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OPERABLE UNIT 3 TREATABILITY STUDY WORK PLAN FINAL MARCH 1994 REF: 5297, 5298

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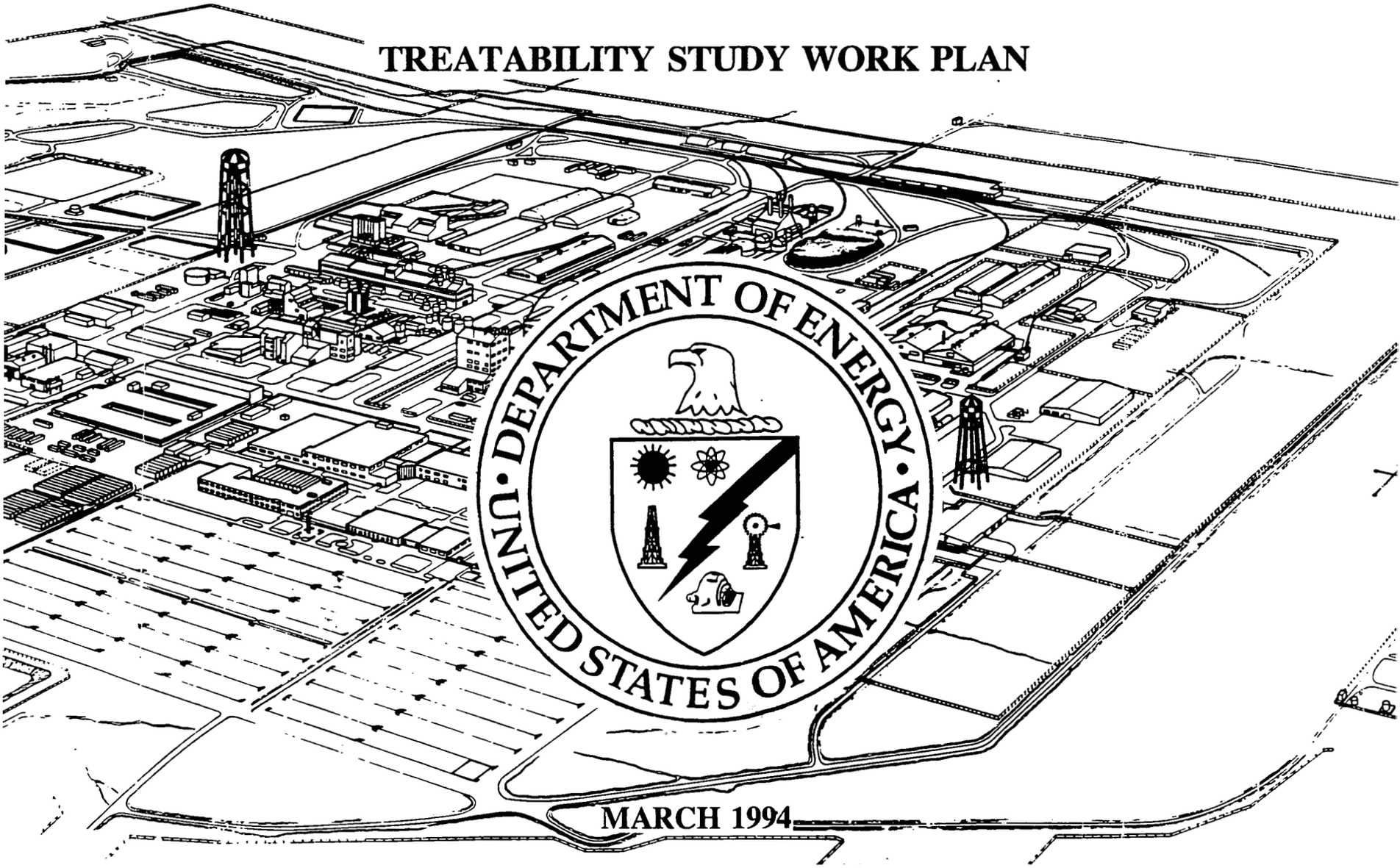
OPERABLE UNIT 3

TREATABILITY STUDY WORK PLAN



MARCH 1994

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

U.S. DEPARTMENT OF ENERGY
FERNALD FIELD OFFICE

FINAL

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OPERABLE UNIT 3

TREATABILITY STUDY

WORK PLAN

FINAL

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FERNALD, OHIO

MARCH 1994

U.S. DEPARTMENT OF ENERGY
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Acknowledgement

The Operable Unit 3 Treatability Study Work Plan was prepared with the support of individuals representing various areas of expertise. Contributors represented Argonne National Laboratory, Fernald Environmental Restoration Management Corporation (FERMCO) and the U.S. Department of Energy Fernald Field Office. The principal authors for this version of the document are:

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NOTATIONS

Abbreviation, Acronyms, and Initialisms

ABCOV	asbestos conversion
ACM	asbestos-containing material
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR(s)	applicable or relevant and appropriate requirement(s)
ASL(s)	analytical support level(s)
ASTM	American Society for Testing and Materials
AWWT	advanced wastewater treatment
BDAT	best demonstrated available technology
BRA	baseline risk assessment
BSM	boat sampling module
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGI	combustible gas indicator
CLP	Contract Laboratory Program
CRP	Community Relations Plan
CRDL(s)	contract required detection limit(s)
CRQL(s)	contract required quantitation limit(s)
CRU3	CERCLA/RCRA Unit 3
D&D ID	Decontamination & Decommissioning Integrated Demonstration
DE(s)	drum equivalent(s)
DF	decontamination factor
DOD	Department of Defense
DOE	Department of Energy
DOE-FN	Department of Energy — Fernald Field Office
DOT	United States Department of Transportation
DQO(s)	data quality objective(s)
EDE	effective dose equivalent
EDTA	ethylenediaminetetraacetic acid
EE/CA	engineering evaluation/cost analysis
EPA	Environmental Protection Agency
ERMC	environmental restoration management contractor
FACTS	Fernald Analytical Computerized Tracking System
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FFCA	Federal Facilities Compliance Act
FMPC	Feed Materials Production Center
FS	feasibility study

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GC	gas chromatography
GFAAS	graphite furnace atomic absorption spectrometer
GFCI	ground fault circuit interruptor(s)
GC/MS	gas chromatography/mass spectrometer
GRA	general response action
HEPA	high-efficiency particulate air filter
HSL	Hazardous Substances List
HSP	Health and Safety Plan
HWMU	hazardous waste management unit
IC	ion chromatography
ICP	inductively coupled plasma (spectroscopy)
IROD	Interim Record of Decision
IRS&T	Industrial, Radiological Safety and Training Department
ISA	initial screening of alternatives
LDR	land disposal restrictions
LLW	low-level waste
LSA	low specific activity
MCL	maximum contaminant level
MEF	material evaluation form
MSDS(s)	Material Safety Data Sheet(s)
NCP	National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
O&M	Operation and Maintenance
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OERR	Office of Energency and Remedial Response
ORC	Ohio Revised Code
USC	United States Code
OSHA	Occupational Safety and Health Administration
OU1	Operable Unit 1
OU2	Operable Unit 2
OU3	Operable Unit 3
OU4	Operable Unit 4
OU5	Operable Unit 5
OVA	organic vapor analyzer
PCB(s)	polychlorinated biphenyl(s)
PCT	product consistency test
PIC	pressurized ion chamber

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PID	photoionization detector
PLM	polarized light microscopy
PPE	personal protective equipment
PRDA	Program Research and Development Announcement
PRG(s)	preliminary remediation goal(s)
PSP	project specific plan
PTI	permit to install
PTO	permit to operate
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
QCC	quantity control coordinator
RA	removal action
RAA(s)	remedial action alternative(s)
RAO(s)	remedial action objective(s)
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation and feasibility study
RI	remedial investigation
ROD	record of decision
RPD	relative percent difference
RREL	Risk Reduction Engineering Laboratory
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SEM-EDX	scanning electron microscope - energy dispersive spectrometer
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SOP(s)	standard operating procedure(s)
SOW(s)	statement(s) of work
SRP	Savannah River Plant
STP	Site Treatment Plan
SVOC(s)	semi-volatile organic compound(s)
TAL	target analyte list
TCL	target compound list
TBC	to be considered
TCLP	toxic characteristics leaching procedure
TEM	transmission electron microscopy
TLV	threshold limit value
TOC	total organic carbon
TOS	task order subcontract
TSCA	Toxic Substances Control Act
TSI	thermal system insulation
TSWP	Treatability Study Work Plan
VOA	volatile organic analyses (analytes)
VOC(s)	volatile organic compounds(s)
WAC	waste acceptance criteria
WEMCO	Westinghouse Environmental Management Company of Ohio

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WPA	OU3 RI/FS Work Plan Addendum
WQC	water quality controls
WWTU	wastewater treatment unit
XRF	X-ray Fluorescence
Y-12	an Oak Ridge, Tennessee, facility

Chemical Symbols and Abbreviations

CH_3COOH	acetic acid
HCl	hydrochloric acid
HF	hydrogen fluoride
HNO_3	nitric acid
H_2O	water
H_2SO_4	sulfuric acid
K_2CO_3	potassium carbonate
$KHCO_3$	potassium bicarbonate
B_2O_3	borax
Na_2CO_3	sodium carbonate
$NaHCO_3$	sodium bicarbonate
Th	thorium
$Th(C_2O_4)_2$	thorium oxalate
ThF_4	thorium tetrafluoride
$Th(NO_3)_4$	thorium nitrate
ThO_2	thorium dioxide
U	uranium
UF_4	uranium tetrafluoride (sometimes called "green salt")
UF_6	uranium hexafluoride
UO_2	uranium dioxide (sometimes called "brown oxide")
$UO_2(NO_3)_2$	uranyl nitrate
UO_3	uranium trioxide (sometimes called "orange oxide")
U_3O_8	uranium oxide

Units of Measure

μCi/ml	microcuries per milliliter
Ci	Curies
CY	cubic yard(s)
dpm	disintegrations per minute
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
g	gram(s)
gal	gallon(s)
h	hour(s)
in	inch(es)
kg	kilogram(s)
L	liter(s)
lb	pound(s)
m	meter(s)

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m^2	square meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mg/L	milligrams per liter
mrad	millirad(s)
mrem	millirem(s)
oz	ounce(s)
pCi/L	picocuries per liter
pCi/g	picocuries per gram
ppb	parts per billion
ppm	parts per million
yd^3	cubic yard(s)
°C	degree(s) Celsius
μCi/g	microcuries per gram
°F	degree(s) Fahrenheit
μg/L	micrograms per liter
μg/kg	micrograms per kilogram
μg	microgram(s)

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1 INTRODUCTION

Under the *Superfund Amendments and Reauthorization Act of 1986* (SARA), it is a statutory preference for the U.S. Environmental Protection Agency (EPA) to select remedial actions involving treatment that "permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants" [*Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), Section 121(b)]. Treatability studies generate site-specific data necessary to serve five primary purposes. These primary purposes are to determine 1) whether the waste is amenable to the treatment process, 2) if pre-treatment is required, 3) the optimal process conditions needed to achieve the desired treatment, 4) the efficiency of a treatment process for a specific waste or wastes, 5) the volumes and characteristics of residuals resulting from various treatment processes.

This work plan proposes treatability studies to support the Fernald Environmental Management Project (FEMP) Operable Unit 3 (OU3) Remedial Investigation/Feasibility Study (RI/FS). This document is written in accordance with EPA guidance *Guide for Conducting Treatability Studies Under CERCLA* (EPA, 1992), and consists of the following major elements:

- site description and problem discussion;
- treatment technology type and process option identification, description and justification;
- objectives for conducting treatability studies;
- experimental design objectives;
- sampling and analysis plan;
- data management, data analysis, and data interpretation strategies;
- project specific health and safety plan;
- summary of the regulations, policies, and permits applicable to treatability studies;
- residuals management plan; and
- specific process option testing plans.

The results of testing these process options will support the remedial alternatives evaluation and feasibility evaluations. This planning is based upon existing information. It should be recognized that considerable additional insight into the nature of the OU3 contaminated materials will be obtained during the remedial investigation and implementation of the removal actions and interim remedial action. This plan will be amended as necessary to incorporate additional or changed test designs to accommodate new or emerging site data.

This document presents the baseline approach to conducting treatability studies. The *OU3 Treatability Study Work Plan* (TSWP) has been developed to contain general treatability study information only in the main body of the document (Sections 1-16). The information presented in Sections 1-16 is applicable to any currently proposed treatability study and is relevant to treatability studies which may be proposed in the future.

Currently, four treatability studies are proposed. Specific test plans for each treatability study are located in the study-specific appendices (Appendices B through E). The study-specific appendices contain information such as data quality objectives, test designs, applicable procedures, equipment and materials, a study-specific sampling and analysis and health and safety plan, summary information on applicable or relevant and appropriate requirements (ARARs), and a permit information summary. Additional bench-scale test designs for treatability studies not addressed in this TSWP will be submitted for review prior

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to initiating the study. Based on the results of the bench-scale studies proposed in this submittal of the TSWP, pilot-scale studies (remedy selection tier) may be conducted. All pilot-scale test designs, along with data quality objectives, test objectives, applicable procedures, equipment and materials, a study-specific sampling and analysis and health and safety plan, summary information on ARARs, permit information summary, and a map showing the pilot-scale study location will be submitted for review prior to implementing the study. The following information relates to the currently proposed treatability studies.

As discussed in Appendix B, Chemical Conversion of Asbestos-Containing Material (ACM), DOE proposes to investigate a new technology that has been claimed to eliminate the toxic nature of asbestos-containing material (e.g., transite and thermal system insulation). DSI Industries Consolidated, Incorporated has developed a new technology of asbestos abatement called the ABCOV Method. The ABCOV Method is a patented and proprietary chemical process which converts the asbestos fibers into a non-toxic material. This is achieved by placing the test media, asbestos-containing material (ACM), in an agitated vessel that contains an acid formulation which attacks the chemical bonds in the asbestos fibers. The fibers gradually decompose and after the solution has been filtered, the test media is a non-toxic, sand-like residue. Specific information regarding data quality objectives, test design, applicable procedures, equipment and materials, etc. for this study can be found in Appendix B.

The proposed Chemical Leaching Treatability Study will test a process option which utilizes a chemical leaching agent to separate contaminants from insoluble solid test media (scabbled concrete, scabbled acid brick, and the solid treated residuals from the Chemical Conversion Treatability Study). The procedure involves vigorously mixing the solid particles, which contain the leachable contaminants, with the leaching solution, under controlled conditions to will allow the desired contaminant to transfer from the solid phase to the liquid phase. Leaching agents are typically solutions (e.g., sodium carbonate/ bicarbonate, citric acid, hydrochloric acid, etc.) which can be utilized to extract contaminants from insoluble media, such as uranium. Specific information regarding data quality objectives, test design, applicable procedures, equipment and materials, etc. for the Chemical Leaching study can be found in Appendix C.

Vitrification of Asbestos-Containing Material and Glass is the treatability study proposed and addressed in Appendix D. Operable Unit 3 contains a large amount of ACM in the form of transite wall and roof panels, pipe insulation, loose insulation, and floor tiles. There is also a large amount of glass present in the form of window glass, laboratory glass, etc. These media are silica-containing materials which at a high temperature, form a non-porous glass which can immobilize and contain other wastes. These media are also assumed to be contaminated with radionuclides, and other chemical contaminants as well as with asbestos (for ACM). The focus of this study will be to determine the quality of the glass formed from vitrifying FEMP ACM and glass and to determine if the glass will immobilize and/or destroy other contaminants of concern. Specific information regarding data quality objectives, test design, applicable procedures, equipment and materials, etc. for the Chemical Leaching study can be found in Appendix D.

The proposed treatability test addresses in Appendix E, Vitrification of Mixed Wastes, will focus on the treatment, removal and/or stabilization of the mixed waste streams contaminated only with RCRA metals (i.e., characteristic wastes) through vitrification. Specific information regarding data quality objectives, test design, applicable procedures, equipment and materials, etc. for the Chemical Leaching study can be found in Appendix E.

1.1 SITE DESCRIPTION

At the FEMP, formerly known as the Feed Materials Production Center (FMPC)[1], the Department of Energy (DOE) is conducting a Remedial Investigation and Feasibility Study to achieve environmental restoration of the site. Response actions at the FEMP are being conducted in accordance with the requirements of CERCLA.

The FEMP is located on a 1,050-acre site in a rural agricultural area about 17 miles northwest of downtown Cincinnati, Ohio (Figure 1.1). The site is near the villages of Fernald, New Baltimore, New Haven, Ross, and Shandon, Ohio.

The FEMP is a government-owned, contractor-operated federal facility where an Environmental Restoration Management Contract (ERMC) approach is being implemented to manage the restoration activities, with Fernald Environmental Restoration Management Corporation (FERMCO), a wholly owned subsidiary of Fluor Daniel Incorporated, currently serving as the ERMC contractor. The FEMP produced high-purity uranium metal products for the DOE and its predecessor agency, the Atomic Energy Commission, during the period 1952-1989. Thorium was also processed, but on a smaller scale, and is still stored on the site. Production activities were stopped in 1989, and the production mission of the facility was formally ended in 1991. The FEMP was included on the National Priorities List in 1989. The current mission of the site is environmental restoration in accordance with the requirements of CERCLA of 1980, as amended by SARA.

1.1.1 Description of Operable Unit 3

The FEMP is divided into five separate *operable units*. The subject of this TSWP is OU3, which consists of the former Fernald Production Area and production-associated facilities and equipment. OU3 includes all above- and below-grade improvements, including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste, product, thorium, effluent lines, K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feedstocks, and coal pile as defined by the *Consent Agreement as Amended under CERCLA Sections 120 and 106(a) in the Matter of: U.S. Department of Energy Feed Materials Production Center, Fernald, Ohio* (EPA 1991). The former Production Area occupies approximately 136 acres near the center of the FEMP site and contains many buildings, scrap metal and soil piles, containerized materials, storage pads, parking lots and roads, railroad tracks, above- and underground tanks, utilities, and equipment. Several impoundments, ponds, and basins also are included. Operable Unit 3 does not specifically include the soil and groundwater under and around the various man-made improvements, but these media are important as potential pathways between sources of contamination in the operable unit and receptors in the environment. Remediation of soil and groundwater will be addressed by Operable Unit 5 (OU5) plans and will be integrated with OU3 remediation.

For OU3, there are a limited number of remedial alternatives available to mitigate the threat of release from the former production facilities and above- and below-grade improvements within OU3. In addition, there is a continuing potential for impacts to human

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[1] Throughout this report, the acronym "FEMP" is used for this facility, even though it was known as the FMPC when in operation.

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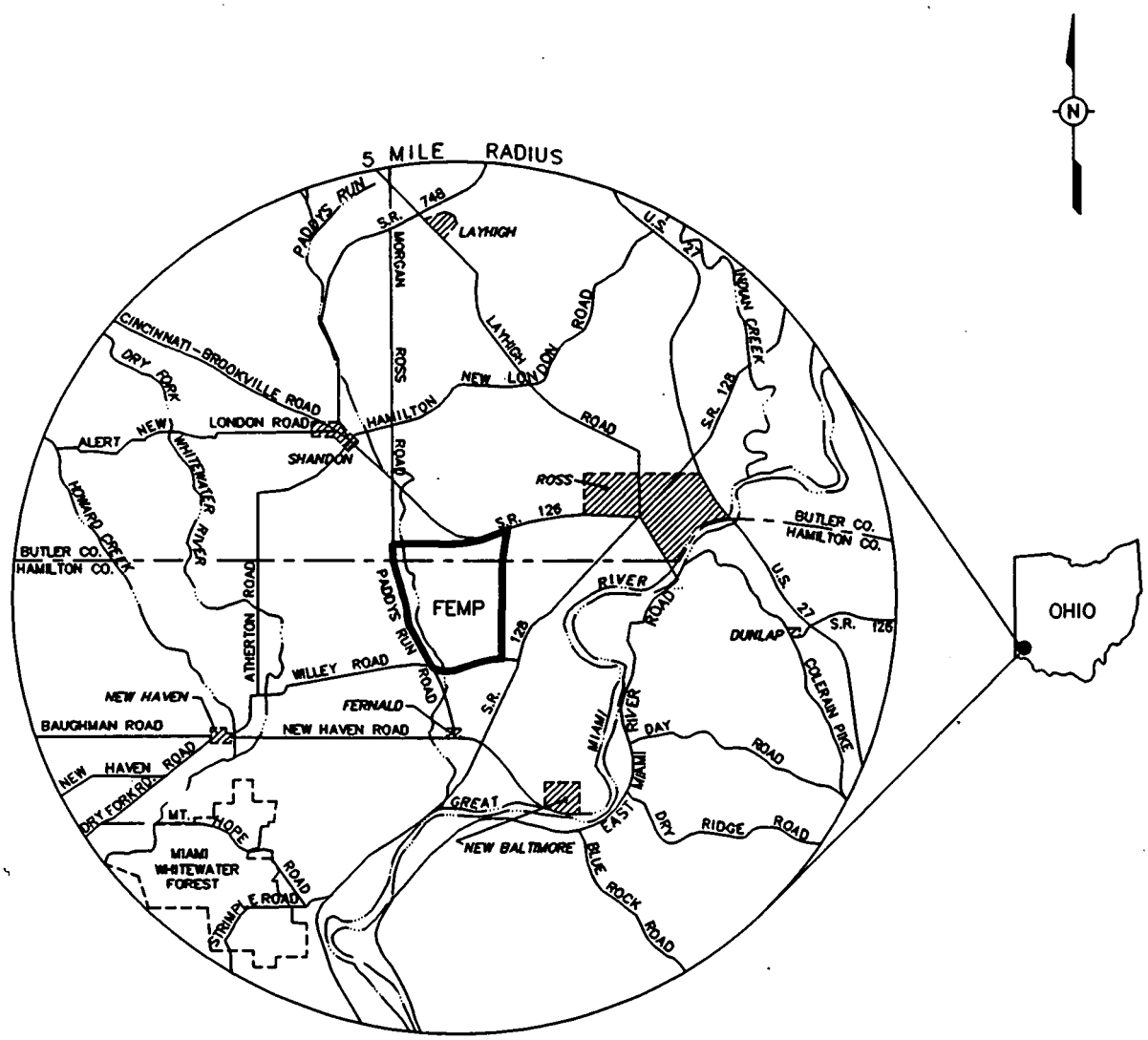

FIGURE 1.1 Location of the FEMP Facility

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health and the environment associated with the facilities remaining in their current condition. DOE, as the lead agency for the FEMP, has the responsibility to reduce risks to human health and the environment as quickly as possible. Therefore, DOE is fulfilling its responsibility as the lead agency in accordance with CERCLA and the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) (FR 1990) in proposing to implement an interim remedial action to accelerate the cleanup process within OU3. DOE has submitted to the EPA the *OU3 Proposed Plan/Environmental Assessment for Interim Remedial Action*. Upon approval of the proposed interim remedial action, an Interim Record of Decision (IROD) will be developed to address the concerns related to the OU3 facilities and improvements prior to the issuance of the final Record of Decision (ROD). The purpose of the proposed plan for interim remedial action and the IROD is to accelerate the remediation of OU3 by documenting the decision to decontaminate and dismantle OU3 facilities, thus allowing OU3 remediation to commence at an earlier date. The final ROD for treatment and disposition of waste materials will be issued as scheduled in the Amended Consent Agreement.

1.2 DESCRIPTION OF OU3 MEDIA AND CONTAMINATION

The following sections identify and describe the varying OU3 media categories and the physical state in which they are found. A summary of the nature and concentration of contamination is presented with the potential contaminants of interest in OU3.

1.2.1 Media Categories

To support the development of remedial alternatives and to estimate waste volumes, the media have been grouped into thirteen main categories on the basis of their primary construction materials and characteristics. Most of the media fit within the definition of a single category; however, because of anomalies in the media, several media types are identified as being multi-faceted (e.g., mica-coated electrical insulation, ceramic tile containing asbestos). The media categories were compiled based on physical characteristics (e.g., plastic, asbestos-containing, etc.), anticipated location of contamination (e.g., surface or volumetrically contaminated), and potential for beneficial reuse/recycle (e.g., bulk steel, etc.). The media categories or groupings may change, however, as the program progresses to factor in additional information. For example, media would be taken off the list if removal actions resulted in their disposition. Media also could be consolidated (e.g., soil or debris piles), or significantly change form (e.g., demolition of a structure to create a debris pile, recycle, etc.).

OU3 RI Field Characterization activities are in progress; currently field characterization sampling activities are approximately 50% complete with nearly 20% of the analytical data validated and returned to CRU3. The OU3 RI Field Characterization Program will generate data which will improve existing knowledge regarding the nature of contamination in OU3 media. This characterization data may validate or negate assumptions made in the OU3 TSWP and may result in potential improvements to test designs which may be presented at a later date.

1.2.1.1 Concrete

This media category includes poured concrete floors and walls which may be slightly or heavily reinforced. Concrete was used heavily for paved surfaces such as storage pads, building floors and for some free-standing, poured walls for shielding purposes, as well as building foundations, roofs, columns, equipment pedestals, shielding, etc. Penetration of

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contamination is anticipated to be limited to a small depth from the surface. It is anticipated that concrete located in wet process areas would tend to have detectable levels of contaminants at lower depths than concrete in dry process areas.

1.2.1.2 Cement Block, Acid Brick, and Gunnite Concrete

Gunnite concrete was used primarily in the refinery area as sprayed on tank shielding to protect operators from exposure to beta-gamma radiation. Because this tank shielding is extremely porous and the tanks were generally filled with uranyl nitrate, this concrete is anticipated to be contaminated throughout.

Cement block construction is primarily used in building walls at the FEMP. Cement blocks are also very similar to gunnite concrete in that they are extremely porous. Any contamination would be expected to migrate throughout either type of blocks.

Acid brick, applied over concrete, was used extensively in corrosive process areas of many FEMP facilities. Acid bricks, though thought to be relatively impervious to contamination, are not completely immune to it. It is anticipated that the weakest parts of an acid brick floor or dike are the mortar joints. Acid bricks are generally thin and may be cracked or broken. These bricks could possibly have uniform contamination throughout due to the nature of the contamination and the physical state which the bricks are found.

1.2.1.3 Asphalt

The greater part of the site roads and parking lots are concrete-based with layers of asphalt covering applied throughout the years. Any potential historical contamination would have been sealed in through successive road repair work, ground in by vehicles, and leaked in through cracks. Therefore, the depth of contamination may be significant and, at some locations, multi-layered.

1.2.1.4 Non-Porous Metals

This media category includes structural steel, mild steel, stainless steel, aluminum and process equipment metals. Structural steel is defined on the basis of thickness and includes, but is not limited to beams, columns, floor decks, railroad tracks, and elevated pipe-line support structures. Process equipment is considered to include tanks, pipe-lines, valves, pumps, and miscellaneous machinery and vessels. It is anticipated that structural steel, representing mostly large solid metal, will be mostly contaminated on the surface with dust and will generally not have been in contact directly with chemicals or uranium compounds; some floor decking and process equipment is comparably thin, is anticipated to have been in direct contact with chemicals and/or uranium compounds, and may be contaminated on both interior and exterior surfaces. Metals may be segregated during the interim remedial activities based on these classifications but the decontamination methods that will be investigated during the treatability studies will be focused more on the differences in the composition of the metals than the differences in shape or mass.

The remaining media in the metal category are generally non-porous and are expected to be contaminated on the surface. Mild steel is used primarily for bulk or structural steel. A significant portion of this metal is coated with a lead oxide-based paint. A significant

number of tanks, reactors, and process vessels are made of stainless steel because of the extensive use of nitric acid for uranium processes across the site. Aluminum, in sheet form, is used across the site as covering for pipe insulation, shielding, conduit, as the exterior skin and roofing of trailers located both on the process and non-process sides, and many other applications.

The FEMP has stored scrap metal which falls within the scope of OU3. The DOE has committed to conduct the "scrap metal piles removal action", identified as Removal #15 in Section 2.5.8 of the *OU3 RI/FS Work Plan Addendum* (WPA). The current inventory includes contaminated recoverable ferrous, contaminated recoverable nonferrous metal, and copper with asbestos-containing wraps. Disposition of the scrap metal piles have been initiated with emphasis on recycling or beneficial reuse. As stated in Section 1.4.1, DOE will coordinate activities with ongoing and future recycling projects planned for OU3 media to collect data and complete recycling/beneficial reuse treatability studies. As a result of the interim remedial action dismantlement activities, additional scrap metal piles may be generated. The remediation scrap metal piles will be managed, stored, and/or dispositioned under Removal #17, Improved Storage of Soil and Debris, pending the final ROD.

1.2.1.5 Inconel and Monel

Both inconel and monel are high-nickel exotic alloys that are manufactured by the International Nickel Company for special applications. Inconel is a nickel-chromium alloy that is highly resistant to oxidizing and reducing environments and is used for severely corrosive environments at elevated temperatures. Inconel was used at the FEMP for various processes that involved hydrofluoric acid. Monel is a nickel-copper alloy that has high strength, good weldability, excellent corrosion resistance over a wide range of temperatures and conditions, and is also highly resistant to oxidizers and reducers. The FEMP has several monel chemical reactors. Both media in this category are expected to be volumetrically contaminated due to the extensive use with acids at varying temperatures and due to the porosity of the materials.

1.2.1.6 Asbestos-Containing Materials

Asbestos-containing materials (ACM) are wide-spread and have been heavily utilized at the FEMP over the years. The list of known ACM include transite wall and roof panels, some floor tiles, pipe insulation, and loose insulation. Due to the porosity of transite and insulation, contamination is assumed to have migrated throughout the depth of the material.

Transite is a trade name for an asbestos-cement composite material composed of primarily portland cement and chrysotile (asbestos) fibers. Transite has been widely used on-site as the interior and exterior structural skin of buildings. The exterior transite panels are usually corrugated sheets, while interior skins are usually flat sheets. Corrugations help to withstand heavy service conditions and forms a weather seal when lapped over other structural or insulation panels. Transite is formed by hydraulically pressing together uncured, thin asbestos-cement sheets to form a hard, durable material. The final product has an approximate density of 112 pounds per cubic feet, and is usually 3/8 inch thick, 42 inches or 48 inches wide, and either 48 inches or 96 inches long.

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1.2.1.7 Non-Asbestos-Containing Insulation and Tile

Other forms of insulation used at the FEMP include fiberglass wall insulation and mica-coated electrical insulation. These are also extremely porous and are assumed to be contaminated throughout.

1.2.1.8 Wood

A significant quantity of wood has been and is being used for general maintenance and construction purposes, such as electrical and telephone poles, drum pallets, small sheds, railroad ties, and cooling towers. With the exception of the cooling tower wood and drum pallets, this wood is expected to have minimal contamination due to the uses of the materials. The cooling tower wood and drum pallets may have significant contamination and, as wood is porous, this media is expected to be volumetrically contaminated.

1.2.1.9 Glass and Ceramic

Various forms of glass and ceramics are encountered at the FEMP: windows; glass columns; laboratory glassware; furnaces lined internally with ceramic for insulation purposes; crucibles; and ceramic tiles. The concentration of contamination will vary widely for this list, depending on the use, location, and form of the material. For example, glass windows and laboratory glassware are not very porous and contamination may be found only on the surface. On the other extreme, ceramics used in lining some furnaces are highly porous and have been contaminated with thorium and enriched uranium compounds.

1.2.1.10 Plastic

Plastic is used extensively throughout the site and may contain significant amounts of contamination. Plastic was used as a building material, heavy plastic lagoon liners, containment plastics, and piping. Plastics exist in a variety of physical forms and from a variety of compounds. Both volumetric and surface contamination may be encountered.

1.2.1.11 Containerized Waste

The Containerized Waste media category includes all backlog waste inventory. This backlog waste is stored in various containers including five gallon cans, 30- and 55-gallon drums, and 85- and 110-gallon over-pack drums. For inventory purposes, waste volumes are expressed in drum equivalents (DE) or the equivalent of a 55-gallon drum. Most wastes are stored in carbon steel 55-gallon drums. In limited cases, stainless steel or plastic drums are used to prevent incompatibility. Sea/Land containers (approximately 250 DEs) and B-25 boxes (approximately 12 DEs) are used to contain volumetrically contaminated debris from maintenance and construction. The stated capacities of these bulk containers assumes 80 percent utilization of available space.

One part of the backlog waste inventory is process residues from past manufacturing of uranium metal and intermediate products. During past operations, uranium was recovered from many of these residues and recycled. Thorium residues constitute a second (smaller) portion of the backlog waste. Another part of the containerized waste is contaminated debris from construction activities and from maintenance of equipment and facilities. Debris generated by ongoing RI/FS activities and removal actions is also included. Approximately

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12,500 DEs of mixed waste (RCRA hazardous wastes which are radiologically contaminated) are included in the backlog inventory which totals approximately 137,500 DEs.

The potential process options which could be implemented for final remediation of the mixed waste streams found in the backlog waste category are currently being coordinated with the Federal Facilities Compliance Act (FFCA) program at the FEMP. In addition to coordination with the FFCA response activities, OU3 treatability studies are being coordinated with other operable unit treatability activities. OU3 coordination with other treatability studies is discussed in further detail in Section 1.4.1.

1.2.1.12 Miscellaneous Media

There are miscellaneous materials across the operable unit that may contain significant levels of contamination. This category includes media such as fabric, composite roofing, plaster, and many others of lesser volume in OU3.

The composite roofing materials contain a polyurethane foam and covers the roofs of several buildings, such as the Services Building, the Main Maintenance Building, the Laboratory, etc. This roofing material has been found to be contaminated in isolated spots.

1.2.2 Nature of Contamination

Section 2.4 of the OU3 RI/FS WPA addresses the nature of contamination present in OU3 media based on the processes and operations performed at the FEMP. A summary of historical information and process knowledge indicating the primary radiological and chemical contaminants of interest for OU3 is presented in the OU3 RI/FS WPA. Appendix A of the OU3 RI/FS WPA provides summary tables of OU3 contaminants of concern and component radiological surveys. Uranium is the principal contaminant of concern, although other radiological and hazardous contaminants are also present or anticipated in OU3 media including the following: thorium; uranium and thorium decay products; lead; mercury; chromium; PCBs; and others.

The OU3 Remedial Investigation Field Characterization Program will generate data which will improve existing knowledge regarding the nature of contamination in OU3. This characterization data may result in potential improvements to test designs which are presented at a later date.

1.3 PRELIMINARY REMEDIAL ACTION OBJECTIVES

Preliminary remedial action objectives are medium-specific or operable-unit-specific goals for protecting human health and the environment. Remedial action objectives for OU3 are addressed in Section 3.2.2 of the OU3 RI/FS WPA. The overall objective of the remedial action for OU3 is to clean up, stabilize, or otherwise control contamination to ensure protection of human health and the environment. Preliminary remedial action objectives for OU3 are identified in Table 3.6 of the OU3 RI/FS WPA.

Preliminary remedial action objectives are initial cleanup goals for individual contaminants for a specific media and a specific future land use. Remediation objectives are based on readily available information or standards (e.g., ARARs). As new information and data are collected during the remedial investigation and baseline risk assessment, the

remediation objectives will be modified. Final remediation action objectives are contaminant-specific cleanup levels that will be documented in the final ROD.

Many of the remedial action objectives for OU3 media will be established and developed by the health and/or environmental risk considerations or regulations. To meet the remedial action objectives, the applicable final disposition options are limited. Some materials may qualify for unrestricted release. Currently, it is anticipated that only non-porous material will be released from the site without radiological restrictions. The preliminary remediation goal for non-porous materials is provided in the *Department Of Energy Order 5400.5, Radiation Protection of the Public and the Environment*, (DOE 1990). If waste cannot be released without radiological restrictions, it is anticipated that preliminary remediation goals may be developed to meet on-site disposition requirements or acceptance criteria for off-site disposition.

1.4 TREATABILITY STUDY APPROACH

The purpose of treating contaminated materials is to achieve a reduction in risk to the environment and human health. Treatability studies support remedy selection during the feasibility study (FS) by providing data about potentially promising treatment processes and alternatives. Treatability studies test the effectiveness, performance, and implementability of potential remedial process options on OU3 media and contaminants of interest. The treatability studies will be conducted to ensure that selected remedial process options comply with ARARs, or waivers will be obtained for the ARARs.

The scope of the treatability studies includes gathering data regarding effectiveness, performance, and implementability on several of the following remedial technology types:

- surface removal;
- surface decontamination;
- dismantlement/bulk removal; and
- volumetric decontamination.

In this work plan, the term *technology types* refers to general categories of technologies, such as volumetric decontamination or surface removal. The term *process option* refers to specific processes within each technology type.

The *OU3 Proposed Plan/Environmental Assessment for Interim Remedial Action* identifies the preferred alternative of decontamination and dismantlement of all structures and other components in OU3. Debris and secondary waste requiring further treatment would be placed in interim storage on-site until a decision concerning final treatment and waste disposition is identified in the final ROD for OU3. Therefore, surface decontamination and dismantlement of intact buildings and facilities will be addressed by the proposed interim remedial action, while final treatment and disposition of the contaminated materials in interim storage will be addressed by the final remedial action for OU3. Treatability studies may be performed on decontamination processes and dismantlement techniques which support the implementation of the interim remedial action and on final treatment processes and disposition options to support the evaluation of the final remedial action alternatives. Studies performed to support the implementation of the interim remedial action may resemble pre-design studies. Evaluations of the treatability study data for processes which support the interim action will be performed during the design stages following completion of the *OU3 Remedial*

Design/Remedial Action Work Plan, while evaluations of treatability study data for processes which support the final remedial action will be performed in the OU3 Feasibility Study Report.

1.4.1 OU3 Coordination With Other Treatability Efforts

DOE will perform OU3 treatability studies in cooperation with other FEMP operable units, technology development efforts, the FFCA activity, and off-site vendors. If a treatability study is being performed by another on or off-site group and the process option is applicable to OU3 media and contaminants, DOE will coordinate efforts and resources to perform the study to ensure that OU3 data needs are met.

The Federal Facility Compliance Act of October 6, 1992, requires each DOE site to develop a Site Treatment Plan (STP) for mixed waste treatment capacity and process development. The STP will include possible process options that could be used to treat mixed waste, selection criteria for identifying the best process, and schedules for development of the selected process. The FEMP mixed waste is also regulated under CERCLA. Most of this waste will be dispositioned under the OU3 CERCLA remedial process. Therefore, the schedules and activities specified in the STP must be consistent with the OU3 remediation process. The OU3 waste streams which will be addressed by the STP have been identified in Section 1.2.1.11. If a mixed waste process option has been identified as a leading remediation candidate for an OU3 mixed waste stream and further data is needed to select the process option, OU3 may perform a treatability study on the process to assist the FEMP in meeting FFCA requirements.

The FEMP has several ongoing and future recycling projects planned for OU3 media. DOE will coordinate activities between OU3 and the recycling projects to collect data and complete recycling/beneficial reuse treatability studies. Currently, recycling studies are being planned for the Plant 7 dismantled transite, metal, and concrete.

Plant 7 dismantled concrete, transite, and metal will also be segregated and assigned for use as test media in OU3 treatability studies. Plant 7 concrete and transite will be utilized for currently identified treatability studies discussed in this work plan. The segregation and collection of these test media is discussed in further detail in Section 6.

Vitrification is a technology which is currently being tested or utilized at several DOE sites. Previous vitrification testing at Savannah River, Idaho National Engineering Laboratory, West Valley, and Hanford has been concerned primarily with stabilization of high-level radioactive waste. Currently, Hanford is planning the vitrification of low-level wastes from underground storage tanks and Savannah River has begun treatability testing for the vitrification of low-level mixed waste streams. A liaison has been established between other DOE sites utilizing vitrification and the FEMP vitrification testing efforts to ensure complete coordination and integration between DOE vitrification projects.

Several DOE Decontamination & Decommissioning Integrated Demonstrations (D&D ID) and Program Research and Development Announcement (PRDA) studies may be performed at the FEMP. Most of these studies are to be performed on OU3 media. DOE will work in conjunction with the D&D ID and PRDA vendors to collect treatability data which meets FEMP needs.

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1.4.2 EPA Guidance

The EPA *Guide for Conducting Treatability Studies Under CERCLA* (EPA, 1992) outlines a three tiered approach to conducting treatability studies for a Superfund site. The approach includes remedy screening, remedy selection, and remedy design. The remedy screening and remedy selection testing are generally pre-ROD studies and the remedy design studies are generally post-ROD. The proposed OU3 treatability study approach is consistent with EPA's phased system for conducting treatability studies which consists of conducting treatability investigations by performing remedy screening and remedy selection studies. Remedy design studies are not currently planned in the scope of this TSWP; however, remedy design testing may be implemented at a later date.

1.4.3 Relationship of Treatability Data to FS Evaluation Criteria

The best representative process option within each technology type will be determined by evaluating the process option with multiple criteria during the detailed analysis of potential remedial alternatives in the FS. The remedy screening and remedy selection treatability studies provide the performance and cost data needed to 1) evaluate potentially applicable treatment alternatives, and 2) select the most applicable remedial alternative for remedial action based on the nine NCP evaluation criteria.

The detailed analysis of alternatives phase of the FS follows the development and screening of alternatives and precedes the actual selection of a remedy in the ROD. During the detailed analysis, the retained remedial alternatives are evaluated based on nine NCP evaluation criteria. The criteria are detailed in the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988) and are:

- overall protection of human health and the environment;
- compliance with ARARs;
- long-term effectiveness and permanence;
- reduction of toxicity, mobility, or volume through treatment;
- short-term effectiveness;
- implementability;
- cost;
- State acceptance; and
- community acceptance.

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2 SCREENING OF PROCESS OPTIONS

In an effort to expedite the RI/FS process for OU3, DOE has submitted a letter to the EPA requesting that the Initial Screening of Alternative (ISA) Report be deleted from the Amended Consent Agreement schedule and that the information that would have been contained in the ISA Report be included as part of the FS Report. However, to support the identification of potential treatability study needs, this section provides a preliminary screening of process options. The information presented in this section will be used to support the development of corresponding sections in the FS Report. The objective of this section is to provide a summary of the preliminary identification and screening of treatment processes. The identification and screening of process options consist of the following general steps.

- Review the RAOs specifying the contaminants and media of interest, exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. The preliminary remediation goals are developed on the basis of chemical-specific ARARs, when available, other available information, and site-specific, risk-related factors.
- Review general response actions for each medium of interest defining containment, treatment, removal, or other actions, singly or in combination, that may be taken to satisfy the RAOs for OU3.
- Identify volumes or areas of media to which general response actions might be applied, taking into account the requirements as identified in the RAOs and the chemical and physical characteristics of the site.
- Identify and screen the process options applicable to each general response action to eliminate those that cannot be feasibly implemented at the site.
- Combine representative process options from each technology type to develop remedial action alternatives and screen alternatives based on technical criteria.

A discussion of the media categories and remedial action objectives was provided in Sections 1.2 and 1.3, respectively. Section 2.1 will consider general response actions. A discussion of the identification and screening of process options is presented in Section 2.2. An identification of remedial action alternatives for the final remediation is provided in Section 2.3, while Section 2.4 discusses the approach used to evaluate remedial action alternatives. Section 2.5 discusses the currently identified treatability studies to be addressed by this TSWP.

2.1 GENERAL RESPONSE ACTIONS

General response actions are those actions that will satisfy the remedial action objectives. Similar to remedial action objectives, general response actions are medium-specific; they can be applied either alone or in combination. General response actions for the final remedial action are identified in Section 3.2.3 of the OU3 RI/FS WPA. The response actions stated in the OU3 RI/FS WPA have been modified below on the assumption that the interim remedial action has been implemented. The general response actions for the final remedial action are defined as follows:

- *No Action* - Represents conditions of no further remedial action than what is currently proposed as part of the interim remedial action;

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- *Treatment (on or off-site)* - Includes physical, chemical, and/or biological measures which will reduce the volume, toxicity, and/or mobility of a contaminant or waste by altering the physical and/or chemical properties; and
- *Disposition/Recycle (on or off-site)* - Includes the removal of the treated or untreated waste and placement in a temporary or permanent pre-engineered environment which will restrict the contaminant migration and thus limit exposure routes.

2.2 SUMMARY OF THE SCREENING OF PROCESS OPTIONS

Based on available information, potentially feasible, media-specific remedial technology types and process options were identified for each of the final remedial action general response actions. These technology types and process options were compiled by utilizing resources described in various EPA documents, EPA databases, and DOE technology summaries as well as other applicable references.

