT: U.S. DEPT. OF ENERGY
PROJECT: SILO 3 ALTERNATIVE
LOCATION: SILO 3 AREA
DESCRIPTION: GRANULAR CEMENT MIX –VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY: G. WALTERS
DATE: 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB-TOT $		TOTAL DIRECT COST $
		SYSTEM 12 PROCESS SYSTEMS										
	12	12-SL-01 4,200 CUFT SILO3 w/ROTARY VANE	1	EA	155	3,300			36,000	39,300		
		VAR. SPEED FEEDER,CYCLONE										
	12	12-SL-3&4 2,100CFT SILOw/RTRY VANE	2	EA	80	1,700			50,000	51,700		
	12	12-SL-02 1,400 CUFT SILO3 w/ROTARY VANE	2	EA	210	4,500			43,000	47,500		
		VAR. SPEED FEEDER,CYCLONE										
	12	12-AU-01 18" DIA AUGER FEEDER 40' LONG	1	EA	40	900			35,000	35,900		
		w/CUSTOM ENCLOSURE SYSTEM										
	12	12-TK-01 FRESH WATER FEED SYS w/100 GAL	1	EA	60	1,300			5,200	6,500		
		ISOLATION TANK,50 GPM 100 PSI										
		CENTRIFUGAL PUMP										
	12	12-VE-01 VACUUM EXTRUDER	1	EA	60	1,300			0	1,300		
	12	12-TK-02 400 GAL RECYCLE WATER TANK	1	EA	20	400			6,600	7,000		
		ELECTRIC ACUTATOR BALL VALVE LL SENSOR INSTR.										
	12	12-PMP-01 50 GPM DIAPHRAM PUMP	1	EA	13	300			2,000	2,300		
	12	12-AG-01 TOP ENTERING 1/2HP AGITATOR	1	EA	10	200			2,000	2,200		
	12	12-WMB-01 WMB CHARGING SYSTEM	1	EA	120	2,600			17,000	19,600		
		includes:WMB elevator,5tn lift,track										
		cell charging door, sealed vestibule										
		mix system and drip pan										
		TOTAL 12	12	EA	768	16,500	0	0	196,800	213,300		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX –VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION		QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $		TOTAL DIRECT COST $
		SYSTEM 30	ELECTRICAL EQUIP										
	30	30–US–1	UNIT SUBSTATION #1	1	EA	900	19,200			185,000	204,200		
	30	30–MC–1	MCC #1	1	EA	180	3,800			25,000	28,800		
	30	30–UP–1	UPS	1	EA	180	3,800			15,000	18,800		
			TOTAL 30	3	EA	1,260	26,800			225,000	251,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX –VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $		TOTAL DIRECT COST $
		SYSTEM 61 DCS										
		CONTROL/MONITOR MIX OPERATIONS	1	SYS	40	900			40,000	40,900		
		TOTAL 61	1	SYS	40	900	0	0	40,000	40,900		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX –VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $		TOTAL DIRECT COST $
		SYSTEM 62 HPS ALLOWANCE										
		HARDWARE			320	6,800			125,000	131,800		
		SOFTWARE							50,000	50,000		
		TOTAL 62	4	EA	320	6,800	0	0	175,000	181,800		

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CONSTRUCTION COSTS
DETAILS

CLIENT U.S. DEPT. OF ENERGY
PROJECT SILO 3 ALTERNATIVE
LOCATION SILO 3 AREA
DESCRIPTION GRANULAR CEMENT MIX –VACUUM EXTRUSION

TOTAL DIRECT COST

PREPARED BY G. WALTERS
DATE 06/24/96

	SYS	DESCRIPTION	QTY	UNIT	TOTAL MH	LABOR $	CONST EQUIP $	MATL $	PLANT EQUIP $	SUB–TOT $		TOTAL DIRECT COST $
		SYSTEM 63/64 ANALYTICAL LAB/PROCESS										
		SAMPLING HOLDING & INSPECTION										
		ALLOWANCE	1	LOT	220	4,700			3,000	7,700		
		GLOVE BOXES	2	EA	40	900			3,800	4,700		
		TOTAL 63/64	3	LOT	260	5,600	0	0	6,800	12,400		

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 2 BY TRUCK TO THE RPCDF

FERMCO
ESTIMATING SERVICES

DATE: 22-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
TY							
LTH PHYSICS S/C							
ERCLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							

	QTY	$					
WASTE CONTAINERS(*)	840	$800				$672,000	$672,000
CERTIFICATION	2,520	$545		$1,373,400			$1,373,400
TRANSPORTATION							
TO ENVIROCARE	504	$3,150			$1,587,600		$1,587,600
TO FEMP	504	$3,150			$1,587,600		$1,587,600
BURIAL	170,550	$12.50			$2,131,900		$2,131,900
RECYCLING	2,520	$100			$252,000		$252,000
STORAGE							
WASTE MANAGEMENT COSTS				$1,373,400	$5,559,100	$672,000	$7,604,500
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTION		A/E		FERMCO			
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$37,000			$37,000
SUB-TOTAL (BASE ESTIMATE)							$7,641,500
RISK BUDGET	12.0%						$917,000
G&A-FERMCO (SEE EXCLUSION COMMENTS)							
ESCALATION (SEE EXCLUSION COMMENTS)							

TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET) $8,558,500

ste containers would be reconditioned at the RPCDF for reuse at the FEMP for either OU4 remedial operations or use in other projects.

FY 96 DOLLARS

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 2 BY TRUCK TO THE RPCDF
10% VOLUME REDUCTION BY VE

FERMCO
ESTIMATING SERVICES

DATE: 22-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
TY							
LTH PHYSICS S/C							
RCLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							

	QTY	$					
WASTE CONTAINERS(*)	770	$800				$616,000	$616,000
CERTIFICATION	2,300	$545		$1,253,500			$1,253,500
TRANSPORTATION							
TO ENVIROCARE	460	$3,150			$1,449,000		$1,449,000
TO FEMP	460	$3,150			$1,449,000		$1,449,000
BURIAL	156,340	$12.50			$1,954,300		$1,954,300
RECYCLING	2,300	$100			$230,000		$230,000
STORAGE							
WASTE MANAGEMENT COSTS				$1,253,500	$5,082,300	$616,000	$6,951,800
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTION		A/E		FERMCO			
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$33,900			$33,900
SUB-TOTAL (BASE ESTIMATE)							$6,985,700
RISK BUDGET	12.0%						$838,300
G&A-FERMCO (SEE EXCLUSION COMMENTS)							
ESCALATION (SEE EXCLUSION COMMENTS)							

TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET) $7,824,000

ste containers would be reconditioned at the RPCDF for reuse at the FEMP for either OU4 remedial operations or use in other projects.

FY 96 DOLLARS

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 2 BY TRUCK TO THE RPCDF
20% VOLUME REDUCTION BY VE

FERMCO ESTIMATING SERVICES

DATE: 22-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
:TY							
ALTH PHYSICS S/C							
CERCLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							
	QTY	$					
WASTE CONTAINERS(*)	660	$800				$528,000	$528,000
CERTIFICATION	1,970	$545		$1,073,700			$1,073,700
TRANSPORTATION							
TO ENVIROCARE	493	$3,150			$1,553,000		$1,553,000
TO FEMP	493	$3,150			$1,553,000		$1,553,000
BURIAL	134,010	$12.50			$1,675,100		$1,675,100
RECYCLING	1,970	$100			$197,000		$197,000
STORAGE							
WASTE MANAGEMENT COSTS				$1,073,700	$4,978,100	$528,000	$6,579,800
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTION	A/E			FERMCO			
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$29,000			$29,000
SUB-TOTAL (BASE ESTIMATE)							$6,608,800
RISK BUDGET	12.0%						$793,100
G&A-FERMCO	(SEE EXCLUSION COMMENTS)						
ESCALATION	(SEE EXCLUSION COMMENTS)						
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)							$7,401,900

aste containers would be reconditioned at the RPCDF for reuse at the FEMP for either OU4 remedial operations or use in other projects.

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FY 96 DOLLARS

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SUMMARY SHEET

FILE #: C4-95-03-01
CLIENT: DOE
PROJECT: SILO3 ALT 2 BY TRUCK TO THE RPCDF
30% VOLUME REDUCTION BY VE

FERMCO
ESTIMATING SERVICES

DATE: 22-Apr-96
ESTIMATOR: M.L. SMITH
LOCATION: FERNALD
TASK#: 4CBAV

	ITEM DESCRIPTION	M/H	RATE	LABOR $	S/C $ / OTHERS	MAT'L $	TOTAL $
DIRECT FIELD COSTS							
SUPERVISION - CONTRACTOR							
SM TOOLS/CONSM'BLS							
EQUIPMENT RENTAL							
TEMP. FACILITIES							
TEMP UTL'S HOOK-UP							
CLEAN-UP							
TY							
LTH PHYSICS S/C							
ERCLA $800 PER PERSON							
PAYRL BRD.&BENFT.							
OVERHEAD & PROFIT							
BOND							
INDIRECT FIELD COSTS							
DIRECT & INDIRECT FIELD COSTS							

	QTY	$					
WASTE CONTAINERS(*)	575	$800				$460,000	$460,000
CERTIFICATION	1,725	$545		$940,100			$940,100
TRANSPORTATION							
TO ENVIROCARE	432	$3,150			$1,360,800		$1,360,800
TO FEMP	432	$3,150			$1,360,800		$1,360,800
BURIAL	117,260	$12.50			$1,465,800		$1,465,800
RECYCLING	1,725	$100			$172,500		$172,500
STORAGE							
WASTE MANAGEMENT COSTS				$940,100	$4,359,900	$460,000	$5,760,000
PROJ.MGMT-FERMCO							
CONSTR MGMT-FERMCO							
FERMCO FIELD SUPPORT COSTS							
ENGINEERING/DESIGN/INSPECTION		A/E		FERMCO			
ENGINEERING COSTS							
SALES TAX - SUBCONTRACT			SALES TAX - FERMCO	$25,300			$25,300
SUB-TOTAL (BASE ESTIMATE)							$5,785,300
RISK BUDGET	12.0%						$694,200
G&A-FERMCO (SEE EXCLUSION COMMENTS)							
ESCALATION (SEE EXCLUSION COMMENTS)							
TARGET ESTIMATE (BASE ESTIMATE PLUS RISK BUDGET)							**$6,479,500**

aste containers would be reconditioned at the RPCDF for reuse at the FEMP for either OU4 remedial operations or use in other projects.

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FY 96 DOLLARS

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APPENDIX D

PUBLIC HEALTH AND OCCUPATION RISK CONSIDERATION FOR SILO 3 ALTERNATIVES

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ACRONYMS AND ABBREVIATIONS

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ARAR	Applicable or Relevant and Appropriate Requirements
cfm	cubic feet per minute
CFR	Code of Federal Regulations
cm	centimeter
CRF	cancer risk factor
D&D	decontamination and decommissioning
DOT	U.S. Department of Transportation
DR	Dose Rate
DST	Distance
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FS	Feasibility Study
ft	feet
ft^2	square feet
ft^3	cubic feet
ILCR	Incremental Lifetime Cancer Risk
in.	inch
kg	kilogram
km	kilometer
lb	pound
m	meter
m^3	cubic meter
MHRF	mechanical hazard risk factor
mg/sec	milligrams/second
mi	mile
min	minute
mR	milliRem
NRW	nonremediation worker
NTS	Nevada Test Site
OU	Operable Unit
pCi/L	picocuries/Liter
pCi/sec	picocuries/second

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ACRONYMS AND ABBREVIATIONS (Cont'd)

R	Rem
RCF	Risk Conversion Factor
RQ	reportable quantity
RR	release rate
ug	micrograms
yd^3	cubic yard

PUBLIC HEALTH AND OCCUPATION RISK CONSIDERATION FOR SILO 3 ALTERNATIVES

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D.1.0 Introduction

This appendix presents the risks associated with implementing alternatives for remediating materials in Silo 3, which is in Operable Unit (OU) 4. The purpose of the risk assessment is to assess the short-term and long-term effectiveness of each alternative. The results of the assessment are in terms of risk to the workers and members of the public. Both quantitative and qualitative analyses are used to estimate the risks from each alternative.

Although the purpose of the risk assessment includes assessing long-term risks, this appendix does not estimate these risks. Long-term risks are related to the residual material and processed waste that remains at the Fernald Environmental Management Project (FEMP) site following remediation. All alternatives considered in this evaluation involve off-site disposal of the processed waste in facilities designed to manage the waste in the long term. The impacts from residual wastes are assumed to be the same for all alternatives considered here. These impacts are assessed in the Feasibility Study (FS) Report for OU4 (DOE 1994a). The OU4 FS should be consulted for a complete understanding of these impacts.

Since long-term effectiveness is covered in the OU4 FS (DOE 1994a), this appendix presents only short-term risks from implementing the alternatives.

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D.2.0 Summary of Baseline Risk Assessment

A Baseline Risk Assessment was developed for OU 4 and presented in the Remedial Investigation for OU 4 (DOE 1993b). That assessment estimates the risks related to the contaminants of concern within OU 4 without any remedial actions taking place. That assessment also estimates the risks associated with the natural background of radiation at the FEMP site.

A summary of that risk assessment is presented in Section D.2.0 of Appendix D of the OU 4 FS (DOE 1994a). That section should be consulted for an understanding of the OU4 Baseline Risk Assessment. (Note the summary in Appendix D of the OU4 FS includes impacts from all materials in OU 4, not just Silo 3 residues.)

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D.3.0 Alternatives Evaluation Risk Assessment

This section comprises the main section of the risk assessment. This section presents the remedial alternatives; the potential receptors, pathways, and exposure parameters; and the conceptual and mathematical models for the analyses.

D.3.1 Description of Alternatives

The risks from four alternatives have been estimated and evaluated here. The reference, or base case alternative is the selected remedy (VIT) from the OU4 ROD (DOE 1994c). That alternative mixes Silo 3 residues with other OU 4 wastes and vitrifies the mixture. Alternative 1 (ALT1) turns the Silo 3 residues into a solid concrete monolith that is solidified in the shipping/disposal package. Alternative 2 (ALT2) turns the Silo 3 residues into concrete granules which are transported to a disposal facility, removed from the package, and placed in a disposal cell. Alternative 3 (ALT3) adds water to Silo 3 residues to take advantage of the natural properties of the material to form a granular waste form. The residues are then transported for further treatment and disposal at a permitted commercial disposal facility. Section 3.0 of the main body of this Silo 3 alternatives evaluation describes each alternative in detail. That section also presents Alternative 4 (ALT4), blending the Silo 3 residues with OU1 wastes. That alternative is included in Section 3 of the main body of this report for a detailed applicable, relevant and appropriate requirements (ARARs) evaluation. Short-term risks have not been assessed for ALT4.

D.3.2 Potential Receptors, Pathways and Exposure Parameters

Remedial action risks are risks associated with implementing remedial action alternatives and are present for the duration of the remediation. The risks are lifetime cancer risks associated with the short-term exposure to chemical carcinogens and ionizing radiation, toxic effects associated with noncarcinogenic chemicals, and physical injuries associated with construction activities. This risk assessment estimates risks delivered to three groups of individuals: remediation workers, nonremediation workers, and the general public. Remediation workers are those workers placed at risk by a specific component of a remedial alternative while implementing that component. Nonremediation workers are only other workers at the FEMP site. They are placed at risk from the airborne transport of contaminants from Silo 3 (within Operable Unit 4) to their workplace. Members of the general public living adjacent to the FEMP site are also placed at risk from the release of constituents of concern from Silo 3. The general public living adjacent to the transport route for Silo 3 residues are placed at risk from direct radiation associated with transport containers and the accidental release of waste material during transportation.

To estimate remedial action risks, this risk assessment examines four distinct remedial alternative components: constructing support and processing facilities; retrieving Silo 3 residues; processing Silo 3 residues; and transporting Silo 3 residues. These components represent the operations that have the potential for contributing to the remedial action risks. Each component is briefly described below. Section D.3.2.2 of this risk assessment describes the exposure pathways.

Constructing Support Facilities

Some degree of support and processing facilities will need to be constructed for each alternative. The more elaborate the processing and waste handling requirements, the more extensive the support facilities. The exposure mode associated with this component is physical injury to remediation workers.

Retrieving Silo 3 Residues

Each alternative involves retrieving the Silo 3 residues from the silo. The exposure modes associated with this component are direct radiation, inhalation of airborne contaminants and immersion in contaminated air, and physical injury. Remediation workers, non-remediation workers, and members of the public are potentially impacted from this component.

Processing Silo 3 Residues

Each alternative involves processing the material. The base case, selected in the OU 4 FS, involves vitrifying the waste. ALT1 processes the waste through cementation into a monolith. ALT2 processes the waste through cementation into granules. ALT3 mixes the Silo 3 residues with water and sodium silicate. The exposure modes associated with this component are direct radiation, inhalation of contaminants and immersion in contaminated air, and physical injury. Remediation workers, non-remediation workers, and members of the public are potentially impacted from this component.

Transportation. Each alternative involves the transport of waste materials off-site. The base case calls for the vitrified material to go to the Nevada Test Site (NTS). ALT1 also calls for the final waste form to be disposed at the NTS. ALT2 and ALT3 call for the residues to be shipped to a representative permitted commercial disposal facility. All alternatives use truck as the transportation mode. The exposure modes associated with this component are direct radiation, inhalation of contaminants and immersion in contaminated air, and physical injury. Transportation workers and members of the public are potentially impacted from this component.