Each of the process options underwent a screening for applicability and appropriateness to OU3 media and contaminants. The goal of the screening process was to focus on processes that were considered potentially applicable or appropriate and potentially improved over baseline process options (e.g., no action, box and bury, etc.) but for which additional data would be required for decision-making and to focus the treatability process on the most feasible options for the various OU3 media. The list of process options was evaluated against three criteria:

- *Effectiveness* - The potential effectiveness of process options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives; the potential impacts to human health and the environment during the construction and implementation phase; overall protection of human health and the environment; compliance with ARARs; the reliability and proven effectiveness of the process with respect to the contaminants and conditions at the site; and volume and type of secondary waste create (a process option can be eliminated on the basis of secondary waste generation only if other process options within the same technology type do not produce secondary waste or if the other process options produce a smaller volume of secondary waste);
- *Implementability* - Ability to obtain necessary permits and right-of-way for off-site actions; the availability of necessary equipment and skilled workers to implement the process; and the availability of treatment, storage, and disposition options; and
- *Cost* - Evaluated on basis of low, medium, or high relative to other process options in the same technology type.

The evaluation factors used to perform the screening process were based on standard EPA guidance criterion (effectiveness, implementability, and cost). In this step, process options were eliminated from the comprehensive list of potential process options based on the technical criteria. Appendix A, Tables A.1 through A.4, summarize the evaluations of the process options in each technology type.

Table 2.1 presents the technology types and the retained process options for OU3. Retention of these processes indicates that the process is applicable to one or more OU3 media categories and anticipated contaminants. Although the retained process options will be evaluated further in the FS, treatability testing may not necessarily be performed on all retained processes. For example, treatability testing would not be performed on retained processes for which adequate information is available. Also, process options with limited applicability to OU3 (e.g., processes which are highly contaminant-specific) may not be considered cost-effective for treatability testing or implementation. The technology types for OU3 media include no action, institutional options, surface removal, surface decontamination, volumetric decontamination, dismantlement/bulk removal, on-site disposition, off-site disposition, and material reuse/recycle.

2.3 FINAL REMEDIAL ACTION ALTERNATIVES

Preliminary alternatives for the remedial actions for OU3 were developed on the basis of the general response actions identified in Section 2.1, *EPA's Guidance for Conducting RI/FS Under CERCLA* (EPA 1988), and the categories specified in the NCP. The two categories of remedial action alternatives discussed in the NCP are source control response actions and groundwater response actions. Only source control response actions are directly applicable to OU3. Source control actions are response actions that reduce the toxicity, mobility, or volume of contaminants. These actions include final remedial action alternatives that employ treatment that removes or destroys contaminants to the maximum extent feasible, thereby minimizing the need for long-term management.

Four final remedial action alternatives are identified and discussed in Section 3.2.4.2 of the OU3 RI/FS WPA. These alternatives have been modified in this section on the assumption that the interim remedial action has been implemented. Development of the modified alternatives is based on 1) the general response actions, 2) selecting a representative process option for each technology type and assembling these process options into final remediation alternatives, and 3) the assumption that the interim remedial action alternative identified in Section 1.4 will be implemented. Note that in assuming that the interim action has been implemented, the alternative for in situ stabilization/containment identified in the OU3 RI/FS WPA has been eliminated. This alternative applies to standing structures which will have been dismantled as part of the interim action. The conditions that will exist following the implementation of the interim remedial action and up to the issuance of the final ROD are that OU3 components have been dismantled and most of the resulting waste and debris placed in interim storage on-site and remaining drums and inventory also have been placed in interim storage on-site. Drums and inventory are expected to be removed from site by removal actions; however, they are included to address the possibility that they have not been removed and that treatment technologies might address them.

The following alternatives for the final remedial action have been identified:

- Alternative 1: No-Action;
- Alternative 2: Disposition (on or off-site)/Recycle; and
- Alternative 3: Treatment/Decontamination and Disposition (on or off-site)/Recycle.

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TABLE 2.1 Retained Process Options

General Response Actions	Technology Types	Retained Process Options
1. No Action/Institutional Options[1]	No Action	No Action
	Institutional Options	Fencing, guards, signs, proprietary ownership, deed restrictions, environmental monitoring
2. Treatment/Decontamination	Surface Decontamination	Dry heat, flash lamp cleaning, strippable coating, electrokinetic migration, electropolishing, chemical foams, gels, and pastes, hand/automated brushing, vacuuming, low pressure vacuuming, and laser activated chemistry
	Surface Removal	Frozen pellet CO_2 blasting, ice blasting, sponge blasting, plastic pellet blasting, shot blasting (iron), high pressure water washing, ultra high pressure water washing, water jet (with or without abrasives), metal milling, concrete milling, scabblers/scarifiers, automatic grinding, hand grinding, honing, and scraping, laser heating, and laser etching and ablation
	Volumetric Decontamination	Chemical leaching, dry heat, catalytic extraction process, proprietary solvents, crush and wash, vitrification (stabilization), chemical conversion, electromagnetic separation/osmosis, biological, compaction, incineration, and solvent extraction
3. Dismantlement/Bulk Removal	Dismantlement/Bulk Removal	Arc saw cutting, explosive cutting, laser cutting, oxygen cutting, thermite reaction lance, plasma arc cutting, hacksaw and guillotine saw, circular cutting, abrasive cutting, mechanical grappler, manual/mechanical removal, backhoe mounted ram, wrecking ball, wall and floor sawing, controlled blasting, paving, cutting, and chip hammers, core stitch drilling, demolition compound, concrete torch, hydro laser, mechanical/hydraulic shears, front end loader/dozer.
4. Disposition/Recycle[1]	On-site	Engineered disposal facility
	Off-site	Landfill, hazardous waste site, low-level waste site, mixed waste site
	Material Reuse/Recycle	Release without radiological restrictions, transfer to other DOE facility for reuse, recycle

[1] Process options identified for these General Response Actions have not been screened in Appendix A but will be screened in the FS.

Variations in the options may be identified within each of the action alternatives (Alternatives 2 and 3) as the final remedial action develops in order to incorporate different elements specific to certain types of materials within each alternative to form comprehensive site-wide alternatives. Disposal may be on-site or off-site, resulting in two options for each disposal alternative. The waste acceptance criteria for either on-site or off-site disposal options may require limited treatment (e.g., drying, size reduction, etc.) for some OU3 wastes prior to burial/shipment.

In order to minimize disposition of materials with potential value, recycling and reuse of materials will be maximized. Materials meeting release criteria in accordance with 40 CFR 268.45, 40 CFR 192, *U.S. Nuclear Regulatory Commissions, 1974, Termination of Operating Licenses for Nuclear Reactors, Regulatory Guide 1.86*, DOE's proposed rule (10 CFR 834 - F.R. March 25, 1993), and DOE Order 5400.5 may be shipped off-site for disposal (DOE 1993a). Portions of non-recoverable and non-recyclable materials, generated by the implementation of the interim remedial action during the period prior to the final ROD, for which no reasonable treatment or recovery option is available (miscellaneous building materials), may be dispositioned at an approved off-site disposal facility prior to issuance of the final ROD. The quantity of this material shipped from the site as a consequence of the interim action would not represent greater than 10 percent of the total OU3 waste.

2.4 INITIAL SCREENING OF REMEDIAL ACTION ALTERNATIVES

Preliminary remedial action alternatives were developed in the OU3 RI/FS WPA in an attempt to meet the established RAOs; alternatives determined not applicable or infeasible were eliminated. The resultant alternatives were based primarily on RAOs and implementability concerns. The intent of initial alternative screening is to comparatively evaluate alternatives on the basis of effectiveness, implementability, and cost in accordance with the NCP at 40 CFR 300.430 (e&f) (Remedial Investigation/Feasibility Study and Selection of Remedy). Alternatives are evaluated more generally in this phase than they will be in subsequent detailed analysis tasks (e.g., during the FS).

As defined by the methodology of Office of Solid Waste and Emergency Response (OSWER) Directive 9355.301, at least one "no-action" and "remove/treat" alternative will be carried forward to the detailed analysis of final remedial alternatives. All final remedial action alternatives identified in Section 2.3 have been retained at this phase for detailed analysis in the FS Report.

2.5 TREATABILITY STUDY DESCRIPTIONS

Based on the results of the screening of process options shown in the screening summary tables located in Appendix A, and the results of the screening of alternatives, several process options have been identified for treatability testing. In order to adequately support the evaluation of alternatives in the detailed analysis, additional data are needed on several process options to better evaluate their performance. Literature searches and other sources of information (e.g., vendor contacts, technology development companies, etc.) either provided limited data for several processes or contained information that is not specific to the media or waste forms common to OU3. Treatability testing may be performed on various processes determined to be applicable to OU3 media and contaminants for which treatability testing will provide data for further evaluation by DOE. Treatability testing is intended to provide information to fill data gaps specific to OU3 media and contaminants.

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The process options selected from Table 2.1 for treatability studies currently addressed in this TSWP reflect the present understanding of OU3 media and contaminants as well as the completeness of the process and alternatives screening. Treatability testing may be performed on a process listed in Table 2.1 for the following reasons:

- the process may be utilized to decontaminate OU3's largest media categories (e.g., concrete, asbestos-containing materials, metals);
- the process may be utilized to decontaminate a media category for which viable treatment options are limited;
- the process is applicable and appropriate to OU3 media categories and contaminants but little or no data is available to evaluate the performance of the process; and
- implementation of the process appears to be cost effective compared to applying a baseline process option (e.g., box and bury).

Large quantities of transite panelling, concrete, metal and other debris will be generated by dismantling OU3 structures. Therefore, the treatability tests proposed in this submittal address 1) treating the volumetrically largest media categories (e.g., concrete and ACM) with process options which provide limited performance data and 2) process options which may be used to treat a media category (e.g., mixed waste) for which viable treatment options are limited. Additional treatability studies (e.g., recycling of metals) may be proposed as OU3 characterization and remediation progresses and as initial treatment testing results become available. Test design plans for treatability studies not addressed in this TSWP will be submitted prior to initiating the study. The introduction to the study-specific appendices will provide reasons for selecting the process option from Table 2.1 for a treatability study, a justification for performing the study, and a short description of the process options.

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3 TEST OBJECTIVES

This section outlines the development of the test objectives and discusses the establishment of performance objectives. The treatability performance and test objectives discussed in this section will be considered during the development of the study-specific objectives. Specific information about the test objectives and criteria for each process option to be studied is detailed in the respective study-specific appendices.

3.1 OBJECTIVE DEVELOPMENT

The range of release/disposition options available after treatment of contaminated OU3 media drive the treatability test objective development. Release/disposition options currently available for OU3 media include:

- On-site Disposal;
- Off-site Disposal;
- Restricted release of media for recycling;
- Restricted release of media for use within the DOE system; and
- Unrestricted release for recycling or disposition.

The *FERMCO Material Release Policy* has been developed to "manage the release of FEMP materials to ensure protection of public health and the environment, to ensure safe use or disposal of the material, to promote recycling, and to facilitate rapid and efficient site remediation." This policy is based on DOE Order 5400.5 which is consistent with NRC Regulatory Guide 1.86.

The *FERMCO Material Release Policy* has placed varying radiological release restrictions on OU3 media based on the anticipated depth of contamination in the media (e.g., surface contaminated versus volumetrically contaminated). Varying chemical disposition restrictions have also been placed on RCRA contaminated media versus non-RCRA contaminated media based on 40 CFR 261.3. Due to these varying restrictions, OU3 materials are subject to different release/disposition criteria. The following sections identify and describe the OU3 media categories based on the depth and nature of contamination present in the media, discuss applicable radiological and chemical release/disposition criteria, and identify potential treatability study objectives.

3.1.1 Surface Contaminated Media

Media with surface contamination are generally considered to be non-porous. OU3 non-porous media categories include metals, glass, and some plastics and miscellaneous media categories. This includes structural steel, stainless steel, mild steel, aluminum, window and laboratory glass, and some plastic building material and containment plastics.

Materials which are determined to have surface contamination below the guidelines referenced in the *FERMCO Material Release Policy* may be released without restriction. However, the ALARA process will be applied to further minimize the potential risks to human health and the environment.

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3.1.2 Volumetrically Contaminated Media

OU3 porous media may be volumetrically contaminated (contamination spread throughout the depth of the media). Considerable additional insight into the nature of the OU3 contaminated materials will be obtained during the remedial investigation (RI) and the implementation of removal actions and interim remedial action. For example, concrete corings will be taken during the RI at selected locations to determine the depth of contaminant migration. OU3 porous media categories include: concrete; cinder/cement block, acid brick, and gunnite concrete; asphalt; inconel and monel; asbestos-containing material; non-asbestos-containing insulation and tile; containerized waste; and a limited quantity of wood, ceramic, and miscellaneous media.

As defined in the policy, volumetrically contaminated media with radiation levels within the range of background levels (no residual radioactive material) and can be shown, administratively, to be clean may be released without restrictions. However, background levels have not yet been determined for these media which will undergo remediation in OU3. Volumetrically contaminated media with radiation levels above background may be recycled/reused if release is restricted to DOE facilities or NRC licensed commercial facilities.

3.2 OBJECTIVES FOR TREATING RADIOLOGICALLY CONTAMINATED MEDIA

Potential treatability study performance objectives for radiologically contaminated media may include reducing residual surface contamination to levels which would make the media suitable for unrestricted release. Where a process option is demonstrated to be incapable of decontaminating the media to levels for unrestricted release, the evaluation of the test results will examine the possibility that the media can be decontaminated to a contamination level suitable for controlled release for recycle/reuse.

Potential treatability study performance objectives for the treatment of volumetrically contaminated media may be to determine the greatest reduction in radiological contamination the process can consistently achieve or the best consistent performance of the test. The results will be used during the detailed analysis of alternatives in the FS to evaluate remedial decisions for recycling and on-site or off-site disposition options.

3.3 OBJECTIVES FOR TREATING CHEMICALLY CONTAMINATED MEDIA

Release restrictions for media with chemical contamination are not differentiated on the basis of surface contamination and volumetric contamination; instead, chemical regulations are based primarily upon determining if the media contains RCRA contaminants with concentrations above threshold limits for hazardous waste and invoking the land disposal restrictions (LDR). If RCRA contaminants are not present in leachates above regulated limits, the media may be released without hazardous waste restrictions. If RCRA contaminants are detected above the regulated limits, the media must be handled as hazardous in accordance with the LDR requirements which may require treatment. Other requirements include meeting the National Pollutant Discharge Elimination System (NPDES) levels, which regulates liquids (usually wastewater) discharged from a NPDES permitted facility, and meeting limits derived from drinking water standards.

Potential performance objectives for treating chemically contaminated media may include reducing the contaminant concentration in the leachate to levels below RCRA

regulated limits. Other potential performance objectives may be to destroy asbestos fibers, thus converting the waste into a non-toxic material (in the case of asbestos treatability studies), and treating liquid wastes to meet NPDES regulated levels.

Potential performance objectives for treating mixed waste (media containing radiological and hazardous contaminants) include performance objectives for treating radiologically contaminated media discussed in Section 3.2 and performance objectives for treating chemically contaminated media discussed above.

3.4 OTHER POTENTIAL OBJECTIVES

The performance objectives discussed in Sections 3.2 and 3.3 can be translated into specific test objectives. Applicable performance objectives can be applied to each treatability study to generate study-specific test objectives. These treatability test objectives may include filling data gaps where additional data is needed to perform the detailed evaluation of the process option in the FS. These additional data needs may generate the following test objectives:

- Demonstrating proof of principle for the applicability of each process option to OU3 waste;
- Demonstrating process performance and implementability;
- Determining the ability of the process option to meet compliance with ARARs;
- Collecting adequate data to support risk calculations in support of the effectiveness criteria evaluation for the detailed evaluation of alternatives;
- Collecting cost estimation data for the refinement of the process requirements;
- Generating an initial database for use in subsequent bench and pilot-scale studies in support of the remedial design;
- Demonstrate that residual risks are controllable; and
- Demonstrate that the process option would achieve permanent reduction of risk to human health and the environment.

In Section 4, objectives are further defined and developed based on treatability test design.

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4 EXPERIMENTAL DESIGN OBJECTIVES

This section of the TSWP provides a general overview of the experimental test objectives for each level of analysis under EPA's as defined in the *Guidance for Conducting Treatability Studies Under CERCLA* (EPA, 1992). Each treatability study test will be developed in accordance with this guidance to meet the requirements necessary to demonstrate process feasibility, performance, and implementability, including the requirements necessary to achieve the predetermined remedial action objectives. Detailed descriptions of the experimental design and test methodology required to demonstrate selected process options are contained in the TSWP appendices. The following sub-sections will contain a general discussion about remedy screening testing goals, remedy selection testing goals, and remedial design/remedial action testing goals.

4.1 REMEDY SCREENING TESTING GOALS

Remedy screening tests will be designed and conducted on a bench-scale level. Bench-scale tests will be performed by on-site technical staff for those process options that utilize standard chemicals or processes. If a proprietary system or specific vendor process is required to conduct testing, work scopes will be developed to procure the necessary on-site resources or the study may be performed off-site by the selected vendor. In general, most remedy screening bench-scale tests are used to provide a qualitative evaluation of the potential effectiveness of a process option. The data needs are determined for each study in the study-specific sampling and analysis plans.

Because the primary objective of remedy screening testing is to determine the potential feasibility of a process option, rigorous analytical QA/QC requirements are not generally required. Ordinarily, it is acceptable to specify that remedy screening data be generated at Analytical Support Levels A/B. Criteria for defining analytical support levels (ASLs) are contained in Section 3 of this TSWP. Examples of performance goals for a remedy screening bench-scale may be to establish:

- the extent of decontamination;
- the optimal test design (e.g. leaching solutions matched to media);
- test parameters for pilot scale studies (e.g., contact cycles, temperature, solution concentration, etc.); and
- criteria for assessing test results to determine if remedy selection testing is necessary.

Analytical results will be used to baseline process option effectiveness and will indicate whether further testing is necessary to more thoroughly evaluate a treatment process. Remedy screening testing will be used to establish the general feasibility of the process option, and if test results are acceptable, to identify remedy selection testing requirements.

4.2 REMEDY SELECTION TESTING GOALS

Remedy selection testing will provide more detailed, quantitative test results which identify and define process performance and cost. Performance data from these tests indicate whether the process option can comply with ARARs or attain predetermined cleanup goals. Results from remedy selection treatability tests will allow for estimation of costs associated with implementation of the remedy to the accuracy required for the FS (+50/-30%). Testing

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to support remedy selection will be implemented as either a quantitative bench-scale or a pilot-scale test. Examples of performance goals for a remedy selection may include the following:

- measure of the contaminants that can be destroyed or removed from the treated media;
- produce design information required for the next level of testing, should the remedy selection evaluation indicate that remedy design studies are warranted; and
- ensure that the removal efficiency achieved by the process option will meet site cleanup goals based on risk assessments and ARARs.

4.2.1 Bench-Scale

Quantitative bench-scale tests will be designed to investigate the capability of a process in removing radionuclide and chemical contamination. Additionally, parameters that may influence process performance will be established and optimized. Quantitative bench-scale tests may be designed and performed by on-site technical staff or by the vendor on or off-site if specialized processes are required.

Test data will be used to verify that the process option can meet expected cleanup goals and will provide information (i.e., performance, cost and design data) in support of the detailed alternative analysis performed in the FS. Due to the accelerated schedule to remediate OU3, semi-quantitative and quantitative data will be collected during the bench-scale phase of testing to support the detailed analysis of alternatives performed in the FS. Therefore, data to support remedy selection must meet high levels of quality assurance/control criteria. Quantitative bench-scale test data will emphasize the use of ASL C or D.

4.2.2 Pilot-Scale

Pilot-scale testing may be necessary where it is difficult to simulate field conditions in the laboratory (e.g., in situ treatment processes) and when actual performance criteria should be documented. Where the types of experiments and equipment involved in remedy selection treatability testing are very specific to the treatment process, pilot-scale testing may need to be conducted by the vendor. Where appropriate, pilot scale test data can be used to provide quantitative information required to optimize the performance of the process option. QA/QC requirements for pilot scale tests will be rigorous and will emphasize the use of ASL C or D.

4.3 REMEDIAL DESIGN/REMEDIAL ACTION TESTING GOALS

The purpose of remedial design/remedial action testing is to optimize the selected treatment process and to obtain detailed cost and performance data prior to, or in the early stages of the remedial action. Remedial design/remedial action testing is often vendor specific and may be conducted by the vendor as a step in remedy implementation. Full-scale on-site tests have been used for this step and as a final confirmation of cleanup level attainment by innovative treatment processes. Remedial design/remedial action treatability studies are not currently planned in the submittal of this TSWP; however, remedial design/remedial action testing may be implemented at a later date.

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5 EQUIPMENT AND MATERIALS

The study-specific appendices provide a listing of major equipment to be used during each treatability study.

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6 SAMPLING AND ANALYSIS

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The OU3 RI/FS WPA contains a detailed Sampling and Analysis Plan (SAP) for the remedial investigation field characterization. The purpose of this section is to describe the modifications to this existing SAP which will be required to accommodate treatability studies. Specific details of the modifications to the OU3 RI/FS WPA SAP will be provided in the TSWP study-specific appendices as SAP Addendum. The SAP Addendum for each treatability study will address sampling and analysis of all treatability test media and residuals before, during, and after treatment. The SAP Addendum will also ensure that samples obtained for characterization and testing are representative of OU3 contaminants, that the quality of the analytical data generated is known, and that the analytical data generated will support treatment performance evaluation.

Section 6.1 outlines the modifications to the WPA SAP for the development of treatability data quality objectives (DQO). Sections 6.2 and 6.3 consist of RI/FS SAP modifications for treatability field sampling methodology and laboratory analysis requirements, while Section 6.4 consists of modifications to the WPA SAP Quality Assurance Project Plan.

6.1 DATA QUALITY OBJECTIVES

Data quality objectives are developed in this document to ensure that all data collected as part of this treatability study are appropriate to meet OU3 decision-making needs. The level of detail and data quality needed, by necessity, vary depending on the intended use of the data.

All investigative activities for OU3 treatability studies must be conducted and documented in a manner that ensures that sufficient data of known quality are collected to support sound decisions concerning the selection of remedial actions during the detailed analysis of alternatives phase of the OU3 FS, and the uncertainty concerning the decisions is maintained within specified limits. As target values for data quality, the DQO specified is not necessarily criteria for acceptance or rejection of data collected.

The Sitewide CERCLA Quality Assurance Project Plan (SCQ) presents a structured eight-step process for the development of DQOs. This structured process provides the rationale for deciding what data are necessary, what quality and type of data are required, how the data will be technically defensible, and how risk is comprehended and minimized to ensure sound decisions throughout the remediation process. The process will help to identify areas of concern, the selection of equipment, quality assurance requirements, and analytical support levels. This process leads to the generation of a DQO summary form, which is intended to provide a quick overview of the major aspects of the data collection effort and the associated objectives. The summary form translates the development of DQOs into a concise field document that identifies media-specific ASLs and sampling and analysis procedures. The form summarizes the analytical and sampling requirements contained in DOE Orders, environmental regulations, the FFCA, Ohio Environmental Protection Agency Director's Findings and Orders, and the Amended Consent Agreement. The form is based on the relationship between sample media and the analytes of concern. A sample DQO summary form is provided in Appendix B of the SCQ. All DQOs developed for OU3 will be approved and documented in a separate document controlled by the FEMP DQO Coordinator. That document will consist of the DQO logic flow worksheet and the DQO summary form.

DQOs are qualitative and quantitative descriptions of the data that specify the quality and quantity required to support decisions concerning remedy selection and implementation. The end use of the treatability study data will determine the appropriate ASL for sample analyses, which in turn, identify appropriate analytical methodologies for measurements in the treatability studies.

The SCQ establishes a DQO process that includes a logic flow consisting of the following eight steps:

- Statement of the problem;
- Identification of a decision that addresses the problem;
- Identification of inputs that affect the decision;
- Specification of the domain of the decision;
- Development of a logic statement;
- Establishment of constraints on uncertainty;
- Optimization of design for obtaining data; and
- Summary.

The FEMP DQO summary form was developed as documentation of DQO development. Analytical and sampling requirements are summarized within the nine sections of this form. DQO information for each treatability study can also be found in the appendices of this TSWP.

ASLs A through E are defined in the SCQ and parallel the EPA DQO Levels I through IV for chemical analysis, but also include analysis of radionuclides, which comprise a large proportion of the analyses supporting the FEMP projects. ASLs were designed to maintain consistency with EPA in the definitions of DQO levels but to avoid confusion between EPA and DOE/EPA programs.

ASLs A and B (limited QA/QC) are generally required for remedy screening and remedy selection data used to decide, qualitatively/semi-quantitatively, whether the process option is potentially feasible and warrants further consideration. ASLs C and D provide a more rigorous QA/QC program and are used to verify whether the process option was effective and whether cleanup criteria have been met. SCQ definitions of the ASLs are included in Table 6.1.

6.2 COLLECTION OF TEST MEDIA

Most test media to be collected for use in the treatability studies will be collected according to sampling methods prescribed in Appendix K of the SCQ. The procedure numbers from the WPA SAP are listed in Table D.6-1 of the OU3 RI/FS WPA. Collection of test media for conducting treatability studies may be performed using both Appendix K procedures from the SCQ and Table D.6-1 procedures from the WPA SAP.

In some instances the treatability test media may be obtained by sampling techniques other than those techniques identified in Appendix K of the SCQ or Table D.6-1 of the WPA SAP. As stated in Section 1.4.1, a predetermined quantity of Plant 7 dismantled concrete, transite, and metal will be segregated and used for treatability testing.

Upon dismantlement, concrete and metal will immediately be placed into storage boxes and transite will be wrapped in plastic. The Plant 7 dismantled media to be used for

TABLE 6.1 Summary of Analytical Support Levels

Analytical Support Levels	Summary
ASL A - Qualitative Field Analysis	Provides the most rapid (real or short time) results. ASL A is often used for preliminary comparison to ARARs, initial site characterization to locate areas for subsequent and more accurate analyses, field screening of samples to select those for fixed laboratory analysis, and engineering screening of alternatives (bench scale tests). These types of data include those generated on-site through the use of photo- or flame-ionization detectors, pH and conductivity meters, alpha and beta/gamma friskers, or radiological wipe samples. Analogous to EPA DQO Level 1.
ASL B - Qualitative, Semi-quantitative, Quantitative	Provides more quality control checks than ASL A and results may be qualitative, semi-quantitative, or quantitative. ASL B can be assigned when rapid turnaround results are needed. Methods may range from more sophisticated techniques to fully defined methods similar to ASL C or D for radiological and nonradiological parameters, but with reduced QA/QC frequency and data reporting requirements for more rapid turnaround times. Also included in ASL B are standard methods (e.g., SW-846 methods with QA/QC requirements different than those specified for ASLs C and D) and conventional parameter analysis in support of regulatory requirements such as NPDES permit monitoring.
ASL C - Quantitative with Fully Defined QA/QC	Provides data generated with full QA/QC checks of types and frequencies specified for ASL D according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The analytical methods are identical to ASL D for QA/QC sample analysis and method performance criteria. ASL C may be used when analyses require a rigid, well defined protocol, but where other information is available, so that a complete raw package validation effort is not required. Laboratories will be required to retain, in the project file, raw instrument data required to upgrade ASL C reports to ASL D.
ASL D - Confirmatory With Complete QA/QC and Reporting	Provides data generated with a full complement of QA/QC checks of specified types and frequencies according to FEMP specified analytical protocols for radiological and nonradiological parameters. The data package includes raw instrument output for validation of ASL D data. It may be used to confirm data gathered at ASLs B and C and when full validation of raw data is required.
ASL E - Non-Standard	Analyses by non-standard protocols that often require method development or validation (e.g., when exacting detection limits or analysis of an unusual chemical compound are required). ASL E methods may be significantly different from those specified for ASLs B, C, or D data. New methods may be developed for ASL E data to allow for parameters or matrices that cannot be analyzed using existing standard methods. This could be caused by interferences, analyses performed outside of accepted requirements for existing methods, or new methods developed to meet site-requirements or project-specific requirements that cannot be met by existing analytical methods.

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treatability testing will be transported directly to the controlled-access OU3 treatability storage warehouse. Test media which is obtained by unconventional methods (e.g., scabbling to collect concrete particulates, Plant 7 dismantled media, etc.) will be discussed in further detail in the study-specific SAP Addendum.

Sampling points are to be chosen based on process knowledge to represent a specified set of conditions described in the test design. Examples of conditions to be specified include: wet process areas versus dry process areas, radiological "hot spots" within a process area, and/or samples contaminated with different forms of uranium (e.g., UF_4, U_3O_8, etc.). In some instances some sampling points have already been identified in the OU3 RI/FS WPA and are currently being sampled in the ongoing field characterization program. Details of sampling requirements for each study are contained in the study-specific appendices.

All test media will be handled in accordance to sample custody requirements contained in Section 7 of the SCQ. An example chain of custody form can be found in Appendix A of the SCQ.

6.3 TREATABILITY STUDY ANALYSIS

The following subsections describe the analytical characterization of the test media performed before, during and after the treatability study is conducted. These subsections will also address characterization of any secondary waste or residual generated by the treatability studies.

6.3.1 Characterization of Media

Test media will be characterized before the treatability studies to identify the nature and concentration of contamination. In the event that a target contaminant is not present in the test media, the sample may be spiked with the target contaminant to test the treatment system. Correlations and trends in initial data collected will help focus the scope of subsequent sampling and analysis. The scope of the final characterization stated in the SAP Addendum may be modified based on data collected from prior analysis to achieve a more efficient and effective sampling and analysis program. Characterization of the final product will also be used to determine the handling, storage, and/or disposition requirements for the treatability generated waste.

A complete listing of potential analytes to be tested can be found in Table 6.2. Each treatability study will request part or all of this list depending on the contaminants of concern for the media being tested in the study. Specific analyte listings for each treatability study can be found in the study-specific appendices.

EPA (1992) guidance suggests for remedy screening a minimum of one sample, and for remedy selection a minimum of two or three samples. To fully characterize each media being studied and to meet the data needs for the FS risk assessments, it is anticipated that three samples per media will be analyzed both prior to the treatability study and after the study is completed. In situations where one or two samples meet the data needs (e.g., data is not utilized for risk assessment development, data is being collected for a spot check analysis, etc.), the quantity of samples may be adjusted accordingly.

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TABLE 6.2 Potential OU3 Characterization Analyte List

Radionuclides

Total uranium
Isotopic uranium
Isotopic thorium
Isotopic plutonium
Plutonium 241
Radium-226 and 228
Neptunium-237
Americium-241
Cesium-137
Strontium-90
Lead-210
Polonium-210
Technetium-99

TAL Inorganics

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

TCL Semi-Volatile Organics

1,2-Dichlorobenzene
1,2,4-Trichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroanilene
2-Nitrophenol
2,2-Oxybis-(1-chlororpropane)
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-Dinitrotoluene
3-Nitroaniline
3,3-Dichlorobenzidine
4-Bromophenyl-phenyl ether
4-Chloro-3-methylphenol
4-Chloroaniline
4-Chlorophenyl-phenyl ether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
4,6-Dinitro-2-methylphenol
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
bis(2-Chloroethyl) ether
bis(2-Chloroethoxy) methane
bis(2-Ethylhexyl)phthalate
Butylbenzylphthalate
Carbazole
Chryzene
Dibenzofuran
Dibenzo(a,h)anthracene
Diethylphthalate
Dimethylphthalate
Di-n-butylphthalate
Di-n-octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Ideno(1,2,3-cd)pyrene
Isophorone
Napthalene
Nitrobenzene
N-Nitroso-di-n-dipropylamine
N-Nitrosodiphenylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene

TCL PCBs

Arochlor-1016
Arochlor-1221
Arochlor-1232
Arochlor-1242
Arochlor-1248
Arochlor-1254
Arochlor-1260

TCL Volatile Organics

1,1-Dichloroethane
1,1-Dichloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dichloroethane
1,2-Dichloroethene (total)
1,2-Dichloropropane
2-Butanone
2-Hexanone
4-Methyl-2-pentanone
Acetone
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
cis-1,3-Dichloropropene
Dibromochloromethane
Ethylbenzene
Methylene chloride
Styrene
Tetrachloroethene
Toluene
Total Xylenes
trans-1,3-Dichloropropene
Trichloroethene
Vinyl Chloride

TCLP Metals

Arsenic
Barium
Cadmium
Chromium
Lead
Mercury
Selenium
Silver

TCLP Semi-Volatile Organics

1,4-Dichlorobenzene
2,4-Dinitrotoluene
Hexachlorobenzene
Hexachloroethane
Hexachloro-1,3-butadiene
Nitrobenzene
Pentachlorophenol
Pyridine
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
o-Cresol
m-Cresol
p-Cresol

TCLP Volatile Organics

Benzene
Carbon tetrachloride
Chlorobenzene
Chloroform
2-Butanone
1,2-Dichloroethane
1,1-Dichloroethylene
Tetrachloroethylene
Trichloroethylene
Vinyl chloride

Additional Analytes

Asbestos
Silica

Sample Preparation Techniques

TCLP or PCT Extraction

5299 Remedy selection testing and final product characterization is semi-quantitative or quantitative and requires a moderate to high level of QA/QC. The data generated will be used to determine 1) the nature and concentration of contamination present in the test media, 2) if testing meets predetermined test objectives, and 3) how to store/manage the final product generated by the study. This data may also be used for risk assessment in the FS. To meet all of these needs, it is necessary that data generated to characterize the media during the remedy selection, bench-scale testing, be analyzed at ASL C with 10% analyzed at ASL D. All non-standard analytical methods are analyzed at ASL E.

Sensitivity goals for sample analysis are necessary to ensure that contaminants are detected at sufficiently low levels to be meaningful for the intended uses of the data. Sensitivity requirements are set for each type of laboratory measurement and are dependent on the analytical support level. Table 6.3 presents a listing of all the major laboratory parameters to be determined in the OU3 Treatability Study and gives the required method detection limits.

6.3.2 Optimizing Test Conditions

During the remedy selection bench scale studies, analyses will be performed in order to identify the progress/performance of the test conditions and to assist in the optimization of the test design. These tests will be performed on an as needed basis and may be required at critical test points throughout the testing.

Each treatability study will require a separate list of analytes dependent on the study being conducted. Analyses for optimizing the test conditions for each treatability study are listed in the study-specific appendices. The number and frequency of analyses will be dependent on the treatability study and the need to determine the progress of the testing.

During the optimization process, the QA/QC level requirements are less stringent than listed for characterization of the media. The data will be used mostly to determine the progress/performance of the testing at specific stages of the study and to assist in "tweaking"the process for more optimal conditions. To meet this need, data generated at ASL A/B is considered adequate. Data from non-standard analytical methods will be generated at ASL E.

6.3.3 Characterization of Secondary and Residual Wastes

Secondary wastes (e.g., wastewater, excess media, sludge, etc.) and treatability residual wastes will be generated as each treatability study is conducted. This waste must be characterized to determine how to manage, store, or dispose of this material.

Analytical testing will be performed to comply with ARARs such as RCRA and NPDES. The listing of potential analytes is found in Table 6.4. Each treatability study will request part or all of this list depending on the secondary waste generated by the study. The nature of the test will determine if this analysis is performed at remedy screening or deferred to remedy selection testing.

The number and frequency of analyses will be dependent on the number of waste streams and the amount of waste generated from each study. Section 11 will discuss the

TABLE 6.3 Analytical Sensitivity Requirements

Parameter	Units	Protocol	Method Detection Limits ASL B		Method Detection Limits ASL C[1]	
			Solids	Liquids	Solids	Liquids
Isotopic U	pCi/g or pCi/L	SCQ	0.4	0.4	0.2	0.2
Isotopic Th	pCi/g or pCi/L	SCQ	0.2	0.2	0.2	0.2
Isotopic Pu	pCi/g or pCi/L	SCQ	0.4	1.0	0.5	0.2
Cs-137	pCi/g or pCi/L	SCQ	2.0	9.0	4.0	1.0
Sr-90	pCi/g or pCi/L	SCQ	1.0	2.0	0.5	1.0
Tc-99	pCi/g or pCi/L	SCQ	20	30	10	15
Pb-210	pCi/g or pCi/L	SCQ	2.0	7.0	1.0	3.0
Po-210	pCi/g or pCi/L	SCQ	0.4	1.0	0.2	0.5
Ra-226	pCi/g or pCi/L	SCQ	0.4	2.0	0.2	1.0
Ra-228	pCi/g or pCi/L	SCQ	1.0	7.0	0.5	3.0
Np-237	pCi/g or pCi/L	SCQ	0.4	1.0	0.2	0.5
Pu-241	pCi/g or pCi/L	SCQ	1.0	1.0	0.5	0.5
Am-241	pCi/g or pCi/L	SCQ	2.0	2.0	1.0	1.0
Total Uranium	ug/g or mg/L	SCQ	1.0	0.1	0.1	0.1
VOCs	ug/kg or ug/L	SCQ	per SW-846	per SW-846	CRQLs[2]	CRQLs
SVOCs	ug/kg or ug/L	SCQ	per SW-846	per SW-846	CRQLs	CRQLs
PCBs	ug/kg or ug/L	SCQ	per SW-846	per SW-846	CRQLs	CRQLs
Metals	ug/kg or ug/L	SCQ	per SW-846	per SW-846	CRDLs	CRDLs
TCLP	mg/L	SCQ	per SW-846	per SW-846	per SW-846[3]	per SW-846

[1] All ASL D analyses will be reported at the Instrument Detection Limits.
[2] Contract Required Detection Limits, per the SOW for the EPA Contract Laboratory Program (CLP).
[3] SW-846 Methodology with full data package.

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TABLE 6.4 Analytical Analyte List for Secondary and Residual Wastes

Radionuclides

Gross alpha/beta
Isotopic uranium
Isotopic thorium
Total uranium

NPDES Parameters

Ammonia
BOD/COD
Copper
Fluoride
Grease & Oil
Hexavalent chromium
Lead
Nickel
Nitrate
pH
Silver
Total chromium
Total dissolved solids
Total suspended solids

TCL PCBs

Arochlor-1016
Arochlor-1221
Arochlor-1232
Arochlor-1242
Arochlor-1248
Arochlor-1254
Arochlor-1260

TCLP Metals

Arsenic
Barium
Cadmium
Chromium
Lead
Mercury
Selenium
Silver

TCLP Semi-Volatile Organics

1,4-Dichlorobenzene
2,4-Dinitrotoluene
Hexachlorobenzene
Hexachloroethane
Hexachloro-1,3-butadiene
Nitrobenzene
Pentachlorophenol
Pyridine
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
o-Cresol
m-Cresol
p-Cresol

TCLP Volatile Organics

Benzene
Carbon tetrachloride
Chlorobenzene
Chloroform
2-Butanone
1,2-Dichloroethane
1,1-Dichloroethylene
Tetrachloroethylene
Trichloroethylene
Vinyl chloride

Additional Analytes

Asbestos
Flash point
Paint filter liquid test
pH

Sample Preparation Techniques

TCLP or PCT Extraction

storage, management and disposition of these wastes in further detail. A list of expected waste streams and quantities of each stream will be detailed in the study-specific appendices.

The characterization data generated at this point will be used to determine the handling, storage, and/or disposition requirements for each secondary waste stream. The requirements for the level of QA/QC is defined by the method of handling, storage, or disposition.

6.4 QUALITY ASSURANCE AND QUALITY CONTROL

The Treatability Study Work Plan will be conducted according to the overall quality assurance program at the FEMP as described in the SCQ. Basic requirements for the development of DQOs, sampling, sample handling and storage, chain-of-custody records, and laboratory and field analyses are specified in the sections and appendices of the SCQ. The following is a summary of sections of the SCQ applicable to the TSWP, much of which is included by reference, with emphasis on any enhancements/ deviations specifically related to the Treatability Study activities.

6.4.1 General Quality Assurance/Quality Control (QA/QC) Requirements

A successful QA/QC program must establish positive controls over planning, implementation, and assessment of all sampling and analysis activities. Because of the breadth and complexity of the media found in OU3, it is essential that all these controls be applied in the treatability study activities from their initiation. The SCQ establishes a framework for control of the various sampling and analysis activities, with general variances to this framework addressed below.

6.4.2 Elements of Quality Assurance/Quality Control

6.4.2.1 Project Description

The FEMP project description is as defined in Section 2 of the SCQ. Project objectives specific to the TSWP are discussed in Section 3 of this TSWP. The project schedule is presented in Section 14 of this TSWP.

6.4.2.2 Project Organization and Responsibility

The general FEMP project organization and responsibilities are described in Section 3 of the SCQ. The Treatability Study organization and responsibilities are specifically discussed in Section 15 of this TSWP.

Section 3.3 of the SCQ discusses the necessity for preparing project-specific DQOs and a project-specific plan (PSP). The development of DQOs for the Treatability Study is discussed in Section 6.1 of this TSWP. The required contents of a PSP are met in this TSWP. The work plan provides such items as the project background, project organization, data needs identification, and sampling approach identification.

The use of processes, procedures, or methods not described in the SCQ is discussed in Section 3.3 of the SCQ.

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6.4.2.3 Quality Assurance Objectives

Section 4 of the SCQ presents FEMP-specific objectives for: the level of quality control effort; accuracy, precision, and sensitivity of analytical data; and data completeness, representativeness, and comparability. A discussion of the key elements necessary for attaining these QA objectives was discussed in the study-specific appendices, and is further discussed below.

The first key element is that the data must demonstrate that appropriate quality assurance was implemented. Associated with this, as discussed in Section 4.1.1 of the SCQ, is that appropriate laboratory quality assurance samples must be taken or prepared (including, as required, duplicates, blanks, spikes, equipment rinsate samples, etc.). The definitions for the frequency of various laboratory quality assurance samples is in Tables 2-2, Appendix A of the SCQ.

Other key elements are that analytical accuracy, precision, and sensitivity requirements be determined and will be discussed in appropriate appendices. These elements are discussed in Section 4.3 of the SCQ.

The remaining key elements are as follows: 1) the need to provide and document required site-specific and job-specific training; 2) the need to provide for proper records administration, preparation, control, and retention; and 3) the need to follow required documentation and drawing change control procedures. These elements will be completed in accordance with the appropriate portions of Section 4.4 of the SCQ.

6.4.2.4 Field Activities and Sampling Requirements

All field activities/sampling for the OU3 Treatability Study will be performed in accordance with the general policies/procedures of Sections 5 and 6 of the SCQ. All field activities will be documented in a daily log as stated in Section 5.1 and Appendix J of the SCQ. Other sampling activities, including the collection of aqueous, solid matrix, gaseous, and miscellaneous samples, will be conducted in accordance with Sections 6.2, 6.3, 6.4, and 6.6 of the SCQ, as well as Appendix K of the SCQ. Procedures for the field storage and shipment of samples, as well as decontamination of equipment, will be in accordance with Sections 6.7 and 6.8, respectively, of the SCQ.

6.4.2.5 Sample Custody

Sample custody will be in accordance with Section 7 of the SCQ. An example of a sample chain-of-custody form which may be used can be found in Appendix A of the SCQ.

6.4.2.6 Sample Container Requirements

Sample volume, sample containers, preservatives, and sample holding times will be in accordance with Section 6 of the SCQ and SCQ Table 6-1 (Appendix B of the SCQ).

6.4.2.7 Calibration Procedures and Frequency

Calibration procedures, frequency of calibration, and the associated documentation requirements are covered by Section 8 and Appendix I of the SCQ. Before any instrument is

used for making measurements at the FEMP, it must be documented that the particular instrument has been calibrated against standards traceable to the National Institute for Standards and Technology (NIST), EPA-certified standards, or if neither are available, the best quality standard that is obtainable. Additional details on instrument calibration are provided in approved site procedures.

6.4.2.8 Analytical Procedures

Whenever available, standard analytical procedures and methods for inorganic and organic analysis (e.g., SW-846, EPA-600 methods, SOW for the Contract Laboratory Program, etc.) will be followed during the treatability studies. These procedures and methods will be in accordance with the requirements of Appendix G of the SCQ. The radiological methods will be in accordance with the performance based criteria listed in Appendix G of the SCQ. When standard analytical methods do not exist or for analytes that are not currently covered under the SCQ (e.g., asbestos), vendor specific methods may be used. The vendors must be able to confirm that their vendor specific methods will be sufficient to meet the data needs and DQOs.