D.3.2.1 Assumptions for Analysis of Remedial Action Risks

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The assessments of remedial action risks require a number of assumptions. Assumptions have been made for each element of the assessment: exposure scenarios, receptors, exposure models, and exposure parameters. The assumptions are documented below.

1. The radioactive source term for Silo 3 residues is specified as the Upper Confidence Limit in Table 1-5 of the OU4 FS (DOE 1994a). Radioactive daughter products not included in the list are assumed to be in equilibrium with longer-lived parents.

2. Waste processing releases 100 percent of the radon-222 within the Silo 3 residues. The radon-222 concentration within the silo material is equal to the radium-226 concentration (i.e., the radon-222 is in secular equilibrium with the radium-226).

3. Releases of particulate matter from retrieval and processing are assumed to be negligible based on the use of rigorous emission controls.

4. During waste processing, operators are not in contact with the off-gas plume, eliminating exposure from inhaling contaminants and dermal contact with contaminants. The release point for the off-gas is assumed to be ground level. Although each alternative does have a stack, the rule-of-thumb that states that releases from a stack whose height is less than two and one-half times the building height should be treated as ground level releases has been applied here. Operators are protected from any airborne release of silo material through personal protective equipment.

5. Non-remediation workers are assumed to have no inhalation protection (e.g., a respirator), but are protected from dermal contact by protective clothing.

6. Off-site individuals exposed to airborne contaminants are exposed through the inhalation pathway only.

7. The release of material during waste processing is characterized similarly to releases from solidification assessed for OU4 material in the OU4 FS.

8. For assessing transportation hazards, RADTRAN® computer model default values are used to the fullest extent practical.

9. For assessing non-radiological transportation risks, it is assumed that trucks transporting material to the representative permitted commercial disposal facility would return with empty packages, so round-trip mileage has been used in the assessment.

10. The radiation dose delivered to an individual by air contaminated with radioactive material has been assumed to be negligible for this assessment. The nature of the radionuclides within Silo 3 residues (i.e., low external radiation hazard) and the very low concentrations of airborne contaminants within the processing facilities for any of the alternatives would result in negligible external radiation doses.

D.3.2.2 Exposure Scenarios for Remedial Action Risks

The following exposure scenarios apply to this risk assessment. Table D.3-1 summarizes the method(s) by which the risk assessment analysis was conducted for this evaluation of the Silo 3 alternatives. The overall approach involved the use of two basic methods of risk assessment techniques encompassing various standard quantitative measures and/or qualitative discussions. Figure D.3-1 graphically depicts these scenarios.

TABLE D.3-1

EXPOSURE SCENARIO RISK ASSESSMENT SUMMARY

HAZARD	PATHWAY	RECEPTOR	EXPOSURE ASSESSMENT METHOD
Direct Radiation	-	Remediation Worker	Quantitatively and Qualitatively
Direct Radiation	-	Non-Remediation Worker	Quantitatively
Construction Hazard	Physical Injury	Remediation Worker	Quantitatively
Mechanical Hazard	Physical Injury	Remediation Worker	Quantitatively
Transportation Hazard	Direct Radiation	Transportation Worker	Quantitatively
Transportation Hazard	Direct Radiation	Member of the Public	Quantitatively
Transportation Hazard	Physical Injury	Transportation Worker	Quantitatively
Transportation Hazard	Physical Injury	Member of the Public	Quantitatively
Transportation Hazard	Atmospheric Dispersion	Member of the Public	Quantitatively
Airborne Emission	Atmospheric Dispersion	Remediation Worker	Qualitatively
Airborne Emission	Atmospheric Dispersion	Non-Remediation Worker	Quantitatively and Qualitatively
Airborne Emission	Atmospheric Dispersion	Member of the Public	Quantitatively and Qualitatively

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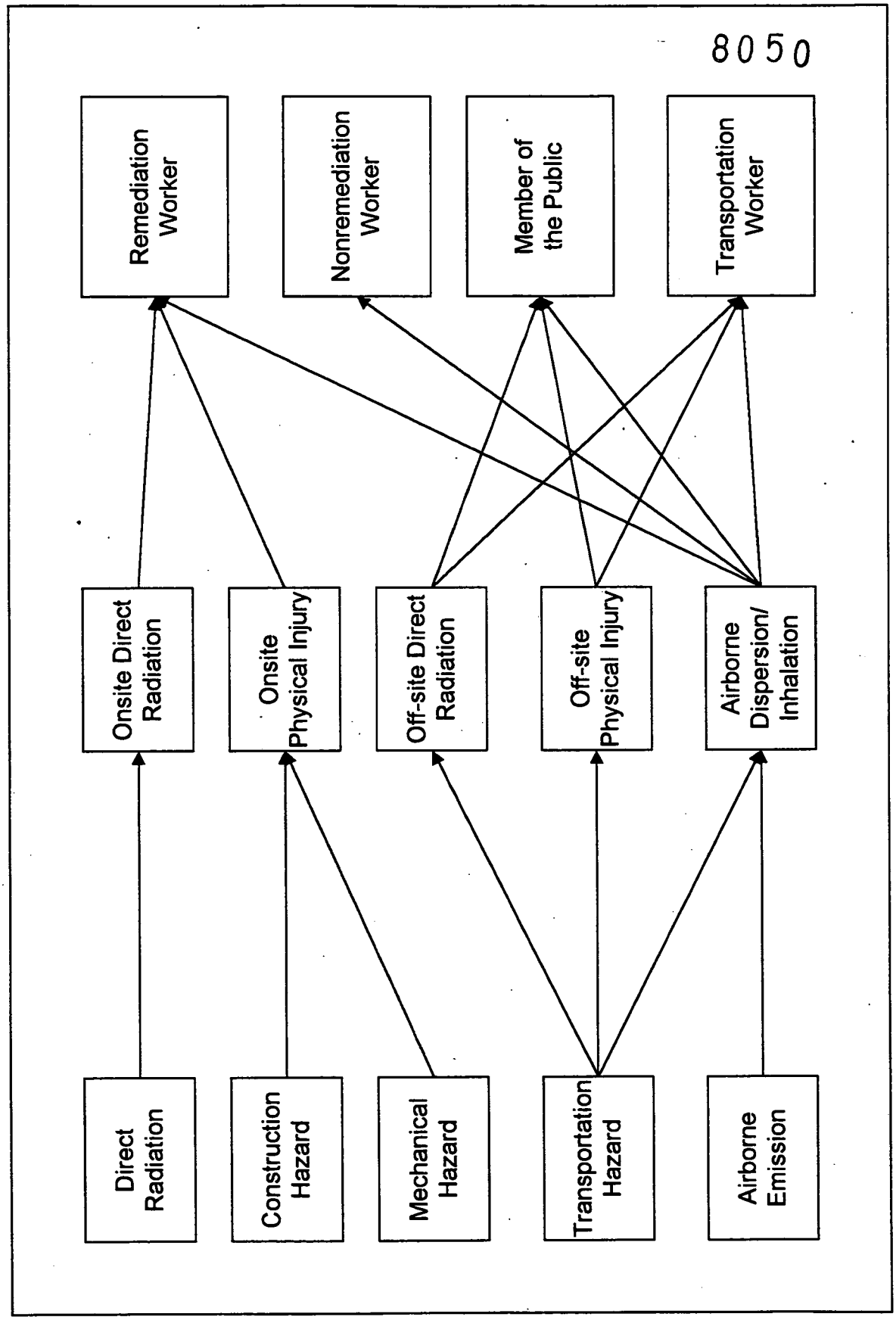

Figure D.3-1 Exposure Pathways

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D.3.2.3 Receptors for Remedial Action Risks

Remediation Workers

Remediation workers are those individuals that are placed at risk from performing remediation-related tasks. For example, an individual operating extraction equipment within Silo 3 is placed at risk by the retrieval operations and would be considered a remediation worker. In contrast, an individual performing remediation work within OU4 who might be exposed to resuspended material from Silo 3 would not be a remediation worker receptor (see non-remediation worker receptor, below). The level of risk to which these individuals are exposed depends on their proximity to the waste, level of personnel protective equipment, length of time of exposure to the hazard, and the type of hazard.

Transportation Worker

Transportation workers (truck drivers for off-site shipments) are a subcategory of remediation worker. They are evaluated separately because their exposure is different from onsite workers and the model used to assess impacts from transporting contaminated material develops estimates for impacts specifically for these individuals. The magnitude of these impacts depends on the level of contaminants in the transported waste, the degree of shielding provided by transport containers, proximity of the worker to the waste shipments, and the duration of transport (including stops).

Nonremediation Workers

Nonremediation workers are those FEMP employees exposed to hazards associated with the remediation of Silo 3 but are not directly involved with Silo 3 remediation activities. For example, an individual performing remediation work within OU 4 who might be exposed to resuspended material from Silo 3 would be a nonremediation worker. The level of risk to which these individuals are exposed depends on the quantity of contaminants transported to their work area and the duration of their exposure.