6.4.2.9 Quality Control Checks and Frequency

Field and analytical quality control/quality assurance checks and frequencies will be in accordance with Section 4 of the SCQ and will be defined in approved sampling procedures. Required frequencies for these quality control/quality assurance checks are found in SCQ Tables 2-2 and 2-4 (Appendix A of the SCQ).

6.4.2.10 Data Reduction, Validation and Reporting

Data reduction, validation, and reporting will be in accordance with requirements specified in Section 11 of the SCQ and the Data Validation Plan located in Appendix D of the SCQ. The data management strategy for the treatability studies will be in accordance with Section 7 of the TSWP.

6.4.2.11 Performance and System Audits

Self assessments and independent assessments (e.g., surveillance, audits, data validation, etc.) of the treatability study activities and data will be in accordance with requirements specified in Section 12 of the SCQ.

6.4.2.12 Preventive Maintenance

Preventive maintenance will be performed on instruments and equipment used for the treatability studies, in accordance with Section 13 of the SCQ. Additional details on preventive maintenance will be provided in approved site procedures.

6.4.2.13 Corrective Actions

Corrective actions will follow the guidance contained in Section 15 of the SCQ.

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7 DATA MANAGEMENT STRATEGY

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The data management system, hardware, software, and software development standards necessary for the development and implementation of the requirements, activities, and work specified for this project conform with the planning and requirements of Appendix F, Data Management Plan, in the SCQ. The data systems and associated operating features comprising the FEMP data management system will be employed to the maximum extent possible and practical. If certain capabilities are not available when the studies are performed, the data management systems will be augmented as necessary with appropriate and existing systems.

7.1 LABORATORY NOTEBOOKS

The notebooks and logbooks discussed in this section pertain to work performed at the treatability study laboratory only. Two types of laboratory notebooks will be used for this project: the laboratory notebook and the analytical logbook.

Project-specific treatability laboratory notebooks are used to provide a complete record of test data that may be collected while conducting experiments by recording all daily laboratory activities and real-time analytical results associated with the project.

Separate analytical logbooks will be used to record the analytical data resulting from laboratory analyses. This data may include information regarding injections or introduction of samples into analytical instrumentation. These logbooks are also used to record maintenance or problems associated with the analytical laboratory instruments.

Notebooks and logbooks will be signed out from the facility Quality Control Coordinator (QCC) to the individuals working on the project. At the completion of a project, the laboratory notebooks will be returned to the facility QCC for retention. Instrument logbooks are returned to the facility QCC when they are filled. The following text has been copied from the approved SCQ, Section 7.1.2., Daily Logs.

"Data collection activities shall be recorded in a bound field log or on daily field log forms (Form 5-1, Appendix B). Entries shall describe activities sufficiently for the sampling team to re-construct a particular situation without reliance on memory.

Field logs shall be bound field survey books or notebooks with sequentially numbered pages, preferably with water-resistant paper (standard engineering field book). Logs shall be assigned to field personnel. They shall be stored in a secure area when not in use. Each log shall be identified by a project-specific control numbers."

7.2 DATA REPOSITORY

FEMP site-wide data systems will provide a centralized, consistent, and flexible repository for data collected/generated under this project. The goal is to provide a centralized data repository for a very large quantity of treatability data, of known quality, that satisfy regulatory requirements and project DQOs and that can support a wide range of ad hoc and

routine data requests for assessment and reporting in a timely manner. Data which is collected or generated from treatability studies will be entered into the data repository and may include information from the laboratory and analytical notebooks along with data described in Section 8 of this TSWP.

Proprietary information generated by private vendors will be managed according to secrecy agreements entered into by the vendor and selected project personnel. The database will provide different levels of data access rights and privileges to users, ensuring that only selected data-center personnel can access, modify, or report data under very clearly defined circumstances.

7.3 QUALITY ASSURANCE/QUALITY CONTROL

All data will be written in standard laboratory notebooks or on standard formatted data entry sheets. All data management and reporting will follow standard QA/QC protocol. Standard QA/QC protocol, as it applies to testing within the laboratory, will adhere to the following guidelines:

- Verification on numerical results - all raw data entries, transcriptions, and calculations are checked;
- Data validation through test reasonableness - summaries of all test results for individual reports are reviewed to determine the overall reasonableness of data and to determine the presence of any data that may be considered outliers;
- Routine instrument calibration will be performed; and
- Use of trained personnel conducting tests - all technicians are trained in the application of standard laboratory procedures for analyses as well as in the QA measures implemented for internal QC checks.

8 DATA ANALYSIS AND INTERPRETATION 5299

Data analysis and interpretation will be an integral part in understanding the utility of the performed treatability tests. A determination of the quality of data collected can be made through data analysis. Through data interpretation, the results of each treatability study will aid in evaluating treatment alternatives on an equal basis and will ultimately provide the means to best fulfill the mission of site remediation. Data will be summarized in either tabular or graphic form. The exact presentation of the data will be a function of experimental design and the relationship between comparison variables.

8.1 DATA ANALYSIS

The OU3 treatability studies are designed with the objective of satisfying the unfulfilled data needs necessary to complete the evaluation of potential treatment processes. The data obtained from conducting treatability studies will be controlled and analyzed by specialists in appropriate technical fields in accordance with Section 6 of this TSWP and Section 7 of the SCQ. Data analysis includes efforts related to the evaluation of sample data. Data analysis includes data verification and validation to ensure the quality of data collected meets the predetermined DQOs. The data will then be evaluated to determine applicability in fulfilling treatability test data needs. The data evaluation task will continue through preparation of the FS report until it is determined that no additional data are required.

Treatability data analysis will be in accordance with the guidance and requirements contained in the SCQ. This task consists of sample management, chemical and radiological analysis, quality control, and data reduction, validation, and reporting. These subjects are addressed in detail in the SCQ.

8.1.1 Quality of Data

Sample management and control will be in accordance with Section 7 of the SCQ. Sample custody will be maintained and documented from the time of collection through analysis. Appropriate records will be maintained in the chain-of-custody process for sample tracking and control.

Analysis of samples and laboratory analytical procedures will be in accordance with Section 9 of the SCQ in conjunction with Appendix E of the SCQ. The listing of approved EPA methods for inorganic, organic, and conventional procedures is found in Appendix G of the SCQ. Performance-based criteria have been established for radiological analytes and are also found in Appendix G of the SCQ.

Performance requirements defined in Appendices A and E of the SCQ will be used to evaluate an analytical laboratory's capability to provide specific analytical services for the FEMP. A list of analytical laboratories performing work for the FEMP is included in Table 3.2 of Appendix A of the SCQ. Other laboratories may be added to this list subject to FEMP approval and EPA audit.

Sample QC will be carried through analytical processes to maintain and verify the quality standards initiated in the field and to verify the quality of measurements taken in the field, laboratory investigation, and associated tasks. Details on the QA program objectives,

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as defined in Section 4 of the SCQ, include field quality assurance, analytical quality control samples, training requirements, records administration, document control, and requirements for completeness, representativeness, comparability, precision, accuracy, and sensitivity.

Data reduction, validation, and reporting for each ASL will be in accordance with Section 11 of the SCQ. Numerical analysis, including manual calculations, mapping, and computer modeling, will be documented and subjected to QC and peer review. The Data Validation Plan is presented in Appendix D and the Data Management Plan is presented in Appendix F of the SCQ.

8.1.2 Accuracy, Precision and Completeness

Specific objectives for the level of quality control, accuracy, precision and sensitivity of analytical data and data completeness, representativeness and comparability are contained in the FEMP Sitewide CERCLA Quality Assurance Project Plan. Data generated during treatability studies will be validated against the study objectives to determine if the pre-established data quality objectives have been met and the data is adequate for the intended use. Data evaluation results will be presented in reports (discussed further in Section 13 of this TSWP) which document the results of each treatability study. Included with these results will be a discussion of the level of confidence in the reliability of the data. Assumptions that may effect decision-making and the limits of uncertainty associated with each data point will also be discussed.

Calculations of precision, accuracy and completeness that may be used to support data quality include the following:

Example calculations of precision:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

where:

RPD = relative percent difference
C_1 = larger of the two observed values
C_2 = smaller of the two observed values.

Example calculation of accuracy:

$$\%R = \frac{100\% \times (S - U)}{C_{sa}}$$

where:

%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added.

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Example of calculation of completeness:

$$\%C = 100\% \times \frac{V}{n}$$

where:

%C = percent completeness
V = number of measurements judged valid
n = total number of measurements necessary to achieve a specified statistical level of confidence in decision making.

8.1.3 Presentation of Data

For each process option tested, data may be presented in tabular or graphic format. The following list of data may be presented:

- concentration of contaminants in test media before and after treatment;
- overall reduction in contaminant concentration;
- contaminant reduction as a function of test parameter (e.g., particle size, temp., pH, contact cycle, etc.);
- weights/volumes reagents;
- description of waste in final form and secondary waste generated;
- success at converting hazardous material to a non-hazardous form;
- physical characteristics of treated waste forms (e.g., percent moisture, bulk density);
- cost and performance data;
- maximum or optimum particle size treated;
- description of gases or vapors released during processing;
- pH and Eh of reagent waste mixture;
- radon emission test results in advanced phase;
- TCLP data results;
- Effectiveness on wet versus dry condition of tested materials;
- Effects of the process design variables on the treatment; and
- Reduction of contaminants concentration as a function of time.

TCLP results may be reported in three ways: 1) actual analysis of extract; 2) results adjusted for spike recovery; and 3) results adjusted for spike recovery and dilution by stabilization reagents.

8.2 INTERPRETATION OF DATA

Interpretation of all treatability study data will be based on the test objectives established prior to performance of the tests. The data results will allow an evaluation of all treatment alternatives in the detailed analysis of alternatives performed during the FS.

The test results will be interpreted using the RI/FS evaluation criteria developed in the 1990 revised NCP Section 300.430(e). When considering the assessment of remedial alternatives, threshold criteria, primary balancing criteria and modifying criteria will be weighed appropriately. Treatability study results will provide data for assessing alternatives against

both the threshold criteria (overall protection of human health and the environment and compliance with ARARs) and the primary balancing criteria (long-term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment, short-term effectiveness, implementability, and cost). Data interpretation will also include 1) determining the variability in tests and the impact on full-scale treatment processes and 2) reasons for deviation from anticipated results.

9 OU3 TREATABILITY STUDIES HEALTH AND SAFETY PLAN 5299

Appendix F contains the *OU3 Treatability Studies Health and Safety Plan* (February 1994) for the OU3 treatability program. These procedures will be implemented and followed by personnel involved in all test and analytical activities related to any test conducted by the OU3 treatability program. This document has been developed under the lead health and safety plan for OU3, the *CERCLA/RCRA Unit #3 (CRU3) Health and Safety Plan* (June, 1993).

The treatability study-specific appendices contain tables and attachments which identify potential hazards and procedure-specific health and safety guidance (e.g., personal protective equipment, permits, training, etc.) for each study and associated analysis. The health and safety guidelines as outlined in the study-specific appendices are in accordance with the *OU3 Treatability Studies Health and Safety Plan.* The information provided in the study-specific tables and attachments are to ensure that the health and safety of all personnel involved in the performance of the activities is appropriately protected.

On-site support groups who perform activities in support of OU3 treatability will use their program's approved procedures and health and safety plans (e.g., treatability test media collection performed by the CRU3 RI/FS Media Sampling group will be conducted under the approved CRU3 RI/FS Media Sampling Health and Safety Plan). Treatability activities and studies performed off-site will be conducted under the vendors approved procedures and health and safety plans.

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10 TREATABILITY REGULATIONS, POLICIES AND PERMITS

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10.1 REGULATORY REQUIREMENTS AND POLICIES

The regulatory requirements discussed by this section are those requirements that have been identified for OU3 Treatability Studies. This section includes a discussion of CERCLA Statutory provisions affecting the currently identified OU3 treatability studies and requirements in the Amended Consent Agreement. Study-specific ARARs and other criteria to be considered that specifically address regulatory requirements for each study are contained in the study-specific appendices. For treatability studies which are identified and performed after submittal of this TSWP, a complete description of regulatory requirements and policies will be included in the study-specific appendix.

10.1.1 CERCLA Statutory Provisions

The ARARs for treatability studies conducted off-site, with only on-site management and storage of test media prior to shipment to the testing facility, would be limited to requirements governing on-site storage and management of the waste. The CERCLA Off-Site Policy [CERCLA Section 121(d)(3)] would apply. This policy states:

> "In the case of any removal or remedial action involving the transfer of any hazardous substance or pollutant or contaminant off site, such hazardous substance or pollutant or contaminant shall be transferred to a facility which is operating in compliance with Section 3004 and 3005 of the Solid Waste Disposal Act (or, where applicable, in compliance with the Toxic Substance Control Act or other applicable Federal law) and all applicable State Requirements...."

Under this policy, the receiving facility would be required to be in compliance with environmental regulations governing activities conducted by that facility prior to shipment of the waste. This is consistent with direction provided by EPA *Guide for Conducting Treatability Studies Under CERCLA*, which states:

> ". . . Off-Site Policy does not specifically exempt the transfer of CERCLA wastes off-site for treatability studies; therefore, off-site laboratories or testing facilities that receive CERCLA wastes must be in compliance with off-site requirements."

The CERCLA Off-Site Notification Requirements (NCP Reference, 55FR8740) would also apply. This requirement states that prior to out-of-state transfer of Superfund waste, the lead agency (DOE) should provide written notice to that state's environmental office, notifying of the pending superfund waste shipment to that state.

If it is determined that RCRA hazardous waste is present in the materials shipped, then restrictions governing treatability study shipments would apply. RCRA at 40 CFR 261.4(e) an (f), establishes standards governing the volume of waste that could be shipped off-site, standards for management of that waste and requirements for operation of the laboratory.

10.1.2 Amended Consent Agreement Provisions

Section X.B.2 of the Amended Consent Agreement allows the DOE to conduct treatability studies for the FEMP, and therefore allows for development and operation of the planned studies as part of the RI/FS process for OU3. This section states:

> "U.S.DOE has submitted RI/FS Work Plan Addenda for the performance of treatability studies required for OUs 1,2, and 4. . . . The U.S.DOE shall submit addenda proposing additional treatability studies, including treatability studies for OU3, if determined to be necessary by U.S. EPA, in a timely manner as necessary to ensure compliance with the schedules contained in this agreement. All work plans shall explain the purpose of the treatability studies and shall include a level of study sufficient to evaluate the various treatment options during the detailed analysis of alternatives."

This work plan was developed to satisfy the requirements of Section X.B.2. of the Amended Consent Agreement and will be directed at presenting a level of detail that is sufficient to develop and evaluate the OU3 alternatives during analysis of the alternatives and remedy selection process.

10.1.3 Federal Facilities Agreement for Control and Abatement of Radon-222 Emissions

The Federal Facilities Agreement for Control and Abatement of Radon-222 Emissions was signed by the EPA and DOE in November of 1991. The purpose of this agreement was to implement a means for compliance with 40 CFR 61 Subpart Q, National Emissions Standard for Radon Emissions from Department of Energy Facilities. The following provision in that agreement could impact the treatability studies planned in OU3:

> If any sources are identified which "contain radium 226 in sufficient concentrations to emit radon-222 in excess of the standard (20 pCi/m^{2}s)," these sources along with estimates of radon emissions must be identified to the EPA within 30 days of discovery, for determination of appropriate action.

This agreement supersedes the requirements established by 40 CFR 61 Subpart Q, as site specific implementation of that regulation. As such, wavier of the standards in 40 CFR 61 Subpart Q is not an option. Therefore, this standard would not be ARAR, and has not been included in the ARARs table.

10.1.4 Potentially Applicable or Relevant and Appropriate Requirements; Other Criteria To Be Considered

Treatability studies conducted under a CERCLA RI/FS must comply with the NCP, as required by the NCP and the Amended Consent Agreement. Guidance prepared by the EPA, in part, consist of the *Guide to Conducting Treatability Studies Under CERCLA*. According to that document, on-site treatability studies must comply with ARARs to the extent practicable or justify a wavier. Accordingly, the treatability studies proposed for OU3 must comply with the ARARs relevant to each treatability project as identified from the ARARs as prepared in response to the RI/FS for OU3, to the extent practicable, or justify a wavier. If waivers for the ARARs identified for this action becomes necessary during implementation, waivers will be requested at the time it is determined that an ARAR is impracticable or cannot be met. Tables of the ARARs from the OU3 ARARs list identified as relevant to each of the

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treatability studies are presented in the study-specific appendices. The tables include an overview statement of what the requirement is about and the rationale for implementation. Introductory text is included with the ARAR tables as an overview of the requirements identified as relevant to each of the currently identified studies.

10.1.5 Federal Facilities Compliance Act

As stated in Section 1.4.1, the Federal Facility Compliance Act, signed October 6, 1992, requires each DOE site to develop a Site Treatment Plan for mixed waste treatment capacity and process development. The FFCA waives sovereign immunity for fines and penalties for RCRA violations at Federal facilities. However, a provision postpones that waiver for three years for mixed waste LDR storage prohibition violations at DOE sites and requires DOE to prepare plans for developing the required treatment capacity for mixed waste. The Act further provides that DOE will not be subject to fines and penalties for LDR storage prohibition violations for mixed waste as long as it is in compliance with an approved plan and order.

The Act specifies that the STP must address all mixed waste at the site, regardless of the time of generation, and must be approved by the State or EPA. For mixed waste for which identified treatment process options exist, the plan must provide a schedule and milestones for constructing the necessary treatment capacity. For mixed waste without an identified existing treatment process, the plan must include a schedule for identifying and developing process options. If a mixed waste process option has been identified in the STP as a remediation alternative for a mixed waste stream and further data is needed to develop the process, OU3 may perform treatability studies on the process option to assist the FEMP in meeting FFCA requirements.

The conceptual STP, submitted in October of 1993, is focused on identifying treatment needs, capabilities, and options for treating the site's mixed waste. The draft STP, due in August of 1994, will identify DOE's preferred option for treating the site's mixed wastes, as well as proposed schedules for constructing capacity. The final proposed STP, due in February 1995, will be submitted to the State or EPA for review and approval, approval with modification, or disapproval, as required by the Act.

10.2 PERMITS

Each of the projects identified in this TSWP is a treatability study which will be conducted on debris and construction rubble from OU3. The rubble and debris specifically addressed here will be generated under existing OU3 activities and actions, being conducted by the DOE under CERCLA Section 104. The studies to be conducted are in support of the remedy selection process as part of the ongoing OU3 RI/FS, to provide information necessary to develop and select alternatives for OU3. Consequently the statutory waiver for permits in CERCLA Section 121(e) applies. This section states the following:

> "(e) Permits and enforcement-
>
> (1) No Federal, State or local permit shall be required for the portion of any removal or remedial action conducted entirely on site, where such remedial action is selected and carried out in compliance with this section."

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Although according to CERCLA statues no permits are required for treatability studies conducted entirely on-site, CERCLA and a similar requirement in the EPA-DOE Amended Consent Agreement make it clear that the substantive requirements of the appropriate permits, that would otherwise be required, must be submitted.

The Amended Consent Agreement, Section XIII states:

"A. U.S.EPA and U.S.DOE recognize, under Section 121(d) and 121(e)(1) of CERCLA, 42 U.S.C. 9621(d) and 9621(e)(1) and the NCP, that portions of the response actions under this Agreement and conducted entirely on the Site are exempt from the procedural requirement to obtain Federal, State or local permits. U.S.DOE must satisfy the Federal and State standards, requirements, criteria, or limitations that would have been included in any such permit to the extent required by CERCLA and the NCP."

"B. When U.S.DOE proposes a response action to be conducted entirely on the site, which in the absence of Section 121(e)(1) of CERCLA and the NCP would require a Federal or State permit, U.S.DOE will include in its submittal to EPA:

1. Identification of each permit that would otherwise be required;
2. Identification of the standards, requirements, criteria or limitations that would have had to have been met to obtain each such permit; and
3. Explanation of how the response action will meet the standards, requirements, criteria, or limitations identified in item 2 above."

Consequently, supporting documentation, containing the information discussed above has been included in the Permit Information Summary located in the study-specific appendices. The substantive or technical requirements have been integrated into this work plan.

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11 RESIDUALS MANAGEMENT

Waste materials or residuals will be generated from treatability study activities. The waste materials will exist in a variety of forms and will contain varying levels of radiological and chemical contamination. A detailed disposition and storage plan will be developed to ensure the safe, efficient and economical handling and disposition of treatability study generated wastes.

Under EPA guidelines, the residuals category will include, but not be limited to, unused waste not subject to testing, treated waste, treatment residuals (e.g., ash, scrubber water,.etc.), laboratory samples and sample residuals, used containers or other expendables, and contaminated protective clothing and debris. Each residual is a problem in itself and the methods of waste disposition selected must take into consideration the proper and most economical route.

This section describes the management plan for the expected residuals. The residuals management encompasses each step in the system from the generation of the waste to storage at the FEMP and final disposition. Figure 11.1 represents the residuals management strategy. It is necessary to consider the entire residuals management process and the interactions between the various steps.

Tables of the anticipated waste streams and quantities of waste generated for each treatability study are presented in the study-specific appendices.

11.1 ON-SITE TESTING

Residuals from all on-site treatability study testing will be collected/segregated, characterized, and packaged as indicated in Figure 11.1. These characterized residuals and unused treatability study samples will be stored at the FEMP until a final disposition is arranged. As with other on-site materials, some of the residuals may be dispositioned prior to the final ROD through existing removal actions and recycling initiatives.

11.2 OFF-SITE TESTING

Residuals generated from off-site treatability studies or off-site analytical laboratory will be managed as indicated in Figure 11.1 and consistent with Section C.6 (Waste Management) of the *Radioanalytical Laboratory Services Task Order Subcontract for the Fernald Environmental Management Project*. This task order subcontract (TOS) has been developed by FERMCO to select and qualify radioanalytical laboratories and to define the general requirements for performing radioanalytical services. Section C.6 of the TOS is summarized in the following subsections. Residuals will be shipped back to the FEMP only with prior FEMP approval in accordance with Section 4.1, Acceptable and Unacceptable Waste, of the *FEMP Waste Acceptance Criteria* (WAC) document.

11.2.1 Laboratory Analytical Residuals

Residuals generated by an off-site laboratory during the processing and/or analysis of FEMP treatability test media will be properly stored and disposed of in accordance with applicable Nuclear Regulatory Commission (or Agreement State) license and USEPA regulations. Care should be taken to minimize generation of mixed wastes through selection

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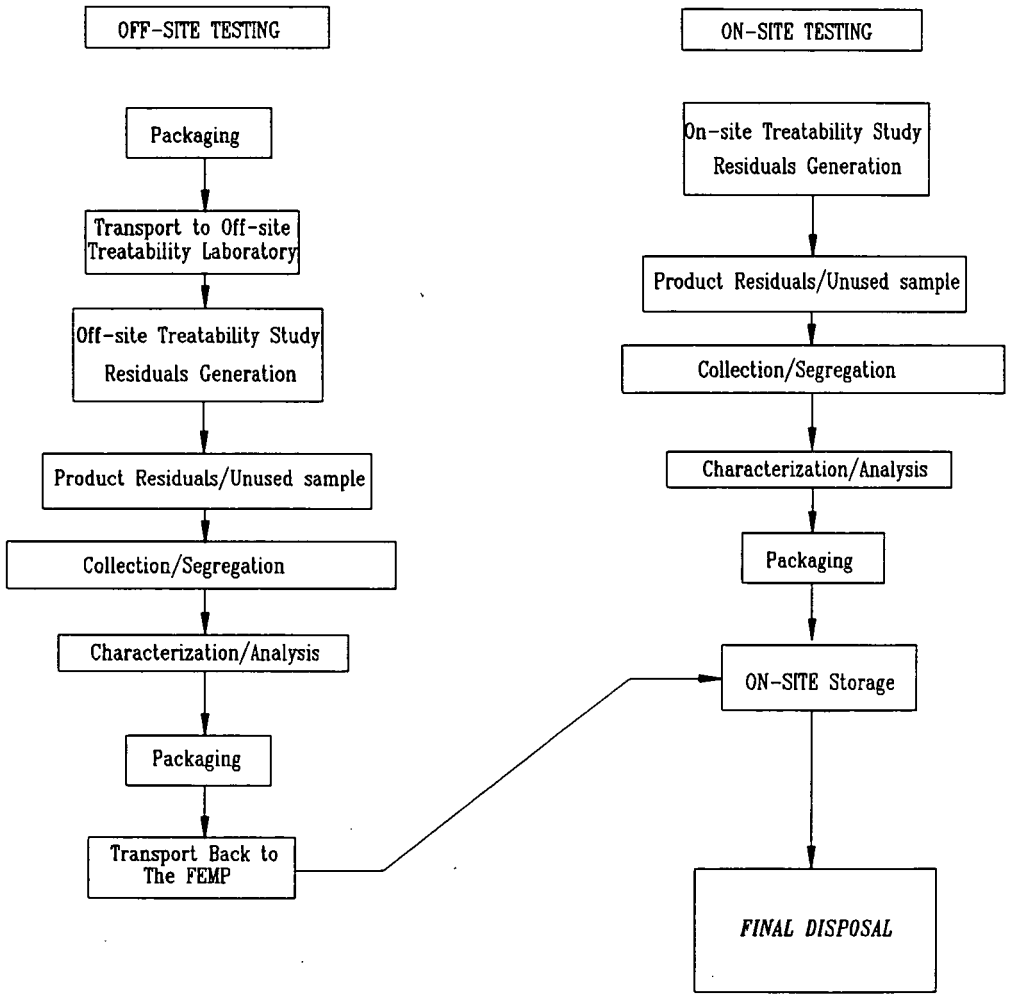

FIGURE 11.1 Treatability Study Residuals Management

of appropriate reagents and methods including selection of non-hazardous liquid scintillation cocktails. Only by prior agreement will unused sample fractions be returned to the FEMP for archiving, storage, and/or disposition. The characterization and management of treatability and analytical residuals will 1) comply with the residual characterization requirements of the regulatory programs and legal agreements, and 2) provide information required to support residual management objectives and the health and safety programs. Management of laboratory analytical residuals and treatability residuals will be performed to ensure the proper identification, management, handling, storage, and disposition of residuals generated from performing treatability studies and treatability related analyses.

11.2.2 Management of Bulk Residuals to be Returned to the FEMP

Samples/residuals will be returned to the FEMP only by prior agreement and in accordance with the WAC. Streams that are generated from the treatability study process and/or laboratory analysis will be segregated by residual type and accumulated in appropriate Department of Transportation (DOT) containers as specified in 49 CFR, Part 173. The WAC provides guidance to facilitate transfer of residuals from off-site generators to the FEMP site in accordance with applicable Federal and state regulations. The FEMP will schedule a pick-up date with an authorized trucking company for return of the residuals.

An inventory will be maintained for each container which includes the following information:

- the sample and release number;
- description of the residual type (e,g, acid digestate);
- estimated volume of residuals added (within ± 10%);
- date when the residual was added; and
- identification of the person making the addition.

11.2.3 Management of Unused Samples/Test Media

Unused portions of samples/test media shall be managed in the following manner:

a. The unused portions of the test media will be packaged for return to the FEMP in the same manner that they were sent;
b. The unused portions of the samples/test media shall not be commingled with any other waste or residues.
c. Samples shall be returned under the exclusions provision in 40 CFR 261.4(d)(e) & (f), OAC 3745-51-04, and applicable state laws at the seller's location;
d. Copies of all required shipping papers (which must include, but are not limited to, an inventory of all samples in each shipping container with each inventory attached to the outside of each container, bill of lading, and radiation screening results) and copies of the chain or custody forms and other documentation that was sent with the original shipment shall be completed and sent to the FEMP prior to shipment; and
e. The FEMP will schedule a pick-up date with an authorized trucking company for return of the unused sample/test media.

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11.3 TRANSPORTATION

All waste and residue shipments will comply with DOT regulations. The DOT defines its regulations in 49 CFR 100-178, "Hazardous Materials Regulation," with particular emphasis on the requirements of 49 CFR 171, "General Information, Regulations, and Definitions." The NRC regulations are defined in 10 CFR 71, "Packaging and Transportation of Radioactive Material."

Together 49 CFR 100-178 and NRC 10 CFR 71 provide a body of regulations that is designed to ensure the safety of handling and transport workers and the general public, and to protect the environment against degradation. Observance of these regulations will ensure criticality safety when waste is transported, ensure containment of material during handling and transport, and protect workers and the general public from the radiation emitted by radioactive material. Because the residuals generated from the treatability study testing program is expected to have various levels of radioactive and chemical contamination, the fundamental principle governing the extent of packaging is that the constraints of the regulations are intended to be commensurate with the hazards of the radioactive material. The regulations, generally, require that each package used for storage or shipment of these wastes must be designed so that the package can be easily handled and properly secured in the conveyance during transport and has a provision for manual handling and lifting attachments.

DOE also anticipates shipping ACM to off-site laboratories for both treatability testing and analytical testing. Most of the ACM is considered radioactively contaminated. The type of package required for this material should include a wide spectrum of package configurations encompassing "strong tight packages" for low specific activity (LSA) waste, Type A and Type B packages including those containing "highway route control quantities." The LSA classification applies to transported materials that are considered to be low risk and thus require less stringent packaging and shipment requirements. Prior to packaging, ACM materials will be vacuum-packed in heavy duty plastic bags for free-air elimination and potential airborne fiber isolation.

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12 COMMUNITY RELATIONS

Public participation in the decision-making process is an integral part of cleaning up the Fernald site. In addition to the community relations activities required by various laws, regulations, guidance, and DOE Orders, DOE has initiated a Public Involvement Program to develop a public consensus about cleanup solutions and future courses of action at Fernald. Public participation activities are described in two documents:

- The Fernald Public Involvement Program, which outlines the additional activities DOE is undertaking to obtain feedback from stakeholders on cleanup alternatives and process options being considered; and

- The site-wide Community Relations Plan (CRP), which fulfills the requirements of the Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, the National Oil and Hazardous Substances Pollution Contingency Plan, and the Resource Conservation and Recovery Act.

The CERCLA-mandated CRP, which is Volume III of the Remedial Investigation and Feasibility Study Work Plan, was approved by EPA in October 1992. The CRP describes the community relations activities (e.g., newsletters, fact sheets, meetings, an information repository, responsiveness summaries, notifications, and videotapes) required to fulfill the requirements of CERCLA, SARA, and the NCP. Fernald's CRP is being revised and updated in early 1994.

A complete list of the community relations activities conducted at the Fernald site are contained in the Fernald Public Involvement Program and in the Community Relations Plan. Both documents are available for inspection in the Public Environmental Information Center, 10845 Hamilton-Cleves Highway, Harrison, Ohio, 45030. Call (513) 738-0164 for information about the center's hours.

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13 REPORTS

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A final report(s) summarizing the treatability tests will be prepared upon completion of treatability testing. The final report(s) will summarize the tests performed, the results achieved, and deviations to the test designs. The test results will also be summarized in the FS Report and will, therefore, become part of the Administrative Record. A copy of the treatability report(s) will also be submitted to the Risk Reduction Engineering Laboratory (RREL) Treatability Data Base to meet the Office of Emergency and Remedial Response (OERR) requirement. Table 13.1 provides a proposed outline of the treatability report contents.

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Table 13.1 Suggested Organization of Treatability Study Report

1.0 Introduction
- 1.1 Waste stream description
  - 1.1.1 Waste matrices
  - 1.1.2 Pollutants/chemicals
- 1.2 Remedial process description
  - 1.2.1 Treatment process and scale
  - 1.2.2 Operating features

2.0 Conclusions and recommendations
- 2.1 Conclusions
- 2.2 Recommendations

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

4.0 Results and discussion
- 4.1 Data analysis of waste stream characteristics
  - 4.1.1 Analysis of waste stream characteristics
  - 4.1.2 Analysis of treatability study data
  - 4.1.3 Comparison to test objectives
- 4.2 Quality assurance/quality control
- 4.3 Costs/Schedule for performing treatability study

References

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

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14 SCHEDULE

The schedule for the OU3 Treatability Study Program, shown in Figure 14.1, was developed to be consistent with meeting the Amended Consent Agreement schedule for the submittal of the draft FS Report on August 7, 1996. The draft TSWP was submitted to USEPA and OEPA on December 22, 1993 for review. Comments were returned by both agencies with conditional approval by USEPA. The scheduled submittal date for the final TSWP, with resolutions to comments incorporated, is March 14, 1994.

As stated in Section 1.4.1, DOE will perform OU3 treatability studies in cooperation with other FEMP programs and operable units. One of these coordinated activities involves possible studies to support the development of the Site Treatment Plan (STP) for mixed waste treatment, as required by the Federal Facilities Compliance Act (see Section 10.1.5). Since the development of the STP may benefit from the OU3 Treatability Study Program, it has been included in Figure 14.1.

The anticipated schedule, as shown in Figure 14.1, lists the treatability studies that are currently discussed in the TSWP appendices. As more studies are added to the TSWP, the schedule will be modified and updated accordingly and will be submitted to USEPA and OEPA as a change page(s) along with the new appendix. Figure 14.1 also provides estimates of when major activities, such as procurement, testing, and report generation, will be performed as part of the chemical conversion, chemical leaching, vitrification of ACM and glass, and vitrification of mixed waste treatability studies. Because of the similarity in test design and application between vitrification of ACM and glass and vitrification of mixed waste, procurement of an off-site vendor to perform these bench-scale studies has been combined into one contract. As a result, the two studies are shown in Figure 14.1 as an integrated project.

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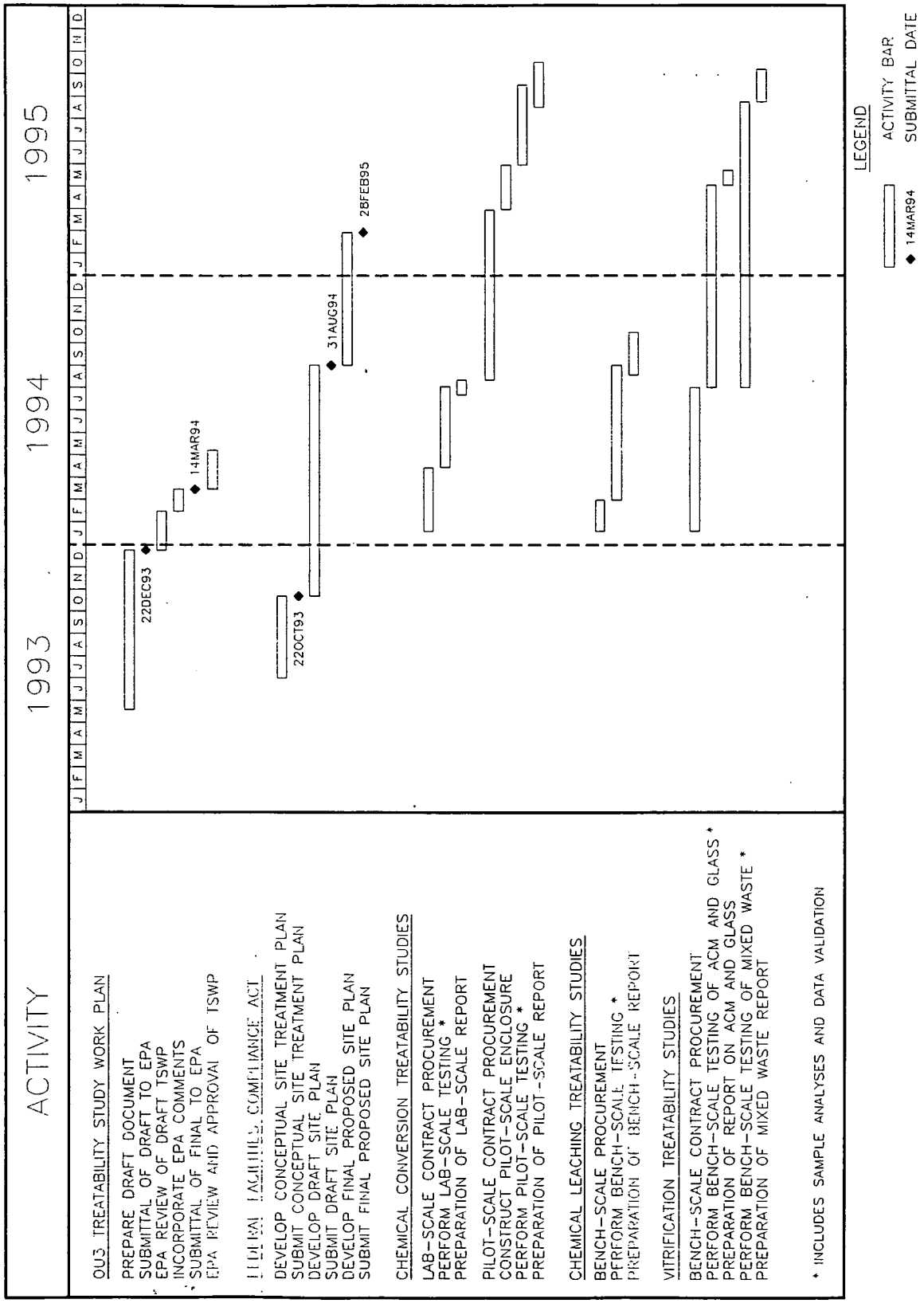

Figure 14.1 Anticipated Operable Unit 3 Treatability Study Schedule

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15 MANAGEMENT AND STAFFING

This section describes the management and staffing structure used in developing the Treatability Study Program. Figure 15.1 illustrates the relationships between the various organizations involved. The ERMC, FERMCO, reporting directly to the DOE Fernald Field Office (DOE-FN), acts as the main contractor for FEMP activities and coordinator of technical support and remediation subcontractors. Under the current FERMCO organizational structure, OU3 activities will be the responsibility of CRU3, with such activities being conducted by individuals of various disciplines matrixed to CRU3 from other FERMCO departments.

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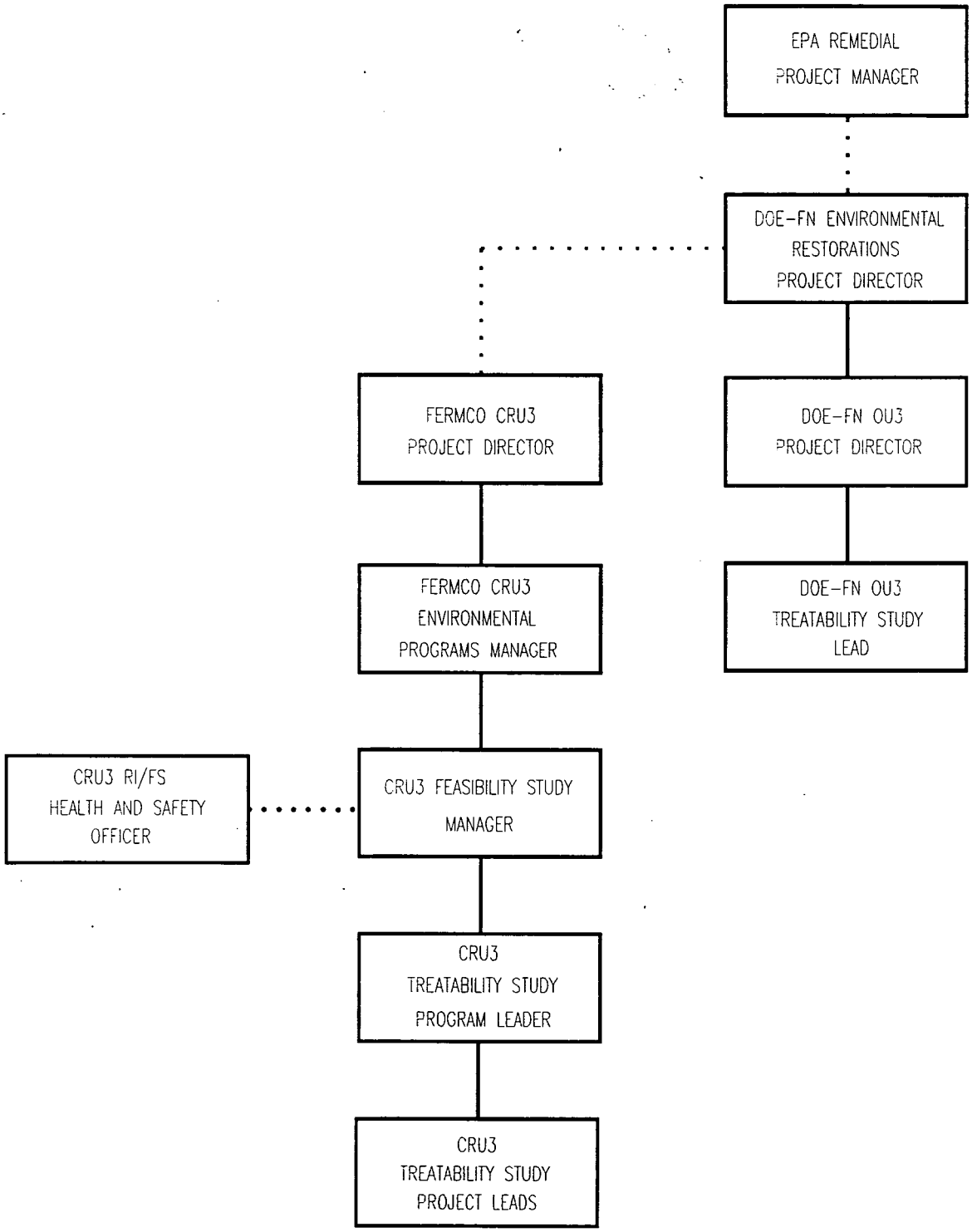

FIGURE 15.1 Treatability Study Management and Staffing

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APPENDIX A

SUMMARY TABLES OF THE SCREENING OF PROCESS OPTIONS

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APPENDIX A
SUMMARY TABLES OF THE SCREENING OF PROCESS OPTIONS

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This appendix presents a summary of the evaluations of OU3 process options. The process options were compiled by utilizing resources described in various EPA documents, EPA databases, and DOE technology summaries as well as other applicable references.

The goal of the screening process described in Section 2.2 was to focus on process options that were considered applicable or appropriate to OU3 media and contaminants but for which additional data would be required for decision-making and to focus the treatability process on the most feasible options for the various OU3 media. Process options were either retained or eliminated from the comprehensive list of potential processes based on the technical criteria described in Section 2.2. Tables A.1 through A.4 include the following:

- listing of process options;
- OU3 media which could be treated by this process;
- whether the process is accepted (A), has been demonstrated or has been suggested as a potential demonstration (D), or is evolving (E);
- anticipated OU3 contaminants of concern which could be treated by this process;
- summary of the existing data regarding effectiveness, implementability, and waste generated;
- estimate regarding whether the capital and operating and maintenance (O&M) costs are high (H), medium (M), low (L), or variable (V), compared to processes within the same group; and
- summary of the decisions and reasons to retain or delete the process option from the list.

The process options which were deleted from further consideration are redlined in Tables A.1 through A.4. Treatability studies detailed by this TSWP are based on process options selected from the retained categories of the following tables.

TABLE A.1 Screening of Surface Decontamination Process Options

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Dry Heat	Concrete, Metals, Copper	D	Radionuclides, Chemicals	This is an industry-accepted process for removing volatiles from surfaces. There is a moderate probability of success for removing oils and PCBs some probability of success for radionuclides. Oils may be combusted.	Off-gas collection/ treatment would be required for airborne contamination. The process is relatively simple to implement.	Removed contaminants and HEPA filters	L	H	Retain: Probability of success for VOAs; off the shelf process; applicable to several media and contaminants. It is recommended to further investigate the efficiency of this process.
Flash Lamp Cleaning	Concrete, Metals, Copper, Transite	D	Radionuclides, Chemicals	This process has been used for organics cleaning. Secondary waste generation is small. The efficiency of radioactive contaminants removal is unknown at this stage, although it is considered to be potentially efficient. Westinghouse Hanford is conducting an experiment for radioactive decontamination.	A HEPA filter low pressure vacuum system is needed to collect off-gasses and remove contaminants. It is a simple process and easy to operate.	Removed contaminants and filters	L	L	Retain: Probability of success for VOAs; off the shelf process; applicable to several media and contaminants. It is recommended to further investigate the efficiency of this process.
Plasma Etching/ Fluorination	Concrete, Copper, Metals, Inconel and Monel, Glass and Ceramics	D	Radionuclides, Chemicals	Plasma (fluorine plasma discharge) is commonly and effectively used to clean high bonding energy contaminants from surfaces of metals, metal oxides, and glasses at a high decon factor (1000). This process provides a means of separating and recovering U from U-mixed contaminants.	A HEPA filter and collection system is required for this process since it is done in vacuum chambers. The process requires complex support equipment, including gas handling for trapped uranium hexafluoride, thermal management, and computer control and monitors.	Removed contaminants and filters	H	L	Delete: Requires totally enclosed system; lengthy process; not efficient; H&S is a major concern.

TABLE A.1 Screening of Surface Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Plasma Surface Cleaning	Metals, copper	D	Radionuclides, Chemicals	Very similar to plasma etching/fluorination except reactive plasma, a chemically reactive species, is used to clean contaminated surfaces.	A HEPA filter and collection system is required for this process since the cleaning is done in vacuum chambers. The process requires complex support equipment, including gas handling for trapped uranium hexafluoride, thermal management, and computer control and monitors. The process requires highly trained staff to operate.	Removed contaminants and filters	H	M	Delete: Requires secondary process to vacuum off contaminants; some off-gases problem; H&S concern; real time reaction.
Plasma Torch	Metals, copper, inconel and monel	E	Radionuclides, Chemicals	The process is in a conceptual stage for radiological decontamination. It has not been used for radiological decontamination but expected to do so effectively.	Bench scale testing on the torch's high temperatures is needed to evaluate process performance.	Evaporated, extracted, melted contaminants and removed deposits and filters	N/A	N/A	Delete: Too conceptual; may damage substrate material.
Strippable Coating	Concrete, Metals, Copper, inconel and monel	A	Radionuclides, Chemicals	Strippable coating effectively removes contaminants upon contact, especially on smooth surfaces. There is a potential for coating not reaching all contaminants on rough/porous surfaces.	Applicable materials (coating material) need to be identified for different surfaces. Contact time also needs to be determined for better removal. Very simple method for decontamination.	Coating materials and contaminants	L	L	Retain: May create increased secondary waste volume. Application to non-porous media.
Electrokinetic Migration	Metals, copper, inconel and monel, concrete	D	Radionuclides, Chemicals	The process has been effectively used for PCBs and oil decontamination with an exceptionally high decon factor. Radionuclide reductions of 90% have been achieved. This process has been demonstrated at Oak Ridge.	Implementation is quite modest and relatively simple to perform. Solution (gels/solvents) recycle system may need to be designed for waste minimization.	Chemical gel and removed contaminants	L	M	Retain: Charge may be induced by electrodes or static charge of solutions; high success during Oak Ridge Y-12 demonstration. Based on Oak Ridge Y-12 demonstrations, this process may be applicable at Fernald.

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TABLE A.1 Screening of Surface Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Electropolishing	Metals, copper, inconel and monel	D	Radionuclides, Chemicals	The process has been proven to be effective for decontamination of conductive medium and is best suited for a flat surface (cracks, crevices, or shadowed areas will not be decontaminated).	Considered a self-decontaminating process. Contaminated electrode may need to be decontaminated or charged for decontamination enhancement. Solution recycle systems may be required for waste minimization.	Electrode and removed contaminants	L	L	Retain: Potentially applicable for ex situ bulk decontamination (e.g., dipping metals into solution).
Electrorefining	Metals, copper, inconel and monel	D	Radionuclides, Chemicals	Well established commercial process. Very similar to electro-wining but less mature for radioactive decontamination.	Very similar to electro-polishing in terms of operational parameters.	Removed contaminants	L	L	Delete: Similar to metallurgy refining; not efficient to implement on-site due to cost vs. volume of material; costly refining operation.
Leach/electro-wining	Metals, copper, inconel and monel	D	Radionuclides, Chemicals	Well established purification process and commercially available.	Requires highly technical engineering personnel or highly trained chemical operator.	Removed contaminants	H	H	Delete: See above.
Chemical Foams, Gels, and Pastes	Metals, copper, inconel and monel	A	Radionuclides, Chemicals	Accepted method. Widely used throughout the nuclear industry for effective smearable surface decon-tamination. The foams, gels, and pastes act as a carrier which suspends lightly bonded contaminants. A decontamination factor (DF) of 2.7-12.5 has been determined for painted surface and 75 to 90% for unpainted carbon steel. Works well on inaccessible areas.	Relatively simple processes and can be implemented for in situ or ex situ decontamination.	Spent foams, gels, and pastes plus removed contaminants	L	L	Retain: Potentially applicable for inaccessible areas; requires second process to vacuum or wash off foam/gel; off the shelf process.
Gas Phase Decontamination	Metals, copper, inconel and monel	E	Radionuclides, Chemicals	The process of deconta-minating the interior (close system) of reactors, vessels, etc. using chlorinetrifluoride (ClF_3) to fluorinate U solid deposits. This is a lengthy process (the complete process takes more than 6 months).	Requires highly trained technologists to operate the process (still conceptual).	UF_4 and ClF_3 can be recycled.	N/A	L	Delete: Requires closed system; lengthy process; similar to plasma etching; H&S concern due to gases.

TABLE A.1 Screening of Surface Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Hand/Automated Brushing	Concrete, metals, copper, inconel and monel	A	Radionuclides, Chemicals	Very effective for smearable contaminants less effective for fixed. May also be used as a floor buffer equipped with on-board vacuum system. Best suitable for flat surfaces. This is a very effective method for loose and low level (depth) fixed contaminant removal.	Very simple to implement; simple operation requires one person to operate. Remote operation possible for area with high level of loose contamination.	Removed con taminants, water, and HEPA filter.	L	L	Retain: Potentially applicable for in situ gross decontamination; off the shelf process.
Ozone/ UV Light Activation	Metals, copper, inconel and monel	D	Radionuclides, Chemicals	Has been used as an effective method in semiconductor industry for organics decontamination. However, there are limits in application. Only those contaminants that will dissociate or react with oxygen to form simple compounds (i.e. CO_2, H_2O, N_2, etc) are effectively removed.	Method requires more research.	Removed or reacted contaminants	H	M	Delete: Must react with O_2, therefore limited applicability; very specialized.
Vapor Extraction	Concrete, metals	E	Radionuclides, Chemicals	If the proper solvent was chosen and used, it should remove most or all of surface contamination. There is difficulty in achieving an outward flux of contaminated solvents from porous building material. Second decontamination technique may be used for those not decontaminated by vapor extraction.	It is a very complex decon system, mainly for setup and shut down. This method is considered to be a very passive method and requires monitoring.	Solvent and removed contaminants	M	M	Delete: Requires closed system; very passive, lengthy process.
Vacuuming	All media with loose contaminants	A	Radionuclides, Chemicals	High efficiency HEPA filter vacuum system with self cleaning HEPA filters. Determined very effective method for loose contamination removal.	Readily available with portable or stationary with extended lining for hard to reach environment. Remote operation possible, required one or two personnel to operate.	Removed contaminants and debris, filters	L	L	Retain: Potentially applicable for in situ gross decontamination.

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TABLE A.1 Screening of Surface Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Low Pressure Vacuuming	Concrete, structural steel, monel, copper, fiberglass insulation	A	Uranium, Technetium, Actinides	Vacuums are proven and reliable for removing gross, loose solid contaminants from surfaces. Decontamination factor of 2-3. Good preliminary step prior to more aggressive decontamination steps. Good preliminary step to reduce PPE requirements during dismantlement.	Readily available, portable and easily implemented. Labor intensive, yet not stressful work. No air permit required. High level of air filtration.	Primary wastes from pre-filters, filters and removed materials	L	L	Retain: Combine with other processes.
Laser Activated Chemistry	Concrete, metals, inconel and monel, copper	E	U, UF_6, Oil, PCBs, Barium, Chromates, Organics, Dioxins	Used for industrial cleaning. Conceptually useful to augment gross decontamination processes that do not work in difficult access areas. Capable of removing all contamination from metal media and large amounts of contamination from concrete.	Laser Activated Chemistry is used in industry. The application to decontamination is still under development. Two to three years required for a prototype systems at a development cost over $3 million.	Generates small amounts of removed debris and spent chemicals.	M	H	Retain: More research required. Possible low productivity, high O&M, limited applicability with high uncertainty of success. Good for limited access areas. Low secondary waste generation.

[1] Various residual wastes are consistent with all processes (e.g., personal protective clothing). Only residual wastes which are specific to the process options are listed.

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TABLE A.2 Screening of Surface Removal Process Options

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Frozen Pellet CO_2 Blasting	Everything except wood, window glass, fabrics	A	Radionuclides, Chemicals	Method is generally applicable to all forms of contaminates, but may produce aerosol of contaminant. Wood and glass would be destroyed by process. Not good for deep cavities, and deep narrow channels. Concrete blocks may have too rough a surface.	May require protective clothing. Reported to not generate waste other than material being removed. May require good ventilation. Could be used with robots.	Contaminant and some surface removal	L	L	Retain: Potentially applicable where fugitive emissions control is critical.
Supercritical CO_2	Concrete, structural steel, monel, copper, metal equipment, aluminum	E	Radionuclides, Chemicals	Only small quantities may be treated. Effectiveness is a function of temperature and pressure.	Not easily implemented for the large size materials to be decontaminated at Fernald. System requires conceptual development.	Substrate debris	H	H	Delete: Process is unavailable commercially.
Ice Blasting	Concrete, structural steel, nickel-lined equipment, monel and copper	A	Radionuclides, Chemicals	Effectiveness depends on speed of stream and cleaning head distance from substrate.	Process water must be treated prior to discharge. May require robotics and an evaporator system to control fugitive emissions.	Contaminants and water	L	L	Retain: Potentially applicable as a test demonstration.
Sponge Blasting	Concrete, metals, plastics, copper, inconel and monel	A	Radionuclides, Chemicals	Method utilizes pressure blasting of water-based urethane foam to remove loose contaminants or coatings.	Remote operation is recommended. Requires 50% engineers, 50% technicians. Solvent collection system/ treatment system needed to incorporate for waste minimization.	Removed contaminants and debris	M	M	Retain: Potentially applicable for in situ decontamination.
Centrifuge Cryogenic Blasting	Concrete, metals, copper, aluminum, monel	E	Radionuclides, Chemicals	Can remove uranium where other processes may not. Otherwise same potential and limitations as regular CO_2.	System requires conceptual development.	Substrate debris	H	H	Delete: Process is unavailable commercially.
Plastic Pellet Blasting	Concrete, structural steel, metal equipment, monel, copper, aluminum	A	Radionuclides, Chemicals	System thrusts plastic abrasives at the surface to be cleaned while instantly vacuuming them away. The method is quick and efficient with little or no cleanup required. Cleanup rates range from 10 to 350 ft^2/hr. Systems have been used effectively on epoxy coatings, lead based paints sand welds in addition to concrete and metal surfaces.	May be some difficulty using the equipment on edges and cracks, and operator fatigue can occur while cleaning vertical surfaces. Plastic pellets are less abrasive than sand and can be readily removed from the eroded surface debris. Pellets can be recycled up to 30 times and eventually incinerated reducing disposal cost.	Recycled pellets; substrate debris	L	L	Retain: Potentially applicable where fugitive emissions control is critical.

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TABLE A.2 Screening of Surface Removal Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Sand Blasting	Concrete, structural steel, metal equipment, monel, copper, aluminum	A	Radionuclides, Chemicals	System thrusts abrasive at the surface to be cleaned. Clean-up rates are similar to above but secondary waste generation is large.	Sand grits are more abrasive to substrate (i.e., material being cleaned). Sand eventually becomes part of the waste stream. Sand can not be incinerated and would therefore preclude this option as a treatment alternative for the waste streams generated.	Sand and substrate debris	L	L	Delete: Process generates excessive secondary waste.
Shot Blasting (iron)	Concrete, structural steel, metal equipment, monel, copper, aluminum	A	Radionuclides, Chemicals	Same effectiveness as plastic pellet blasting but may be designed to rates of 2500 ft^2/hr. DF on the order of 10-100.	Shot blasting has been quoted as being twice as fast as scarifying. Shot pellets may be recycled many times but ultimately erode and becomes part of waste stream.	0.1 lb/m^2 of pellets generated as waste and substrate debris.	L	L	Retain: Potentially applicable for vertical surfaces.
High Pressure Water Washing (HPW)	Metal, concrete, rubber, plastic	A	Radionuclides, Chemicals	This technique uses varying pressure levels to decontaminate both concrete and metal surfaces. Other materials have also been treated. Water blasting creates no hazardous fumes, operator exposure is low and liquid waste streams can be recycled. The method cleans from 10 to 60 ft^2/hr, removing about 1/16" of surface.	Significant worker training is required as HPW systems are used to clean and cut. Safety is an important issue. A typical commercial unit has a high pressure pump that can supply up to four work stations. Each station uses five gpm of water. Even though the pressure is very high, the units can easily be hand held because the flow rate of water is low. The area being decontaminated can be as far as 300 yards from the location of the pump. Commercial units normally have a shroud around the jet that is connected to a vacuum system that collects all the water and debris loosened by the jet. Commercial systems are available to remove any soluble radioactive ions (e.g., ion exchange) from the recycle water streams. With recycle of water, usage is less than 55 gallons/day.	Substrate debris (assume 40 ft^2/hr for removal of 1/16" rubble generated equals two ft^3/day) and process water	L	L	Retain: Systems are commercially available and have been well tested. Substrate damage is minimal. Potentially applicable for materials that may be recyclable.

TABLE A.2 Screening of Surface Removal Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Ultra High Pressure Water Washing (UHPW)	concrete block/brick, asphalt, metals, monel, inconel	A	Radionuclides, Chemicals	UHPW system pressurizes water up to 55,000 psi and forces it through small diameter nozzles at speeds up to 3,000 ft/sec. Care must be taken so as not to damage the substrate. Otherwise the water jets thoroughly penetrate and remove surface contamination. Systems operate at approximately five gpm and the treatment rate is approximately 60 ft^2/hr. UHPW/robotic system used successfully at TMI.	This method can be very dangerous as the water stream can cut through protective gear and human tissue. A water treatment system for water recycle/reuse is required. Vacuum systems designed for lower pressure water blasting must be enhanced for UHPW.	Substrate debris, process water	L	L	Retain: Potentially applicable for vertical surfaces.
Water Jet (with or without abrasives)	Concrete, structural steel, asphalt	A	Radionuclides, Chemicals	Water jet equipment systems combine ultra high pressure water systems with an abrasive. The process has been used to cut concrete up to 6" thick. A shroud and vacuum system is used to contain the waste. Systems have been used successfully at TMI, Oak Ridge, and overseas. Primary objective of this system is dismantlement, not surface decontamination.	Nozzle attachments for these systems have a short life. System is sometimes used in conjunction with crushers. Abrasives, usually garnet are consumed at a rate of approximately two lbs/min. During operation system can cause noise levels of 110 db. Equipment includes nozzle, nozzle holder, high pressure pump, an abrasive supply unit and a slurry collector.	Abrasives and water	L	L	Retain: Potentially applicable for vertical surfaces.
Water Jet (with or without abrasives)	ACM	E	Radionuclides, Chemicals	Removal of asbestos from pipes, valves and walls must be done remotely.	Robotic manipulators must be developed to support this use. Shrouds and vacuum systems must also be enhanced.	Abrasives, water, and air filters	H	H	Retain: Potentially applicable if fugitive dust can be controlled.
Metal Milling	Structural steel, metal equipment, monel, copper, aluminum, sheet metal	A	Radionuclides, Chemicals	Metal milling effectively shaves off a layer of metal. Method has been used to decontaminate individual metal items at K-25. About 2.5 ft^2 per hour of metal can be milled.	Method is suitable only when there is a large number of similar items to be decontaminated due to 1 hour set up time between differently shaped items.	Top 1/8" of metal and filters	L	L	Retain: Potentially applicable for material that may have salvage value.

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TABLE A.2 Screening of Surface Removal Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Concrete Milling	Concrete	A	Radionuclides, Chemicals	Machine removes top layer of concrete or pavement. Method primarily used for large-area horizontal surfaces. Sizing may not be available to remove surfaces inside buildings although roads and streets may be a possibility.	Equipment commercially available to pavement contractors. Data base is not available for equipment used as a decontamination device. Difficult for cylindrical rotating drum (primary component) to reach into corners or tight spaces.	Removes from .2" to 1" of concrete surface and filters	L	L	Retain: Potentially applicable for decontaminating roads or pads.
Scabblers/ Scarifiers	Concrete	A	Radionuclides, Chemicals	Scabblers are pneumatically operated machines that remove laitance from concrete surfaces (laitance is the crust that forms on concrete when it is allowed to set without finishing). Scabbler (also known as scarifiers) units utilize tungsten carbide bits that repeatedly deliver a measured blow to the concrete surface. Layers of 1/8 to 3/16 inch per pass are removed. Scabblers can be hand-held or pushed like a lawn mower. Vertical surfaces may be scabbled at 15 to 50 sq ft per hour; horizontal surfaces at 40 to 400 sq ft per hour. Scabbling alone may not work near cracks or joints. If contamination has penetrated a crack the contaminated concrete must be chiseled. Otherwise, scabbling/ scarification has a high removal rate and is commercially available with built in debris collection and HEPA filtering.	Systems should be used in conjunction with HEPA filter equipped vacuum systems. Mechanical scabbling is usually done without water, therefore aqueous waste generation is avoided. Units are available which are hooded and fitted with drumming equipment to collect dust and debris. Scabbling operation requires three member teams; one person to operate scabbler, one person to operate vacuum system and ensure that air supply is maintained, and one person to remove debris.	Dust, debris generation of one ft^3 per 65 ft^2 of floor surface treated and filters	L	L	Retain: Potentially applicable for decontaminating large floor spaces.
Automated Grinding	Concrete, structural steel, metals, monel, copper, aluminum, sheet metal	E	Radionuclides, Chemicals	Surface removal technique that generates heat that may volatize organics.	Requires development of robotics. Need to develop system to treat off gas.	Vapors from organics, substrate debris, and abrasives	M	L	Retain: Potentially applicable when used with other processes.

TABLE A.2 Screening of Surface Removal Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Hand Grinding, Honing, and Scraping	Concrete, structural steel, metals, monel, copper, aluminum	A	Radionuclides, Chemicals	Successfully applied to small jobs. Heat generated -- causes organics to vaporize and decompose.	Needs development to contain off gases. Requires personnel to wear protective clothing.	Vapors from organics, substrate debris, and abrasives	L	L	Retain: Potentially applicable when used with other processes.
Laser Heating	Concrete, metals, inconel and monel, copper	E	U, UF_6, Oil, PCBs, Ba, Chromates, Organics, Dioxins	Used for industrial removal of paint/coatings. Current applications deal with non-porous materials. Effective for large surface areas requiring a high degree of decontamination with minimum waste generation.	Laser Heating is used on a trial basis by USAF. Not used in decontamination at this time. Demonstration of this process is one to two years away at a development cost over $2 million.	Removed material collected on filter media.	L	H	Retain: More research required. Possible low productivity, high O&M, limited applicability with high uncertainty of success. Good for limited access areas. Low secondary waste generation.
Laser Etching and Ablation	Concrete, metals, inconel and monel, copper	E	U, UF_6, Oil, PCBs, Ba, Chromates, Organics, Dioxins	Used for surface removal. Process has actually decontaminated aluminum to free release levels. Surface removal of concrete.	Laser Etching and Ablation has been used to demonstrate decontamination of aluminum to free release levels. A production prototype system would require two to three years effort at a development cost over $2 million.	Removed material collected on filter media.	L	H	Retain: More research required. Possible low productivity, high O&M, limited applicability with high uncertainty of success. Good for limited access areas. Low secondary waste generation.

[1] Various residual wastes are consistent with all processes (e.g., personal protective clothing). Onoy residual wastes which are specific to the process options are listed.

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TABLE A.3 Screening of Volumetric Decontamination Process Options

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Chemical Leaching	Inconel and monel, copper, ACM	D	PCBs, Organics	Could leave PCB residues lower than two ppm.	Needs development of tools for cleaning up residues (e.g., a shop vac). Also needs a laboratory study to confirm effectiveness. Can be done continuously or on spot basis.	Leached media (filter cakes) and spent leachates	L	L	Retain: Used by BNFL. Swiss Process to recycle fluoroboric acid.
Chemical Leaching	Inconel and monel, ACM, concrete, acid brick, ceramics	D	Uranium, Metals	Has been used effectively in England by BNFL. Effectiveness also depends on solvent and materials (e.g., nitric acid does not work well on nickel containing material). Fluoroboric acid used by Swiss can be used for uranium and can be recycled.	Needs development of tools for cleaning up residue (e.g., a shop vac). Disposal of residue can be done continuously or on spot basis.	Leached media (filter cakes) and spent leachates	L	L	Retain: Used by BNFL.
Dry Heat	ACM	E	Volatile Organics, Oils, PCBs	Although dry heat is an accepted technique for removing volatile contaminants from solid surfaces, the effective use for removing contaminants from volumetrically contaminated media is uncertain and untried. The process is likely to be effective for removing volatiles and oils but may not be effective for PCBs.	Needs ability to collect gas-phase contaminants. Laboratory bench scale tests needed. Specific process may not be needed because heat may be supplied by other processes.	Volatiles in air	L	L	Retain: Probably not feasible for uranium. PCBs uncertain/untried. May be study specific to VOAs and oils.
Catalytic Extraction Process	Metals, inconel and monel, copper, wood, concrete, cinder block, acid brick, transite, plastics	E	Uranium, Organics, Heavy Metals	Theoretically, the process is one-step for nearly all contaminants. Catalyst separates out radionuclides. Organics decompose to C and H. Silica separates out to slag. Molten metal can be Fe, Ni, or other metals that do not volatilize easily.	Not labor intensive. Relatively low exposure to toxics and radioactive materials. Special room will be required for separating out radionuclides. Metals can be sold to recover cost of operation. References state that Tc cannot be separated out at the present time. Investigating means of dealing with Tc thru PRDA. Zirconium will be investigated as surrogate for uranium in a PRDA. Done at 3000°F.	Silica and radioactive slag	H	H	Retain: Retain only for tie into PRDA. Metals act as catalyst. Tc does not separate out. Alternative to incineration. Applicable only to drums of organics.

TABLE A.3 Screening of Volumetric Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Proprietary Solvents	Metals, concrete, acid brick	D	Metals, PBCs	These solvents have been tested on a number of media. Demonstrated and accepted for PCBs. More information need regarding effectiveness on radionuclides.	System has been demonstrated at Oak Ridge. More information needed for implementability.	Spent solvents with contaminants	L	L	Retain: Data presented is biased (from vendor). More data needed from users.
Crush and Wash	Brittle media, transite, concrete, acid brick	D	All Contaminants	Effectiveness depends on solvents used. Proprietary solvents need to be evaluated for effectiveness in treatability test. Process has been demonstrated for uranium.	May contaminate equipment used for crushing. Liquid streams may need processing. Process can probably be somewhat automated.	Spent solvents and crushing equipment	M	L	Retain: Results depend on media/contaminants. Merge with soil washing process.
Vitrification (stabilization)	Transite, glass, concrete, concrete blocks	D	Uranium, Asbestos	Will result in volume reduction for transite and concrete. Will result in stabilization and will destroy asbestos fibers. Can be used as flux for other wastes.	Implementability will not be difficult. Plant will have been built for other operable units.	Vitrified glass, filters, water	H	H	Retain: Matrix with OU1 and OU4.
Chemical Conversion	ACM	A	Asbestos	The product is very effective in destroying asbestos fiber. Investigating process as a possible pre-treatment for radiological decontamination.	This process is moderately easy to implement. Special concerns include HEPA air system, process water treatment, containment (<1% H_2S gas is emitted from process) and transite must be pulverized for treatment.	Non-TSCA, sludge/sand, Spent solutions, filters	L	L	Retain: Private company has performed successful drum-scale test. Save money in containers/disposal.
Electro-magnetic Separation/ Osmosis	Contaminated solutions	D	Radionuclides, Chemicals	This process has been used commercially to decontaminate solutions. It is reported to have reduced Tc contamination in a Ni solution from 4000 to one Bq.	Equipment can be installed in two to three weeks. Small scale operation can be set up in a 20 ft. X 20 ft. area. No special concerns have been identified.	Electrodes	L	L	Retain: Part of PRDA. Needs more research.

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TABLE A.3 Screening of Volumetric Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Biological	Aqueous effluent from other surface decontamination processes	A	Organics, Solvents, Gasoline, Heavy Metals	Biological processes that utilize bacteria, algae, fungi, and microorganisms to destroy toxic organics have been demonstrated and are available. Contaminant removal percentages are as high as 97%. Biological processes are also available to remove heavy metal ions from solution (e.g., Algasorb).	Biological aqueous treatment systems utilize bioreactors packed with porous material that contain microbes. Testing must be completed to determine strength of waste stream and projected flow rates. Air permitting may be required if heavy concentration volatiles are degraded. Resident time range of waste within bioreactor must also be established. Treatability studies are also required to determine the most likely form of contamination, the extent to which the compound may dissolve or stay in suspended form and expected concentrations in solution.	Contaminants are degraded to CO_2 and H_2O. Effluents may be discharged to AWWT or NPDES discharge	L	L	Retain: Applicable and appropriate to most OU3 media and contaminants.
Compaction (including shredders and crushers)	Concrete, cinder block, acid brick, asphalt, wood, metal, insulation, tile	A	Radionuclides, Chemicals	Compaction/shredder/crusher systems exist in commercial areas (e.g., automotive, scrap metal) and can crush, shred and compact materials including sheet metal and/or concrete. Systems can be enhanced to include kilns, incinerators, or supercompactor devices for waste disposal or recycle/reuse. Systems may be designed as closed loop systems and are gas tight thereby preventing fugitive emissions. System components are housed within three to four in. steel and provide worker shielding.	Systems capable of providing volume reduction benefit of four to one for construction and demolition waste and reducing up to two-ton blocks of concrete to powder form. Prior to operation it must be verified that potential chemical contaminants would not react with chamber seals. Worker training to operate equipment is required as well as maintenance. Operating permits are not generally required. Processed material that has been decontaminated may be reused as fill or for future structures (e.g., processed concrete).	Lubrication system may need to be purged or recycled. Contaminated equipment.	H	M	Retain: Standard process. Good opportunity to establish volume reduction capability and effectiveness of outfeed systems.
Compaction (including shredders and crushers)	Glass, ceramic	A	Radionuclides, Chemicals	Material can be processed.	Glass abrasive to auger coating and may require additional maintenance.		NA	NA	Retain: Standard process. Good opportunity to establish volume reduction capability and effectiveness of outfeed systems.

TABLE A.3 Screening of Volumetric Decontamination Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Compaction (including shredders and crushers)	ACM	A	Radionuclides, Chemicals	Material can be processed.	System can be fitted so that processed ACM may be drummed and disposed.		H	M	Retain: Standard process. Good opportunity to establish volume reduction capability and effectiveness of outfeed systems.
Incineration	Low level waste, wood, plastics (excluding PVC)	A	Some Radionuclides, Some Waste Oils	Incineration is a method of thermal destruction of waste streams containing toxic or hazardous compounds. It is applicable to a wide range of organic wastes but is generally not used in treating inorganics or metals. Low-level radioactive waste incineration is now being performed by SEG, Oak Ridge, TN. This process volume reduces material through combustion thereby concentrating the radionuclide contamination in the incinerator ash. For some materials the combustible waste is volume reduced 100:1. Effluent controls are used to recover incinerator off-gases and particulates (i.e., HEPA).	SEG facility is designed to accept low level waste. SEG will not accept hazardous waste, although in some cases waste oils will be accepted. The facility also will not incinerate transite or other forms of ACM. Transport permits must be obtained from the state of TN to ship waste to SEG's Oak Ridge facility. Important physical parameters of the waste include type of matrix, moisture content, and heating value. Strict criteria are employed by the facility to determine if waste may be accepted. In general, most incinerator facilities will not accept building materials, transite or other non-combustibles.	Effluents from the incineration process are recycled and reused. Incinerator ash is compacted, packaged and either buried at Barnwell, shipped back to the generator or shipped to another low-level disposal facility.	L	M	Retain: Potentially applicable for PPE, plastic, paper, filters and other forms of low level wastes.
Solvent Extraction	Metals, copper, composite roofing, transite, concrete	D	Organics, PCBs	Needs demonstration. Bench studies have proven effective on organics. Bench scale studies have been performed on PCBs with success. No studies on transite or concrete but effectiveness seems likely. May need more stages of extraction to get to same level due to porosity.	Metals must be size reduced/ shredded to less than 2" size. This is an additional cost. Solvent system and extractor would not be labor intensive. Solvents could be non-regulated to reduce health and safety concerns.	Spent solvent and filter cakes	H	M	Retain: Potential test demonstration.

[1] Various residual wastes are consistent with all processes (e.g., personal protective clothing). Only residual wastes which are specific to the process options are listed.

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TABLE A.4 Screening of Dismantlement/Bulk Removal Process Options

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Arc Saw Cutting	Metal	A	NA	Cutting action is obtained by maintenance of a high current electric arc between the blade and material being cut. Good for cutting materials with voids.	System requires specialized power supply and high capacity containment envelopes.	5-20 gpm water spray for blade cooling and particulates in air	V	M	Retain: Cutting speeds are much faster than torch cutting. Potential applicability for mass cutting of pipe.
Explosive Cutting	Concrete	A	NA	Can cut metal with 8 in. of thickness and can be used in air or under water. Simultaneous cuts are possible. Effective in high radiological areas.	Non-configuration limited method.	Debris, particulates	L	V	Retain: Can be done remotely. Potential applicability for insufficient access areas.
Laser Cutting	Metal, ACM	A	NA	High-power CO_2 laser cuts metal up to 2" thickness, although it is slow with poor quality cutting.	Best suited for high radiation and inaccessible areas.	Minimal	H	N/A	Retain: Can be done remotely. Possible use for transite, asbestos removal.
Oxygen Cutting	Ferrous metal	A	NA	Can be used for metal with 3" thickness or less.	It is hand-held, best suited for building equipment interior.	off gases, dust	L	L	Retain: Process is widely used and skilled workers commercially available.
Thermite Reaction Lance	Metal, concrete	A	NA	It is effective in cutting reinforced rods and other ancillary components with irregular surfaces. Its application in pipe cutting is limited to very thick walls.	Extensive ventilation is required.	Smoke, dust, heat	L	L	Retain: Potential applicability where gross manual cutting is required.
Plasma Arc Cutting	Metal	A	NA	Good for rapid cuts in conducting metals. Primarily used in disassembly programs.	Good ventilation and air filtration must be provided. DC power supply of 1000 amps required.	Aerosol (4-6 lbs/hr), water spray, dust	H	H	Retain: Potentially applicable for equipment dismantlement.
Hacksaw and Guillotine Saw	Metal, concrete, wood	A	NA	Portable equipment can effectively cut pipe up to 14" diameter. Stationary equipment has cutting capability up to 25" thickness.	Available in both portable and stationary mounts. Set-up time is small.	Scrap metal, lubricating oil	L	L	Retain: Relatively inexpensive and common. Potentially applicable for size reduction of disposed material.
Circular Cutting	Concrete, metal	A	NA	Self-propulsion makes it an effective decommissioning tool for piping demolition, cutting. Limited to linear cuts.	Manual or remote operation possible. Process has been demonstrated.	Debris, lubricating oil, noise	V	L	Retain: Potentially applicable for removing pipework.

TABLE A.4 Screening of Dismantlement/Bulk Removal Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Abrasive Cutting	Metal	A	NA	Applicable for piping. Cuts by grinding action and will produce sparks. Unsuitable for or near combustible materials.	Portable and stationary systems available. In most portable applications the operator would have to work within contamination control envelope.	Debris, noise, dust	M	L	Retain: Potentially applicable for metal sectioning.
Mechanical Grappler	Concrete, metal, wood	A	NA	Effectively used for cooling tower demolition.	Relatively easy to perform and tasks easily accomplished.	Debris, noise, dust	V	L	Retain: Potentially applicable where access is limited.
Manual/ Mechanical Removal	Concrete, metal, wood	A	NA	Hand removal with combined high level crank for elevation accessibility.	Relatively easy to perform and tasks easily accomplished. Worker safety controls must be enforced.	Debris, noise, dust	V	L	Retain: Potentially applicable where access is limited.
Backhoe Mounted Ram	Concrete, metal, wood	A	NA	Successfully used for light concrete demolition. Slow for heavily reinforced concrete. Can reach heights of 100 ft.	Recommended for applications with limited access for heavy equipment such as wrecking ball, blasting. Maintenance required.	Debris, noise, dust	V	L	Retain: Potentially applicable where access is limited.
Wrecking Ball	Concrete, metal, wood	A	NA	Method has been used in dismantling the Elk River Reactor Containment Building. It is proven effective for concrete demolition.	Recommended where contamination is limited and with thickness of 3 ft or less.	Debris, noise, dust	V	L	Retain: Potentially applicable for administration building and clean buildings.
Wall and Floor Sawing	Concrete, metal, wood	A	NA	Could effectively be used to cut concrete with thickness up to 3 ft.	Remote/Manual operation available. Best suited for high-contamination concrete and demolition where airborne is not permitted. User fatigue may be a problem.	Debris, noise, dust	L	M	Retain: Potentially applicable for large obstruction-free surface areas.
Controlled Blasting	Concrete, metal, wood	A	NA	Method is well suited for heavily reinforced concrete demolition with thickness greater than two ft. Effectively used for complex geometry configuration when several cuts must be made simultaneously (e.g., removal of a large prestressed beam where it is impractical to shore up the ends for temporary support.	Useful in limited access areas. Water spray may be used to reduce airborne dust.	Debris, noise, dust	L	L	Retain: Potentially applicable for towers.

TABLE A.4 Screening of Dismantlement/Bulk Removal Process Options (Cont'd)

Process Option	Applicable Media	Status	Applicable Contaminants	Effectiveness	Implementability	Waste Generation[1]	Capital Cost	O&M Cost	Decisions and Reasons
Paving, Cutting, and Chip Hammers	Concrete	A	NA	Effective near cracks and joints. Used in conjunction with other processes.	Recommended for use on floors to remove small areas that are inaccessible for heavy equipment. Airborne can be controlled by water sprays. Limited removal capacity make impractical for use on large areas.	Debris, noise, dust	L	L	Retain: Potentially applicable where access is limited.
Core Stitch Drilling	Concrete	A	NA	Method produces no gases or smokes, thereby facilitating contamination control. Dust can be controlled by water sprays. Applicable for limited access areas.	Not recommended for reinforced concrete. This is a time consuming and cost inefficient method for large volumes of concrete.	Debris, noise, dust	L	H	Retain: Potentially applicable where access is limited.
Demolition Compound	Concrete	A	NA	Excellent for massive non-reinforced concrete where noise, vibration, dust must be avoided.	Recommended for concrete of less than 12" thickness.	Debris, noise, dust	L	L	Retain: Potentially applicable where access is limited.
Concrete Torch	Concrete	A	NA	Will cut any material that is likely to be encountered in a nuclear facility. Can burn through reinforced concrete of 1-2", diameter with a depth of up to 3½ ft.	Can be combined with other methods such as hammers for complete demolition.	Off gases, smoke	L	L	Retain: Potentially applicable when used with other demolition methods.
Hydro Laser	Concrete, metal, asphalt	A	NA	When used with an abrasive media can cut concrete up to 6 ft. thick.	Shroud/vacuum systems must be designed to contain substrate debris, process waters and spent abrasive. Worker safety is a significant issue.	Debris, water, spent abrasive, noise	M	M	Retain: Potentially applicable for surface removal applications.
Mechanical/ Hydraulic Shears	Concrete, metal	A	NA	Effective for size reduction of demolished metal or concrete structures. Can be used to demolish structures.	Materials being sheared must meet size limitations established for shearing equipment.	Dust, water spray	M	L	Retain: Will be used on Plant 7 demolition. Data collected for test purposes.
Front End Loader/Dozer	Concrete, metal structures	A	NA	Effective way to demolish small structures.	Dust control may be required.	Dust, debris, noise	L	L	Retain: Potentially applicable when used with other demolition methods.

Various residual wastes are consistent with all processes (e.g., personal protective clothing). Only residual wastes which are specific to the process options are listed.

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APPENDIX B

CHEMICAL CONVERSION OF ASBESTOS-CONTAINING MATERIALS

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APPENDIX B
CHEMICAL CONVERSION OF ASBESTOS-CONTAINING MATERIALS

As discussed in Section 1.2.1.6, the original construction of the former Production Area involved extensive use of asbestos-containing materials (ACM). A predominant portion of the exterior and interior walls and roofs of process buildings are comprised of corrugated and flat panels of transite, which is an asbestos-cement composite. The current volume of transite is estimated to be 1,500 cubic yards or 3,000 tons. Also, there are several miles of process and steam piping that have asbestos-containing insulation, referred to as thermal system insulation (TSI).

It is assumed because of its use and proximity to uranium processes that essentially all of the ACM contains varying degrees of uranium contamination. There are numerous other potential contaminants that are being considered in the formulation of the sampling and analysis plan. The combination of asbestos and low-level radioactive contamination complicates decisions concerning the final disposition of wastes. The removal or destruction of the asbestos fibers in these materials would lower the risks to human health and the environment that are associated with the toxic nature of asbestos. Additionally, the reduction of toxicity through the removal or destruction of the asbestos fibers would simplify the decisions surrounding the final disposition of waste streams. DOE proposes investigating a new process option from Table 2.1 that has been claimed to eliminate the toxic nature of ACM.

DSI Industries Consolidated, Inc. has developed a new technique of asbestos abatement called the ABCOV Method. The ABCOV Method is a patented and proprietary chemical process which converts both serpentine (chrysotile) and amphibole (grunerite, known also as amosite) asbestos into a non-toxic material. This is achieved by placing ACM in an agitated vessel that contains a weak acid formulation, called ABCOV-C, which attacks the weaker bonds in the asbestos fibers. The fibers gradually decompose after approximately 30 minutes, and the solution is then sampled for asbestos to ensure a complete reaction. After the solution has been filtered, the non-toxic, sand-like residues are drummed and sampled, while the filtrate is regenerated with small quantities of ABCOV-R and ABCOV-R1, allowing for the recycle of the ABCOV-C for the next batch.

The ABCOV Method also uses another chemical formulation, instead of amended water, during ACM removal operations. DSI claims that this chemical, ABCOV-T, soaks through the ACM more readily than amended water and will therefore be used in smaller quantities. As this liquid soaks into the ACM, it starts the conversion process by conditioning the material for the batch chemical reaction in the agitated tank.

The ABCOV Method potentially has the following major advantages over conventional friable asbestos abatement:

- Eliminates the toxic nature of the waste, thereby relieving the "cradle-to-grave" liability that accompanies ownership of friable ACM;
- Reduces the volume of low-level radioactively contaminated insulation by as much as 80% by changing the fibrous nature of the ACM into a sand-like, compact material;
- Eliminates the transporting and disposing of a toxic waste, thus reducing costs and eliminating environmental problems associated with asbestos-

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containing wastes;

- Would be supportive if the final remedy involved dispositioning the treated ACM on-site; and
- Overall lower costs for the removal, treatment, and disposal of TSI than the wet techniques used during conventional asbestos abatement.

This treatability study is intended to verify or reject the claims of DSI and to gather further information to aid in the design of an effective full-scale treatment facility. Further justification for performing this study is given in the Section B.1.

Preliminary cost analyses show that if the ABCOV Method proves to be effective at destroying asbestos fibers and is chosen as the lead OU3 remedial alternative for ACM, the potential cost savings for the treatment of pipe insulation is approximately $2.2 million. The treatment of transite would cost approximately $4.8 million more using the ABCOV Method instead of conventional removal and disposal techniques; however, the reduction in risks to human health and the environment that are associated with the toxic nature of asbestos may make this cost acceptable.

B.1 TEST OBJECTIVES

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Although the ABCOV Method has been used to treat ACM at commercial facilities, it is not yet considered to be a proven process option since sufficient detail on results in varied applications are not yet available. Therefore, to provide enough data for the OU3 Feasibility Study selection process, further testing of the ABCOV Method should be performed as part of the OU3 Treatability Studies.

The objectives of the proposed testing will include the following:

- to verify asbestos conversion in pipe insulation;
- to test the applicability of the ABCOV Method on transite cement composites;
- to determine the minimum retention time(s) of the various forms of ACM in the weak acid, ABCOV-C, that allows full conversion of asbestos fibers;
- to establish the recycling conditions for the rejuvenation of ABCOV-C;
- to verify the long-term reliability of the treatment system; and
- to perform a cost/benefit analysis comparing the ABCOV Method with the conventional asbestos wet removal and disposition methods currently in use at the site.

Based on the treatability study results and the cost/benefit analysis, a recommendation as to whether or not to proceed to RD/RA-scale testing will be addressed in the treatability study report.

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B.2 EXPERIMENTAL TEST DESIGN AND PROCEDURES

Treatability testing of the ABCOV Method may be performed in three phases: initial lab-scale preparatory work; pilot-scale testing of transite; and pilot-scale testing of TSI. If the ABCOV Method proves successful during the lab-scale phase, the treatability study will continue on to pilot-scale testing which utilizes a small version of a full-scale asbestos conversion system.

Initial characterization will be performed on the test media to provide baseline conditions regarding the nature and concentration of contamination present in the test media. The contaminants identified in the test media during the initial characterization will provide guidance as to what analyses are to be performed during the final characterization. In the event that an anticipated contaminant (such as uranium or lead) is not present in the test media, the sample may be spiked with that contaminant to test the treatment system.

The proposed phases of testing are described in the following subsections.

B.2.1 Design of Lab-Scale Treatability Testing

Because the ABCOV Method is being tested rigorously at several commercial facilities and labs, enough confirmatory data has been collected to support a larger scale demonstration of the process. However, to support the pilot-scale testing, some initial media-specific tests must be performed in the lab to determine the asbestos concentration within the media and the minimum residence time for the complete conversion of asbestos fibers to occur. The following steps are proposed for the design of the lab-scale treatability test.

1. Prepare and ship samples of the test media to the laboratory for initial characterization analyses as discussed in Section B.4.3.
2. Determine the mass and volume of the medium.
3. Enclose the transite within a 10-mil (minimum thickness) bag with copious amounts of ABCOV-T, seal the bag, place it within a second 10-mil bag, and seal the outer bag.
4. Crush the transite into 1/2-inch particles (or smaller) under a HEPA hood without breaking either bag.
5. Analyze the crushed transite and TSI for concentration and types of asbestos fibers using a polarized light microscopy (PLM).
6. Add crushed transite to the 3/4-gallon conversion tank filled with ABCOV-C (see Section B.3 for a description of the chemicals used during the ABCOV process).
7. Perform a PLM test on a filtered solid sample at regular intervals (approximately every ten to fifteen minutes), recording the time and the asbestos fiber concentration, until a PLM test indicates that the asbestos fiber concentration has dropped below one percent by area.
8. Determine the necessary filter size to effectively filter the solution of converted ACM.
9. Determine the optimum rates and amounts of ABCOV-R and ABCOV-R1 for recharging the ABCOV-C for the media. Approximately six batches are anticipated to support a determination. A pH meter and ion-specific meter are to be employed.
10. At the conclusion of the testing, homogeneously mix the residues from

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the transite runs and prepare the samples for final characterization as discussed in Section B.4.5. Also, determine final weight and volume. Analytical needs dictate that a minimum of 5.0 kilograms (dry weight) of solid residues must be generated per media type.

11. Perform steps 1, 2, and 5 through 10 for TSI.
12. For both media types, analyze the final solid and aqueous streams, as discussed in Sections B.4.5 and B.4.6.
13. Analyze ABCOV-T, ABCOV-C, ABCOV-R, and ABCOV-R1 to support a complete material balance.

B.2.2 Design of Pilot-Scale Treatability Testing on Transite

The proposed pilot-scale system is designed to operate using 350 gallon batches, which is large enough to convert the asbestos fibers of two to three transite panels at a time. The system is comprised of one stainless steel conversion tank and three polyethylene tanks that are used as an ABCOV-C holding tank, a regeneration tank, and a washing tank. The basic configuration of this system is illustrated in Figure B.2.1.

The four tank system will be fully contained within an easily decontaminated compartment. A negative-pressure filtration system draws the compartment air at a rate of six to eight air changes per hour through an activated carbon bed to remove any organic vapors and through a HEPA filter for removing airborne asbestos fibers. The interior and exterior of the compartment will be monitored for airborne asbestos fibers, hydrogen sulfide (in the event there are sulfur-bearing compounds present in any of the forms of ACM tested), and airborne radionuclides.