Members of the Public

Members of the public vary in character based on the exposure scenario. For those scenarios where contaminants are dispersed in the air and carried to the FEMP site boundary, these individuals are located at the fenceline, i.e., the location of the "off-property farmer". For transportation scenarios, the off-site individuals live along the transport route or, in the case of truck transport, share the roadway with the trucks. The transportation model assessed collective and maximum individual risks from exposure to contaminants during transport.

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D.3.2.4 Exposure Models for Remedial Action Risks

This section presents the exposure models used to estimate the remedial action risks. The section has been divided into subsections for each alternative component-exposure mode-receptor combination.

Construction-Physical Injury-Remediation Worker

The risk from mechanical injury, both for injuries and fatalities, is based on a risk conversion factor developed by the United States Department of Labor. This conversion factor translates hours worked to risk from a mechanical hazard. Equation 1 provides the expression for the risk.

$$\text{Risk} = \text{MHRF} \bullet T_n \qquad \text{(Eq. 1)}$$

where,

MHRF = mechanical hazard risk factor, injuries or fatalities per person-hour worked
T_n = Person-hours worked during facility construction
n = 1, 2, 3, 4, 5, . . .
T_4 = person-hours worked during site preparation
T_5 = person-hours worked during facility decontamination and decommissioning (D&D)

Variable T_2 and T_3 are defined in subsequent exposure models.

Retrieval-Physical Injury-Remediation Worker

The mechanical hazard impacts from retrieving Silo 3 residues are calculated using Equation 1 for the Construction-Physical Injury-Remediation Worker pathway. The only difference is the total person hours worked, which is T_2 (person hours needed to retrieve Silo 3 residues).

Retrieval-Direct Radiation-Remediation Worker

During extraction of the Silo 3 residues, the remediation worker is exposed to direct radiation from the residues in the silo. The magnitude of the exposure for this pathway is qualitatively evaluated.

Processing-Inhalation/Immersion-Remediation Worker

Remediation workers are not exposed through the inhalation pathway, because of personnel protective equipment. As presented in assumption 10 (Section D.3.2.1), immersion pathway contributions are ignored here.

Solidification-Direct Radiation-Remediation Worker

Direct radiation exposure to remediation workers is calculated by Equation 2. The dose rate has been developed for a variety of exposure cases. In all cases, the waste material is in a transportation

container. In some cases, multiple containers are on a truck. The cases are:

1. Dose rate 1 meter from a waste container. This case is assessed for all four alternatives and is used for package handling dose assessments. The dose rate from the side and the end are calculated.

2. Dose rate 1 meter from a truck with multiple packages. This case defines the transportation index, is used in estimating the dose from transportation pathways, and is used for the dose to an onsite truck driver. This case is assessed for all four alternatives.

3. Dose rate 10 meters from the line of trucks full of containers outside the process facility. This case is assessed for the three cement alternatives (ALT1, ALT2, and ALT3) and is used for assessing exposure to non-remediation workers.

The collection dose equivalent delivered for a single type of operation is the product of the dose equivalent rate the operators are exposed to during the operation, the length of time for the operation, and the number of operations performed. The collective dose equivalent associated with an alternative is the sum of the collective dose equivalent for each operation for that alternative.

$$H_E = \Sigma DR \bullet t_n \bullet N_n \qquad \text{(Eq. 2)}$$

where,

H_E = Collective effective dose equivalent from radionuclide i, mrem
DR = Dose rate for silo material, mrem/hr
t_n = Number of hours per operation activity
N_n = Number of times a single operation activity is performed
n = Total number of operations that expose an individual

DR is based on the MICROSHIELD® computer code, using the radionuclide distribution in the Silo 3 residues. The dose rates for each case and each alternative depends on the amount of Silo 3 residue in a container, the density of the waste form, and the shielding characteristics of the containers.

The risk from exposure to ionizing radiation is measured in incremental lifetime fatal cancers. The risk is calculated by Equation 3. The effective dose equivalent is summed over all radionuclides.

$$ILCR = H_E \bullet CRF \qquad \text{(Eq. 3)}$$

where,

ILCR = Incremental lifetime cancer risk
CRF = Cancer risk factor, ILCR/mrem

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Processing-Physical Injury-Remediation Worker

The mechanical hazard impacts are calculated using Equation 1 for the Construction-Physical Injury-Remediation Worker pathway. The only difference is the total person hours worked during waste processing, which is T_3.

Processing-Inhalation/Immersion-Nonremediation Worker

The contaminants are released through a stack and a Gaussian plume dispersion model is used to estimate the concentration at the receptor location. Equations 4 and 5 describe the calculation of air concentration. Equation 5, used to calculate the centerline plume concentration, was taken from the AIRDOS-United States Environmental Protection Agency (EPA) computer model (Moore *et al*, 1979), which is discussed in the Risk Assessment Work Plan Addendum. The Gaussian dispersion factor χ/Q is summed over the six Pasquill stability classes (A, B, C, D, E, and F). Since radon-222 is the only constituent of concern, the impacts are presented in terms of concentration and working levels. The working level of radon-222 is the concentration, in pCi per liter (pCi/L) divided by 100 pCi/L. This conversion to working levels assumes that the radon-222 remains in secular equilibrium with its radioactive progeny.

$$C_a = RR \bullet (\chi/Q) \qquad \text{(Eq. 4)}$$

where,

RR = release rate of contaminant, pCi/sec (radionuclides) or mg/sec (chemicals)
χ/Q = Gaussian dispersion factor, sec/m^3

$$\chi/Q = \Sigma FRAC \bullet \exp[-\tfrac{1}{2}(H/\sigma_z)]/(\pi \bullet \sigma_y \bullet \sigma_z \bullet \mu) \qquad \text{(Eq. 5)}$$

where,

FRAC = fraction of time for a given stability class
H = release height, meters(m)
σ_z = vertical dispersion coefficient (a function of stability class), m
σ_y = horizontal dispersion coefficient (a function of stability class), m
π = 3.1415...
μ = mean wind speed, meters per second (m/s)

Processing-Inhalation/Immersion-Member of the Public

The immersion and inhalation impacts for this exposure are calculated the same as for the Processing-Inhalation/Immersion-Nonremediation Worker pathway.

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Transportation - Direct Radiation - Transportation Worker

The magnitude of the transportation impacts is calculated by the TRANSNET computer model system. The TRANSNET system is operated by Sandia National Laboratory and includes routing models (HIGHWAY® and INTERSTATE® for truck transport and INTERLINE® for rail transport) and an impact model (RADTRAN 4®). For this analysis, the route yielding the shortest distance between FEMP and the disposal site is used.

In order for RADTRAN® to assess the impacts from direct radiation, a dose rate one meter away from the truck or rail car must be calculated. For this analysis, MICROSHIELD® is used to estimate the dose rate.

RADTRAN® also assesses the impacts from releases of material from a transportation accident. The code uses as input data radionuclide concentration and release fractions to assess these impacts. Default values for exposure from this release are used.

Unit inventory RADTRAN® calculations were made. In these unit calculations, a truck with a transportation index of 1.0 made a single trip. The calculation results yielded a unit dose equivalent to the transportation worker. The total dose equivalent is the product of the unit dose equivalent, the transportation index for the shipment, and the number of trips to dispose the waste volume.

Transforation - Direct Radiation - Member of the Public

Unit inventory RADTRAN® calculations were used to assess the direct radiation exposure to members of the public. The calculations yield a maximum individual exposure. As with the transportation workers, the total dose equivalent is the product of the unit dose equivalent, the transportation index for the shipment, and the number of trips to dispose the waste volume.

The collective population dose equivalent to the public is also based on unit inventory analyses. The collective dose is the sum of the collective dose delivered to members of the public who live along the transportation route, members of the public who share the road with the truck, and members of the public who are exposed while the truck is stopped. The total dose equivalent is the product of the unit dose equivalent to the public, the transportation index for the shipment, and the number of trips to dispose the waste volume.

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Transportation - Atmospheric Dispersion - Member of the Public

Members of the public are potentially exposed following a hypothetical accident. The accident releases waste material and the material is dispersed in air. Again, a unit inventory RADTRAN® analysis was made (one curie of each radionuclide in a package). The dose equivalent delivered to the public from each individual radionuclide in the waste is the product of the unit dose from the accident, the container inventory for the radionuclide, the waste form factor, and the total number of packages transported. These individual radionuclide doses are summed to determine the dose equivalent for the entire waste volume.