The following steps of the proposed test design will be performed for transite if the lab-scale results support further testing.

1. Weigh the transite to determine the initial bulk volume.
2. Take initial samples of the transite panels, combine them, and analyze as discussed in Section B.4.
3. Determine the volume of transite after crushing.
4. Spray ABCOV-T over the particles to start the conversion process. It may be possible to collect and recycle the ABCOV-T that is not absorbed.
5. Confirm the minimum residence time of crushed transite, determined during the lab-scale testing, to achieve an asbestos concentration below one percent by area using a PLM.
6. Filter and analyze solid residuals as discussed in Section B.4.
7. Measure mass and volume of solid residuals to determine volume/mass reduction.
8. Analyze used ABCOV-C to calculate a complete chemical balance as discussed in Section B.4.
9. Stop the conversion process for recharge of ABCOV-C using ABCOV-R1 when the pH of ABCOV-C exceeds 5.5.
10. Continue testing until ABCOV-C needs recharging a second time.
11. Neutralize liquid wastes (spent ABCOV-C) with lime.
12. Analyze liquid wastes as discussed in Section B.4.

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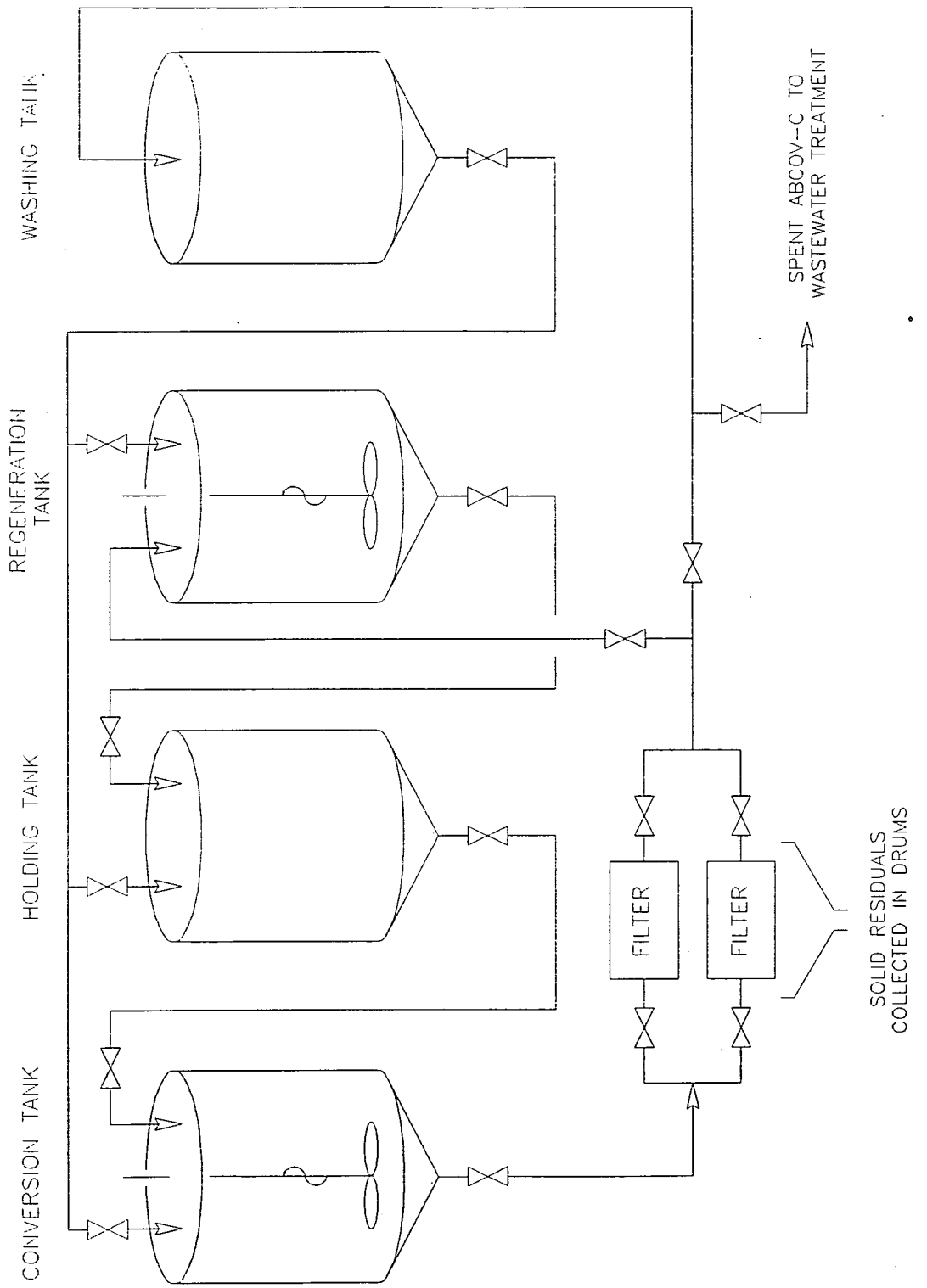

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FIGURE B.2.1 Basic Mixing System for the ABCOV Method

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13. If analysis of liquid wastes is acceptable, transfer to the on-site wastewater treatment unit.
14. Document number of batches per recharge, tons of dry transite per recharge, total operating time (including dress out, breaks, etc.) per recharge or ton, and volume reduction.

B.2.3 Design of Pilot-Scale Treatability Testing on TSI

Following the pilot-scale testing of the ABCOV Method on transite, a similar period of testing will be performed on TSI. The difference between this portion of the pilot-scale testing and the transite portion is that TSI does not have to be crushed in order to be treated. The TSI will readily fall apart in solution if agitated with a high-shear mixer. The following steps outline the pilot-scale testing proposed for the TSI.

1. Determine the initial bulk volume of TSI by measuring circumference and length.
2. Remove TSI using ABCOV-T and glovebags. It may be possible to collect and recycle the ABCOV-T that is not absorbed.
3. Wipe down the "cleaned" pipe with ABCOV-T and ABCOV-W.
4. Collect the TSI until a batch quantity is obtained and take a sample of the TSI, and analyze according to Section B.4.
5. Confirm the minimum residence time of TSI, determined during the lab-scale testing, to achieve an asbestos concentration below one percent by area using a PLM.
6. Filter and sample solid residuals for analyses as discussed in Section B.4.
7. Measure the mass and volume of solid residuals to determine the volume/mass reduction.
8. Analyze spent ABCOV-C as discussed in Section B.4 to calculate a complete chemical balance.
9. Stop the conversion process for recharge of ABCOV-C using ABCOV-R1 when the pH of ABCOV-C exceeds 5.5.
10. Document the number of batches per recharge, the linear feet and/or volume of TSI per recharge, total operating time (including dress out, breaks, etc.) per volume or recharge, and volume reduction.

Following the TSI testing, if determined necessary, a long-duration test may be performed using TSI from various locations (and therefore different contaminants) in order to verify long-term reliability. At the end of the long-duration TSI testing, the liquid wastes (spent ABCOV-C) will be analyzed, as discussed in Section B.4, for the NPDES and CWA analytes. If the analyses demonstrate that the liquid wastes conform to the design of the site wastewater treatment system, the spent ABCOV-C will be transferred and treated accordingly. Further discussion of the management of residuals can be found in Section B.8.

B.3 TEST EQUIPMENT AND MATERIALS

The following is a list of equipment used in the pilot-scale treatability study.

- One 304 stainless steel, cylindrical, open top, cone bottom, 350 gallon capacity holding tank complete with: two-piece gasketed stainless steel cover complete with staco-type hold down clamps; 6-inch agitator flange, offset and angled; two 2-inch NPT half coupling, welded; two 1-inch NPT half coupling, welded; and carbon steel legs with drilled floor pads.
- Three high density polyethylene, open top, cone bottom, 350 gallon capacity holding tanks complete with: two-piece gasketed polyethylene hinged cover with polyethylene bolts; two 2-inch PVC bulkhead fitting installed; two 1-inch PVC bulkhead fitting installed; and carbon steel corrosion resistant stand.
- Three magnetic driven seal-less pumps, 3/4 horsepower, 3-phase motor.
- One slurry pump, 3 horsepower, 3-phase motor.
- One bag filter system rated for 3.0 ft^2 filter area.
- One stainless steel mixer with variable drive, AC input, DC output, 1 horsepower, 115-volt motor, saw tooth propeller and stuffing box.
- One direct drive stainless steel mixer, 115-volt, 1750 rpm.
- One lexan viewport, 6-inch wide x 10-inch long with neoprene gasket and stainless steel cover plate mounted to cover on the stainless steel tank.
- Four dry cut starters to keep pumps from running dry.
- One heavy-duty carbon steel baseplate constructed in two sections with underneath forklift entry and eyehooks for crane lift option, assorted piping, ball valves and check valves constructed from PVC schedule 80.
- One activated carbon filter for the microtrap.
- One activated carbon scrubber system for the mixer with 2-inch hose and 1/4 horsepower blower.
- One chemical spill kit, as required by OSHA.

Table B.3.1 lists the six chemical formulations used during the ABCOV Method and describes their purpose.

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TABLE B.3.1 Chemical Designations Used in the ABCOV Method

Chemical Designation	Purpose
ABCOV-T	Liquid used for the removal of ACM from beams, and decking, boiler and pipe lagging, and start the conversion process (ABCOV-T starts the destruction of the asbestos fibers through a chemical reaction by breaking the molecular structure of the asbestos fibers).
ABCOV-W	Liquid used to neutralize the surface where ACM has been removed with ABCOV-T.
ABCOV-C	Liquid used for the final conversion of the asbestos fibers within the removed ACM.
ABCOV-R	Solid used to regenerate used and filtered ABCOV-C after every batch for reuse.
ABCOV-R1	Liquid used to regenerate used and filtered ABCOV-C after numerous batches for reuse.
ABCOV-L	Liquid used to decontaminate and recycle coveralls, boots, gloves, tools, respirators, HEPA filters, etc.

B.4 SAMPLING AND ANALYSIS PLAN ADDENDUM

B.4.1 Data Quality Objective

The development of the DQO for the Chemical Conversion Treatability Study, in accordance with the SCQ eight-step process, is summarized in the following subsections.

B.4.1.1 Problem Statement

Construction materials used in OU3 buildings or equipment, after many years of use, have generally become contaminated and will require decontamination efforts to allow possible recycle and reuse of many materials without radiological restrictions. The contaminant of principal concern throughout the site is uranium, along with its natural decay daughter products. Other contaminants, which may be encountered in certain areas of the plant, include asbestos, thorium and its decay daughters, heavy metals having special uses (e.g., lead in many paints, chromium leached from stainless steel), PCBs in the vicinity of certain electrical equipment, and organic solvents, principally in maintenance areas.

The Asbestos Survey and Assessment report depicting the location of asbestos and asbestos-containing material (ACM) at the FEMP was submitted to the Westinghouse Environmental Management Company of Ohio (WEMCO) on February 28, 1992 (Diagnostic Engineering, 1992). This survey identified 56 of 74 facilities surveyed as having asbestos in the form of transite walls and roof panels, TSI, and floor tiles. These materials are also assumed to be contaminated with radionuclides and other contaminants due to likely exposures to these contaminants over the production history of the site.

The various forms of contaminated ACM at the FEMP represent a potential threat to human health and the environment. Because the OU3 facilities will be dismantled and the resulting material treated and/or dispositioned, there is a need to identify a process option that will adequately allow for the safe and economic remediation of this contaminated ACM.

B.4.1.2 Identification of a Decision that Addresses the Problem

The primary function of this treatability study, particularly the lab-scale phase, is to answer the question: "Is the ABCOV Method a viable approach to eliminating asbestos as a hazard?"

The secondary function of this treatability study, if the answer to the first question is an affirmative, is to find, during both the lab-scale and pilot-scale phases, the answer to the question: "What are the operating conditions that best facilitate the conversion of asbestos fibers in the two predominant forms of ACM at the FEMP (transite and TSI) into a non-toxic, sand-like material?" The collection of data during this treatability study is intended to provide sufficient knowledge to support the selection process that will be detailed in the OU3 Feasibility Study.

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B.4.1.3 Identification of Inputs that Affect the Decision

The inputs required to make a decision concerning the feasibility of using the ABCOV Method as a potential remedy for the large quantity of contaminated ACM at the FEMP include, but are not limited to:

- the concentration and types of asbestos fibers in the ACM tested both prior to and after asbestos conversion;
- the concentrations and mobility of radionuclide and other contaminants in the ACM prior to chemical conversion and in the final liquid and solid product streams after chemical conversion;
- the required amounts of the two recharging chemicals, ABCOV-R and ABCOV-R1, to effectively rejuvenate the ABCOV-C solution;
- the minimum residence times of the various forms of ACM in the ABCOV solution(s) that allows for the full conversion of asbestos fibers;
- the number of times that the ABCOV-C is able to be recharged using ABCOV-R without having to be recharged with ABCOV-R1;
- whether the concentrations of radionuclides and other contaminants can be reduced in the final "solid" product as well as any changes in relative contaminant mobility as a result of treating the ACM; and
- final storage/disposition of all waste streams, including secondary wastes.

Additional inputs include using TCLP testing to determine if either the final liquid or solid product is determined to be a RCRA hazardous waste, and whether the final liquid waste stream can be disposed of through the on-site wastewater treatment unit.

B.4.1.4 Specification of the Domain of the Decision

In this treatability study, the media will define the domain to which the decision will be applied. The media in this treatability study will be ACM. Transite panels and TSI are the two forms of ACM to be studied.

B.4.1.5 Development of Logic Statements

The major use of this data will be to determine the effectiveness of the ABCOV Method on converting ACM to a non-ACM form. The purpose of the lab-scale testing is to establish the amounts of the various chemicals involved in the chemical conversion and the mixing time of the ACM and chemicals to achieve full conversion of asbestos fibers. If the ABCOV chemical conversion process proves to be effective on either of the two forms of ACM (transite or TSI) in lowering the asbestos concentration of the ACM to below one percent by area using PLM at the lab-scale testing, then a pilot-scale treatability study will be proposed.

Pilot-scale testing will use the information gathered during the lab-scale testing to initiate a larger scale, 350 gallon batch testing of chemical conversion using the ABCOV Method on the ACM listed above. The purpose of the pilot-scale testing is to determine:

- the effectiveness of converting larger amounts of ACM (e.g., transite-approximately two to three panels at a time) into a non-ACM (below one percent asbestos by area) form;
- the effect of the ABCOV process on radiological and chemical contaminants in the ACM;
- if the neutralized ABCOV liquid can be disposed of through the on-site wastewater treatment unit; and
- cost effectiveness.

If the pilot-scale testing for any of the ACM material proves to be effective in reducing the asbestos fibers to below one percent by area and the chemical process is effective in reducing final waste volumes and/or is proven to be cost effective, then the ABCOV chemical conversion process will be evaluated in the OU3 Feasibility Study as a potentially viable alternative for asbestos treatment.

B.4.1.6 Establishment of Constraints on Uncertainty

The purpose of this step is to define possible decision errors based on study findings. For the treatability studies, a decision error would be the adoption of an inappropriate treatment. A false positive error could be the adoption of a treatment, based on the results obtained in the study, that is not truly effective on either OU3 media or the contaminants of concern. A false negative error could be to disregard a treatment process option, based on the results obtained in the study, that could prove effective in decontaminating OU3 media.

In the case of a false positive error, the consequence could be positively evaluating the process in the OU3 Feasibility Study as a viable option and potentially choosing this process option for final remediation of the FEMP. This could result in schedule delays and substantial economic losses as well as being detrimental to the credibility of the site remediation.

In the case of a false negative error, the consequences could be two-fold. First, contaminated wastes may be dispositioned without proper decontamination, which could result in risks to public health and the environment. Second, more treatability studies may need to be performed on a different process option to establish a potentially viable alternative, which could delay the final remediation and increase costs, as well as possibly affecting the credibility of the site remediation.

While neither error is desirable, due to the fact that the pilot-scale treatability study described in this section is likely to be the final stage of testing prior to the OU3 Feasibility Study, a false negative error would be potentially more significant to the conclusions of the OU3 Feasibility Study. If either type of error occurs, even if the process proves to be moderately effective, the option exists for either further testing to verify/correct the test results or combining this process with other treatability process options to complete the decontamination. Additional testing and use of triplicates as well as other QA/QC measures allows for the test design to provide constraints on the uncertainty of results.

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B.4.1.7 Development of a Cost-Effective Design for Obtaining Data

As discussed in Section B.2, the Chemical Conversion Treatability Study may be divided into three phases for treating both transite and TSI:

- *Laboratory-Scale* - Testing will be performed on the two predominant forms of ACM at the FEMP (transite and TSI). Both forms of ACM will be mixed with the ABCOV chemicals in a tank. Mixing will continue until a PLM analysis of the "solid" mixture indicates that the asbestos fiber concentration has dropped below one percent by area. PLM analyses would be conducted approximately every 15 minutes during the mixing stage. It is anticipated that approximately six batches of both media types would be processed before the ABCOV-C solution would need to be recharged with ABCOV-R1. These batches will be processed using the optimum particle size to determine the rates and amounts of both ABCOV recharging solutions, ABCOV-R and ABCOV-R1. Due to the timing of this phase in the treatability study, both initial characterization of the media and final characterization of both the liquid and solid phases may be completed at the same time for potential use in the OU3 Feasibility Study risk assessments and to conduct a chemical balance.

- *Pilot-Scale* - After the completion and evaluation of the lab-scale results, further testing may be performed for either or both of the ACM types. The proposed pilot-scale testing is designed to process 350 gallon batches, which is large enough to convert the asbestos fibers of at least two transite panels. Again, the ACM will be mixed with the ABCOV solutions and agitated until PLM testing shows that the number of asbestos fibers in the mixture has been reduced to below one percent per area. The timing of the asbestos testing will be based on the information collected in the laboratory testing. The ACM will also be fully characterized prior to the pilot-scale testing. The final liquid and solid phases produced by the conversion process will also be fully characterized for asbestos, radiological, and inorganic contaminants to determine the effectiveness of the process in converting asbestos fibers as well as determining the effect of the chemical conversion process on the contaminants in the ACM. The final liquid phase will also be analyzed to determine if it can be treated and disposed of through the on-site wastewater treatment unit. The characterization of the final solid phase will assist in the evaluation of final storage and/or disposition options.

- *Long Duration* - The pilot-scale for TSI may be expanded to include the evaluation of long-duration testing using TSI from various locations (and therefore different contaminants). This will be used to verify longer-term reliability of the asbestos conversion process and to gather data associated with solubilities and effects of contaminants on the characteristics of the treatment process.

Laboratory analyses and the level of QA/QC will correspond to the final use of the data. The data collected during the chemical conversion process of either the laboratory or pilot-scale testing (parameters to optimize the test design) will be used to measure the progress of the conversion process and to determine when to add reagents. The quality of data required during this phase is less stringent (ASL A/B) and provides qualitative/semi-quantitative results. ASL E would be applicable for asbestos determinations by PLM.

For both the laboratory and pilot-scale testing it will be important to fully characterize both of the media being used in the study. The levels of radionuclides, inorganics, volatile and semi-volatile organics, and PCBs will need to be established prior to treatment. Again, after the conversion process has been optimized, it will be important to fully characterize the treated media to determine the effectiveness of the treatment study on all of the contaminants. Due to the importance of this information in making final decisions about the treatability study and the possibility that this data may be used in OU3 Feasibility Study risk assessments, this data must be higher quality, quantitative data (ASL C with 10% D).

Precision will be assessed through the use of triplicate sampling or analyses during both the lab-scale and pilot-scale studies which require a high quality level. Accuracy will be evaluated through the establishment of a routine program involving the assessment of analytical results for method blanks, matrix spike/matrix spike duplicates, and laboratory control samples as directed in the SCQ. Sensitivity will be monitored through the achievement of specified detection limits and quantitation limits. Completeness will be assessed based on the percentage of usable data points from the total set of data points collected. Pursuant to the SCQ, completeness is expected to be at least 90%. If sufficient valid data points are not obtained to meet project objectives, additional sampling and analysis will be considered. Comparability will be maintained through the use of standard sampling, analytical, and validation procedures where available or applicable.

B.4.1.8 Data Quality Objective Summary

To support the above approach, ASLs A though E will be required. The optimization process of both the laboratory and pilot-scale testing is expected to be mostly ASL A/B with the asbestos determination by PLM to be ASL E. The characterization analyses both before chemical conversion and after is expected to be ASL C, with 10% ASL D for confirmation, which allows the data to be used reliably in risk assessment. Any non-SCQ approved procedures used for evaluation of the treatment would be performed at ASL E. The analytes of concern for the chemical conversion study include asbestos, radionuclides (especially uranium), metals, and organics. Laboratory QA/QC types and frequencies will follow those prescribed in the SCQ. No field QA/QC samples will be collected when the media is removed from the FEMP buildings; however, QA/QC samples will be collected when portions of the collected test media are sent to the laboratories for characterization.

B.4.2 Field and Laboratory Sampling

As discussed earlier in this section, two forms of asbestos-containing material (transite and pipe insulation) will be collected for the treatability study. It is anticipated that ACM needed for the lab-scale study will be taken from containerized ACM waste currently in on-site storage (see Section 6.2). For the pilot-scale study, it is anticipated that the two types of ACM will be collected from various locations at the FEMP and will be chosen based on

process knowledge of the contaminants in the ACM. To the extent practical, collection of ACM for this treatability study will be integrated with on-going asbestos abatement activities. The collection of all ACM will be performed by asbestos-certified personnel using approved procedures.

All samples for the treatability testing outlined in this Sampling and Analysis Plan Addendum will be taken from the various test media that is collected above. Sample sizes will be dependent on the required volume for testing. Collection of these samples will follow approved SCQ sampling procedures. QA/QC samples (e.g., trip blanks, etc.) will be collected to accompany the samples to the analytical laboratory as per SCQ requirements.

B.4.3 Initial Characterization of Test Media

Prior to the lab-scale and the pilot-scale phases of this treatability study, the analytical characterization of the two test media will be performed. The initial characterization test parameters for both the lab-scale and the pilot-scale are given in Table B.4.1. The information in this table includes the estimated number of samples, analytes, procedures/methods, objectives of the testing, and the analytical support levels (ASLs). The initial characterization data will be compared to final characterization data obtained on the final solid and liquid products to evaluate the effectiveness of the chemical conversion process on the asbestos fibers of the ACM.

The concentrations of contaminants in both media will be determined by performing a variety of analytical tests. As discussed in Section 6 of the TSWP, a minimum of three samples will be analyzed per media type for the initial characterization and the list of analytes will be taken from Table 6.1. For this treatability study, the following analytes have been selected for the initial characterization of the ACM:

- TAL inorganics;
- polychlorinated biphenyls (PCBs);
- TCL organics (volatile and semi-volatile); and
- radionuclides.

The analytical testing will follow approved methods outlined in Appendix G of the SCQ.

For the purposes of the initial characterization, triplicate PLM analyses shall be performed. Asbestos testing will use 40 CFR 763 as guidance.

Prior to the start of the asbestos conversion in the lab-scale and pilot-scale studies, the weight and volume of the TSI, non-crushed transite, and crushed transite will also be determined. ASTM methods will be followed for weighing the ACM.

B.4.4 Optimization of Test Parameters

During the lab-scale phase of the chemical conversion treatability study, the variables of the study will be the rates and amounts of the recharging solutions, ABCOV-R and

TABLE B.4.1 Initial Characterization of Media

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective / Intended Use	ASL
3 per medium	ACM	TAL Inorganics, PCBs [1]	ICP, GFAAS	SCQ Appendix G	To determine the concentration of inorganic contaminants.	C/D
3 per medium	ACM	TCL Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of volatile organic contaminants.	C/D
3 per medium	ACM	TCL Semi-volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of semi-volatile contaminants.	C/D
3 per medium	ACM	Radionuclides	---	SCQ Appendix G	To determine the concentration of radionuclide contaminants.	C/D
3 per medium	ACM	Asbestos	PLM	40 CFR 763	To determine the concentration and type of asbestos fibers.	E
1 per medium	ACM	Mass and Volume	Balance	ASTM	To determine initial mass and volume of ACM.	E

[1] Media will be analyzed for PCBs based on knowledge of potential contamination by historical processes.

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ABCOV-R1, to be added to the ABCOV-C solution. The analytical testing to be conducted to measure these variables include:

- temperature;
- pH; and
- fluoride ion concentration.

Asbestos testing will be performed during the lab-scale study to monitor the progress of the chemical conversion and to establish the typical time(s) for full chemical conversion for both transite and TSI.

During the pilot-scale testing, the analytical testing include the parameters discussed above and will be expanded to include monitoring of the interior and exterior air of the enclosure for:

- airborne asbestos;
- hydrogen sulfide; and
- airborne radionuclides.

The air testing is to be used for evaluating the effectiveness of the negative-pressure filtration system which will be attached to the enclosure.

Asbestos testing on the conversion mixture will be performed routinely based on the times determined in the lab-scale testing in order to monitor the progress of the conversion and to establish the completion of the conversion process.

For analytical parameters defined in the SCQ, SCQ approved methods will be followed. The airborne testing will follow FEMP approved industrial hygiene or radiological safety methods. Asbestos testing will use 40 CFR 763 as guidance. Other non-SCQ approved methods will follow ASTM methods. The test parameters for both the lab-scale phase and the pilot-scale phase are given in Table B.4.2. This table includes estimated number of samples, analytes, procedures/methods, objectives of the testing, and the ASLs.

B.4.5 Final Characterization

After each phase of this treatability study, both the final liquid and solid products will be sent to an analytical laboratory for characterization. The test parameters for the final characterization are given in Tables B.4.3 (lab-scale) and B.4.4 (pilot-scale). These parameters include estimated number of samples, analytes, procedures/methods, objectives of the testing, and the ASLs. These characterization studies will provide the data necessary to evaluate the effectiveness of the ABCOV chemical conversion process (to reduce asbestos fibers to below one percent by area) on OU3 ACM, to determine the effect of the ABCOV process on radiological and chemical contaminants in the ACM, and to determine the handling, storage, and disposition requirements for the final liquid and solid products. Radionuclides are not expected to alter the rate or effectiveness of asbestos decomposition because they will not interfere with the chemical reactions involved with the ABCOV Method. However, the effects of the chemical reactions (primarily the slowly rising pH) on the solubility of the radionuclides are more difficult to predict. Characterization of the final solid residuals and the wastewater streams will be performed to also determine the concentrations of radionuclides that are

TABLE B.4.2 Optimization of Test Design

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective / Intended Use	ASL
TBD	ACM in Solution	pH	pH meter	SCQ Appendix G	To determine when ABCOV-C needs recharging (pH > 5.5).	B
TBD	ACM in Solution	Temperature	Thermometer	SCQ Appendix G	To determine temperature of solution in conversion tank during exothermic reaction.	B
TBD	ACM in Solution	Fluoride	Ion Selective Electrode	SCQ Appendix G	To determine when ABCOV-C needs recharging.	B
TBD	ACM in solution	Asbestos	PLM	40 CFR 763	To monitor progress of asbestos fiber conversion.	E
Continuous	Air	Airborne asbestos[1]	PLM	Industrial Hygiene SOP	To monitor internal and external air contamination.	E
Continuous	Air	Airborne radionuclides[1]	Low Background Counter	Radiological Safety SOP	To monitor internal and external air contamination.	E
Continuous	Air	Hydrogen sulfide[1]	---	Industrial Hygiene SOP	To monitor internal and external air contamination.	E

[1] This sampling will be performed during the pilot-scale studies. However, the need for this sampling will be assessed for the lab-scale studies once the laboratory testing set-up has been established.

TABLE B.4.3 Final Characterization - Lab-Scale

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective / Intended Use	ASL
3 per medium	Solids, non-ACM residuals	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine the concentration of inorganics in the final product.	C/D
3 per medium	Solids, non-ACM residuals	TCL Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of VOCs in the final product.	C/D
3 per medium	Solids, non-ACM residuals	TCL Semi-Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of SVOCs in the final product.	C/D
3 per medium	Solids, non-ACM residuals	Radionuclides	--	SCQ Appendix G	To determine the concentration of radionuclides in the final product.	C/D
3 per medium	Solids, non-ACM residuals	Asbestos	PLM	40 CFR 763	To determine the concentration and types of asbestos fibers in the final product.	E
1 per medium	Solids, non-ACM residuals	Mass and Volume	Balance/ Graduated Cylinder	ASTM	To determine the final mass and volume of the final product.	E
3 per medium	Spent solution	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine the concentration of inorganics in the solution.	C/D
3 per medium	Spent solution	TCL Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of VOCs in the solution.	C/D
3 per medium	Spent solution	TCL Semi-Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of SVOCs in the solution.	C/D
3 per medium	Spent solution	Radionuclides	--	SCQ Appendix G	To determine the concentration of radionuclides in the solution.	C/D

TABLE B.4.4 Final Characterization - Pilot-Scale

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective / Intended Use	ASL
3 per medium	Solids, non-ACM residuals	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine the concentration of inorganics in the final product.	C/D
3 per medium	Solids, non-ACM residuals	TCL Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of VOCs in the final product.	C/D
3 per medium	Solids, non-ACM residuals	TCL Semi-Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of SVOCs in the final product.	C/D
3 per medium	Solids, non-ACM residuals	TCLP Inorganics	ICP, GFAAS	SCQ Appendix G	To determine leachability of inorganics in the final product.	B
3 per medium	Solids, non-ACM residuals	TCLP Volatile Organics	GC/MS	SCQ Appendix G	To determine leachability of VOCs in the final product.	B
3 per medium	Solids, non-ACM residuals	TCLP Semi-Volatile Organics	GC/MS	SCQ Appendix G	To determine leachability of SVOCs in the final product.	B
3 per medium	Solids, non-ACM residuals	Radionuclides	--	SCQ Appendix G	To determine the concentration of radionuclides in the final product.	C/D
3 per medium	Solids, non-ACM residuals	Asbestos	PLM	40 CFR 763	To determine the concentration and types of asbestos fibers in the final product.	E
1 per shift	Solids, non-ACM residuals	Asbestos	TEM	Proposed ASTM	To confirm the absence of asbestos fibers in the final product.	E
1 per medium	Solids, non-ACM residuals	Mass and Volume	Scale/Drum Equivalents	ASTM	To determine the final mass and volume of the final product.	E
3 per medium	Spent solution	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine the concentration of inorganics in the solution.	C/D
3 per medium	Spent solution	TCL Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of VOCs in the solution.	C/D
3 per medium	Spent solution	TCL Semi-Volatile Organics	GC/MS	SCQ Appendix G	To determine the concentration of SVOCs in the solution.	C/D
3 per medium	Spent solution	Radionuclides	--	SCQ Appendix G	To determine the concentration of radionuclides in the solution.	C/D

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retained in the solid matrix and the concentration of radionuclides that have been solubilized into the liquid.

As with the initial characterization, the concentration of contaminants will be determined by performing a variety of analytical tests. As discussed in Section 6, a minimum of three samples will be analyzed per ACM type for the final characterization and the list of analytes will be taken from Table 6.1. The analytes include:

- TAL inorganics;
- TCL organics (volatile and semi-volatile); and
- radionuclides.

However, if no contaminants in one of these analyte categories are detected during the initial characterization, then the listing of analytes in Tables B.4.3 and B.4.4 will be reduced accordingly.

For the purposes of final characterization, triplicate PLM analyses will be performed to determine the concentration and type(s) of asbestos fibers remaining in the test media. Also, the mass and volume of the residuals will be determined.

In addition to the chemical analyses, for the pilot-scale study, TCLP (inorganic, VOCs, and SVOCs) as well as a determination of mass/volume reduction will be performed. For example, the final solid product will be weighed, both wet (as is) and after drying.

Transmission electron microscopy (TEM) will be performed on the final solid product during the pilot-scale testing. Regulations governing the conversion of ACM waste material into asbestos-free material, given in 40 CFR 61.155, state that TEM analyses of eight-hour composite samples of the product is required to adequately confirm the integrity of the system and will allow for the disposition of the final product as non-ACM waste.

All analytical methods will be performed using SCQ approved methods when available. For asbestos, 40 CFR 763 will be the guiding document. For non-SCQ approved methods, ASTM methods will be followed.

B.4.6 Characterization of Secondary Waste

The types of wastes that are expected to be generated as a result of the chemical conversion treatability study include the final solid product from converted ACM, the final spent ABCOV solutions, any secondary wastewater, and any residue from the analytical testing. The final solid product would be characterized for storage and disposition as part of the analysis performed during the final characterization testing described above. The residues for the analytical testing would be handled as described in Section 11.0 of this TSWP.

It is anticipated that the spent ABCOV solutions would be treated and disposed of through the on-site wastewater treatment unit. Therefore, the spent ABCOV solutions as well as any secondary water generated during the treatability study will be analyzed for water quality parameters as defined in the Site NPDES Permit. Any secondary waste solutions that have not been analyzed for TAL Inorganics in the final characterization testing will be analyzed to meet the requirement of the Clean Water Act (CWA). Also, for the pilot-scale studies, TEM analyses will be performed on the spent solution before transfer to the on-site wastewater treatment system. The test parameters are given in Table B.4.5.

TABLE B.4.5 Characterization of Secondary Waste

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective / Intended Use	ASL
2-3	Spent solution and excess water	NPDES (see Table 6.3)	Various	SCQ Appendix G	To characterize liquid for processing through water treatment facilities.	B
2-3	Secondary waste solutions	CWA (Sb, As, Cd, Pb, Hg, Se, Ag, Zn)	ICP or GFAAS	SCQ Appendix G	To characterize liquid for processing through water treatment facilities.	B
2-3	Secondary waste solutions	Asbestos	TEM	Proposed ASTM	To confirm the absence of asbestos fibers in the spent solution.	E

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B.5 OU3 TREATABILITY STUDY HEALTH AND SAFETY PLAN ADDENDUM

Appendix F contains the OU3 Treatability Studies Health and Safety Plan. This document has been developed under the OU3 lead health and safety plan, the CERCLA/RCRA Unit #3 (CRU3) Health and Safety Plan. The OU3 Treatability Studies Health and Safety Plan contains health and safety information which may apply to any treatability study conducted.

Table B.5.1 contains information which identifies potential hazards and procedure-specific health and safety guidance for the Chemical Conversion of Asbestos-Containing Material Treatability Study. This information is provided to ensure that the health and safety of all personnel involved in conducting this treatability study are appropriately protected.

TABLE B.5.1 Treatability Study Health and Safety Requirements

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Controls	Decontamination & Disposal Procedures
1) General Project Minimum Requirements to access work site.	Uranium contamination and general industrial safety hazards. (Not all hazards are specified on this summary.)	Thermo-luminescent Dosimeter (TLD)	• FERMCO issued clothing; • Hard hat; • Safety glasses with rigid side shields; and • Steel-toed safety shoes	• Site GET Training; • Site Worker Training; • Rad Worker II Training; • 24-hour Supervised Field experience; • 8-hour Supervisor's Training for supervisory personnel; • Orientation on Project Specific Health & Safety Matrix; • Orientation in Project Specific MSDSs; and • Site NVO-325 Training for supervisor required to load boxes.	• FERMCO must have proof of physical examination signed by physician; • Initial, annual, and termination in-vivo exam (whole body count); and • Initial, bi-weekly, and termination urinalysis.	Material, equipment, and personnel monitoring required prior to leaving controlled area.	• FERMCO supplies respirator cleaning facility; and • FERMCO supplies bags and drums for disposition of contaminated waste and water.
2) Site Mobilization	Reference Activity 1.	Reference Activity 1. Permits will specify type of air and personnel monitoring.	Reference Activity 1.	Reference Activity 1. Training required to operate special equipment.	Reference Activity 1.	Reference Activity 1. Radiation work permit (RWP) required for work. Provide warning signs and barriers to establish construction areas.	Reference Activity 1.
3) Removal of TSI	Reference Activity 1. Release of asbestos fibers, airborne radionuclides, broken/torn waste containers, and heat stress.	Reference Activity 1. Asbestos monitoring as required by OSHA 1926.58 for any asbestos work.	• Full anti-Cs for asbestos work; • Hard hat; • Steel-toed safety shoes; • Full-face respirator with HEPA cartridges; • Latex or vinyl surgical gloves with cotton inner gloves or leather palm gloves if handling metal jacketing or sharp objects; and • Cool (ice) vest for heat stress control.	Reference Activity 1. • Certification by the Ohio Department of Health (24-hour Asbestos Abatement Worker or 32-hour supervisor); • 8-hour annual asbestos refresher training; and • FEMP respirator training and quantitative fit test (every six months for negative pressure APR).	Reference Activity 1. Proof of medical examination with asbestos component required by 29 CFR 1926.58 signed by physician. Documentation of respirator medical certification signed by physician provided to FERMCO Medical Services.	Reference Activity 1. • FERMCO Work Permit, RWP, and Asbestos Work Permit are required; • Barriers and warning signs to establish asbestos regulated area; • Negative pressure glove bags for asbestos removal HEPA vacuum for clean-up; • Amended water, surfactant, or ABCOV-T used to control emissions; • Worker rest schedule developed to alleviate heat stress; and • Fall protection for work above six feet.	Reference Activity 1. Shower shall be located at the exit of working area. Personnel will exit to the shower, remove disposable coveralls, shoe covers, and gloves, and put in labeled asbestos waste containers. Personnel then remove safety shoes and leave in staging area and remove launderable clothing. Still wearing respirator, personnel shall proceed to shower, rinsing off respirator. Remove respirator and cartridges. Dispose of cartridges as ACM waste. Shower water and wastewater shall be filtered.

TABLE B.5.1 Treatability Study Health and Safety Requirements (Cont'd)

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Controls	Decontamination & Disposal Procedures
4) Lab-Scale Studies (performed under laboratory hoods equipped to handle asbestos fibers or acid fumes): • prepare media for testing by crushing transite and mixing TSI; • analyze for concentration and type of asbestos fibers; • determine treatment amounts; and • determine necessary particle and filter size.	Reference Activity 1. Release of asbestos fibers, airborne radionuclides, hydrogen sulfide (H_2S), and weak acids.	Air monitoring requirements are determined by Industrial Hygiene.	Minimum Requirement: Safety goggles; cotton inner gloves with latex or vinyl surgical gloves; acid-resistant overgloves; and splash apron.	Reference Activity 2. General site requirements plus certification by the Ohio Department of Health (24-hour Asbestos Abatement Worker or 32-hour Supervisor), 8-hour annual refresher, FEMP respirator training and quantitative asbestos fit test (every six months for negative pressure APR). Basic Chemical Hygiene required for all tasks performed in lab (under hood).	Reference Activity 1.	Reference Activity 2. Activities must be performed under an exhaust-equipped hood with adequate HEPA filtration for asbestos or under an approved chemical lab hood for controlling acid fumes. Media that are being prepared for testing (crushing transite and mixing glovebags of TSI) must be supersaturated with the wetting agent, ABCOV-T. FERMCO Work Permit and Asbestos Work Permit required.	Personnel will wash hands and face prior to hand-to-mouth contact. At the exit of the controlled area, personnel will be required to perform a whole body frisk and/or a PCM survey.
5) Pilot-Scale Studies: • Construction of enclosure (three stage decontamination chamber with five compartments and a complete three stage asbestos conversion area w/ conversion room, two air locks, wash room, and holding area).	Reference Activity 1. Heat stress and cold stress.	Reference Activity 2. Monitoring requirements for heat and/or cold stress are determined by Industrial Hygiene.	Reference Activity 1.	Reference Activity 1.	Reference Activity 1.	Reference Activity 2. FERMCO Work Permit and RWP required. Fall protection required for heights exceeding six feet. General housekeeping etiquette required.	Reference Activity 1. Upon exiting a controlled/contamination area, personnel will be required to conduct a whole body frisk and/or PCM survey.

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TABLE B.5.1 Treatability Study Health and Safety Requirements (Cont'd)

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Controls	Decontamination & Disposal Procedures
6) Pilot-Scale Studies: • Conversion of ACM within enclosure.	Reference Activity 3. Exposure of workers and/or environment to H_2S, and weak acids.	Personnel and ambient monitoring for asbestos, H_2S, and airborne radionuclides as well as monitoring for heat stress are required to ensure worker protection and enclosure integrity.	Reference Activity 3.	Reference Activity 3.	Reference Activity 3.	Reference Activity 1. HEPA ventilation required on the enclosure. Barriers/warning signs re required to establish asbestos regulated area. HEPA vacuum shall be used for clean-up of ACM.	Reference Activity 1. ABCOV-L decontamination solution and ABCOV-W rinse solution may be used, as applicable and as part of testing the process, for asbestos decontamination of tools and launderable PPE. Shower will be located at the exit of working area. Personnel will exit to the shower, remove disposable coveralls, shoe covers, and gloves, and put in labeled asbestos waste containers. Personnel then remove safety shoes and leave in staging area and remove launderable clothing. Still wearing respirator, personnel will proceed to shower, rinsing off respirator. Remove respirator and cartridges. Dispose of cartridges as ACM waste. Shower/wastewater will be filtered. Upon exiting a controlled area personnel will be required to conduct a whole body frisk and/or PCM survey.

The requirements of this document are based upon current conditions and/or planned on current operations in areas near the treatability study area. This document is to be used as an aid in conjunction with the OU3 Treatability Studies Health & Safety Plan and assist the contractor in understanding the requirements of the project. This document does not relieve the contractor of planning for or providing a safe work area. This document does not relieve the contractor from recognizing and complying with other appropriate State and Federal regulations.

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B.6 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS; OTHER CRITERIA TO BE CONSIDERED

The ARARs identified for this project include regulations resulting from implementation of the Clean Air Act (CAA). The CAA's objective is to protect and enhance the quality of the nation's air resources in order to promote and maintain public health and welfare and the productive capacity of the population. ARARs for the Chemical Conversion of Asbestos-Containing Materials Treatability Study include standards from the National Ambient Air Quality Standards for particulates and standards from the National Emission Standards for Hazardous Air Pollutants (NESHAP) for all radionuclides except radon, radon and specific standards identified for asbestos handling and processing.

The Resource Conservation and Recovery Act (RCRA) also resulted in implementation of regulations that have been identified as ARARs for the management of debris and rubble prior to treatment, after treatment, and potentially to any new waste streams generated by this treatability study. The goals of RCRA are to protect human health and the environment, conserve energy, and reduce or eliminate the generation of hazardous waste. Promulgated requirements under RCRA were identified as ARARs for this study for waste characterization, container storage, generator standards, and standards for Miscellaneous Units (RCRA Subpart X).

Requirements from the Toxic Substances Control Act (TSCA) are also included as ARARs for this action. TSCA authorizes U.S. EPA to establish regulations governing testing of chemicals and substances, manufacture notification for new substances and mixtures, control of chemicals and substances that pose an imminent hazard and reporting and record keeping requirements. ARARs from the TSCA regulations identified for this treatability study are for the storage of asbestos-containing materials.

Regulations implemented by the Clean Water Act (CWA) also are ARARs for this treatability study. The CWA's objective is to restore and maintain the physical, chemical, and biological integrity of the nation's waters. ARARs for this project include compliance with the NPDES Permit for potential discharge through the on-site wastewater treatment system.

The ARARs for this project identified from the State of Ohio's regulations include regulations to control air quality non-degradation.

Other standards from requirements such as DOE Orders and NEPA, identified as ARARs or criteria to be considered (TBCs), include standards for radiation exposure, endangered species protection, solid waste management, and radioactive waste management at Federal facilities.

Potential ARARs and TBCs for this treatability study are listed in Table B.6.1 (contaminant-specific) and Table B.6.2 (action-specific).

TABLE B.6.1 Potential Contaminant-Specific Requirements

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
40 CFR 61, Subpart H	Radionuclides (except radon-222)	Emissions of radionuclides to the ambient air from the Chemical Conversion Study shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 0.1 mrem.	Potentially applicable	Radioactive materials within this operable unit could contribute to the dose to members of the public from the air pathway during this treatability study.
OAC 3745-15-07	Various in air	The emission or escape into open air from any source whatsoever 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.	Potentially applicable	During treatability study activities, some potential exists for emissions of radionuclides and toxic chemicals to the air, which could endanger individuals or damage property.
ORC 3704.01-.05	Various in air	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 states air resource so as to promote the public health, welfare, and economic vitality of the people of the state.	Potentially applicable	During treatability study activities, some potential exists for emissions of radionuclides and toxic chemicals to the air, which could endanger individuals or damage property.
National Emissions Standard for Hazardous Air Pollutants (40 CFR 61, Subpart M, sections 150 and 155)	Asbestos	Standard for waste disposal for manufacturing, fabricating, demolition, renovation, and spraying operations.	Potentially applicable	These regulations are applicable to the waste disposal resulting demolition or renovation of any building in which friable asbestos is present.
DOE Order 5400.5, Chapter II, Section 1a	Radiation	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 could contribute to the total dose to members of the public from this DOE facility.

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TABLE B.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment	Various in air	Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following. (For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.)	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radiation sources within this operable unit might contribute to the total dose to members of the public form this facility.

Isotope	Derived Concentration Guide[a] (μCi/mL) D	W	Y
Actinium-227	4×10^{-15}	1×10^{-15}	1×10^{-14}
Actinium-228	4×10^{-11}	1×10^{-10}	1×10^{-10}
Americium-241	-	2×10^{-12}	-
Bismuth-210	9×10^{-10}	6×10^{-11}	-
Bismuth-212	6×10^{-10}	7×10^{-10}	-
Bismuth-214	2×10^{-9}	2×10^{-9}	-
Cesium-137	4×10^{-10}		
Cobalt-60	4×10^{-10}	8×10^{-11}	
Europium-152	-	5×10^{-11}	-
Lead-210	9×10^{-13}	-	-
Lead-212	8×10^{-11}	-	-
Lead-214	2×10^{-9}	-	-
Neptunium-237	-	2×10^{-14}	
Plutonium-238[c]	-	3×10^{-14}	4×10^{-14}
Plutonium-239[c]	-	2×10^{-14}	4×10^{-14}
Plutonium-240[c]	-	2×10^{-14}	4×10^{-14}
Plutonium-241[c]	-	1×10^{-14}	2×10^{-12}
Plutonium-242[c]	-	1×10^{-12}	2×10^{-12}
Polonium-210	1×10^{-12}	1×10^{-12}	
Protactinium-231	-	9×10^{-15}	1×10^{-14}
Protactinium-234	-	-	-
Radium-223	-	2×10^{-12}	-
Radium-224	-	4×10^{-12}	-
Radium-226	-	1×10^{-12}	-
Radium-228	-	3×10^{-12}	-
Radon-220[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}
Radon-222[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}
Technetium-99	1×10^{-8}	2×10^{-9}	-
Ruthenium-106	2×10^{-10}	1×10^{-10}	3×10^{-11}
Strontium-90[c]	5×10^{-11}	-	9×10^{-12}
Thorium-227	-	8×10^{-13}	7×10^{-13}
Thorium-228	-	5×10^{-14}	4×10^{-14}
Thorium-229	-	6×10^{-15}	7×10^{-15}

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TABLE B.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment (Cont'd)				

Isotope	Derived Concentration Guide[a] (μCi/mL) D	W	Y
Thorium-230	-	4×10^{-14}	5×10^{-14}
Thorium-232	-	7×10^{-15}	1×10^{-14}
Thorium-natural	-	7×10^{-15}	1×10^{-14}
Thorium-234	-	5×10^{-10}	4×10^{-10}
Uranium-231[c]	2×10^{-8}	1×10^{-8}	1×10^{-8}
Uranium-233[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-234[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-235[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-236[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-238[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-238[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-natural[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}

[a] D, W, and Y represent lung retention classes; removal half-times 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 yearly DCG is for plutonium radionuclides with an absorption factor (f_1) value of 1×10^{-6}. The value shown for weekly DCG is for plutonium radionuclides with a f_1 value of 1×10^{-3}. The value shown for daily and weekly DCG is for Uranium radionuclides with a f_1 value of 5×10^{-2} and for yearly DCG is for uranium radionuclides with a f_1 value of 2×10^{-3}. 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}.

[d] Still being assessed.

TABLE B.6.2 Potential Action-Specific Requirements

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 261.7	Empty containers	Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if: • no more that 2.5 cm (one inch) of residue remains on bottom of inner liner; and • less than 3% by weight of total capacity remains (less than 110 gallon container); or • less than .3% by weight of total capacity remains (greater that 110 gallon container).	Potentially relevant and appropriate	Containers used to treat or store waste from this treatability study may contain hazardous substances which must be removed before the containers may be re-used or disposed of. No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.
40 CFR 264.111 OAC 3745-66-11	Closure of units storing or treating hazardous waste	General performance standard requires elimination of need for further maintenance and control; elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.	Potentially relevant and appropriate	No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate. Closure of the treatment unit using technical requirements for a RCRA unit might be relevant and appropriate.
40 CFR 264-114 OAC 3745-66-14	Closure of units storing or treating hazardous waste	During the partial and final closure, all contaminated equipment, structures and soils must be properly disposed.	Potentially relevant and appropriate	No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.
40 CFR 264.171-.175, .177, and .178 and OAC 3745-55-71 through -78	Container storage	Containers of RCRA hazardous waste must follow these guidelines: • Containers must be maintained in good condition; • Type of containers must be compatible with hazardous waste to be stored; • Containers must be closed during storage (except to add or remove waste); • Inspect container storage areas weekly for deterioration; • Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers 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; and • At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Potentially relevant and appropriate	No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.
40 CFR 264, Subpart X	Misc. units	Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined by 40 CFR 260.	Potentially relevant and appropriate	The asbestos treatment unit might be designed to meet standards for RCRA miscellaneous units. These standards may be relevant and appropriate since asbestos is a hazardous substance.

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TABLE B.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 264.192 through -.197	Tank systems (new construction)	Design and operation of tank systems: • Design and installation of new tank systems or components • Containment and detection of releases • General operating requirements • Inspections • Responses to leaks or spills and disposition of leaking or unfit-for-use tank systems	Potentially applicable	These requirements may be applicable for alternatives where new tanks or tank systems for treatment and storage of waste are constructed. Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, the RCRA standards for management of waste might be applicable.
40 CFR 122 (OAC 3745-31)	Wastewater treatment	Wastewater treatment facilities and/or industrial processes which produce process wastewater must meet substantive permitting requirements including: • Discharge limitations (technical and water quality based); • Certain monitoring requirements; and • Best management practices.	Potentially applicable	Both on-site and off-site direct discharges to surface waters are required to meet the substantive requirements of the NPDES program. Therefore, these requirements are applicable to those actions that produce wastewater. This action will result in discharge to the FEMP WWTU and subsequent discharge under NPDES permit.
10 CFR 1021.2	Treatment	DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR 1500-1508.	Potentially applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.
DOE Order 5820.2A, Chapter III	Management of low level and mixed wastes	DOE solid low-level wastes shall be managed in accordance with DOE Order 5820.2A, Chapter III and the additional requirements cited therein. Low-level radioactive wastes must be sufficiently characterized as to: • Physical and chemical characteristics; • Total volume (container); • Total weight (container); and • Major radionuclides and concentrations in order to permit proper segregation treatment, storage, and disposal. Prior to disposal, LLRW shall be treated as appropriate: • To meet performance objectives; and • To reduce volume, improve stability, and reduce potential for water infiltration.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radioactive materials within this operable unit may exhibit the characteristics of low level waste and require management as required by this chapter.
Solid Waste Disposal Act, as amended (42 USC 6901, et seq.); Solid Wastes (40 CFR 262.11), Ohio Hazardous Waste Management Regulations; OAC 3745-52-11.	Waste characterization and management	A waste must be evaluated to determine if it is a hazardous waste, i.e. either a waste listed in 40 CFR 261 or a characteristic waste. A characteristic waste is determined by its (1) ignitability (defined by flash point, oxidizer, and other); (2) corrosivity (defined by pH ≤ 2 or ≥ 12.5, rate of steel corrosion, and others); (3) reactivity (defined by instability, violent reaction with water, explosivity, cyanide- or sulfide-bearing nature and vapor generation potential, and other); or (4) leachability, as defined by 40 CFR 261.24 for the constituents identified by TCLP.	Potentially applicable	These requirements are applicable to the characterization and management of waste generated by this action as a requirement of the stipulated Amended Consent Decree with the State of Ohio.

TABLE B.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
Radiation Protection of the Public and the Environment (DOE Order 5400.5, Chapter IV)	Decontamination	Structural debris that is released from DOE facilities for reuse without radiological restrictions shall be decontaminated to specified levels.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.
Radioactive Waste Management (DOE Order 5820.2A, Chapter III)	Waste management	External exposure to radioactive waste (including releases) should not result in an effective dose equivalent of >25 mrem/yr to any member of the public; releases to the atmosphere are to meet the requirements of 40 CFR 61 and an environmental monitoring program must be implemented to address compliance with performance standards.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

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B.7 PERMIT INFORMATION SUMMARY

As stated in Section 10.2 of the TSWP, according to CERCLA statutes, no permits are required for treatability studies, such as this one, that are conducted entirely on site. CERCLA and a similar requirement in the USEPA-DOE Amended Consent Agreement make it clear that the substantive requirements of the appropriate permits, that would otherwise be required, must be submitted.

Table B.7.1 identifies each permit that would be required to obtain, the standards, requirements, criteria or limitations that would have had to be met to obtain each such permit, and provides an explanation of how the response action will meet the standards, requirements, criteria or limitations. The substantive or technical requirements have been integrated into the study-specific test design.

TABLE B.7.1 Permit Information Summary

Identification of permits for which the administrative requirements have been waived by CERCLA Section 121(e)(1)	Identification of standards, requirements, criteria, or limitations normally required by the waived permits	Actions used to meet the requirements of the waived permits
OAC 3745-31-02(A): A Permit to Install (PTI) is required for all new or modified sources that have the potential to emit pollutants.	The Best Available Technology (BAT) is required to control emissions.	Best Available Technology will be used.
OAC 3745-35-02(A): A Permit to Operate (PTO) is required for any air contaminant source.	A PTO application must be submitted.	The source will comply with applicable air pollution laws.
40 CFR 61 (NESHAP), Subpart H: National emission standard for emission of radionuclides other than radon from DOE facilities.	From 40 CFR 61.92, emissions from a project must not cause the site to exceed 10 mrem/year dose to any member of the public.	This will be determined by maintaining records of measured or estimated isotopic-specific emissions from the project, using them to estimate contribution to off-site dose impacts.
40 CFR 61 (NESHAP), Subpart H: National emission standard for emission of radionuclides other than radon from DOE facilities.	From 40 CFR 61.93(b), stacks/vents which have the potential, under normal operating conditions but without any emission control devices operating, to release radionuclides in sufficient quantity as would cause an effective dose equivalent to a member of the public of 0.1 mrem/year or greater shall have a continuous emission monitor/sampler system installed and operating. Other stacks/vents will need to have periodic confirmatory measurements conducted to verify their projected low emission/dose impact status.	Upon completion of a final design for the project, all stacks and vents will be identified and CAPP88PC air dispersion/dose impact modeling will be conducted to determine monitoring requirements for each point source.
40 CFR 61 (NESHAP), Subpart M: National emission standard for hazardous air pollutants: asbestos.	40 CFR 61.155(a) requires prior approval of the USEPA Administrator to convert asbestos material to non-asbestos material.	Provide the necessary descriptions of the process and the operations to show complete conversion of asbestos to non-asbestos forms.

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B.8 RESIDUALS MANAGEMENT

As discussed in Section 11 of this document, residuals resulting from the OU3 treatability studies will be collected, segregated from other waste streams, and either stored until ultimate disposition is determined by the OU3 final ROD or treated and/or dispositioned under current approved site programs. Table B.8.1 lists the anticipated residuals which may be present at the conclusion of the lab-scale and pilot-scale testing of the ABCOV Method on transite and TSI.

Approximately two to three gallons of spent ABCOV-C solution will be generated during the lab-scale testing and 350 gallons will be generated for each media tested if the treatability study goes into pilot-scale testing. This totals to approximately 700 gallons, assuming both TSI and transite will be tested during the pilot-scale. This quantity of spent ABCOV-C solution will require treatment and/or disposal. Testing has been performed during a demonstration of the ABCOV Method by a commercial facility which shows that unused ABCOV-C does not contain any problematic constituents which could possibly violate the site NPDES Permit or the CWA. Based on process knowledge of the type of contaminants found within OU3, it is anticipated that the spent ABCOV-C will be able to be treated by the on-site wastewater treatment system without any additional treatment steps. To ensure that this is the case, analyses of the spent ABCOV-C will be performed and evaluated prior to treatment, as listed in Table B.4.7.

Solid residuals, which resemble wet sand, will be segregated into two media categories (transite residues and TSI residues) and stored in 55-gallon drums pending analyses and further treatment and/or dispositioning. In an effort to test the removal of leachable radionuclides and other priority pollutant heavy metals, a portion of the residues will be used as feed for the Chemical Leaching Treatability Study as described in Appendix C.

The quantity of residues generated during the lab-scale will be essentially negligible in relation to the quantities generated during the pilot-scale and are, therefore, absorbed into the estimated quantities listed in Table B.8.1.

The pilot-scale system is designed to treat up to 225 pounds (wet) of transite per batch. It is anticipated that approximately six batches will be performed before the ABCOV-C requires regeneration with ABCOV-R1. This portion of testing on transite is expected to conclude when ABCOV-C needs regeneration a second time. Based on these assumptions, approximately 2,700 pounds (wet) of potentially low-level radioactive residues will be generated. If there is no volume reduction of the transite during the treatment, the residues will fill over three 55-gallon drums.

Approximately 22.5 ft^3 of TSI can be treated in a 350-gallon tank of ABCOV-C. If the pilot-scale test runs six batches before the ABCOV-C must be regenerated, signifying the conclusion of the test, and if there is an 80% reduction in volume, approximately 27 ft^3 of residues will be generated. This amount could be contained within four 55-gallon drums.

The air filtration systems used to both lower the concentration of airborne contaminants within the pilot-scale enclosure and to reduce emissions of these contaminants to the atmosphere will generate small amounts of waste material. This waste will come from the periodic cleaning of the activated carbon filter, used for capturing organic gases and

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TABLE B.8.1 Estimated Treatability Study Residuals

Residual Description	Estimated Quantity
Spent ABCOV-C from lab-scale and pilot-scale	700 gallons [2]
Solid residues from lab-scale and pilot-scale testing of transite	4 drum equivalents [1]
Solid residues from lab-scale and pilot-scale testing of TSI	4 drum equivalents [1][2]
Activated carbon from air filtration system	>1 drum equivalent
Contaminated personal protective clothing	2.7 drum equivalents [2]

[1] Estimated quantity does not take into account that some amount of residues may be used as feed for the Chemical Leaching Treatability Study.
[2] Estimated quantity does not consider any longer-duration testing of TSI.

vapors, such as hydrogen sulfide and any acid fumes from the conversion tanks. The frequency of changing the activated carbon will be determined from industrial hygiene air sampling results.

The operational lives of HEPA cartridges are largely affected by the concentration of particulates in the air. Since the air within the pilot-scale containment structure is not expected to have a high particulate concentration due to the wet nature of the process, the HEPA cartridges should not have to be replaced during the several month span of pilot-scale testing. However, in the event that any cartridge must be replaced during this treatability study, the spent cartridge will be disposed of according to approved site procedures.

During the pilot-scale portions of this treatability study, a large portion of the treatment and supporting activities will require the use of various items of disposable and reusable personal protective equipment, such as anti-contamination, chemical resistant suits, full-face respirators, chemical gloves, etc. A large percentage of this equipment is considered disposable and will be packaged and disposed of as low-level radiological waste.

Based on on-going site asbestos work, waste management estimates concerning baled, contaminated trash, and vendor-supplied information of the operation of the treatment system, the following assumptions were made to establish the quantity of used personal protective equipment that will be dispositioned:

- an average of four operators, supervisors, and health and safety personnel will "dress out" every day of the pilot-scale testing;
- personnel dress out four times per day;
- both media will require approximately two weeks (ten days) of treatment and testing, at a minimum;
- 40 sets of anti-Cs, in bags, fill a 55-gallon drum equivalent; and
- the contaminated trash baler compacts at a ratio of 3:1.

Based on these assumptions, a total of 320 sets of anti-Cs will be worn and dispositioned, filling eight non-compacted drum equivalents or 2.7 compacted drum equivalents.

The pilot-scale tank system will be cleaned and reused, if possible, for other studies. The containment structure will also be decontaminated to the extent possible and either reused or dispositioned. In the event any part of either the tank system or the containment is dispositioned, this material will be added to the list of residuals and considered in future cost analyses.

As stated before, all sampling, handling, transporting, and disposal activities will be governed by approved site procedures.

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APPENDIX C

CHEMICAL LEACHING

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APPENDIX C
CHEMICAL LEACHING

Chemical leaching has been utilized for many years and in many applications, particularly in the non-ferrous mining industry, to concentrate and recover valuable resources from what would otherwise be waste material. Generally, this method employs a chemical leaching agent to separate specific chemical species from insoluble bulk media. The procedure involves vigorously mixing the finely divided solid particles, containing the leachable component, with the solution containing the leaching agent, under controlled conditions which will allow the desired component to transfer from the solid phase to the liquid phase, thereby bringing about the intended separation as the liquid is removed from the solids. This process has been used extensively at the FEMP in previous uranium processing work, but not for the purpose of removing uranium to such low levels as is the object of the present cleanup work.

The test material to be treated in this study will be scabbled concrete, acid brick, and the asbestos-containing materials (ACM) treated waste from the Chemical Conversion Treatability Study. Concrete has been used very extensively throughout the FEMP, as the foundation of virtually every building, the grade level floor of most of them and in some cases, upper level floors and walls. In every building where uranium was processed or stored, concrete surfaces (e.g., walls, floors and foundations of structures) have become contaminated.

Scabbling is a surface removal technique which physically removes layers of surface material, up to as much as one half of an inch. Scabbling has been an ongoing practice at the FEMP to reduce the exposure to workers in accordance with DOE Order 5480.11, *Radiation Protection for Occupational Workers*. Preliminary data from the scabbling performed at the FEMP has indicated that the concrete and acid brick contamination is limited to surfaces. One concrete location where scabbling was performed required only a sixteenth to an eighth of an inch removal of the surface to reduce the contamination from 10^5 counts per minute to below detection of the instrument (< 1,000 counts per minute). Scabbled concrete and acid brick residues would potentially contain virtually all of the contamination. If all of the Operable Unit 3 (OU3) concrete and acid brick surfaces were scabbled (sixteenth to an eighth of an inch of the surface removed), the total volume of collected material would represent less than five percent of the total original volume of concrete and acid brick. Successful leaching of this scabbled media will further reduce the volume of contaminated media to be dispositioned at a low level waste (LLW) facility to less than one percent of the original volume. Leaching of the ACM waste from the Chemical Conversion Treatability Study is also expected to bring about a similar reduction in volume of LLW requiring specialized disposition.

Leaching agents are typically solutions (e.g., sodium carbonate/bicarbonate, citric acid, hydrochloric acid, etc.) which can be utilized to extract chemical compounds or metals, such as uranium, from insoluble media. Media which will be tested during this study include concrete, acid brick, and the solid residues from the Chemical Conversion Treatability Study.

The chemical leaching process is typically conducted in an agitated vessel. This assures contact of all the contaminated media with the leachate solution. In some studies the solids may be loaded into a column with the leaching agent flowing either up or down the column and contacting the bed of solids. It is anticipated that the vessel method will be utilized for this treatability test. Additional leaching techniques, such as open piles (e.g., mill

tailings piles) and in situ ore body leaching do not lend themselves to close environmental control and will not be considered for OU3 work.

The final disposition of the contaminants, after accumulating them in the leachate, will be concentrated further by precipitation from the leachate. This will be conducted as part of the waste water processing system. The neutralized leachate slurry will be filtered and the contaminants, as filter cake, will be prepared for disposition in the same manner as other LLW filter cakes generated at the FEMP, for off-site disposition. The solids will be tested by TCLP to assure the stabilization of any contained contaminates. The filtrate will be analyzed to assure all RCRA requirements are met and that the liquid is in full compliance with the current NPDES permit for waste water discharge. In the event that any test is not satisfactory, the waste materials will be recycled for further processing to meet all requirements.

The reasons for choosing this process option from Table 2.1 for a treatability study are the following:

- chemical leaching is applicable and appropriate to OU3 media and contaminants but additional data is required to complete effectiveness, implementation, cost analysis, and secondary waste generation evaluations of this process option;
- chemical leaching is a potential treatment alternative for two of the largest OU3 media categories (concrete and ACM);
- it is anticipated that chemical leaching will significantly reduce the volumes of concrete and ACM waste which require disposal at a LLW facility; and
- the large volumes of concrete and ACM which can be treated to give a reduced contaminant concentrations of the concrete and the ACM treatment waste may support a decision for on-site disposal.

Performing chemical leaching prior to final waste disposition offers the following potential benefits:

- a cost effective decontamination method;
- separation of contaminants (e.g., uranium and other radionuclides, metals, small quantities of PCBs, and organic solvents) from the remaining volume of construction rubble and other waste media;
- significant volume reduction in the quantity of material which may require special disposal;
- reduced need for special packaging, long-term monitoring, and/or long distance transportation for disposition;
- on-site disposition of decontaminated media; and
- beneficial reuse/recycling of decontaminated media.

C.1 TEST OBJECTIVES

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The goal of this treatability study is to demonstrate the use of chemical leaching as a viable alternative for the removal of contaminants from certain types of media which will allow 1) controlled recycling/reuse of the remaining uncontaminated bulk volumes of media, including the option of disposal of noncontaminated waste material on site, and/or 2) final disposition of a greatly reduced volume of media containing the collected contaminates. Other study-related objectives include:

- determining if chemical leaching can effectively remove hazardous contaminants from scabbled concrete, acid brick, and ACM treatment residues (spiking of samples with target contaminates to demonstrate removal, if necessary);
- determining if chemical leaching can effectively remove radiological contaminants from these same media;
- demonstrating a practical, cost effective means of contaminant removal;
- confirming the cost/benefit ratio of performing the leaching processes to bring about a substantial volume reduction of LLW; and
- effectively treating and disposing of secondary wastes which are generated by the process.

Several factors or variables influence the efficiency and success of the leaching operation. The process of mass transfer of the leaching solvent to the contaminant and the migration of the contaminant to the matrix surface is the largest factor influencing the efficiency. Contaminants which are embedded in the media must be dissolved by the leaching agent and flushed out. A major objective is to identify the particle size which provides greater surface area for leachate/contaminant contact and a shorter path for mass transfer, thereby reducing the migration time and providing a more efficient leaching environment. In addition to the particle size, other major objectives are to optimize:

- the type of leaching agent;
- concentration of the leaching agent;
- number of extractions required to leach the contaminants;
- residence time of leachate in the media; and
- physical and chemical characteristics of the leaching process (e.g., pH, temperature, agitation of solutions, etc.).

Chemical leaching of OU3 waste material has much in common with the soil washing treatability study being employed in the Operable Unit 5 (OU5) . In both cases there is a need to: 1) identify one or more efficient leaching agent; 2) provide a means of direct contact between the leaching agent and the target contaminants; 3) achieve satisfactory levels of removal; and 4) convert the collected contaminants into an acceptable form for disposition. The pilot-scale treatability study now being conducted by OU5 will be regularly monitored to gain mutually beneficial data and information regarding the leaching process. It should also be pointed out that there are several distinctions between the two leaching processes which need to be individually investigated, so that a single test program would not be adequate.

Data will also be collected so that a complete cost/benefit analysis can be conducted upon completion of the lab studies. Based on the study results and cost analysis, a recommendation as to whether to proceed to the pilot-scale testing will be given in a treatability report.

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C.2 EXPERIMENTAL TEST DESIGN AND PROCEDURES

Chemical leaching has been selected as a process option to be evaluated in a treatability study to determine the effectiveness of extracting radionuclides and heavy metals from concrete, acid brick, and converted ACM sludge/sand. Chemical leaching involves removing contaminants from the aforementioned test media by a chemical process using aqueous leaching solutions. Extracted contaminants may be further concentrated (e.g., precipitation, evaporation, etc.) or subjected to alternative treatment processes (e.g., stabilization).

The first lab-scale phase of the proposed test program is designed to look for gross impacts of several variables on the test media. As stated in the Introduction, the chemical leaching process has been used extensively at the FEMP in previous uranium processing work. The original constants were formulated by FEMP personnel who have had previous experience with leaching processes. Variables to be tested in this lab-scale phase of testing include:

- *type of leaching solution* (nine leaching solutions) - nitric acid, sulfuric acid, hydrochloric acid, ethylenediamine tetraacetic acid (EDTA), citric acid, acetic acid, ammonium, potassium and sodium carbonate/ bicarbonate solutions;
- *leach solution concentration* (three concentration levels) - one, two and three Normal (N);
- *types of media* (three types of media) - scabbled surface material of concrete, of acid brick, and sludge residue from the Chemical Conversion Treatability Study;
- *media solids particle size* (three particle size ranges) - screened material subdivided into three size ranges;
- *media solids loading* (three loading levels) - 100, 200 and 400 g/L.
- *residence time of each extraction cycle* (three time periods) - one, two, and four hours; and
- *number of extraction cycles* (number of cycles to be based on leaching results) - two, three or four cycles.

The chemical leaching process will be considered a feasible process option warranting further testing (e.g., pilot-scale testing) if the target compound(s) concentration is reduced by 80 percent in the test media and the process is considered cost-effective. Those combinations of variables not providing favorable results will not be considered for further testing.

Leaching solutions commonly used to extract uranium from the test media logically fall into three categories: carbonates; weak organic acids; and strong acids. Solutions combining various ratios of carbonate and bicarbonate salts of ammonium, potassium or sodium make up the carbonate category. Weak organic acids may include EDTA, citric acid, and acetic acid. Sulfuric, nitric, and hydrochloric acid are examples of strong acids. The first lab-scale phase will include all nine of these solutions, each at three concentrations, as indicated above.

Although the strong acids category would be expected to provide the quickest and most thorough contaminant removal, other factors may make these acids less desirable. These factors include: restrictions on the handling and use of acid reagents; probable dissolution of media as well as contaminants; possible atmospheric emissions; and possible generation of RCRA characteristic wastes. The criteria for a leaching category to be considered effective is:

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(% reduction of the target contaminant concentration) - (% dissolution of test media volume) $\geq$ 80 %

Concrete constitutes the largest single volume of media within OU3. Process knowledge provides guidance in the type of contamination which is likely to be present in the various process areas of OU3. Two of the three media samples to be used in this test program will be residues collected from surface scabbling activities conducted on the concrete and acid brick floor of the Pilot Plant. The Pilot Plant was selected as a media collection location due to the varying uranium and thorium forms which are anticipated to be found (e.g., $UO_2(NO_3)_2$, UO_3, UF_4, U_3O_8, ThO_2, ThF_4, $Th(C_2O_4)_2$, and $Th(NO_3)_4$). Test samples of concrete and acid brick will be taken from several locations within the "dry" and "wet" process areas of the pilot plant, which will incorporate both uranium and thorium, each likely to be found in a variety of forms. Table C.2.1 lists the media to be collected, location of the media and expected contaminants.

The third media to be tested is a filter cake residue from a process, as discussed in Appendix B, which decomposes the asbestos crystal structure, thereby converting asbestos containing materials to non-ACM. Such materials (transite, pipe and wall insulation, etc.) are anticipated to also contain uranium and/or other contaminants which would classify them as low level radioactive wastes.

Initial characterization will be performed on the test media to provide baseline conditions regarding the nature and concentration of contamination present in the test media. The contaminants identified in the test media during the initial characterization will provide guidance as to what analyses are to be performed during the final characterization. In the event that a target contaminant is not present in the test media, the sample may be spiked with the target contaminant to test the treatment system.

The first lab-scale phase of the test program will proceed through four major steps, determining and optimizing the most promising variables and eliminating those which do not meet the selection criteria. Optimal conditions or the most promising variables are defined by the combination of variable(s) and constants which yield the greatest reduction in contaminant concentration after chemical leaching is performed on the test media. Costs will be weighed if two variables produce similar results. The more cost-effective variable would be selected for further testing, while the second variable is set aside and may be re-considered at a later time. All of the test activities will be conducted in a laboratory hood and all health and safety requirements will be observed. Each of the leaching operations will be conducted in one-liter beakers, vigorously agitated, and maintained at a temperature of 65°C.

Since some of the media are anticipated to contain various concentrations of fluoride compounds, each of the prospective leaching categories will be analyzed for fluoride content before performing the study to aid in determining a contaminant mass balance. The fluoride analysis will be conducted with an ion-selective electrode and the data will be used to evaluate the effectiveness of leaching uranium and thorium fluorides.

Upon completion of this phase of lab-scale testing, the results will be analyzed. Based on the results, the second phase of testing will be performed. This phase will be conducted on a scale of twenty-liter quantities to supply adequate quantities of material for the extensive analyses to be conducted on the final residues of the test work and to verify the results of the first phase lab-scale tests and to collect additional performance and cost data for pilot-scale testing.

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TABLE C.2.1 Test Media and Expected Contaminants

Media Description	Location	Contaminant Form
Scabbled Concrete	Pilot Plant	$UO_2(NO_3)_2$, UO_3, UF_4, U_3O_8, ThO_2, ThF_4, $Th(C_2O_4)_2$, $Th(NO_3)_4$
Scabbled Acid Brick	Pilot Plant	$UO_2(NO_3)_2$, UO_3, UF_4, U_3O_8, ThO_2, ThF_4, $Th(C_2O_4)_2$, $Th(NO_3)_4$
Converted ACM Solid Residues	Various from Chemical Conversion Treatability Study	UO_3, U_3O_8, UF_4, UO_2F_2

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C.2.1 Lab-Scale, Phase I Procedures

Step 1 - Select Optimal Leaching Solution(s) and Concentration(s) for Media

In the first step, the three media samples described in Table C.2.1 will be tested with each of the nine leaching solutions, prepared in three concentrations, to yield a total of 81 tests. The goal of these tests is to identify potentially successful leaching solutions and to eliminate ineffective solutions/concentrations from the study.

Constants:

temperature (65°C);
time (four hours);
agitation (continuous);
solids loading ratio (200 grams solids/liter of liquid); and
particle size (-400 mesh).

A. Test all nine solutions specified in Section C.2.1.
B. Test all three concentrations (1N, 2N, and 3N).
C. Run the three test media with nine solutions using three concentrations. This equates to 81 tests.
D. Run each leach test cycle four hours. Repeat each test.
E. At the end of each test run, send solids and liquids to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis for liquid, where applicable.
F. Select effective solution(s) and concentration(s) based on performance and cost benefit.

Step 2 - Select the Particle Size Range and Solids Loading Ratio for Each Media

The mean particle size of the leachable solid is anticipated to be a major factor in leaching efficiency. As the particle size increases, a point is reached where the leaching efficiency is severely reduced. A portion of the homogenized test media will be screened to determine the particle size range of the media. Since the scabbled residue is described as "dust", it is anticipated that very little, if any, of the test media will exceed two millimeters (mm). The concrete and/or acid brick particles collected from scabbling operations will be screened into a number of size fractions, by mean particle size, which will be combined into three, approximately equal proportions by mass. These three size ranges will provide the three levels of particle size to be used in the test program. Particulate size ranges to be tested are anticipated to be: two millimeters to 74 microns (-10, +200 mesh), 74 to 37 microns (-200, +400 mesh), and less than 37 microns (-400 mesh). Any residues from scabbling, or other sources, larger than two millimeters, will be investigated if the largest particle size range of this test demonstrates acceptable leaching properties.

The ratio of media to leaching agent volume will be based on the practical limitations of agitation, filtration, or other handling requirements of the lab-scale test work. Also there may be an inverse correlation between particle size and loading ratio such that the smaller particles, having less tendency to settle, may be able to accommodate a more concentrated loading level. A minimal quantity of solids must be available for laboratory analysis at the conclusion of each test. These ratios are expected to be approximately 100, 200, and 400 grams of test media solids per liter of leaching agent.

Each particle size range will be combined with each loading ratio and individually tested with the leaching solution judged to be effective in Step 1. The particle size range having greater than ten percent increase in leaching efficiency above a more coarse fraction and/or less than ten percent loss in leaching efficiency from a finer fraction will be considered most satisfactory. A differential of less than ten percent between particle size test results is assumed to be countered by the increased costs of additional grinding of the media to reach a finer particle size range. If the most coarse fraction has a loss of leaching efficiency greater than ten percent from the middle fraction, it will be a strong indication that leachability of more coarse fractions will be unsatisfactory.

Constants:

temperature (65°C);
time (four hours);
agitation (continuous);
effective leaching solutions (from Step 1); and
solution concentration (from Step 1).

A. Test all three selected variable particle sizes (<37, 37-74, and >74 microns).
B. Test all three solids loading ratios (100, 200, and 400 grams solids/liter of liquid).
C. For each effective leaching solution at optimum concentration (from Step 1), run three media at three particle sizes and three solids loadings.
D. Interrupt tests after one, two, and four hours and perform optimization parameters:
   Solid filter cake - gross β/γ radiation frisk; and
   Liquid leaching agent and rinse water - uranium dimple test, and fluoride analysis of liquid, when applicable.

E. At end of test run, send solids and liquids samples to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis of liquid, when applicable.
F. Select particle size range and solids loading ratio (or combinations of both, if applicable) yielding the best performance and cost benefit for each effective leach solution.
G. Run duplicate of selection(s).
H. Send solids and liquids to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis for liquid, where applicable.

Step 3 - Select the Leach Cycle Residence Time

The time of contact for each leach cycle is an important factor to be considered in determining the cost and duration of a leaching operation. It is important to minimize the leach period, while still achieving satisfactory results, to reach maximum efficiency. The measurements taken at the points of interruption (one, two, and four hours) during Step 2, as well as the laboratory analyses of each test run, will provide guidance in recognizing whether the 4 hour leaching period is inadequate to achieve satisfactory decontamination or is unnecessarily long. Based on these previous results, three time periods will be chosen, which will be designated short, long and optimum. These will be used in this test series to verify the most efficient contact time interval.

Constants:

temperature (65°);
agitation (continuous);
effective solutions/concentration (from Step 1);
particle range size (from Step 2); and
loading ratio (from Step 2).

A. For each of the effective solutions/concentration choices from Step 1, as well as optimum particle size and loading choices from Step 2, select the three time intervals to be tested.
B. Run tests for each of the time intervals.
C. At end of test run, send solids and liquids samples to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis of liquid, when applicable.
D. For each media, select optimum residence time, based on performance and cost benefit.
E. Run duplicates of optimal selections.
F. Send solids and liquids to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis of liquid, when applicable.

Step 4 - Select Number of Extractions

Where multiple extractions are found to be necessary to achieve adequate removal of contaminants, a counter-current contacting arrangement will be utilized to determine if improved efficiency will result. A second, third or more contact cycle may be used, if total leaching effectiveness increases. This type of contacting is illustrated in Figure C.2.1. As the number of extractions in the series increases, the concentration of contaminant removal per stage is reduced. Eventually, the number of stages is no longer effective. It is anticipated that this leaching process will not exceed four stages, and may possibly only require three.

Constants:

temperature (65°C);
agitation (continuous);
effective solutions/concentration (from Step 1);
particle size range (from Step 2);
solids loading ratio (from Step 2); and
residence time (from Step 3).

A. For each media, with constants established from previous tests, run a two-extraction and a three-extraction series.
B. After each extraction series, send solids and liquids to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis of liquid, when applicable.
C. Select the number of extractions based on performance and cost benefit.
D. If significantly more contaminant removal occurred in the three stage extraction series than in the two stage series, and more contamination remained in the residue to be removed, a four-extraction series will be run.
E. Send solids and liquids to laboratory. Analyze for total uranium, total thorium, and gross α/β radiation. Add fluoride analysis of liquid, when applicable.

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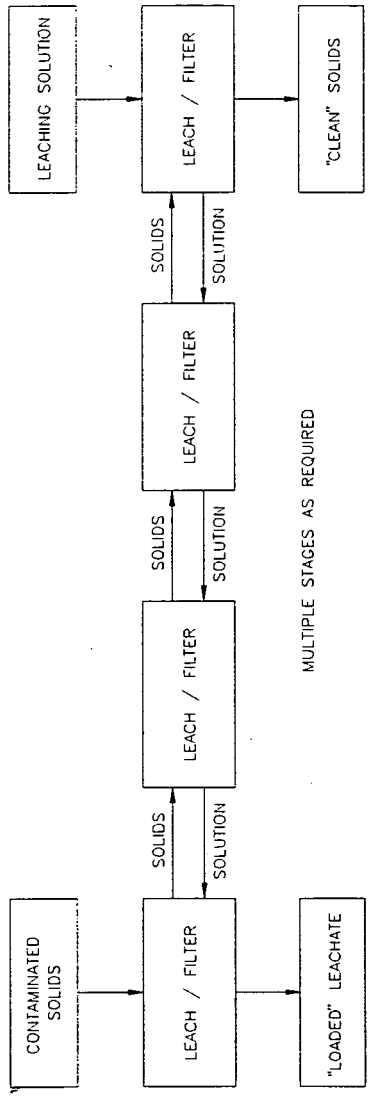

FIGURE C.2.1 Counter-Current Contacting Diagram

C.2.2 Lab-Scale, Phase II Procedures

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The Lab-Scale, Phase II testing will be conducted to verify the selected variables from the Phase I testing and to optimize the test results. The larger quantities which will be processed in this phase will supply the required sample quantities for the proposed comprehensive analytical needs described in the SAP Addendum. The Phase II testing will also collect performance and cost data to be used for implementation of the pilot-scale testing.

Constants (from Lab-Scale, Phase I program):

- temperature (65°C);
- agitation (continuous);
- effective solutions/concentration (from Step 1);
- particle size range (from Step 2);
- solids loading ratio (from Step 2);
- residence time (from Step 3); and
- number of extractions (from Step 4).

A. For each media, run the optimal variable selections, repeated three times, in twenty-liter quantities.

B. Analyze test media and liquid residuals in laboratory (TAL inorganics, TCL organics, isotopic radionuclides). For liquids, add NPDES parameters and fluoride analysis, when applicable.

If no leaching agent proves effective for a specific media or contaminant, further preparation of the media may be required. A candidate for additional preparation before leaching is concrete or acid brick contaminated with uranium tetrafluoride (UF_4). UF_4 is known to be very difficult to dissolve, even under hot, strong acid conditions. A treatment, which has been found to render the uranium soluble, is strong heating (>800°F) of a dry mixture of UF_4 and lime (CaO). This produces calcium fluoride (CaF_2) and an oxide form of uranium which more readily dissolves. Furnacing the concrete/UF_4 residue from scabbling may also bring about the same desirable reaction and allow satisfactory leaching to proceed. Such a preparation step will be investigated, if needed, when working with UF_4-contaminated media.

C.2.3 Pilot-Scale, Phase III Procedures

The implementation of this phase of testing will be based on results of the lab-scale phases. Pilot-scale testing will be performed to collect detailed performance and cost data in support of the remedial design/remedial action studies. Pilot-scale procedures will be submitted prior to implementation of the treatability test.

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C.3. TEST EQUIPMENT AND MATERIALS

The equipment list to be used for the Chemical Leaching Treatability Study, Phase I and II, are listed in Table C.3.1.

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TABLE C.3.1 List of Equipment[1]

Equipment Category	Item Description
Instruments	pH digital meter, thermometer (calibrated and traceable), bench scales, β/γ frisker, ion selective electrode(s)
Filtration Equipment	vacuum source, filter funnel, filter paper
Dry/Wet Screening Apparatus	Sieve vibrating shaker, standard testing sieves (8")
Decontamination Materials	Standard phosphate-free laboratory detergent, potable water from FEMP water system, certified de-ionized organic-free (ASTM Type II) water, steam cleaner, and plastic/aluminum wrap
General Laboratory Equipment	Hot plate, ventilated laboratory hood, stirring apparatus, beakers, plastic containers, balance (calibrated), spatula, reagent storage/dispensing bottles, wash bottles

1 This equipment list does not include analytical instrumentation for initial or final characterization.

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C.4 SAMPLING AND ANALYSIS PLAN ADDENDUM

Section 6.0 of the TSWP describes the modifications to the *OU3 RI/FS Work Plan Addendum* SAP. The sampling and analysis described in Section 6.0 is generic and applicable to any treatability study performed for the OU3 Treatability Program. Section 6 presents general protocols and procedures which may be implemented in full or in part by any study conducted. This Sampling and Analysis Plan Addendum presents the detailed protocols and procedures that will be used to collect data during the Chemical Leaching Treatability Study.

C.4.1 DATA QUALITY OBJECTIVE

The development of the DQO for the Chemical Leaching Treatability Study, in accordance with the SCQ eight-step process, is summarized in the following subsections.

C.4.1.1 Problem Statement

Construction materials used in OU3 buildings or equipment, after many years of use, have generally become heavily contaminated. They will require extensive decontamination efforts to allow possible recycling and reuse of many of these materials without spreading the contamination beyond the FEMP boundaries. The principle contaminant of concern throughout the site is uranium, along with its natural decay daughter products. Other contaminants which may be encountered in certain areas of the FEMP include thorium and its decay daughters, RCRA heavy metals (e.g., lead in many paints, chromium leached from stainless steel), polychlorinated biphenyls (PCBs) which may be found in the vicinity of certain electrical equipment, and organic solvents (e.g., TCA), located principally in maintenance areas.

These contaminants are found on, or embedded slightly into, the surfaces of structures and/or equipment of OU3. Especially in the case of concrete, it has been found that by scabbling a very thin layer from the surface, essentially all of the contamination is also removed. This reduces the volume of contaminated material which must be disposed of as LLW to less than five percent of the original volume. Successful leaching of this media will further reduce the volume of LLW to be disposed of which will provide a total reduction to less than one percent of the original volume.

C.4.1.2 Identification of a Decision that Addresses the Problem

The decision to be arrived at from this treatability study is whether the radiological and chemical contaminants (e.g., uranium, thorium, hazardous metals, etc.) can be effectively leached from the media. The leaching process must be done at less cost than the cost to "box and bury" the scabbled, contaminated media. It must also be thorough enough that the leached media is no longer designated as low level waste. The leached contaminates must be amenable to stabilization, as part of the total process. All other secondary waste streams must be satisfactorily disposed without creating additional hazardous waste and/or mixed waste.

C.4.1.3 Identification of Inputs that Affect the Decision

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The inputs required to make a decision concerning the feasibility of this treatability study include determining for each test media:

- the most effective leaching agent and leaching agent concentration;
- the optimal residence time of test media in solution;
- the optimal mean particle size;
- the optimal number of extractions;
- the most cost efficient loading ratio;
- the characteristics of secondary waste generated;
- whether the radionuclides and metals can be separated from the spent leachate and rinse water;
- the appropriate storage/disposition of all waste streams; and
- the cost benefit of performing chemical leaching versus other options.

C.4.1.4 Specification of the Domain of the Decision

In this treatability study, the media will define the domain to which the decision will be applied. The media included in this treatability study include concrete, acid brick, and the waste stream from other OU3 treatability studies (e.g., chemical conversion).

C.4.1.5 Development of Logic Statements

The principal purposes of this treatability study are to determine if the process option is feasible and to demonstrate the application of the process. Other purposes of the lab-scale testing are: (1) to determine the effectiveness of this treatability study in achieving the removal of the contaminants of concern from the media, (2) to determine the optimal operating conditions for the chemical leaching process, and (3) optimize the process to determine the best that this option can perform consistently.

The criteria of success during the lab-scale phase is to achieve a greater than 80% reduction in target contaminant concentration. The treatment results are expected to show a significant reduction in the radiological and chemical contaminants in each media, and to collect preliminary performance and cost data. If results from the lab-scale study support the effectiveness and feasibility of this process, then the treatability study will proceed to the pilot-scale testing.

C.4.1.6 Establishment of Constraints on Uncertainty

The purpose of this step is to establish an acceptable probability of making an incorrect decision based on study findings. For the treatability studies, a decision error would be the selection of an inappropriate treatment option. A false positive error would be the selection of a treatment option, based on the results obtained in the bench-scale study, that is not truly effective on either OU3 media or the contaminants of concern. A false negative error would be to disregard a treatment option, based on the results obtained in the lab-scale or bench-scale study, that could prove effective in decontaminating OU3 media. At this stage of the treatment study, the consequence of a decision error would be mostly cost and/or credibility. Only leaching agent solutions that prove to be effective against OU3 contaminants of concern will proceed into the pilot-scale study. In the case of a false positive error, the consequence

would be continuing the study into the pilot-scale level which could be costly and when/if the study then proved to be ineffective, could damage the credibility of the FEMP. In the case of a false negative error, the consequence could be having to dispose of these media without decontamination or having to begin another treatability study with a different process option which could delay final remediation. While neither error is desirable, a false negative error is of somewhat greater concern because of the potential of discarding effective treatment processes.