Transportation-Physical-Injury - Transportation Worker or Member of the Public

Physical injuries are based on miles traveled. Equation 6 presents the calculation for the physical injury impacts for both transportation workers and members of the public.

$$\text{Risk} = \text{RCF} \bullet \text{DST} \qquad \text{(Eq. 6)}$$

where,

RCF = Risk conversion factor for worker or member of the public for truck transport, miles^{-1} (mi^{-1})

DST = Distance traveled by truck, miles

D.3.2.5 Qualitative Analyses

Qualitative analyses have been included for those exposure pathways for which risks can not be quantified. For the qualitative analyses, judgment on the likelihood of an exposure mechanism or severity of an exposure is estimated. The estimation is in relative or qualitative terms. Impacts can be high, moderate, or low. Events can be probable, occasional, unlikely, or incredible. From these estimates of severity and probability, a hazard rating can be assigned. These ratings determine if the risk is major, serious, marginal, or negligible. Tables D.3-2 and D.3-3 provide definitions of the qualitative assessment terms.

TABLE D.3-2

CONSEQUENCES AND PROBABILITY CATEGORIES

Category	Level	Description
		Consequence
High	1	Worker exposure to radiation greater than 3R, worker death or permanent injury, or release of radioactive material or hazardous chemicals in a quantity greater than 1 reportable quantity (RQ).
Moderate	2	Worker exposure to radiation greater than 30 mR but less than 3 R, serious worker injury (e.g., broken bones, burns), or release of radioactive material or hazardous chemicals in a quantity greater than 0.01 RQ but less than 1 RQ.
Low	3	Worker exposure to radiation less than 30 mR, minor worker injury (e.g., cut, bruises), or release of radioactive material or hazardous chemicals in a quantity less than 0.01 RQ.
		Probability
Probable	4	Can be expected to occur several times in the lifetime of the facility.
Occasional	3	Likely to occur during the lifetime of the facility.
Unlikely	2	Not expected but is possible over the lifetime of the facility.
Incredible	1	Not possible over the lifetime of the facility

TABLE D.3-3

HAZARD RATINGS

Category	Level	Description
Major	I	May cause death or permanent injury to workers, an exposure to radiation in excess of 3 R, or a significant off-site release of radiological or chemical contaminants at least once in the lifetime of the facility.
Serious	II	Death or permanent injury to workers, an exposure of a worker to radiation in excess of 3 R, or a significant off-site release of radiological or chemical contaminants is possible but not expected over the life of the facility. Serious worker injury, moderate radiation exposure, or a detectable off-site release of radiological or chemical contaminants is expected once in the lifetime of the facility. Less severe impacts are expected several times in the lifetime of the facility.
Marginal	III	Serious worker injury, moderate radiation exposure, or a detectable off-site release of radiological or chemical contaminants is possible but not expected over the life of the facility. Less severe impacts are expected at most once in the lifetime of the facility.
Negligible	IV	Minor worker injury, small radiation exposure to workers, or immeasurable off-site release of chemical contaminants is possible but not expected over the life of the facility.

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D.3.2.6 Exposure Parameters for Remedial Action Risks

This section tabulates (Tables D.3-4 through D.3-9) the exposure parameters used in the quantitative assessment. Similar sets of parameters, e.g., risk factors, exposure durations, et cetera, have been grouped together. References for the parameter values have been provided. The most prevalent reference is the OU4 FS (DOE 1994a). This notation indicates the parameter is from the risk assessment performed for the OU4 FS and presented in Appendix D of the Operable Unit 4 FS (DOE 1994a).

Table D.3-3 presents the risk factors for the analysis. The factors include the cancer risk factor for radiation exposure, the physical injury risk factors for remediation workers, and the nonradiological transportation risk factors. these factors are taken from the OU4 FS.

Table D.3-4 identifies the total number of person hours for the five activities for which physical injuries to remediation workers are calculated. The person-hour estimates for the Base Alternative are from the cost estimate in the OU4 FS for the vitrification alternative for Silo 3 residues. The person-hour estimates for the three cement waste form alternatives are based on staffing estimates developed in conjunction with the conceptual designs presented in the main body of this report.

Table D.3-5 identifies unit operations associated with waste package handling. The table also presents the time durations for each operation.

Table D.3-6 presents the dose rate estimates from the Microshield® analyses. These dose rate values are used in assessing the direct radiation exposure to remediation and nonremediation workers.

Table D.3-7 presents the transportation pathway parameters. These parameters include number of packages, truck trips, miles traveled per truck trip, the transportation index (TI) and the waste form.

Finally, Table D.3-8 defines the equations used to calculate dispersion parameters and the fraction of time that a certain stability class is present at the FEMP site.

TABLE D.3-4

RISK FACTORS

Parameter	Value	Units	Reference
CRF	1.25×10^{-4}	per person-rem	OU4 FS
MHRF (injury)	3.4×10^{-5}	injuries per person-hour	OU4 FS
MHRF (fatality)	5.0×10^{-7}	fatalities per person- hour	OU4 FS
RCF (truck worker injury)	4.1×10^{-8}	injuries per mile	OU4 FS
RCF (truck worker fatality)	2.1×10^{-9}	fatalities per mile	OU4 FS
RCF (truck public injury)	1.2×10^{-7}	injuries per mile	OU4 FS
RCF (truck public fatality)	1.3×10^{-8}	fatalities per mile	OU4 FS

TABLE D.3-5

EXPOSURE DURATIONS

		Duration, person-hours			
Variable	Activity	VIT	ALT1	ALT2	ALT3
T1	Construction	11192	1119	1119	1119
T2	Retrieval	9706	9706	9706	9706
T3	Facility Operations	105882	10740	24960	14580
T4	Site Prep	9358	9358	9358	9358
T4	D&D	47240	4724	4724	4724

TABLE D.3-6

UNIT OPERATION DURATIONS

Operation	Value	Units
Survey shipping box	0.033	person-hrs per box
Oversee truck loading	0.17	person-hrs per box
Driving truck onsite	0.083	person-hrs per truck
Put lid on box	0.17	person-hrs per box
Smear survey package	0.017	person-hrs per box
Reside outside truck area	5	hours per week
Base ALT Process Operations	156	weeks[a]
ALT1 Process Operation	17.9	weeks[b]
ALT2 Process Operation	41.6	weeks[b]
ALT3 Process Operation	24.3	weeks[b]

a) 24 hour days, 7 day weeks (75% available)
b) 8 hour days, 5 day weeks

TABLE D.3-7

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RADIATION DOSE RATES

	Dose Rate, mR/hr			
Area	VIT	ALT1	ALT2	ALT3
Side of Package	0.36	0.78	0.80	1.2
Truck Cab (onsite)	Not Applicable	1.4	1.5	2.2
Outside Truck Area	Not Applicable	0.30	0.31	0.35

TABLE D.3-8

TRANSPORTATION PARAMETERS

Parameter	VIT	ALT1	ALT2	ALT3
Packages	1437	2160	2520	2190
Truck Trips	719	540	504	365
Miles (mi) per trip	2062	2062	3354	3354
TI, mR/hr	0.42	1.4	1.5	2.2
Waste Form	Immobile	Large chunks	Large Powder	Large Powder
Packages per Truck	2	4	5	6

TABLE D.3-9

DISPERSION COEFFICIENT FORMULATION

Pasquill Class	σ_y (m)	σ_z (m)	FRAC[a]
A	$0.22 \cdot x^a / [1 + (0.0001 \cdot x)]^{1/2}$	$0.20 \cdot x$	0.09
B	$0.16 \cdot x / [1 + (0.0001 \cdot x)]^{1/2}$	$0.12 \cdot x$	0.04
C	$0.11 \cdot x / [1 + (0.0001 \cdot x)]^{1/2}$	$0.08 \cdot x / [1 + (0.0002 \cdot x)]^{1/2}$	0.04
D	$0.08 \cdot x / [1 + (0.0001 \cdot x)]^{1/2}$	$0.06 \cdot x / [1 + (0.0015 \cdot x)]^{1/2}$	0.33
E	$0.06 \cdot x / [1 + (0.0001 \cdot x)]^{1/2}$	$0.03 \cdot x / [1 + (0.0003 \cdot x)]$	0.27
F	$0.04 \cdot x / [1 + (0.0001 \cdot x)]^{1/2}$	$0.016 \cdot x / [1 + (0.0003 \cdot x)]$	0.22

Source: Operable Unit 1 Feasibility Study

[a]The parameter "x" is the downwind distance, in meters.

[b]From Operable Unit 1 Remedial Investigation, Figure E-3-1.

D.3.3 Toxicity Assessment

The toxicity assessment presents information concerning the potential effects of contaminants of concern. Section D.3.3 of the OU4 FS (DOE 1994a) provides a toxicity assessment for the contaminants of concern in Silo 3 residues and should be consulted for the information on toxicity of contaminants.

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D.4.0 Short-term Exposure Risks

This section presents the short-term risk results. Section D.4.1 tabulates the impacts. Section D.4.2 discusses the qualitative risks in terms of hazard ratings. Section D.4.3 summarizes the risks in text.

D.4.1 Quantitative Analysis

Table D.4-1 presents the incident free and accident transportation impacts. Table D.4-2 presents the direct radiation risks. Table D.4-3 presents the mechanical hazards risks. Finally, Table D.4-4 presents the radon impacts. These impacts are in terms of concentration and working levels.

The dose equivalent and risk values have been rounded to one significant figure. Any inconsistencies in the relationship between dose and risk estimates are due to this rounding.

TABLE D.4-1

TRANSPORTATION RISKS

TYPE	VIT		ALT1		ALT2		ALT3	
	Dose	Risk	Dose	Risk	Dose	Risk	Dose	Risk
Max Individual, (rem)	2E-6	3E-10	6E-6	8E-10	6E-6	8E-10	7E-6	8E-10
Population, Incident Free, (person-rem)	3	4E-4	8	1E-3	7	8E-4	7	9E-4
Crew, person-(rem)	6	8E-4	20	2E-3	10	2E-3	10	2E-3
Population, Accident, (person-rem)	8E-6	1E-9	6E-2	7E-6	2E-1	3E-5	2E-1	3E-5

TABLE D.4-2

DIRECT RADIATION RISKS

Alternative	Remediation Worker		Nonremediation Worker	
	Collective Dose, person-mrem	Risk	Collective Dose, person-mrem	Risk
VIT	100	1E-5	0	0
ALT1	1000	1E-4	30	3E-6
ALT2	3000	3E-4	60	8E-6
ALT3	2000	3E-4	60	5E-6

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TABLE D.4-3

MECHANICAL RISKS

TYPE	Number of Injuries and Fatalities			
	VIT	ALT1	ALT2	ALT3
Worker Injury	6	1	2	1
Worker Fatality	0.09	0.02	0.02	0.02
Transportation Worker Injury	0.06	0.05	0.07	0.05
Transportation Worker Fatality	0.003	0.002	0.004	0.003
Public (Transportation) Injury	0.2	0.1	0.2	0.1
Public (Transportation) Fatality	0.02	0.01	0.02	0.02

TABLE D.4-4

RADON IMPACTS

Release Scenario	RR, pCi/sec	Chi/Q, sec/cu.m	Radon-222 Concentration, pCi/l	Working Levels
ALT VIT, NRW[a]	1.35E+00	5.98E-04	8.08E-07	8.08E-09
ALT VIT, Public	1.35E+00	1.61E-04	2.17E-07	2.17E-09
ALT1 NRW	7.14E+06	5.98E-04	4.27E+00	4.27E-02
ALT1, Public	7.14E+06	1.61E-04	1.15E+00	1.15E-02
ALT2, NRW	3.07E+06	5.98E-04	1.84E+00	1.84E-02
ALT2, Public	3.07E+06	1.61E-04	4.93E-01	4.93E-03
ALT3, NRW	5.26E+06	5.98E-04	3.15E+00	3.15E-02
ALT3, Public	5.26E+06	1.61E-04	8.44E-01	8.44E-03

a) NRW = Nonremediation Worker

D.4.2 Qualitative Analysis Results

Two exposure modes, direct radiation and inhalation of particulates, are analyzed here.

The direct radiation pathway for remediation workers during retrieval has been evaluated qualitatively. It is expected that a single worker would have low exposure (less than 30 mrem) from remediation activities. As such, this pathway has a hazard rating of "Negligible."

The other exposure mode deals with the inhalation of particulates. The Silo 3 residues would pose a significant inhalation hazard. Silo 3 residues pose a significant radiological inhalation hazard. Ten percent of the Derived Air Concentration for Silo 3 residues would be reached with a concentration of 3.6 micrograms of material in a cubic meter of air. Workers could be exposed to levels over 30 mrem, given the small concentrations needed. As such, this pathway has a hazard rating of "Marginal."

D.4.3 Conclusions

No exposure pathway for any of the four alternatives evaluated here pose unacceptable short-term risks. For remediation workers, mechanical hazards pose the highest risk. For non-remediation workers, direct radiation poses the highest risk. Note that direct radiation is the only pathway of exposure for nonremediation workers. For members of the public, nonradiological (mechanical) hazards from transportation pose the greatest risks.

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D.5.0 Remedial Action Risks Uncertainty Analysis

In general, the estimates of remedial action risks in this assessment are conservative, (i.e., the estimates overestimate the risks likely to be experienced during remedial activities). These conservative analyses are necessary to account for uncertainties inherent in the assessment. This section presents some of the uncertainties in the assessment. The section has been subdivided by exposure mode. Additional discussions on uncertainties associated with risk assessments can be found in Section D.5.0 of Appendix D of the OU4 FS (DOE 1994a).

Direct Radiation. The magnitude of external exposure to radiation is directly related to the time the exposed individual spends near the radiation source. The exposure time is very uncertain. It is likely that, during operations, a person would minimize his exposure to radiation by controlling his exposure time.

Immersion and Inhalation

As with direct radiation from discrete sources, the exposure from direct radiation from immersion in and inhalation of contaminated air depends on source strength (air concentration) and exposure duration. For the assessment of retrieval risks, it is uncertain what, if any, releases would occur from the process.

For remediation workers, inhalation impacts were ignored, since the workers would be in respirators. However, respirators do not completely eliminate the intake of contaminants in the air. The respirators afford a protection factor, on the order of a factor of 50 (source: 10 CFR Part 20), to the worker, i.e., the worker is exposed to a concentration 50 times less than is normally in the air. Given the low risk from inhalation to remediation workers and the expected relatively lower exposure duration time of nonremediation workers (by a factor of 5), the contribution to risk from inhalation by nonremediation workers can be ignored.

For releases of radon-222 from residue processing, the receptors are also placed close to the release (200 meters), thus exposing them to a higher-than-expected concentration of radon. Also, the release is assumed to be from ground level, while it would likely be elevated. Elevated releases would result in greater dispersion and lower contaminant exposure point concentrations. Finally, some of the radon-222 would be dissolved in the water used in waste processing and not released. No credit was

taken for this binding of radon-222 in the stabilized waste form.

For particulate releases from processing, it is assumed that the quantities released would result in negligible risks. The processing systems include off-gas treatment systems. These systems would control the release of particulates through scrubbers and high efficiency filters. Although no system can boast of a zero release, the very small fraction of particulates that would be released should not greatly increase the risk from remedial operations. As designs are developed, releases from the Silo 3 residues processing, as well as Silo 3 residues retrieval, may be quantifiable and the uncertainty in the risks reduced.

Mechanical Hazards

The mechanical hazards risk coefficients are based on general construction activities. Remedial activities considered in this risk assessment generally involve less "hands-on" work and it is likely that workers actual risk from mechanical hazards would be less than that calculated in this assessment.

Transportation

The transportation impacts were assessed with the RADTRAN 4® computer code. The exposure scenario was defined based on many of the code default parameter values. These defaults are designed to give upperbound estimates on impacts.

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APPENDIX E

TREATABILITY STUDY ISSUES

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ACRONYM LIST

ICP	inductively coupled plasma
OU4	Operable Unit 4
RCRA	Resource Conservation and Recovery Act
TCLP	Toxicity Characteristic Leaching Procedure

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TREATABILITY STUDY ISSUES

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E.1.0 Introduction

The Silo 3 remediation alternatives presented in this study are based on the results of sampling, analyses, and treatability studies conducted in support of the Operable Unit 4 (OU4) Feasibility Study. A number of data gaps remain; however, relative to the physical and chemical characteristics of Silo 3 residues (treated and untreated). As a result, the remediation alternatives presented in Section 3 have been developed conservatively to compensate for this uncertainty. While this provides an adequate basis for initial evaluation and comparison of alternatives, additional sampling and treatability testing are necessary in order to develop these alternatives in greater detail. Selected data gaps, and their significance to the remediation alternatives, are summarized in Table E.1-1 below:

TABLE E.1-1
TREATABILITY STUDY ISSUES

DATA GAP	SIGNIFICANCE	ALTERNATIVES AFFECTED
Variability in physical characteristics of residues within Silo 3. Unknown presence of consolidated solids in Silo 3 strata.	Design of retrieval system and operations. Material handling systems.	All
Effectiveness of alternative cement formulations in stabilizing RCRA TCLP metals. Specific formulations to achieve flowable liquid and granular waste forms.	Cement formula and treatment system/equipment requirements. Treated waste volumes. Treatment system throughput.	Alternatives 1, 2 and 3
Variability of Silo 3 residues chemical characteristics. Unknown range of contaminant concentrations.	Ability of cement formula and treatment system to meet disposal facility waste acceptance criteria.	All
Physical characteristics of treated Silo 3 residues in flowable liquid form.	Flowability for box loading. Final density and waste volume. Potential for temperature buildup.	Alternative 1 only
Physical characteristics of treated Silo 3 residues in granular form.	Mixer operations/mix duration. Flowability for box loading. Dusting potential. Volume reduction potential.	Alternative 2 only
Physical characteristics of conditioned Silo 3 residues in granular form.	Mixer operations/mix duration. Water volumes. Flowability for box loading. Dusting potential.	Alternative 3 only

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E.2.0 Treatability Study Approach

Detailed planning would be performed prior to collecting additional samples of Silo 3 residues or performing additional treatability tests. Sampling and Analysis Plans and Treatability Test Plans would be developed that identify specific objectives and the approaches to be taken in achieving these objectives. The general considerations and approaches that would be addressed during development of detailed plans are summarized below.