C.4.1.7 Development of a Cost-Effective Design for Obtaining Data

The chemical leaching study will be divided into three phases:

- *Lab-scale, Phase I* - This phase will be a semi-quantitative/quantitative investigation to determine the optimal operating conditions for each media in the chemical leaching process. For each test media, the variables will be tested on a one-liter beaker scale to determine the most effective solutions and conditions. The testing will include analyzing each of the variables individually while the other parameters remain constant. While testing each variable, the tests will be interrupted after one and two hours, as well as at the conclusion (four hours) to perform "spot check" analytical tests. These "spot checks" are performed to gather semi-quantitative data regarding the progress of the test. After determining the optimum level for each of the test variable(s) during the lab-scale phase, a duplicate run of the test will be performed for that selection. Leaching solution(s) and conditions which are most effective in reducing target contaminant concentrations will be used in Phase II. The media and spent leachate/rinse water will be sent to a laboratory and quantitatively analyzed for total uranium, total thorium and gross alpha/gross beta radiation. This analysis will verify the selection of the test variable(s).

- *Lab-scale, Phase II* - This phase will involve quantitative determinations to verify the results of the Phase I tests, including optimal operating conditions, gathered in Phase I testing. During this phase, the most effective conditions will be tested, in triplicate, in a twenty liter system, to supply adequate quantities of both solid (filter cake) and liquid (filtrate) samples, verify the operating process and gather data regarding performance and cost. Analytical testing performed during this phase will include Radionuclides, TAL Inorganics, TCL Volatile Organics, TCL Semi-volatile Organics, and PCBs (if necessary). Upon completion of this phase, a determination to proceed to pilot-scale testing can be made.

- *Pilot-Scale* - This phase of testing will be implemented based on results of the lab-scale phases. Pilot-scale testing will be performed on a larger scale (e.g., 55-gallon drum) to collect detailed performance and cost data in support of the remedial design/remedial action studies. This phase, however, is not part of this treatability study, but will be addressed at a later time.

It is anticipated that evaluation of the parameters identified in this test design will be sufficient to evaluate the variations expected to be encountered in OU3 concrete, acid brick, and ACM sludge. Laboratory analyses and the level of QA/QC will correspond to the final use of the data. During the lab-scale Phase I, the data will be used to make a "yes/no" decision about the effectiveness/selection of each variable tested. During the spot check or optimization process, the level of QA/QC will be minimal because this data will be used to "spot check" the process. The analysis performed after identifying the most effective variables will be used to verify the selection of that operating condition. The quality of data required at this phase is qualitative/semi-quantitative (ASL A/B).

During the lab-scale Phase II, it will be important to fully characterize each of the media being used in the study. The levels of radionuclides, metals, and organics (including PCBs, if necessary) will need to be established. Due to the importance of this information in making final decisions about the treatment study and the possibility that this data may be used for OU3 Feasibility Study risk assessments, this data must be of a higher quality (ASL C/D).

Precision will be assessed through the use of duplicate or triplicate sampling or analyses during the lab-scale phases. Accuracy will be evaluated through the establishment of a routine program involving the assessment of analytical results for method blanks, matrix spike/matrix spike duplicates, and laboratory control samples as directed in the SCQ. Sensitivity will be monitored through the achievement of specified detection limits and quantitative limits. Completeness will be assessed based on the percentage of usable data points from the total set of data points collected. Pursuant to the SCQ, completeness is expected to be at least 90 percent. If sufficient valid data points are not obtained to meet project objectives, additional sampling and analysis will be considered. Comparability will be maintained through the use of standard sampling, analytical, and validation procedures, where available and applicable.

C.4.1.8 Data Quality Objective Summary

To support the above approach, ASLs A though D will be required, with lab-scale analyses expected to be mostly ASL A/B. The characterization analyses both before treatment and after optimization is expected to be ASL C, with ten percent ASL D for confirmation, to allow for validation of the treatment study. Any non-standard procedures used for evaluation of the treatment option would be performed at ASL E. The analytes of concern for the chemical leaching study include radionuclides (especially uranium), metals (e.g., lead, barium, chromium), and organics (e.g., PCBs and 1,1,1-trichloroethane). Laboratory QA/QC types and frequencies shall follow those prescribed in the SCQ.

C.4.2 Field and Laboratory Sampling

The media to be collected for the Chemical Leaching Treatability Study include: concrete; acid brick; and non-ACM sludge/sand from the Chemical Conversion Treatability Study. Upon analysis of the preliminary results of the chemical leaching tests on concrete, acid brick, and converted ACM sludge/sand, additional media or forms of the media may be collected and tested. These additional media may include cinder/cement block and gunnite concrete. Additional forms of the media may be concrete contaminated with U_3O_8, UO_3, RCRA metals, etc.

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Concrete and acid brick will be chosen based on process knowledge of the uranium and/or thorium species (UF_4, ThF_4, UO_3, etc.) present in the media. The concrete and acid brick will be gathered from the FEMP Pilot Plant and may be collected using a variety of methods. The test media may be collected in the form of concrete cores or concrete chips using procedure EP-CRU3-020, *Sampling Hard-Surfaced Media* (SCQ Section K.8.3). The test media may also be collected from the scabbling process currently being performed at the FEMP. Several radiologically contaminated areas at the FEMP are being decontaminated using an automated chiseling technique, "scabbling", which removes the surface layer and collects the contaminated residues in "knock-out" drums. For the purpose of the treatability study, portions of this residue would be collected from the drums using SCQ method K.5 "Drum Sampling".

During the Chemical Conversion Treatability Study, the final product will contain sludge/sand from transite and other asbestos-containing materials which have been converted from ACM to non-ACM. This material will be drummed as part of the treatability study for storage or disposition. The chemical leaching treatability study team will remove media from these drums using SCQ Method K.5, "Drum Sampling", to obtain the material necessary for the treatability study.

After collection of the media, the test media will be delivered to the treatability laboratory. Samples will be collected from each media to be sent to an analytical laboratory for initial characterization testing. Portions of each media will also be removed for use in each phase of this study. QA/QC samples (e.g., trip blanks) will be collected to accompany the samples to the analytical laboratory as per SCQ requirements.

C.4.3 Initial Characterization of Test Media

Prior to beginning the lab-scale phases of this treatability study, a portion of the test media will be sent to an analytical laboratory for initial characterization. The characterization test parameters for are given in Table C.4.1. The information in these tables include: estimated number of samples; analytes; procedures/methods; objectives of the testing; and the ASLs.

The analyses are performed to determine the nature and concentration of contamination present in the test media. Initial characterization will be performed on the concrete and acid brick only. The chemical conversion solids will have been characterized during the final characterization of the chemical conversion study. As discussed in Section 6.3.1, it is anticipated that three samples per media will be analyzed for the initial characterization. In situations where one or two samples met the data needs of the study, the quantity of samples may be adjusted. The list of analytes will be taken from Table 6.2 including:

- TAL inorganics;
- TCL semi-volatile organics (TCL PCBs when process knowledge suggests presence in media);
- TCL volatile organics; and
- radionuclides.

All of the analytical testing performed will follow approved methods outlined in Appendix G of the SCQ.

TABLE C.4.1 Initial Characterization of Test Media

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
≥3 ea. media	Concrete, Acid Brick	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine nature and concentration of metals contamination.	C/D
≥3 ea. media	Concrete, Acid Brick	Radionuclides	TBD[2]	SCQ Appendix G	To determine nature and concentration of radiological contamination.	C/D
≥3 ea. media	Concrete, Acid Brick	TCL Semi-Volatile Organics (TCL PCBs if necessary)	GC/MS, GC	SCQ Appendix G	To determine nature and concentration of semi-volatile organic contamination.	C/D
≥3 ea. media	Concrete, Acid Brick	TCL Volatile Organics	GC/MS, GC	SCQ Appendix G	To determine nature and concentration of volatile organic contamination.	C/D
1 ea.[1]	Leachates	Fluoride	Ion Selective Electrode	SCQ Appendix G	To establish the baseline fluoride content in the leaching solution prior to the study.	B
1	Concrete, Acid Brick, Sludge	Particle Size	Sieve	SCQ Appendix G	To establish the baseline particle sizes.	B

[1] Fluoride analysis of liquids performed only if test media contains fluoride (e.g., UF_4).

[2] Analytical instrumentation is selected by the FEMP-approved off-site analytical laboratories; data generated by the analytical laboratory must meet the Performance Specifications as described in Appendix G of the SCQ.

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C.4.4 Optimization of Test Parameters

As previously described, during the lab-scale phases of this treatability study the test conditions will remain constant while the variables tested change. The analytical testing to be conducted during the optimization period is to monitor the progress of the test. The data to be obtained during the "spot check" or optimization analysis need only be semi-quantitative in nature. The following is a description of the optimization analyses to be performed during the lab-scale phase:

- Uranium - Determined in the leaching agent through a simple colorimetric procedure currently followed in the FEMP Wastewater Treatment Facilities as a spot check. The "dimple" test, Spot Test No. 3: Spot Test for Uranium - Plant 6 Effluent is performed using potassium ferrocyanide and glacial acetic acid.

- Radiological - Determined in the test media using a beta/gamma radiation frisker. The purpose for this testing will be to determine if there appears to be a reduction in the radiological level of the media as it is undergoing leaching and to semi-quantitatively determine the amount of reduction which occurs after the sample has been agitated for one, two, and four hours.

- Fluoride - Determined in the leaching solution to assist in the evaluation of leaching media containing fluoride species of uranium or thorium (e.g., UF_4 or Th_4). SCQ approved methods will be followed.

- Temperature - Continuous monitoring of the leaching solution temperature during the study. SCQ approved methods will be followed.

For analytical parameters defined in the SCQ, SCQ approved methods (see Appendix G of the SCQ) will be followed. For those parameters not defined in the SCQ, standard methods (e.g., ASTM) will be followed. The test parameters for the "spot check" optimization testing are given in Table C.4.2. The parameters include: estimated number of samples; analytes; procedures/methods; objectives of the testing; and the ASLs.

C.4.5 Final Characterization

The test parameters for the Lab-Scale, Phase I and Lab-Scale, Phase II final characterization testing are given in Tables C.4.3 and C.4.4, respectively. The parameters include: estimated number of samples; analytes; procedures/methods; objectives of the testing; and the ASLs. Correlations and trends in the initial data characterization collected will help focus the scope of final characterizations. The scope of final characterizations may be modified based on data collected from prior analyses to achieve a more efficient and effective sampling program.

After each variable is tested during the Lab-Scale, Phase I both the leachate and final test product will be sent to an FEMP analytical laboratory for characterization. The leachate and the final product from the Lab-Scale, Phase I study will be characterized to verify the effectiveness of the variable on the target contaminant. This analysis also effectively aids in the selection of which variables continue into the Lab-Scale, Phase II where only the most

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TABLE C.4.2 Optimization of Test Design

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
TBD	Leachate	Total Uranium	"Dimple" Test	WTP SOP	To monitor leaching of uranium into leaching solution.	A
TBD	Leached Media	Radionuclides	Beta/Gamma Frisker	SCQ Appendix K	To monitor leaching of radionuclides from media.	A
TBD[1]	Spent Liquids	Fluoride	Ion Selective Electrode	SCQ Appendix G	To monitor leaching from uranium and thorium forms with fluoride (e.g., UF_4/ThF_4).	B
Continuous	Spent Liquids	Temperature	Thermometer	SCQ Appendix G	To monitor the temperature of the leaching solution during the study.	A

[1] Fluoride analysis of liquids performed only if test media contains fluoride (e.g., UF_4).

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TABLE C.4.3 Final Characterization - Lab-Scale, Phase I

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
TBD	Concrete, Acid Brick, Sludge	Total Uranium	Colorimetric	SCQ Appendix G	To determine concentration of total uranium contamination.	B
TBD	Concrete, Acid Brick, Sludge	Gross Alpha/Gross Beta Radiation	TBD[2]	SCQ Appendix G	To determine total alpha/beta radiation levels.	B
TBD	Concrete, Acid Brick, Sludge	Total Thorium	Colorimetric	SCQ Appendix G	To determine concentration of total thorium contamination.	B
TBD	Spent Liquids	Total Uranium	Colorimetric	SCQ Appendix G	To evaluate the concentration of total uranium in the liquids. Also, for handling/storage/disposition requirements.	B
TBD	Spent Liquids	Gross Alpha/Gross Beta Radiation	TBD[2]	SCQ Appendix G	To determine total alpha/beta radiation levels.	B
TBD	Spent Liquids	Total Thorium	Colorimetric	SCQ Appendix G	To evaluate the concentration of total thorium in the liquids. Also, for handling/storage/disposition requirements.	B
TBD[1]	Spent Liquids	Fluoride	Ion Selective Electrode	SCQ Appendix G	To evaluate the effectiveness of leaching uranium and thorium forms which contain fluoride.	B

[1] Fluoride analysis performed for liquids only if test media contains fluoride (e.g., UF_4).

[2] Analytical instrumentation is selected by the FEMP-approved off-site analytical laboratories; data generated by the analytical laboratory must meet the Performance Specifications as described in Appendix G of the SCQ.

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TABLE C.4.4 Final Characterization - Lab-Scale, Phase II

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
3	Concrete, Acid Brick, Sludge	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determined the concentration inorganics in the final product. Also for handling/storage/disposition requirements.	C/D
3	Concrete, Acid Brick, Sludge	Radionuclides	TBD[2]	SCQ Appendix G	To determined the concentration radionuclides in the final product. Also for handling/storage/disposition requirements.	C/D
3	Concrete, Acid Brick, Sludge	TCL Semi-Volatile Organics (TCL PCBs if necessary)	GC/MS, GC	SCQ Appendix G	To determined the concentration semi-volatile organics in the final product. Also for handling/storage/disposition requirements.	C/D
3	Concrete, Acid Brick, Sludge	TCL Volatile Organics	GC/MS, GC	SCQ Appendix G	To determined the concentration volatile organics in the final product. Also for handling/storage/disposition requirements.	C/D
3	Spent Liquids	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determined the concentration inorganics in the leachate. Also for handling/storage/disposition requirements.	C/D
3	Spent Liquids	Radionuclides	TBD[2]	SCQ Appendix G	To determined the concentration radionuclides in the leachate. Also for handling/storage/disposition requirements.	C/D
3	Spent Liquids	TCL Semi-Volatile Organics (TCL PCBs if necessary)	GC/MS, GC	SCQ Appendix G	To determined the concentration semi-volatile organics in the leachate. Also for handling/storage/disposition requirements.	C/D
3	Spent Liquids	TCL Volatile Organics (PCBs if necessary)	GC/MS, GC	SCQ Appendix G	To determined the concentration volatile organics in the leachate. Also for handling/storage/disposition requirements.	C/D
1 ea.[1]	Spent Liquids	Fluoride	Ion Selective Electrode	SCQ Appendix G	To evaluate the effectiveness of leaching fluoride contaminants. Also for handling/storage/disposition requirements.	B

[1] Fluoride analysis performed for liquids only if test media contains fluoride (e.g., UF_4).
[2] Analytical instrumentation is selected by the FEMP-approved off-site analytical laboratories; data generated by the analytical laboratory must meet the Performance Specifications as described in Appendix G of the SCQ.

effective, optimal operating conditions are retained. The Lab-Scale, Phase I parameters to be tested include total uranium, total thorium and gross alpha/gross beta radiation.

In addition, the final leachate solutions will also be tested for fluoride if fluoride is present in the original test media. SCQ approved methods would be followed for all of these parameters.

After the Lab-Scale Phase I study, the optimal operating conditions will be selected for each media based on performance and cost benefit data gathered. During the Lab-Scale Phase II, the most effective conditions will be tested, in triplicate, in a twenty liter system to verify the operating process and gather information and data regarding performance and cost. Lab-Scale Phase II analytical characterization will be more comprehensive for the purpose of determining the nature and concentration of both the final "sludge" product and the leaching solution. The Lab-Scale Phase II final characterization is listed in Table C.4.4 and will include the following analytes:

- TAL inorganics;
- TCL volatile organics;
- TCL semi-volatile organics (TCL PCBs when process knowledge suggests presence in media); and
- radionuclides.

All analytical procedures followed will be as defined in Appendix G of the SCQ.

C.4.6 Characterization of Secondary Waste

The types and anticipated quantities of wastes that are expected to be generated as a result of the chemical leaching treatability study are listed in Section C.8. Residuals from analytical testing would be handled as described in Section 11.0.

Contaminants accumulated in the leachate, will be concentrated further by precipitation from the leachate. This will be conducted as part of the waste water processing system. The neutralized leachate slurry will be filtered and the contaminants, as filter cake, will be prepared for disposition in the same manner as other LLW filter cakes generated at the FEMP, for off-site disposition. The solids will be tested by TCLP to assure the stabilization of any contained contaminants. The filtrate will be analyzed to assure all RCRA requirements are met and that the liquid is in full compliance with the current NPDES permit for waste water discharge. In the event that any test is not satisfactory, the waste materials will be recycled for further processing to meet all requirements.

It is anticipated that the spent leaching agent solutions and rinse water would be treated and disposed of through the FEMP waste water treatment process. Therefore, the spent liquid solutions as well as any other liquid secondary water generated during the treatability study will be characterized for storage and/or disposition as part of the analysis performed during the final bench-scale characterization testing described above and also analyzed for water quality parameters as defined in the Site NPDES Permit. Any secondary waste solutions that have not been analyzed for TAL inorganics in the final characterization testing will be analyzed to meet the requirements of the Clean Water Act. The test parameters are given in Table C.4.5.

TABLE C.4.5 Characterization of Secondary Waste

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
2-3	Spent solution and excess water	NPDES (Refer to Table 6.4 of the TSWP)	Various	SCQ Appendix G	To characterize liquid for processing through water treatment facilities.	B
2-3	Secondary waste solutions	CWA: Sb, As, Cd, Pb, Hg, Se, Ag, Zn	ICP or GFAAS	SCQ Appendix G	To characterize liquid for processing through water treatment facilities.	B

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C.5 OU3 TREATABILITY STUDY HEALTH AND SAFETY PLAN ADDENDUM

Appendix F contains the OU3 Treatability Studies Health and Safety Plan. This document has been developed under the OU3 lead health and safety plan, the CERCLA/RCRA Unit #3 (CRU3) Health and Safety Plan. The OU3 Treatability Studies Health and Safety Plan contains health and safety information which may apply to any treatability study conducted.

Table C.5.1 contains information which identify potential hazards and procedure-specific health and safety guidance for the Chemical Leaching Treatability Study. This information is provided to ensure that the health and safety of all personnel involved in conducting the chemical leaching study are appropriately protected.

TABLE C.5.1 Treatability Study Health and Safety Requirements

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Controls	Decontamination & Disposal Procedures
1) General Information about tasks specified in this summary of Health and Safety Plan require-ments.	Hazards identified for each task to be performed. NOTE: Not all hazards are specified on this summary.	Permits will specify type. Air and personal monitoring may be performed.	Minimum PPE required for each identified task will be indicated as well as other equipment to be utilized in the event of upgrade.	Site access training required: Radiation Worker II, GET and Site Worker Training, Respirator training and fit test. 24 hour supervised field experience. Supervisors must have 8-hour Supervisor Training. Asbestos workers must meet OEPA requirements. Orientation on project-specific Health and Safety requirements and MSDS is required. Training to operate specialized equipment as needed.	Proof of medical examination signed by doctor must be maintained for all personnel. After initial bio-assay, bio-assay is required bi-monthly and with exit in-vivo.	Provide warning signs and barricades to protect existing construction and equipment, pedestrians and vehicular traffic from falling material. Two access points to each study area, one control point, and orange fencing to define construction work area. Materials, equipment and personnel monitoring required prior to leaving controlled area.	FERMCO supplies a respiratory cleaning facility. FERMCO supplies bags and drums for disposition of contaminated disposables and water.
2) Sieving of media and weighing of test samples	Airborne uranium dust.	As required by Industrial Hygiene, personnel monitoring may be performed.	Minimum Requirements: Latex or vinyl surgical gloves; safety goggles; splash apron.	Reference Activity 1. Completion of Chemical Hygiene Basic.	Reference Activity 1.	Reference Activity 1. All activities will be performed under an exhaust system (i.e., hood).	Reference Activity 1. Personnel will wash hands and face prior to any hand to mouth contact. At exit of controlled area personnel will be required to conduct a whole body frisk and/or PCM survey.

TABLE C.5.1 Treatability Study Health and Safety Requirements (Cont'd)

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Control	Decontamination & Disposal Procedures
3) Preparation of leaching solutions	Acids: citric acid acetic acid sulfuric acid nitric acid hydrochloric acid, EDTA Caustics: sodium carbonate/ bicarbonate	Reference Activity 2.	Reference Activity 2.	Reference Activity 2.	Reference Activity 1.	Reference Activity 2.	Reference Activity 2.
4) Addition of media to leaching solution	Possible spill/splash of acid or caustic	Reference Activity 2.	Reference Activity 2.	Reference Activity 2.	Reference Activity 1.	Reference Activity 2.	Reference Activity 2.
5) Mixing of hot leaching solution with media	Possible spill/splash of acid or caustic. Possible fume generation.	Reference Activity 2.	Reference Activity 2.	Reference Activity 2.	Reference Activity 1.	Reference Activity 2.	Reference Activity 2.
6) Filtration of leaching solution from media solids	Possible spill/splash of acid or caustic	Reference Activity 2.	Reference Activity 2.	Reference Activity 2.	Reference Activity 1.	Reference Activity 2.	Reference Activity 2.
7) Sampling of leaching solution	Possible spill splash of acid or caustic	Reference Activity 2.	Reference Activity 2.	Reference Activity 2.	Reference Activity 1.	Reference Activity 2.	Reference Activity 2.
8) Sampling of media - initial, intermittent, and final	Radionuclides, Acids/Caustics	Reference Activity 2.	Reference Activity 2.	Reference Activity 2.	Reference Activity 1.	Reference Activity 2.	Reference Activity 2.

The requirements of this document are based upon current conditions and/or planned on current operations in areas near the treatability study area. This document is to be used as an aid in conjunction with the OU3 Treatability Studies Health and Safety Plan and assist the contractor in understanding the requirements of the project. This document does not relieve the contractor of planning for or providing a safe work area. This document does not relieve the contractor from recognizing and complying with other appropriate State and Federal regulations.

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C.6 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS; OTHER CRITERIA TO BE CONSIDERED

The ARARs identified for this project include regulations resulting from implementation of the Clean Air Act (CAA). The CAA's objective is to protect and enhance the quality of the nation's air resources in order to promote and maintain public health and welfare and the productive capacity of the population. ARARs for Chemical Leaching of Non-Asbestos-Containing Material include: 1) standards from the National Ambient Air Quality Standards for particulates, 2) standards from the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for all radionuclides except radon, 3) radon, and 4) specific standards identified for asbestos handling and processing.

The Resource Conservation and Recovery Act (RCRA) also resulted in implementation of regulations that have been identified as ARARs for the management of debris and rubble both prior to and after treatment and potentially to any new waste streams generated by the Chemical Leaching Treatability Study. The goals of RCRA are to protect human health and the environment, conserve energy, and reduce or eliminate the generation of hazardous waste. Promulgated requirements under RCRA were identified as ARARs for this study for waste characterization, container and tank management and storage, generator standards, and standards for Miscellaneous Units (RCRA Subpart X).

Requirements from the Toxic Substances and Control Act (TSCA) are also included as ARARs for this action. TSCA authorizes USEPA to establish regulations governing testing of chemicals and substances, premanufacture notification for new substances and mixtures, control of chemicals and substances that pose an imminent hazard, and reporting and record keeping requirements. ARARs from the TSCA regulations identified for this treatability study are for the storage of PCBs.

Regulations implemented by the Clean Water Act (CWA) also are ARARs for this treatability study. The CWA's objective is to restore and maintain the physical, chemical, and biological integrity of the nation's waters. ARARs for this project include compliance with the NPDES Permit for potential discharge through the site Waste Water Treatment System.

The ARARs for this project identified from the State of Ohio's regulations include regulations on permitting new sources.

Other standards from requirements such as DOE Orders and NEPA, identified as ARARs or criteria to be considered (TBCs) include standards for radiation exposure, and radioactive waste management.

Potential contaminant-specific and potential action-specific ARARs and TBCs are listed in the Tables C.6.1 and C.6.2, respectively.

TABLE C.6.1 Potential Contaminant-Specific Requirements

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
40 CFR 50.5, National Ambient Air Quality Standard for SO_x	SO_x	Emissions from a major source for SO_x shall not exceed a maximum 3-hour concentration of 1300 $\mu g/m^3$.	Potentially relevant and appropriate	During the process of treatment, some potential exists for emissions of SO_x to open air. Probably not a major source; therefore only relevant and appropriate. Emission controls are planned, but design efficiencies would be directly related to the standard. The federal standard prevails since no state standard has been developed.
40 CFR 61, Subpart H	Radionuclides (except radon-222)	Emissions of radionuclides to the ambient air from OU3 Chemical Leaching Study shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 0.1 mrem.	Potentially applicable	Radioactive materials within this operable unit could contribute to the dose to members of the public from the air pathway during this treatability study.
OAC 3745-23-01, National Ambient Air Quality Standard for NO_x	NO_x	Emissions from a major source for NO_x shall not exceed an annual arithmetic mean concentration of 100 $\mu g/m^3$.	Potentially relevant and appropriate	During the process of treatment, some potential exists for emissions of NO_x to open air. Probably not a major source; therefore only relevant and appropriate. Emission controls are planned, but design efficiencies might be directly related to the standard. The state standard has precedence under the State Implementation Plan.
OAC 3745-71, National Ambient Air Quality Standard for Lead	Lead	Lead emissions from a major stationary source shall not exceed 1.5 $\mu g/m^3$ based on a quarterly average.	Potentially relevant and appropriate	During the process of this treatability study, some potential exists for emissions of lead to open air. Probably not a major source; therefore only relevant and appropriate.
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment	Various in Air	Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following. (For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.)	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radiation sources within this operable unit might contribute to the total dose to members of the public form this facility.

Isotope	Derived Concentration Guide* (μCi/Ml) D	W	Y
Actinium-227	4×10^{-15}	1×10^{-15}	1×10^{-14}
Actinium-228	4×10^{-11}	1×10^{-10}	1×10^{-10}
Americium-241	-	2×10^{-12}	-
Bismuth-210	9×10^{-10}	6×10^{-11}	-
Bismuth-212	6×10^{-10}	7×10^{-10}	-
Bismuth-214	2×10^{-9}	2×10^{-9}	-
Cesium-137	4×10^{-10}	-	-
Cobalt-60	4×10^{-10}	8×10^{-11}	-
Europium-152	-	5×10^{-11}	-

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TABLE C.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment (Cont'd)	Various in Air			

Isotope	Derived Concentration Guide[a] (μCi/mL) D	W	Y
Lead-210	9×10^{-13}	-	-
Lead-212	8×10^{-11}	-	-
Lead-214	2×10^{-9}	-	-
Neptunium-237	-	2×10^{-14}	
Plutonium-238[c]	-	3×10^{-14}	4×10^{-14}
Plutonium-239[c]	-	2×10^{-14}	4×10^{-14}
Plutonium-240[c]	-	2×10^{-14}	4×10^{-14}
Plutonium-241[c]	-	1×10^{-14}	2×10^{-12}
Plutonium-242[c]	-	1×10^{-12}	2×10^{-12}
Polonium-210	1×10^{-12}	1×10^{-12}	
Protactinium-231	-	9×10^{-15}	1×10^{-14}
Protactinium-234	-	-	-
Radium-223	-	2×10^{-12}	-
Radium-224	-	4×10^{-12}	-
Radium-226	-	1×10^{-12}	-
Radium-228	-	3×10^{-12}	-
Radon-220[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}
Radon-222[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}
Technetium-99	1×10^{-8}	2×10^{-9}	-
Ruthenium-106	2×10^{-10}	1×10^{-10}	3×10^{-11}
Strontium-90[c]	5×10^{-11}	-	9×10^{-12}
Thorium-227	-	8×10^{-13}	7×10^{-13}
Thorium-228	-	5×10^{-14}	4×10^{-14}
Thorium-229	-	6×10^{-15}	7×10^{-15}
Thorium-230	-	4×10^{-14}	5×10^{-14}
Thorium-232	-	7×10^{-15}	1×10^{-14}
Thorium-234	-	5×10^{-10}	4×10^{-10}
Thorium-natural	-	7×10^{-15}	1×10^{-14}
Uranium-231[c]	2×10^{-8}	1×10^{-8}	1×10^{-8}
Uranium-233[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-234[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-235[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-236[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-238[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-natural[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}

TABLE C.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment (Cont'd)	Various in Air	[a] D, W, and Y represent lung retention classes; removal half-times 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 yearly DCG is for plutonium radionuclides with an absorption factor (f_1) value of 1×10^{-6}. The value shown for weekly DCG is for plutonium radionuclides with a f_1 value of 1×10^{-3}. The value shown for daily and weekly DCG is for Uranium radionuclides with a f_1 value of 5×10^{-2} and for yearly DCG is for uranium radionuclides with a f_1 value of 2×10^{-3}. 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}. [d] Still being assessed.		
	Radon-222	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	Although not promulgated standards, these constitute requirements for protection of the public with which the proposed action will comply.
	Radon-220, -222	The immersion derived concentration guide for both radon-220 and radon-222 in air in an uncontrolled area is 3 pCi/L.	To be considered	Although not promulgated standards, these constitute requirements for protection of the public with which the proposed action will comply.
	External gamma radiation	The level of external gamma radiation in any occupied or habitable building must not exceed the background level by more than 20 μR/h.	To be considered	Pertinent to the proposed action if habitable buildings are involved in the proposed action.
DOE Order 5400.5, Chapter II, Section 1a	Radiation	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	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radiation sources within this operable unit could contribute to the total dose to members of the public from this DOE facility.

TABLE C.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter II, Section 1d	Radiation	Provide a level of protection for persons consuming water from a public drinking water supply operated by the DOE. Such persons consuming water from the supply shall not receive an effective dose equivalent greater than 4 mrem in a year. For multiple radionuclides, the sum of the effective dose equivalents from the radionuclides (excluding radium-226, radium-228, and radon) shall not exceed 4 mrem in a year from drinking water.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radioactive materials within this operable unit could contribute to the dose to members of the public form drinking water.

TABLE C.6.2 Potential Action-Specific Requirements

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
10 CFR 1021.2	Treatment	DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR 1500-1508.	Potentially applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.
40 CFR 122 (OAC 3745-31)	Wastewater treatment	Wastewater treatment facilities and/or industrial processes which produce process wastewater must meet substantive permitting requirements including: • Discharge limitations (technical and water quality based); • Certain monitoring requirements; and • Best management practices.	Potentially applicable	Both on-site and off-site direct discharges to surface waters are required to meet the substantive requirements of the NPDES program. Therefore, these requirements are applicable to those actions that produce wastewater. This action will result in discharge to the FEMP WWTU and subsequent discharge under NPDES permit.
40 CFR 261.7	Empty containers	Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if: • no more that 2.5 cm (one inch) of residue remains on bottom of inner liner; and • less than 3% by weight of total capacity remains (less than 110 gallon container); or • less than .3% by weight of total capacity remains (greater that 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 and the inner liner has been removed from the container.	Potentially relevant and appropriate	Containers used to treat or store waste from this treatability study may contain hazardous substances which must be removed before the containers may be re-used or disposed of.
Solid Waste Disposal Act, as amended (42 USC 6901, et seq.); Solid Wastes (40 CFR 262.11), Ohio Hazardous Waste Management Regulations; OAC 3745-52-11.	Waste characterization and management	A waste must be evaluated to determine if it is a hazardous waste, i.e. either a waste listed in 40 CFR 261 or a characteristic waste. A characteristic waste is determined by its (1) ignitability (defined by flash point, oxidizer, and other); (2) corrosivity (defined by pH ≤ 2 or ≥ 12.5, rate of steel corrosion, and others); (3) reactivity (defined by instability, violent reaction with water, explosivity, cyanide- or sulfide-bearing nature and vapor generation potential, and other); or (4) leachability, as defined by 40 CFR 261.24 for the constituents identified by TCLP.	Potentially applicable	These requirements are applicable to the characterization and management of waste generated by this action as a requirement of the stipulated Amended Consent Decree with the State of Ohio.

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TABLE C.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 264.13 through -.16 General Standard	Treatment, storage, or disposal facility standards	Waste Analysis: 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 disposition. Security: 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 to facility approaches. Inspections: Operators of a facility must develop a schedule and regularly inspect monitoring equipment, safety and emergency equipment, security devices and operating and structural equipment that are important to preventing, detecting or responding to environmental or human health hazards, promptly or immediately or immediately remedy defects, and maintain an inspection log. Training: 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.	Potentially applicable	Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, the RCRA standards for management of waste might be applicable.

TABLE C.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 264.32 through .35	Treatment, storage, or disposal facility preparedness and prevention	TSD operators must design, construct, maintain and operate facilities to minimize the possibility of a fire, explosion or any unplanned sudden or non-sudden release of hazardous waste to air, soil, or surface water which could threaten human health or the environment. All facilities must be equipped with an internal communications 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. All fire and spill control and decontamination equipment must be tested and maintained as necessary to assure proper emergency operation. All personnel must have immediate access to emergency communication or alarm systems whenever hazardous waste is being handled at the facility. Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment.	Potentially applicable	Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, the RCRA standards for management of waste might be applicable.
40 CFR 264.52, Contingency Plan	Contingency plans and emergency procedures for TSDs	Contingency plans should address procedures to implement a response to hazardous substance incidents, 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.	Potentially applicable	Hazardous waste from this action should be treated, stored, and disposed of in accordance with TSD facility standards. Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, the RCRA standards for management of waste might be applicable.
40 CFR 264.55 Emergency Coordinator	Contingency plans and emergency procedures for TSDs	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.	Potentially applicable	Hazardous waste from this action should be treated, stored, and disposed of in accordance with TSD facility standards. Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, the RCRA standards for management of waste might be applicable.

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TABLE C.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 264.111 OAC 3745-66-11	Closure of units storing or treating hazardous waste	General performance standard requires elimination of need for further maintenance and control; elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.	Potentially applicable	Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, closure using RCRA standards may be applicable.
40 CFR 264.114 OAC 3745-66-14	Closure of units storing or treating hazardous waste	During the partial and final closure, all contaminated equipment, structures and soils must be properly disposed.	Potentially applicable	Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, closure using RCRA standards may be applicable.
40 CFR 264.171-.175, .177, and .178 and OAC 3745-55-71 through -78	Container storage	Containers of RCRA hazardous waste must follow these guidelines: • Containers must be maintained in good condition; • Type of containers must be compatible with hazardous waste to be stored; • Containers must be closed during storage (except to add or remove waste); • Inspect container storage areas weekly for deterioration; • Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers 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; and • At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Potentially applicable	These requirements are applicable to actions utilizing containers for temporary storage or storage before disposition.
40 CFR 264, Subpart X	Misc. units	Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined by 40 CFR 260.	Potentially applicable	Units used for the treatment of waste in this treatability study may contain hazardous constituents and, therefore, closure using RCRA standards for miscellaneous units may be applicable.

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TABLE C.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 268.50	Land disposal restrictions on storage of restricted waste	The storage of hazardous waste restricted from land disposal under RCRA Section 3004 and 40 CFR 268, Subpart C is prohibited unless wastes are stored in tanks or containers by a generator or the on-site operator of a TSD facility solely for the purpose of accumulation of such quantities as to facilitate proper treatment or disposal. TSD facility operators storing waste under this provision must also clearly mark each container to identify the contents and the beginning date for accumulation of the waste and clearly mark each tank with a description of contents, quantity of contents, and beginning accumulation date, or record such information in the facility operating record.	Potentially applicable	Restricted hazardous waste removed from this treatability study may be stored or accumulated prior to treatment, packaging, and disposal in accordance with the technical standards in this requirement. Units used for treatment and storage of waste in this treatability study may contain hazardous constituents and, therefore, the RCRA standards for management of waste might be applicable.
Radiation Protection of the Public and the Environment (DOE Order 5400.5, Chapter IV)	Decontamination	Structural debris that is released from DOE facilities for reuse without radiological restrictions shall be decontaminated to specified levels.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.
Radioactive Waste Management (DOE Order 5820.2A, Chapter III)	Waste management	External exposure to radioactive waste (including releases) should not result in an effective dose equivalent of >25 mrem/yr to any member of the public; releases to the atmosphere are to meet the requirements of 40 CFR 61 and an environmental monitoring program must be implemented to address compliance with performance standards.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

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TABLE C.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
DOE Order 5820.2A, Chapter III	Management of low level and mixed wastes	DOE solid low-level wastes shall be managed in accordance with DOE Order 5820.2A, Chapter III and the additional requirements cited therein. Low-level radioactive wastes must be sufficiently characterized as to: • Physical and chemical characteristics; • Total volume (container); • Total weight (container); and • Major radionuclides and concentrations in order to permit proper segregation treatment, storage, and disposal. Prior to disposal, LLRW shall be treated as appropriate: • To meet performance objectives; and • To reduce volume, improve stability, and reduce potential for water infiltration.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.
Toxic Substances Control Act, as amended (15 USC 2607-2629; PL 94-499, et seq.); Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions (40 CFR 761), Subpart D, Storage and Disposal	PCB Storage	Material contaminated with PCBs >50 ppm must be stored for disposal (within one year) in a facility that is marked for storage and is not located in a 100-year floodplain. The facility should have a roof and walls to prevent rain from reaching the stored PCBs and an impervious floor with 6-inch curbing to provide a double containment volume. Stored articles or containers should be checked monthly for leaks.	Potentially applicable	Storage of materials or containers with PCB concentrations in excess of 50 ppm is expected to be part of this treatability study.

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C.7 PERMIT INFORMATION SUMMARY

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As stated in Section 10.2 of the TSWP, according to CERCLA statutes, no permits are required for treatability studies conducted entirely on site. CERCLA and a similar requirement in the Amended Consent Agreement make it clear that the substantive requirements of the appropriate permits, that would otherwise be required, must be submitted.

Table C.7.1 identifies each permit that would be required to obtain, the standards, requirements, criteria or limitations that would have had to be met to obtain each such permit, and provides an explanation of how the response action will meet the standards, requirements, criteria or limitations. The substantive or technical requirements have been integrated into the study-specific test design.

TABLE C.7.1 Permit Information Summary

Identification of permits for which the administrative requirements have been waived by CERCLA Section 121(e)(1)	Identification of standards, requirements, criteria, or limitations normally required by the waived permits	Actions used to meet the requirements of the waived permits
OAC 3745-31-02(A): A Permit to Install (PTI) is required for all new or modified sources that have the potential to emit pollutants.	The Best Available Technology (BAT) is required to control emissions.	Best Available Technology will be used.
OAC 3745-35-02(A): A Permit to Operate (PTO) is required for any air contaminant source.	A PTO application must be submitted.	The source will comply with Best Available Technology.
40 CFR 61.90-97: (NESHAP), Subpart H: National emission standard for emission of radionuclides other than radon from DOE facilities.	From 40 CFR 61.92, emissions from a project must not cause the site to exceed 10 mrem/year dose to any member of the public.	This will be determined by maintaining records of measured or estimated isotopic-specific emissions from the project, using them to estimate contribution to off-site dose impacts.
40 CFR 61.90-97: (NESHAP), Subpart H: National emission standard for emission of radionuclides other than radon from DOE facilities.	From 40 CFR 61.93(b), stacks/vents which have the potential, under normal operating conditions but without any emission control devices operating, to release radionuclides in sufficient quantity as would cause an effective dose equivalent to a member of the public of 0.1 mrem/year or greater shall have a continuous emission monitor/sampler system installed and operating. Other stacks/vents will need to have periodic confirmatory measurements conducted to verify their projected low emission/dose impact status.	Upon completion of a final design for the project, all stacks and vents will be identified and CAP88PC air dispersion/dose impact modeling will be conducted to determine monitoring requirements for each point source.

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C.8 RESIDUALS MANAGEMENT

The chemical leaching treatability study may generate residuals in the following forms:

- concrete, acid brick, and decontaminated chemical conversion solids in the form of filter cakes;
- spent leaching agents and deionized rinse water;
- precipitates from the spent leaching agents and deionized rinse water;
- sample materials returned from the analytical laboratory; and
- used containers, equipment, protective clothing, paper products, and other expendables.

The estimated types and quantities of chemical leaching treatability test residuals are presented in Table C.8.1. Residuals generated from the chemical leaching study will be managed in accordance with Section 11.0 of the TSWP.

The concrete, acid brick, and chemical conversion filter cakes and solids returned from the analytical laboratories are anticipated to be unchanged from the original test media from which they were taken, except in the level of contamination. These solids are anticipated to be non-RCRA, low-level solids which may be dispositioned by Removal Number 9 or placed in drums and stored at the FEMP pending disposition at a permitted facility.

Disposition of the spent leachate and deionized rinse water from the proposed treatability study is anticipated to be performed by the on-site Plant 8 Waste Water Treatment facility (WWT). Liquid residuals containing contaminants which were dissolved into the leaching agent and rinse water solutions from the chemical leaching study will be neutralized and precipitated/filtered prior to disposition at the WWT. The precipitate will contain the original test media contaminants, such as uranium and other metals, which were successfully leached. This precipitate may contain RCRA and/or radiological contaminants. Samples of these solids will be subjected to laboratory analysis to determine the storage at the FEMP pending disposition under the requirements of the FFCA STP or the OU3 final ROD.

Other secondary wastes generated (e.g., used containers, protective clothing, paper products, other expendables, debris) will be accumulated, packaged in drums, and stored until ultimate disposition is determined by the OU3 final ROD or dispositioned by an approved site program.

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TABLE C.8.1 Estimated Treatability Study Residuals

Residual Description	Estimated Quantity
Concrete & Acid Brick	100 pounds
Leachate and Rinse Water Precipitate	5 pounds
Spent Leaching agent and Rinse Water	200 gallons
Decontaminated Chemical Conversion Solid	20 pounds

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APPENDIX D

VITRIFICATION OF ASBESTOS-CONTAINING MATERIALS AND GLASS

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APPENDIX D
VITRIFICATION OF ASBESTOS-CONTAINING MATERIALS AND GLASS

Operable Unit 3 contains a large amount of asbestos-containing material in the form of transite wall and roof panels, pipe insulation, loose insulation, and floor tiles. There is also a large amount of glass present in the form of window glass, laboratory glass, etc. which is an excellent glass forming material. These media are assumed to be contaminated with radionuclides, and other chemical contaminants as well as with asbestos (for ACM).

Vitrification is the process of melting silica-containing materials (and/or other glass-forming material) at a high temperature to form a non-porous glass which can immobilize and contain other wastes. Vitrification of ACM and glass are divided into two Phases. During this proposed treatability study, Phase I, ACM and glass will be processed at a high temperature in a joule-heated continuous melter[1] to form vitrified glass. At such high temperatures, asbestos fibers are destroyed and other contaminants are immobilized. When the solution is cooled, vitrified glass is formed through the bottom of the melter. Although commercial ACM vitrification processes have been developed, a limited amount of data is available for vitrifying ACM which may be contaminated with radiological and chemical contaminants. The focus of this study will be to determine the quality of the glass formed from vitrifying FEMP ACM and glass. The treatability study proposed in this TSWP is to be performed in two stages; the crucible-melt stage and then followed by the mini-melter stage.

The quantity of ACM and glass at the FEMP is not large enough to justify the cost of building a stand alone large-scale vitrification plant. The data generated from the Phase I study will help in designing larger scale vitrification processes that will be used in conjunction with vitrifying other FEMP wastes. Data from Phase I will be required to determine the effectiveness, implementability, and costs of utilizing ACM and glass as glass forming media while vitrifying other FEMP wastes. Phase II of this study will utilize OU3 glass forming media (e.g., ACM) as feed material while vitrifying other FEMP wastes.

Vitrification is a technology which is currently being tested or utilized at several DOE sites. Previous vitrification testing at Savannah River, Idaho National Engineering Laboratory, West Valley, and Hanford has been concerned primarily with stabilization of high-level radioactive waste. Currently, Hanford is planning the vitrification of low-level wastes from underground storage tanks and Savannah River has begun treatability testing for the vitrification of low-level mixed waste streams. No vitrification testing has been completed or is planned at other DOE sites for ACM and glass which may be contaminated with radiological and/or hazardous constituents. A liaison has been established between other DOE sites utilizing vitrification and the FEMP vitrification testing efforts to ensure complete coordination and integration between DOE vitrification projects.