E.2.1 Physical Characteristics

Obtain additional core samples from Silo 3, including one at a manhole near the silo's wall and one at the center manway. Also, obtain a horizontal sample from one of the lowest decant ports using a tube sampler. Collect the decant port sample in a way that does not break-up agglomerated material. A sample of material obtained by vacuuming from the top of the tank would also be useful. Measure packed and fluffed bulk density and angle of repose of Silo 3 residues.

E.2.2 Chemical Characteristics

Section core samples about every 1 to 2 feet for separate analysis to assess the potential impacts of stratification. Do not rely on appreciable mixing of Silo 3 residues during retrieval actions. The waste collected from each section would be placed in separate jars and sealed.

E.2.3 Treatability Characteristics

Design treatability tests that measure the sensitivity of the process and waste form as follows:

(1) varying ratios of waste, additives, and water;
(2) mixing shear;
(3) mixing time;
(4) order of adding materials to the mixer; and
(5) addition of more solids or more water if the mixture does not have the right consistency.

Leach small samples of each cored section in a Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) extract under static conditions and then analyze for indicator metals [inductively coupled plasma (ICP) metal analysis may be sufficient; atomic adsorption for other metals is preferred, but more expensive]. Analyze some subset of the samples by the formal

RCRA TCLP procedure and establish correlations to the static test results. This would help establish which core sections represent the "envelope" of conditions. These "envelope" core samples would be used later for verifying the adequacy of formulations.

Establish preliminary waste form performance specifications, including angle of repose of poured material, upper and lower limit on mixing time to achieve desired properties, dusting properties of granular product, strength of the granule-to-granule bonds, etc.

Establish indicator tests for all mixed samples. For example, for pourable mixes, the mixed material would be sealed in clear plastic jars, set aside for two days, and then inspected for free water. The product would then be probed to obtain a qualitative measure of its "set." For granular product, the material would be sealed for two days and then spread and allowed to dry in the air. The material would then be shaken in a sealed jar and inspected for dust formation.

Establish quantitative tests for the mixed products once formulation ranges are narrowed. Tests would include RCRA TCLP metals for stabilized products and measurement of dispersible dust for granular products. The bulk densities of the products would also be measured.

Investigate sources of blast furnace slag. Slags vary significantly in chemical and physical properties; chemically reducing blast furnace slags from consistent ore bodies are the most desirable. Use a blast furnace slag obtained from a supplier who can commit to supplying a single, consistent, and effective slag one to two years after treatability testing is completed. This would ensure that the waste formulations developed would be valid when actual operations are conducted. This issue also applies for portland cement, although cement properties are less variable from supplier to supplier. A standard grind, such as Type I/II portland cement from a local supplier would be considered appropriate.

Estimate the heats of hydration in portland cement, blast furnace slag, and Silo 3 residues, and then perform adiabatic heat rise calculations to set upper limits on the amount of cement that can be added to a formulation. The formulation(s) would be designed to yield an adiabatic temperature rise not to exceed 50 to 60 °C. This would ensure that the waste form temperature would not rise to the boiling point and boil or explode. Confirmatory heat rise tests would be conducted later after candidate formulations are narrowed. Actual waste would be used in these tests. This would ensure that other possible exothermic reactions are not taking place to any significant extent.

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E.2.4 Volume Reduction

Evaluate the economics of the DOE-Mound vacuum extrusion equipment under Alternative ALT2, investigate the potential effectiveness of compactability of the final waste volume. Establish a formula envelope for the mixer, and determine a target volume reduction percentage based on economics (see Section 3.4.7 of the main report). Evaluate the RCRA TCLP metal performance of the product at the target volume reduction percentage and at varying ($\pm$10 percent) percentages of compaction. This would help determine if a vacuum extruded product could be produced within acceptable waste acceptance criteria of the representative permitted commercial disposal facility, for a net cost savings to the project.

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E.3.0 Proof-of-Process Testing

DOE-FN is considering to remediate the Silo 3 residues through a commercial vendor experienced in stabilization/solidification techniques. A Request for Proposal (RFP) process will be used to procure a vendor to perform the remediation of Silo 3 residues. Scope of the contract would include overall responsibility for removal of the waste from the silo, treatment by stabilization/solidification to provide a waste form that meets the disposal facility waste acceptance criteria (WAC). Packaging and transportation to the disposal facility would be optional in the contract. The fixed fee contract would require the subcontractor to be responsible for the overall project including cost, schedule, equipment, and chemical additives. No developmental stabilization/solidification technology would be accepted. Before design of process equipment, the vendor would be required to perform proof-of-process testing on actual Silo 3 residues. Test parameters would be specific to the disposal facility WAC. The disposal facility's WAC have been developed to ensure that any disposed waste meeting the WAC provides long term protection of human health and the environment.

E.3.1 General Testing Considerations

Identify a suitable surrogate for Silo 3 residues to enable cost-effective preliminary laboratory mixability tests, pilot-scale mixability tests, and full-scale equipment shakedown tests. Testing using surrogate waste would minimize the expense of experimentation with difficult-to-obtain actual waste and also minimize the generation of mixed waste. Identify a suitable laboratory-scale mixer that simulates the level of shear and mixing action expected in the full-scale mixer(s).

Establish the method of producing samples for RCRA TCLP metals testing [e.g., by crushing jar-sized samples of product, or by producing pellets (i.e., vacuum extrusion) that pass the RCRA TCLP maximum size criterion].

When preliminary laboratory testing is completed using simulants and actual waste, and specifications for mixing are defined (including specification of shear, mixing time, order of adding materials, etc.), then pilot-scale mixing tests need to be conducted using simulated wastes. The pilot-scale mixes would be checked for angle of repose, bulk density, free water and set (for pourable products after two days), and crushing resistance (for granular products after drying). Also, the mixer could be tested for ease of cleaning after completion of testing.

When pilot tests and hot laboratory tests indicate specifications are likely to be met, final verification testing would be done in the laboratory using the "envelope" core samples. The verification tests would

include reasonable ranges of fractions of the additives to simulate errors in weighing materials to the mixer. Final RCRA TCLP metals tests, bulk density, angle of repose, crush resistance, etc., would be conducted on collected samples.

Conduction of shakedown tests in the processing facility prior to hot start-up. The shakedown tests would include mixing using simulated waste and the selected formulation. Samples of the shakedown test mixed material would be collected and exposed to the same tests conducted during pilot-scale testing.

After shakedown tests are completed, one mixed batch using actual waste would be made. A thermocouple should be inserted in the middle of the poured casting to monitor temperature rise. Material in the package would be checked for angle of repose. Samples would be collected and sealed. RCRA TCLP and other tests (e.g., dusting) would be conducted after a suitable curing period. To shorten the curing period, the sample may be charged to an oven at ~80 °C and cured within sealed sample containers. Prior testing would be necessary to establish the time required for curing by this method and to verify that this approach yields comparable RCRA TCLP metals results.

APPENDIX F

NEPA SUPPLEMENT ANALYSIS

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ACRONYM LIST

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
DOE	United States Department of Energy
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FS/PP-EIS	Feasibility Study/Proposed Plan-Environmental Impact Statement
NEPA	National Environmental Policy Act
NTS	Nevada Test Site
OU	operable unit
ROD	Record of Decision
RPCDF	representative permitted commercial disposal facility
SEIS	Supplemental Environmental Impact Statement

APPENDIX F

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F.1.0 NEPA Supplement Analysis

F.1.1 Requirements for Conducting a Supplement Analysis

This Appendix provides an evaluation of the alternatives being considered for the remediation of the Silo 3 residues and a recommendation as to the appropriate level of National Environmental Policy Act (NEPA) evaluation required for the action. The remediation of the Fernald silos (including Silo 3) was evaluated in the Operable Unit 4 (OU4) Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS) which was approved by United States Department of Energy (DOE) and United States Environmental Protection Agency (EPA) through the issuance of a Record of Decision (ROD) on December 7, 1994.

After issuance of the ROD, it was determined that a modest cost savings could be achieved by shipping material for disposal via truck as opposed to the combination of rail/truck evaluated in the OU4 FS/PP-EIS. Therefore, a Supplement Analysis to the original EIS was prepared and approved on January 9, 1996 by DOE concluding that preparation of a full Supplemental Environmental Impact Statement (SEIS) was not required.

The following provides a second Supplement Analysis to the OU4 FS/PP-EIS for the revised alternatives being considered for Silo 3.

F.1.1.1 Council on Environmental Quality Regulations (40 CFR 1500) and DOE Regulations (10 CFR 1021)

There are two relevant regulations dealing with the decision whether or not to prepare a SEIS. These regulations are the Council on Environmental Quality's (CEQ's) NEPA implementation regulations (40 CFR 1500) and the DOE's NEPA implementing regulations (10 CFR 1021).

F.1.2 Evaluating Proposed Changes

Both the CEQ and DOE regulations require an agency to prepare a SEIS where the agency has made a substantial change in a proposed action, or if there are new significant circumstances in the proposed EIS action that are relevant to environmental concerns. The agency may also prepare a SEIS if the agency determines that the purposes of NEPA would be furthered by the supplement.

In addition, the DOE NEPA regulations require the preparation of a "Supplemental Analysis" where

the decision to prepare a SEIS is unclear (10 CFR 1021.314). The Supplement Analysis should discuss the changed or new circumstances that are pertinent in determining whether or not to prepare a SEIS. The discussion should therefore contain sufficient information for DOE to determine whether a SEIS, new EIS, or no new NEPA documentation is required.

F.1.3 Applying "Rule of Reason"

It is inevitable that new information is learned after the finalization of an EIS, and NEPA case law confirms that an agency does not need to supplement an EIS every time new information comes to light. The agency should however, take a hard look at the environmental impacts of its planned action. It should apply a "rule of reason" in deciding whether or not to prepare a SEIS.

In applying this rule of reason, the agency should evaluate factors related to the new information or circumstances for the action. These factors might include the environmental significance of the new information or circumstances; its probable accuracy; the care that the agency used to evaluate the information and its impact; and the degree to which the agency supports its decision to prepare or not prepare a SEIS.

F.1.4 Approval of Supplement Analysis and SEIS by DOE

If a Supplement Analysis is developed to determine whether or not to prepare a SEIS, this information should be made available to the public for information. If the Supplement Analysis supports the decision to supplement the original EIS, DOE must meet the same requirements for filing an EIS (e.g., preparing a Record of Decision). One exception here is that the public scoping requirements are optional if the scope of the proposed action has not changed from the original EIS.

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F.2.0 Evaluation of Alternatives

F.2.1 Onsite Vitrification - Off-site Disposal at the NTS (VIT)

This alternative would involve combining cold metal oxides from Silo 3 with residues from Silos 1 and 2 and treating them through vitrification. This process would involve constructing a feed preparation system to prepare and deliver a feed slurry containing both silo residues and glass-formers to the melter. The vitrification process would include a nominal 25-ton per day joule-heated melter and would be constructed in conjunction with the melter feed system immediately east of the silos. A melter off-gas system would mitigate the potential for an unplanned release of contamination and the treatment of effluent gases. This alternative would involve the packaging, loading and shipping of stabilized material to a waste disposal site at the Nevada Test Site (NTS) via truck. A detailed discussion of this alternative is available in Section 3.2.1.

The treatment and disposal aspects of this alternative were fully evaluated in the original Operable Unit 4 FS/PP-EIS. In addition, transportation of silo residues to the NTS via the truck scenario was evaluated in a Supplemental Analysis to the OU4 FS/PP-EIS which was approved by DOE on January 9, 1996. This alternative does not represent a significant change in scope from what was evaluated in the OU4 FS/PP-EIS.

Potential environmental impacts including human health risks are consistent with those evaluated in the original EIS. Impacts would be limited because the project would be carried out in previously disturbed areas with the appropriate engineering controls employed. Short- and long-term human health risks associated with this alternative to both workers and the public would fall within the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) target risk range of 10^{-4} - 10^{-6}. This includes risks associated with transportation and disposal of the material. A full discussion of the potential environmental impacts is included in Sections 3.2.4 and 3.2.6.

F.2.2 Onsite Stabilization - Off-site Disposal at the NTS (ALT1)

This alternative would involve the same removal process for the Silo 3 residues as VIT (Section 3.2). A treatment facility constructed on-property would house the process for stabilization. The process would involve mixing the Silo 3 residues with portland cement and blast furnace slag, placing the stabilized material in containers and transporting the material to the NTS for disposal (Section 3.3). Four boxes would be carried on each truck load and approximately 540 truck shipments would be required to transport the stabilized material to the NTS.

The stabilization of the silo residues with cement and disposal of the residues at the NTS was discussed in the OU4 FS/PP-EIS. Consistent with the previous alternative, transportation of the silo residues to the NTS via the truck scenario was evaluated in a Supplemental Analysis.

F.2.3 Onsite Stabilization - Off-site Disposal at a RPCDF (ALT2)

This alternative would involve the same removal process for the Silo 3 residues as VIT (Section 3.2). Stabilization would be accomplished by thoroughly mixing the Silo 3 residues with portland cement and blast furnace slag. An engineered metal sided building would be constructed in the previously disturbed area east of the silos which would house the stabilization operations. Stabilized residues would be loaded into containers and loaded onto trucks. An estimated 504 truck shipments would be necessary to transport all of the stabilized material to the RPCDF.

The use of cement to stabilize the Silo 3 residues was evaluated in the OU4 FS/PP-EIS. The truck transportation alternative was evaluated in the aforementioned Supplemental Analysis. Therefore, nothing in this alternative would represent a change in scope from the initial OU4 FS/PP-EIS and Supplemental Analysis.

Though not evaluated in the OU4 FS/PP-EIS, the geology and climate of the Representative Permitted Commercial Disposal Facility (RPCDF) are sufficiently similar to those of the NTS. Therefore, human health risks and potential environmental impacts resulting from disposal of treated Silo 3 residues at the RPCDF should be similar to those evaluated for the NTS in the OU4 FS/PP-EIS. There would be no unacceptable short-term or long-term risks associated with this alternative as discussed in Sections 3.4.3 and 3.4.5. Potential environmental impacts at the FEMP site would be minimal as the action would be carried out in previously disturbed areas with appropriate engineering controls. The geology and climate of the representative permitted commercial disposal facility (RPCDF), in conjunction with specific engineering controls required for the facility, would prevent long-term impacts at the site, assuming proper maintenance.

F.2.4 Off-site Stabilization and Disposal at a RPCDF

This alternative would be very similar to the previous alternative except that Silo 3 residues would be "conditioned" for transportation utilizing a mixture of silicite and water. Final treatment of the material would occur at the RPCDF prior to disposal (Section 3.5). Although this alternative was not specifically evaluated in the FS/PP-EIS, it is so similar to the cementation alternative (e.g., mixing

would take place in a metal sided building as a batch operation) that this alternative would not represent a significant new action.

Human health risks and environmental impacts associated with this alternative are discussed in Sections 3.5.3. and 3.5.5. Risks and impacts associated with this alternative would be very similar to the previous alternative, therefore, no significant new information related to environmental impacts would be associated with this alternative.

F.2.5 Onsite Blending with OU1 Waste Pit 5 Material - Off-site Disposal at a RPCDF

Under this alternative, Silo 3 residues would be removed and stored in the OU1 area near the process intended to "blend-dry" waste pit material. The process would involve blending the Silo 3 residues with OU1 Waste Pit 5 material, segregating the waste based on size, reducing the size of material through drying, and managing debris associated with the material. A waste loadout and storage area would be in place to transfer dried materials into rail cars. The material would then be transported to the RPCDF via rail. A detailed description of this alternative is provided in Section 3.6.

The drying and segregation of the Waste Pit Area material was evaluated in the OU1 FS/PP-NEPA evaluation. The OU1 FS/PP was not a formal EIS; however, NEPA values were incorporated in the CERCLA FS/PP pursuant to DOE's revised policy on NEPA issued in June of 1994. Although the evaluation in the OU1 FS/PP did not specifically consider the Silo 3 residues, blending of the Pit 5 material with the Silo 3 residues would not result in a significant change in the scope of the original alternative.

Human health risks and potential environmental impacts are evaluated in Section 3.6.1. There are no unacceptable risks associated with this alternative. Transportation risks are less than those for disposal at the NTS because the waste can be sent in bulk via rail. Environmental impacts associated with this alternative would be minimized due to the location of activities at the Fernald Environmental Management Project (FEMP) site and the use of engineering controls. The RPCDF impacts would be similar to those discussed in previous alternatives.

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F.3.0 Conclusion

As required under the DOE NEPA regulations, DOE has conducted this Supplemental Analysis to determine whether or not a SEIS needs to be conducted for the revised Silo 3 alternatives. Based upon the results of this analysis, DOE has determined that the proposed Silo 3 alternatives do not constitute a substantial change in project scope or result in the availability of significant new information related to environmental impacts from the original EIS alternatives. Therefore, a SEIS is not recommended for the proposed alternatives.

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