Currently, two vitrification processes are being developed at the FEMP. The Minimum Additive Waste Stabilization (MAWS) program is conducting a treatability study for the vitrification of various FEMP wastes (e.g., pit wastes). OU4 is developing a program to vitrify OU4 silo wastes. The OU3 Treatability Program will integrate with the MAWS and OU4 programs whenever possible to utilize OU3 glass forming media as feed material while vitrifying the various FEMP waste streams. Appendix E of this TSWP proposes to vitrify

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[1] Joule-heated continuous melter is also referred to as "mini-melter" and "10 kg melter" in the TSWP.

selected OU3 mixed waste streams. Based on initial results of the proposed Phase I studies, the OU3 mixed waste streams may be vitrified with OU3 ACM as glass forming media.

The reasons for choosing this process option from Table 2.1 for a treatability study are the following:

- Vitrification is applicable and appropriate to OU3 ACM and glass, but additional data is required regarding the quality of glass formed, how to most efficiently and effectively implement vitrification of FEMP ACM and glass, and the cost to perform the task;
- Vitrification is a potential treatment alternative for ACM which is one of the largest OU3 media categories;
- Disposal of radiologically contaminated ACM is prohibited at LLW facilities under current regulations. It is anticipated that the vitrification process will destroy asbestos fiber and significantly reduce the volumes of ACM waste;
- The process option has the potential to immobilize radiological and chemical contaminants (including hazardous chemical contaminants), reduce the volume of the waste to be dispositioned at a LLW facility, and destroy asbestos fibers; and
- A potential exists for using ACM and glass (silica-containing materials) as glass forming additives in conjunction with vitrifying other FEMP wastes.

Performing the vitrification treatability study for ACM and glass prior to final disposition offers the following potential benefits:

- a cost effective volumetric treatment (stabilization) method;
- destruction of asbestos fibers and significant reduction in volume;
- use of proven commercial technology will reduce learning curve and cost; and
- potential benefits in creating a viable long term solution for other DOE sites with a significant quantity of contaminated ACM and glass.

The treated material will potentially 1) protect human health and the environment, 2) provide long-term effectiveness and permanence, 3) reduce toxicity, mobility, and volume, and 4) comply with ARARs.

D.1 TEST OBJECTIVES

There is a large quantity of OU3 ACM and glass which exists in various forms. These media will require treatment before final disposition due to the nature of the contaminants present. The vitrification treatment process has the potential to destroy asbestos fibers, immobilize radionuclides and other metals, while producing a volume reduction. The goals of the OU3 bench-scale vitrification studies are to 1) determine if ACM and glass can be used as a material to form glass, and 2) collect performance and cost data applicable to OU3 media vitrification. The OU3 vitrification treatability study will consist of two stages to be performed on the bench-scale level:

- *Remedy Screening Bench-Scale Testing* -
  Crucible melts will be conducted on ACM and glass only to collect data to determine if various forms of FEMP ACM and glass will form glass of a nature that the asbestos fibers are destroyed and contaminants are immobilized in the glass product.
- *Remedy Selection Bench-Scale Testing* -
  ACM and glass will be utilized in a 10 kilogram melter to collect quantitative performance and cost data.

The objectives of the vitrification process are to collect data which:

- determines if OU3 waste to be used as glass forming media;
- quantifies any reduction in volume of contaminated media;
- determines if complete melting or destruction of the asbestos fibers (reduction in toxicity);
- determines if vitrification can be used to effectively immobilize radionuclides and other contaminants;
- determines if vitrification of ACM and glass media can be performed in a conventional joule-heated melter;
- can be used to determine the feasibility of on-site disposition of the treated wastes; and
- determines which glass forms may be synthesized (e.g., monoliths, gems, etc.).

Upon completion of the bench-scale studies, a cost/benefit analysis will be completed. Based on the study results and cost analysis, a recommendation to proceed with the pilot-scale level will be given in a treatability report. The pilot-scale study may utilize OU3 feed material to form glass in conjunction with other FEMP media to demonstrate an ability to use two wastes to form one more stable and lesser volume waste.

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D.2 EXPERIMENTAL DESIGN AND PROCEDURES

The objective of the study is to collect performance data and develop process information for the vitrification of ACM and glass. The study is intended to determine the glass-forming compositional range that meets the combined requirements of leach resistance and processability. It is anticipated that this study will be divided into two stages. Phase I will focus on determining the glass-forming capability of ACM and glass, on a crucible and mini-melter scale (10 kilograms) at an off-site treatability laboratory[2]. Phase II may involve adding ACM and glass as feed materials in combination with other FEMP wastes into a pilot-scale melter being constructed at the FEMP. The scope of this test design is limited to Phase I. The Phase II test design will be submitted prior to implementation of the study.

The contaminants identified in the test media during the initial characterization will provide guidance as to the analysis which are performed during the final characterization. In the event that a target contaminant is not present in the test media, the sample may be spiked with the target contaminant to the test treatment system.

D.2.1 Selection and Collection of Test Media

The glass-forming capabilities of four media will be determined. These media include transite, pipe insulation, floor tiles, and glass. Transite, pipe insulation and floor tiles are ACM. Table D.2.1 describes the chemical composition of asbestos in each of these ACM. All ACM contain silicates which are excellent glass-forming agents. The FEMP also contains a large volume of glass in the form of window glass, laboratory glass equipment, etc. These media may be used in combination with ACM to form glass. The location and sample volume of each media to be collected for this study are described in Table D.2.2. Buildings 2A and 4A have been selected due to the presence of the radiological contaminants in the media and Building 7A, because it is to be dismantled during the time frame of the testing. The FEMP personnel requirements for the selection, packaging and shipping of the media to the vendor are discussed in Section D.4.

D.2.2 Operation Parameters and Optimizing the Test Design

Activities in this task will be directed toward the development of optimum compositions for vitrification of ACM and glass. The characterization data obtained for the waste samples will be used for selecting the blends used in the vitrification composition variability study. Chemical additives that may be investigated include sodium carbonate (Na_2CO_3) , sodium hydroxide (NaOH), borax ($Na_2B_4O_5(OH_4) \times H_2O$) or boric acid ($H_3BO_3$) that will decompose into sodium oxide (Na_2O) and boron trioxide (B_2O_3). Na_2O helps lower the viscosity of the mix as well as in aiding the formation of glass, while B_2O_3 is a good glass-forming agent.

A flow-diagram illustrating the sequential steps in glass preparation and glass characterization is given in Figure D.2.1. Initial characterization of media will be performed as listed in Table D.4.1 of Section D.4. Analytical tests designed for optimization will be used to test the performance during operations and these tests are listed in Table D.4.2 in Section D.4.

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[2] "Off-site treatability laboratory" is also referred to as "treatability laboratory" and "vendor".

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TABLE D.2.1 Asbestos Compositions

Commercial Mineral Name for Asbestos	Mineral Group	Chemical Formula	Type of Media Present at FEMP
Chrysotile	Serpentine	$Mg_6(OH)_8Si_4O_{10}(\pm Fe)$	transite, formed pipe TSI, ACM mud joint packing, floor tiles
Crocidolite	Amphibole	$Na_2Fe^{3+}{}_2Fe^{2+}{}_3(OH)_2Si_8O_{22}(\pm Mg)$	formed pipe TSI, ACM cement joint packing
Anthophylite	Amphibole	$(Mg,Fe)_7(OH)_2Si_8O_{22}$	N/A
Amosite	Amphibole	$Fe_7(OH)_2Si_8O_{22}(\pm Mg, Mn)$	formed pipe TSI, ACM cement joint packing
Actinolite	Amphibole	$Ca_2Fe_5(OH)_2Si_8O_{22}(\pm Mg)$	N/A
Tremolite	Amphibole	$Ca_2Mg_5(OH)_2Si_8O_{22}(\pm Fe)$	N/A

TABLE D.2.2 Description of Test Media

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Media Description	Quantity	Location	Potential Contaminants[1]
Transite (ACM)	100 kilograms	Ore Refinery Plant (2A)	uranium (up to 5% enriched) ores, uranyl nitrate, UO_3, U_3O_8, thorium nitrate, silver, chromium, lead, arsenic, ammonia, H_2SO_4, nitric acid, soda ash, tetrachroloethylene, kerosene
		Green Salt Plant (4A)	UF_4, U_3O_8, UO_3, UO_2, mercury, catalyst (nickel), ammonia, HF
Pipe insulation (ACM)	10 kilograms	Ore Refinery Plant (2A)	uranium (up to 5% enriched) ores, uranyl nitrate, UO_3, U_3O_8, thorium nitrate, silver, chromium, lead, arsenic, ammonia, H_2SO_4, nitric acid, soda ash, tetrachroloethylene, kerosene
Floor Tiles (ACM)	10 kilograms	Ore Refinery Plant (2A)	uranium (up to 5% enriched) ores, uranyl nitrate, UO_3, U_3O_8, thorium nitrate, silver, chromium, lead, arsenic, ammonia, H_2SO_4, nitric acid, soda ash, tetrachroloethylene, kerosene
Glass	20 kilograms	Plant 7 (7A)	UF_4, UF_6, UO_2, UO_2F_2, HF, UO_3, ammonia, catalyst (nickel), biological hazard due to bird dropping

[1] Expected Contaminants are derived from TABLE A-3 of *OU3 RI/FS Work Plan Addendum* and are based only on knowledge of what materials were used in and on process in the facility identified.

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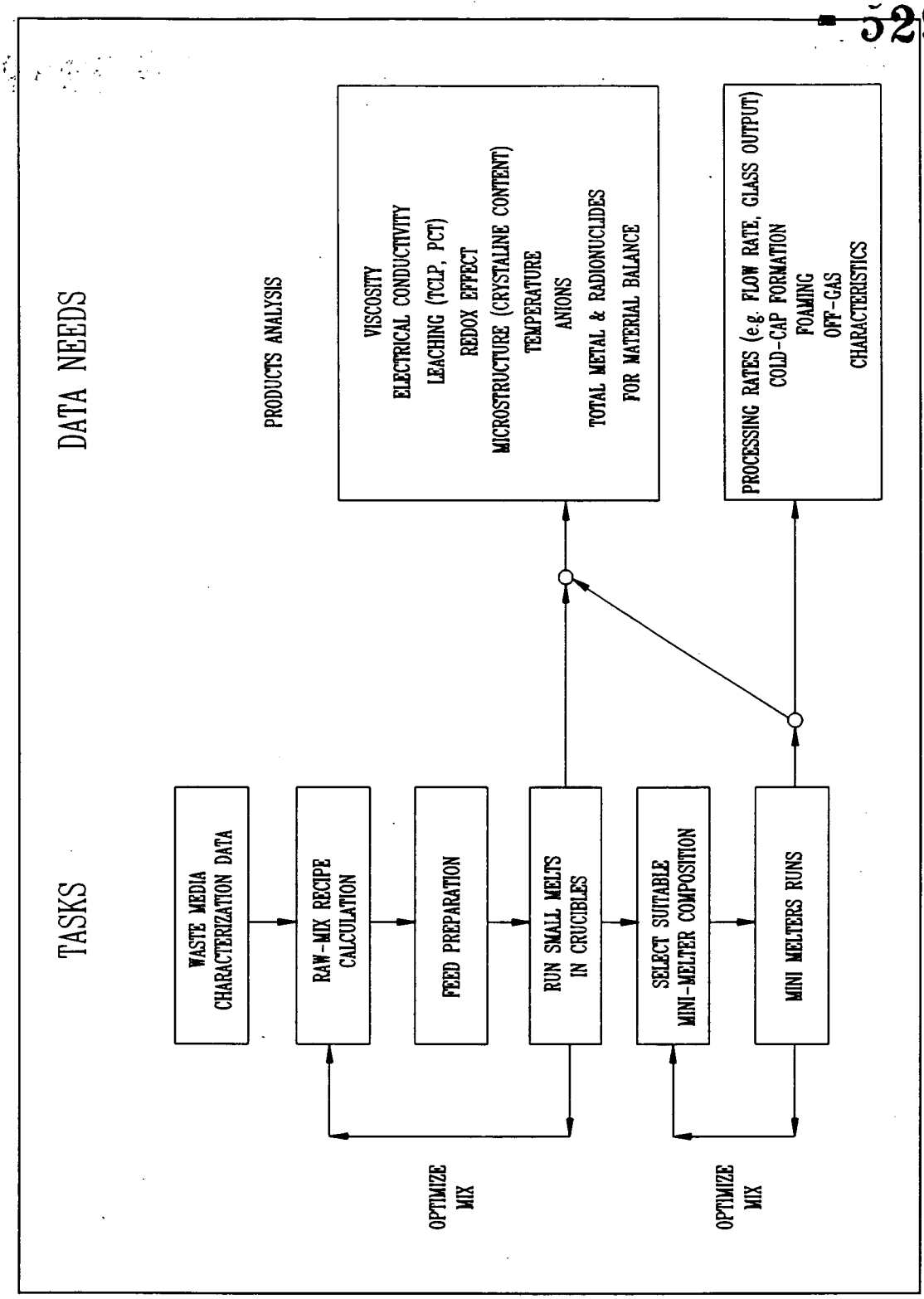

FIGURE D.2.1 Sequential Steps for Glass Preparation

D.2.2.1 Crucible Melts

The composition study will be based on mixes from the four media (transite, pipe insulation, asbestos floor tiles, and glass). Each crucible melt will consist of approximately 400 grams of media. Raw-mix recipe calculations for the feed will be based on previous experience and glass composition property correlations that have been previously developed. The initial test matrix to be used is detailed in Table D.2.3. Once the initial eight melts are analyzed, if required, some additional melt formulations will be performed to fine tune the exact composition of the mix in forming glass. An essential component is feed-back data from the glass characterization studies which will be used to refine the glass study. These small melts will be prepared in the crucibles at temperatures of between 1100-1250°C.

D.2.2.2 Mini-Melter

Two compositions from the crucible studies will be selected on the basis of the collected process and leach data, waste loading and additive requirements. This data will be used for process demonstrations in a small-scale continuous joule-heated 10 kilogram ceramic melter and which has capability for the continuous production of glass at a rate of approximately 0.5 kilogram/hour. It is expected that preliminary melts will be conducted to "fine tune" operating parameter for the up-scaled melter. Approximately 20 kilograms of glass will be produced in each of these runs at temperatures of about 1150°C. These runs will be used to collect data on processing parameters that cannot be obtained from crucible melts alone.

Based on the mini-melt runs, data on processing rates, cold-cap formation, foaming, and off-gas characteristics will be collected. Data will be also collected regarding cold-cap formations, feed rates, and productions volumes for application to large-scale demonstration of vitrification systems. Processing rates will be determined in terms of both kilograms/hour of feed material to the melter and kilogram/hour of glass produced. Cold-cap formation is the accumulation of unmelted feed material on top of the glass pool which occurs at high feed rates and ultimately limits the maximum throughput that is achievable. Foaming occurs in a glass furnace with the release of decomposition gases at high temperature (mostly carbon dioxide (CO_2) from carbonates). Foaming events will be recorded if they occur together with current process parameter measurements (temperature, current and voltage readings, feed rates, and concentrations of significant species in the off-gas).

D.2.3 Process Design and Comparative Analysis

The data obtained from the crucible melts and mini-melter runs will help provide the technical and economic basis for scale-up studies for the vitrification of FEMP wastes. The technical assessment will include an analysis of the effect of glass composition on key glass properties (viscosity, electrical conductivity, and leach resistance) and, therefore, the likely achievable waste loadings that are consistent with processability and leach resistance constraints.

TABLE D.2.3 Crucible Melt Matrix Formulations

Melt Number	Asbestos Weight%	Transite Weight%	Glass Weight%	Floor Tiles Weight%	Na_2O Weight%	B_2O_3 Weight%
1	4	70	4	2	10	10
2	4	80	4	2	5	5
3	4	90	4	2	0	0
4	0	80	0	0	10	10
5	0	90	0	0	5	5
6	5	85	0	0	5	5
7	0	85	5	0	5	5
8	0	85	0	5	5	5

Notes:

(1) Na_2O and B_2O_3 will be added as the stoichiometrically equivalent quantities of Na_2CO_3 and either B_2O_3 or $NA_2B_4O_5(OH)_4 \times H_2O$ (Borax).

(2) Formulations may be revised as appropriate to reflect data from previous melts and waste characterization studies.

Preliminary waste form criteria for the vitrified material will be developed based on the data obtained and model studies and assessments performed. The process assessments performed and the preliminary waste from criteria developed will be documented in the reports described in Section 13.0 of the TSWP.

D.2.4 Implementation

Implementation requirements and logistics will be assessed. The effects of meeting the As Low As Reasonably Achievable (ALARA) and shielding requirements on the melter design and construction, special handling systems and fugitive emissions control will be incorporated in this evaluation. Both technical and cost considerations will be incorporated into the development and assessment of the implementation requirements.

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D.3 TEST EQUIPMENT AND MATERIALS

The major operations of this test are intended to be performed at an off-site treatability laboratory. The activities include ACM and glass analysis and characterization, glass melting, standard leach tests on the vitrified product analysis of the materials and leachates, and end-product characterization. The equipment for these studies is listed in Table D.3.1.

A joule-heated ceramic mini-melter is available at the treatability laboratory that has a capacity of about six liters and is capable of producing glass on a continuous basis at a rate of about 0.5 kilogram/hour. It is slurry fed and will be modified to enclosed screw type feed mechanism to accept ACM waste. It can allow low-level radioactive feeds. It has been used to develop uranium- and thorium-leaded glasses in a small-scale simulation of the vitrification process for high-level nuclear waste at the West Valley Nuclear Facility (West Valley, New York) as well as Pit Waste from the FEMP OU1. Other features of the melter include lid heaters that allow operation with either a hot or cold top and an off-gas system incorporating an oil scrubber and a three-stage High Efficiency Particulate Air (HEPA) filter assembly.

Up to one kilogram quantities of glass will also be melted in platinum or ceramic crucibles in the extensive batch melting treatability laboratory. Standard glass characterization techniques, including viscosity, conductivity, and microstructure determination using SEM-EDX will also be performed by the vendor.

The treatability analytical laboratory will be used to dissolve and analyze ACM and glass samples. Facilities in this laboratory include a microwave oven for acid solubilization of solid samples, ion chromatography equipment, direct current plasma (DCP), atomic absorption (AA) and inductively coupled plasma-mass spectrometers (ICP-MS) that can provide a complete analysis of the inorganic components of the samples and can detect radionuclides, such as uranium, thorium, and plutonium in the parts per trillion range. The analytical laboratory produces more than half a million data points per year. Standard laboratory equipment including ovens, balances, sieves, and additional equipment for physical characterization of the samples are available. Modern radioactive counting equipment is also available in the laboratory for analysis of low levels of the radionuclides. Analysis of the leachate solutions will be carried out in the analytical laboratory.

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Table D.3.1 List of Equipment

Equipment/Instrument	Application
Glove box	radioactive sample preparation
ASTM sieves	particle size analysis
Flasks, balances, ram	density determination
Sandbath, microwave	sample sludge dissolution for analysis
DC-Plasma spectrometer	inorganic analysis
Polarized light microscope, scanning electron microscope, or transmission electron microscope	asbestos analysis
Ion exchange chromatograph	anion analysis
TOC-Analyzer	total organics analysis
Inductively coupled plasma-mass spectrometer	radionuclide analysis
Germanium spectrometer with marrinelli beaker	Gamma counting
TGA furnace, crucibles, platinum spindles and graphic casting molds: temperature and power measuring devices, heaters	prepare crucible melts
Joule-heated continuous ceramic melter	continuous melting (vitrification)
Viscometer, furnace	viscosity measurements
Conductivity measuring (bridge furnace) device	conductivity measurements
Scanning electron microscope with energy dispersive analyzer	microstructure analysis
Rotary agitator, zero-headspace extraction vessel, pH meter, oven	TCLP tests

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D.4 SAMPLING AND ANALYSIS PLAN ADDENDUM

Section 6.0 of the TSWP describes the modifications to the *OU3 RI/FS Work Plan Addendum* SAP. The sampling and analysis described in Section 6.0 is generic and applicable to any treatability study performed for the OU3 Treatability Program. Section 6 presents general protocols and procedures which may be implemented in full or in part by any study conducted. This Sampling and Analysis Plan Addendum presents the detailed protocols and procedures that will be used to collect data during the Vitrification of Asbestos-Containing Material Treatability Study.

D.4.1 Data Quality Objectives

The development of the DQO for the Vitrification Treatability Study, in accordance with the SCQ eight-step process, is summarized in the following subsections.

D.4.1.1 Problem Statement

The Asbestos Survey and Assessment Report, depicting the location of asbestos and ACM at the FEMP was submitted to Westinghouse Environmental Management Company of Ohio on February 28, 1992 (Diagnostic Engineering, Inc. 1992). This survey identified 56 of 74 facilities surveyed as having ACM. This asbestos is found in the form of transite walls and roof panels, pipe insulation, loose insulation, and floor tiles. This material is also assumed to be contaminated with radionuclides and other chemical contaminants that were in use at the site. These contaminants represent a current and future health threat which will be the subject of this study effort. Since the CERCLA decision-making process places large emphasis on reduction in toxicity, mobility, and/or volume of the contaminants, vitrification of these materials, which may result in the improvement in each, has been identified as the focus of this study.

Vitrification is the process of melting silica-containing material at a very high temperature to form a non-porous solid (glass) which can immobilize and contain other waste media including contaminants of concern.

Currently, the MAWS program is conducting a treatability study for the vitrification of OU1 pit waste. Vitrification performed by OU3 Treatability Studies may be integrate with the MAWS vitrification study to utilize OU3 glass-forming media in combination with OU1 wastes.

D.4.1.2 Identification of a Decision that Addresses the Problem

The decisions to be made during the conductance of this treatability study include: whether the OU3 ACM can be used as a feed material to form glass during the vitrification process; whether there is a significant volume reduction of OU3 contaminated media remaining for disposition; whether complete melting or destruction of the asbestos fibers occur; whether containment of radionuclides and other contaminants is accomplished; and whether remediation of multiple waste streams can be accomplished by combining OU3 media with media from other operable units.

D.4.1.3 Identification of Inputs that Affect the Decision

The inputs required to make a decision concerning the feasibility of the treatability study include but are not limited to: nature and concentration of the contamination (asbestos, radionuclides, metals, organics, etc.) in the ACM prior to treatment; assessment of the ACM glass-forming capabilities; confirmation of the reduction of asbestos fibers to less than 1% by area; and containment of additional contaminants (e.g., radionuclides, metals, etc.) in the newly formed glass by passing the TCLP and PCT leachability studies.

D.4.1.4 Specification of the Domain of the Decision

In this treatability study, the media will define the domain to which the decision will be applied. The media included in this treatability study include ACM in the form of transite walls and roof panels, pipe insulation, loose insulation, and floor tiles.

D.4.1.5 Development of Logic Statements

The major use of this data will be to determine the effectiveness of this treatability study on the media and contaminants of concern. The purpose of the bench-scale testing is to determine if the process option is feasible, to attempt to optimize the process to determine the best that this technology can perform consistently, and whether the process option is cost effective for the FEMP. The criteria for a successful treatability study includes the reduction of asbestos fibers to less than 1% by area using polarized light microscopy (PLM) or transmission electron microscopy (TEM), production of glass of predetermined quality, and leaching of metals or organics not to exceed the RCRA regulatory limits during PCT and TCLP leachability tests. If this can be determined at the bench-scale level, then the treatability study has the potential to proceed to the pilot-scale level for more detailed evaluation.

D.4.1.6 Establishment of Constraints on Uncertainty

The purpose of this step is to establish an acceptable probability of making an incorrect decision based on study findings. For the treatability studies, a decision error would be the selection of an inappropriate treatment technology. A false positive error would be the selection of a process option, based on the results obtained in the bench-scale study, that is not truly effective on either OU3 media or the contaminants of concern. A false negative error would be to disregard a process option, based on the results obtained in the bench-scale study, that could prove effective in decontaminating OU3 media. At this stage of the treatment study, the consequence of a decision error could be increased cost and/or loss of credibility as well as schedule slippage in a worst case assumption. In the case of a false positive error, the consequence would be continuing the study into the pilot-scale level which could be costly and when/if the study then proved to be ineffective, could affect the credibility of the FEMP. In the case of a false negative error, the consequence could be having to dispose of these media without treatment or having to begin another treatability study with a different process option which could delay final remediation. While neither error is desirable, a false negative error is considered somewhat greater concern because of the potential of discarding effective treatment technologies that could result in cheaper, more effective disposition of wastes. Because the treatability study is only at the bench-scale level at this point, it is assumed that any false positives may be discovered at the pilot-scale level. The level of concern increases in the magnitude of both types of errors because, in the case of a

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false negative, only treatability studies that prove to be even effective against OU3 contaminants of concern will proceed into the pilot-scale study and a treatability study that shows to be highly effective, in the case of a false positive, could displace a process option that is in effect a better choice.

D.4.1.7 Development of a Cost-Effective Design for Obtaining Data

The bench-scale study for vitrification will be divided into two phases:

- *Remedy Selection Bench-Scale, Stage I* - Crucible melts will be conducted on the ACM and glass to collect quantitative data to determine if various forms of ACM will form glass of desirable qualities. Tests will be performed on the vitrified material for any remaining asbestos fibers as well as testing to determine the leaching potential of other contaminants contained in the OU3 material (radionuclides, metals, etc.). Only OU3 media will be included in this phase.

- *Remedy Selection Bench-Scale, Stage II* - OU3 ACM and glass will be utilized in a 10 kilogram melter to collect quantitative performance, volume reduction, and cost data. Analytical testing includes the characterization of the OU3 media prior to the vitrification process including asbestos, radionuclides, metals, and organics. The leachability of these same contaminants from the final vitrified product would be tested using both the TCLP and PCT leaching procedures. During the 10 kg melter process, optimization testing would be conducted to verify test conditions and "tweak" the process as necessary. The quality of the final glass product and the volume reduction will be determined.

It is anticipated that evaluating ACM and glass through the identified crucible melts and the 10 kg melter discusses in Section D.2 will be sufficient to evaluate the range of variables which may be encountered in OU3 ACM and glass, and will thus support a correct evaluation of the process option. The list of laboratory analyses, the estimated number of samples to be analyzed, the methods/procedures to be followed, the level of QA/QC, and the objective of each analysis are discussed further in the Sampling and Analysis section, Section D.4.

During remedy selection, it will be important to fully characterize each of the media types being used in the study. The nature and concentration of asbestos, radionuclide, and metal contamination will need to be established prior to the study. Again, after the vitrification process has been optimized, it will be important to characterize the leachability of the vitrified material to determine the effectiveness of the treatment study on all of the contaminants of concern. Due to the importance of this information in making final decisions about the treatment study and the possibility that this data may be used in the OU3 Feasibility Study risk assessment, this data must be a higher quality, ASL C/D (ASL E will be used for non-standard methods).

During the optimization process of both the crucible melts and the 10 kilogram melter studies, however, the level of QA/QC will be lower, ASL A or B (ASL E will be used for non-standard methods), because this data will be used to measure ongoing conditions or to "tweak" the process, not to make any final decisions.

Precision will be assessed through the use of duplicate or triplicate sampling or analyses during the phase of the remedy selection study which requires a high quality level. Accuracy will be evaluated through the establishment of a routine program involving the assessment of analytical results for method blanks, matrix spike/matrix spike duplicates, and laboratory control samples as directed in the SCQ. Sensitivity will be monitored through the achievement of specified detection limits and quantitation limits as summarized in Section 7. Completeness will be assessed based on the percentage of usable data points from the total set of data points collected. Pursuant to the SCQ, completeness is expected to be at least 90%. If sufficient valid data points are not obtained to meet project objectives, additional sampling and analysis may be considered. Comparability will be maintained through the use of standard sampling, analytical, and verification and/or validation procedures.

D.4.1.8 Data Quality Objective Summary

To support the above approach, ASLs A though E will be required, with the optimization process of remedy selection phases expected to be mostly ASL A or B. The characterization analyses both before and after treatment is expected to be ASL C, with 10% ASL D for confirmation, to allow for use in the OU3 Feasibility Study risk assessments as well as to allow for validation of the treatment study. Any non-standard procedures used for evaluation of the process option would be performed at ASL E. The analytes of concern for the vitrification study include asbestos, radionuclides (especially uranium), organics, and metals. Laboratory QA/QC types and frequencies will follow those prescribed in the SCQ. All non-standard methods shall include types and frequencies of QA/QC samples.

D.4.2 Field and Laboratory Sampling

As discussed in Section D.2, three types of asbestos-containing material (transite, tiles, and pipe insulation) and glass will be collected from various locations at the FEMP and shipped to the vendor for the treatability study. Table D.2.2 lists the media type, the location where the media will be collected, and the anticipated contaminants present in the collected media.

It is anticipated that 100 kilograms of transite will be taken from Buildings 2A and 4A and will be placed in airtight containers or double/triple wrapped in plastic and placed in containers to ship to the off-site treatability laboratory. Ten kilograms each of pipe insulation and floor tiles will also be collected to support this study. The ACM pipe insulation and floor tiles may be taken from Building 2A or other process area building. The collection, packaging, and shipping of the ACM will be performed by asbestos-certified personnel.

Miscellaneous glass will be collected during the Plant 7 dismantlement. As the glass is removed from the building, it will be placed in containers for storage and disposition. The glass will consist mostly of window glass. A portion of this glass (approximately 20 kilograms) will be placed in containers for shipment to the vendor for use in this treatability study.

All samples for the testing outlined in this Sampling and Analysis Plan Addendum will be taken from the various drums of media that the FEMP sends to the treatability laboratory containing the material collected from activities described above. Sample sizes will be dependent on the required volume for vitrification testing and supporting laboratory analysis.

Specific procedures for sampling the test media and vitrified product will be developed by the vendor and submitted as SOPs to the FEMP. Samples required by Quality Control are also specified within these procedures and meet the requirements of the FEMP SCQ.

D.4.3 Initial Characterization

Prior to either the crucible melt or the 10 kilogram melter phase of this treatability study, the physical and chemical characterization of the four media to be studied will be performed. The initial characterization test parameters are given in Table D.4.1. This table includes information about the estimated number of samples, analytes, procedures and methods, objectives of the testing, and the ASLs. These characterization studies will provide the data necessary to design the vitrification composition variability study performed during the crucible melts, as well as some of the process design parameters for vitrification systems. The data will also be compared to final characterization data obtained on the final product (Section D.4.5) to evaluate the effectiveness of the vitrification process on ACM and glass.

The nature and concentration of contaminants of each media will be determined by performing a variety of analytical tests. As discussed in Section 6.3.1, it is anticipated that three samples per media will be analyzed for the initial characterization. In situations where one or two samples met the data needs of the study, the quantity of samples may be adjusted. For this treatability study, TAL inorganics and radionuclide analyses have been selected for the initial characterization of the ACM.

Other initial characterization testing required for performing the vitrification treatability study, which are considered to be non-standard, non-SCQ approved procedures include:

- Specific Gravity: determined by weighing a known volume of the sample and determining the weight/volume ratio following the ASTM D854-83 procedure. Tests will be carried out on wet (as received) samples and oven-dried (110 ± 5°C) for at least 12 hours. The expected uncertainty is estimated to be within a standard deviation of 0.021 g/cm^3, as described in ASTM D854-83.

- Anions: testing for anions should be conducted for fluoride, sulfate, and chloride using an IC or an ion selective electrode to determine the concentration and nature of anion content in the test media.

- Carbon Content: measured using a carbon analyzer attached with a 183 boat sampling module (BSM). This system is capable of measuring the total carbon (TC), total organic carbon (TOC), and the inorganic carbon (IC) content. The estimated analytical error of measuring the carbon content on solid material to be within ±10%.

- Thermogravimetric Analysis: weight loss data will be obtained by heating representative samples of the media: 110°C for 18 hours; 450°C for four hours; and 1150°C for four hours. Programmable furnaces for crucible melts will be used for the weight loss measurements assuring control of time and heating rates. The estimated analytical error is ±5% which is due to errors in weighing.

TABLE D.4.1 Initial Characterization of Test Media

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
1/media	ACM and Glass	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine concentration and nature of metals contamination.	C/D
1/media	ACM and Glass	Radionuclides	TBD[1]	SCQ Appendix G	To determine concentration and nature of radiological contamination.	C/D
1/media	ACM and Glass	Silica	TBD[1]	Non-SCQ, non-standard	To determine the concentration of silica to create melt matrix formulations.	E
1/media	ACM and Glass (dissolved media)	Anions (fluoride, sulfate, chloride)	IC, Ion Selective Electrode	Non-SCQ, non-standard	To determine concentration and nature of anion content.	E
1/media	ACM and Glass	Carbon Content	TOC	SCQ Appendix G	To determine total organic and inorganic carbon content.	B
1/media	ACM and Glass	Asbestos	PLM, SEM, or TEM	Non-SCQ, non-standard	To determine the presence and type of asbestos fibers.	E
1/media	ACM and Glass	Specific Gravity (wet/as is and dry)	Pycnometer	ASTM D854-83	To assist in feed system development.	E
1/media	ACM and Glass	Thermogravimetric Analysis	Furnace for crucible melts	Non-SCQ, non-standard	To determine weight loss vs. temperature.	E

[1] Analytical instrumentation is to be selected by the vendor; data generated from the selected analytical instrumentation must meet the Performance Specifications.

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- Asbestos: the composition and percentage of each asbestos form (chrysotile, amosite, crocidolite) will be determined using either PLM, scanning electron microscopy (SEM), or TEM.

- Silica: the content of silica in the test media will be determined using one of the following ASTM methods - ASTM C146-80, ASTM C25-93, ASTM C169-92, or equivalent methods.

Copies of the non-standard procedures are contained in *Treatability Study Work Plan For Operable Unit 1*, November 1992 (OU1 TSWP) and are listed in the following tables as non-SCQ, non-standard.

D.4.4 Optimization of Test Parameters

Although the vitrification treatability study will be conducted in two phases (crucible melts and 10 kilogram mini-melter), the testing for optimization of the test parameters remain the same. The specifics of the testing are given in Table D.4.2. The optimization parameters include the estimated number of samples, analytes, procedures and methods, objectives of the testing, and the analytical support levels.

Activities during this task will be directed toward the monitoring of test conditions and "tweaking" those conditions to optimize the vitrification test process. Standard operation conditions, including temperature and current requirements, are included in the OU1 TSWP. Data will be collected on processing rates, cold-cap formation, foaming, and off-gas characteristics. Processing rates will be determined by flow rate and glass output determinations in terms of both kilogram/hour of feed material fed to the melter and kilogram/hour of glass produced. Foaming events will also be recorded if they occur together with the current process parameters measurements (temperature, current and voltage readings, feed rates, and concentrations of significant species in the off-gas).

D.4.5 Final Characterization

After the crucible melt phase and the 10 kilogram melter phase of this treatability study, both the chemical characterization and leachability testing of the final product will be performed. The test parameters for the final characterization are given in Table D.4.3. Correlations and trends in the initial data collected will help focus the scope of final characterization. The scope of final characterization may be modified based on data collected from prior analyses to achieve a more efficient and effective sampling program. These parameters include the estimated number of samples, analytes, procedures and methods, objectives of the testing, and the ASLs. These characterization studies will provide the data necessary to 1) evaluate the effectiveness of using OU3 ACM and glass to form glass, 2) evaluate the effectiveness of the vitrification process on immobilizing OU3 contaminants contained in the test media, and 3) to determine the handling, storage, and disposition requirements for the final product.

As with the initial characterization, the nature and concentration of contaminants of each melt will be determined by performing a variety of analytical tests. As discussed in Section 6, it is anticipated that three samples will be analyzed per melt type for the final characterization and the list of analytes will be taken from Table 6.2. For this treatability

TABLE D.4.2 Optimization of Test Design

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
10/melt	Glass melt	Temperature	Thermocouples	SCQ Appendix G	To determine melt pool temperature in various locations.	B
10/melt	Glass melt	Current and Voltage	Ammeters, voltmeters	Non-SCQ, non-standard	To determine power input to glass melt.	E
5/melt	Glass	Glass output	Balance	Non-SCQ, non-standard	To determine glass production rates.	E
5/melt	Feed slurry	Flow rate	Metering pump	Non-SCQ, non-standard	To determine feed rate to melter.	E

TABLE D.4.3 Final Characterization

Anticipated Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
1/melt	Glass	TCLP Preparation - TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine leachability of metals in final product.	C/D
1/melt	Glass	TCLP Preparation - Radionuclides	TBD[1]	SCQ Appendix G	To determine leachability of radionuclides in final product.	C/D
1/melt	Glass	Asbestos	SEM, TEM, or PLM	Non-SCQ, non-standard	To determine final asbestos content of glass.	E
1/melt	Glass	PCT (standard) - TAL Inorganics (2 samples will be extracted at 90°C)	ICP, GFAAS	Non-SCQ, non-standard/SCQ App. G	To determine leachability of metals in final product.	E/C/D
1/melt	Glass	PCT (standard) - Radionuclides (2 samples will be extracted at 90°C)	TBD[1]	Non-SCQ, non-standard/SCQ App. G	To determine leachability of radionuclides in final product.	E/C/D
1/melt	Solution (dissolved glass)	Anions (fluoride, sulfate, chloride)	IC, Ion Selective Electrode	Non-SCQ, non-standard	To determine concentration & nature of anions in final product.	E
1/melt	Glass	Temperature	Thermocouples	SCQ Appendix G	To obtain measure of leachability.	B
1/melt	Glass	Crystal content	SEM-EDX	Non-SCQ, non-standard	To determine extent and type of devitrification.	E
1/melt	Glass melt	Viscosity	Rotating spindle	Non-SCQ, non-standard	To determine melt viscosity vs. temperature.	E
1/melt	Glass melt	Electrical conductivity	AC bridge	Non-SCQ, non-standard	To determine melt conductivity vs. temperature.	E
1/melt	Glass	Redox state	Mossbauer spectroscopy	Non-SCQ, non-standard	Effect of Redox state on glass properties.	E

[1] Analytical instrumentation is to be selected by the vendor; data generated from the selected analytical instrumentation must meet the Performance Specifications as described in the SCQ, Appendix G.

study, the glass will undergo both TCLP and PCT leaching with the leachate being analyzed for TAL Inorganics and radionuclides.

Other final characterization testing required for performing the vitrification treatability study, which are considered to be non-standard (non-SCQ approved) procedures include:

- Savannah River Product Consistency Test (PCT): this test is the standard for high-level waste glasses. This test evaluates the relative chemical durability of glasses by measuring the concentration of the chemical species released from crushed glass (75-150 microns) to the test solution (deionized water in this case) at 90°C. All tests are conducted in triplicate with a standard glass included in each test batch. The overall uncertainty in the test results is estimated to be ±15%. In addition, data from this test will permit direct comparison of the glass leaching behavior with that of high-level nuclear waste glasses.

- Viscosity Measurement: to be measured from the calculation from measurements of the torque and rotation speed of a spindle attached to a viscometer. Measurements are taken over a range of temperatures, typically from 1000°C to 1150°C. The overall uncertainty is estimated to be ±10%.

- Anions: testing for anions shall be conducted for fluoride, sulfate, and chloride using an IC or an ion selective electrode to determine the concentration and nature of anion content in the final product.

- Conductivity Measurement: to be determined by measuring the resistance of the glass melt as a function of frequency using a calibrated platinum electrode probe. The results are extrapolated to zero frequency to obtain the DC conductivity. The measurements are taken over a temperature range, typically from 1000°C to 1150°C. The overall uncertainty is estimated to be ±-5%.

- Crystal Content: to be determined using Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS). This procedure characterizes the microstructure of the glasses and permits analysis of the glassy and crystalline phases using energy dispersive x-ray spectrometry. This equipment permits determination of both the volume fractions and compositions of crystalline phases in both as-melted and heat treated glasses. The percentage of crystals is estimated by examining several samples with regions of approximately one square centimeter. The overall uncertainty is estimated to be ±20%.

- Redox state: to be determined using Mossbauer spectroscopy. This procedure measures the effect of reduction/oxidation state on the glass properties.

- Asbestos: the composition and percentage of each asbestos form (chrysotile, amosite, crocidolite) will be determined using either PLM, SEM, or TEM.

Copies of the non-standard procedures described above are listed in the following tables as non-SCQ, non-standard and are contained in OU1 TSWP.

D.4.6 Residuals Characterization

It is anticipated that most residuals generated as a result of the vitrification of ACM and glass will be characterized as a part of the analysis performed during the optimization testing or final characterization testing described above. Characterization of the off-gases generated from the vitrification process is described in Table D.4.4. Based on the proposed melt matrix formulas (i.e. test media and additives), a detailed description of the anticipated off-gas produced and the required monitoring/characterization will be provided. Unused leachate from analysis may also be mixed with feed materials during the 10 kilogram mini-melter vitrification runs to minimize the amount of waste to be returned to the FEMP. Further information on the management, storing, handling, and characterization of residuals can be found in Section 11 of this TSWP.

TABLE D.4.4 Residuals Characterization Parameters

Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
1/melt	Off-gas	Off-gas composition	Specific absorption tubes, sampling train-ICPMS; DCP	Non-SCQ, non-standard	To determine concentrations of selected components in off-gas.	E
3/melt	Off-gas	Off-gas flow rate	Flow meter, thermocouple	Non-SCQ, non-standard	To determine flow rate for calculation of emission rates.	E

D.5 CRU3 TREATABILITY STUDY HEALTH AND SAFETY PLAN ADDENDUM

Appendix E contains the OU3 Treatability Studies Health and Safety Plan. This document has been developed under the OU3 lead health and safety plan, the CERCLA/RCRA Unit #3 (CRU3) Health and Safety Plan. The OU3 Treatability Studies Health and Safety Plan contains health and safety information which may apply to any treatability study conducted.

Table D.5.1 contains information which identifies potential hazards and procedure-specific health and safety guidance for the vitrification treatability study. The vitrification treatability study will be performed off-site. On-site activities include test media collection, packaging, shipping, and residual management and storage/disposition. The on-site activities will be performed by asbestos-certified personnel using approved procedures and health and safety plans (e.g., the CRU3 RI/FS Media Sampling Health and Safety Plan). Treatability personnel will only observe the on-site activities. Therefore, the only health and safety requirements applicable to the treatability personnel are general site requirements (e.g., training, medical, personal protection, and decontamination procedures).

TABLE D.5.1 Treatability Study Health and Safety Requirements

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Controls	Decontamination & Disposal Procedures
1) General Information about tasks specified in this summary of Health and Safety Plan requirements.	Hazards identified for each task to be performed. NOTE: Not all hazards are specified on this summary.	Permits will specify type. Air and personnel monitoring may be performed.	Minimum PPE required for each identified task will be indicated as well as other equipment to be utilized in the event of upgrade.	Site access training required: Radiation Worker II, GET and Site Worker Training, Respirator training and fit test. 24 hour supervised field experience. Supervisors must have 8-hour Supervisor Training. Asbestos workers must meet OEPA requirements. Orientation on project-specific Health and Safety requirements and MSDS is required. Training to operate specialized equipment as needed.	Proof of medical examination signed by doctor must be maintained for all personnel. After initial bio-assay, bio-assay is required bi-monthly and with exit in-vivo.	Provide warning signs and barricades to protect existing construction and equipment, pedestrians and vehicular traffic from falling material. Two access points to each study area, one control point, and orange fencing to define construction work area. Materials, equipment and personnel monitoring required prior to leaving controlled area.	FERMCO supplies a respiratory cleaning facility. FERMCO supplies bags and drums for disposition of contaminated disposables and water.
2) Observation of ACM removal and glass collection (removal/ collection performed as stated in Section D.4.1)[1]	Heat/cold stress.	Personnel monitoring as required by Industrial Hygiene.	Reference Activity 1. Safety glasses with rigid side shields; steel toed safety boots; hard hat.	Reference Activity 1.	Reference Activity 1.	Reference Activity 1. FERMCO Work Permit and RWP required.	Personnel should wash hands and face prior to any hand to mouth contact. At exit of controlled area personnel will be required to conduct a full body frisk and/or PCM survey.

[1] Oversight personnel will abide by the provisions of the Health and Safety Plan governing the activities being performed.

The requirements of this document are based upon current conditions and/or planned on current operations in areas near the treatability study area. This document is to be used as an aid in conjunction with the OU3 Treatability Studies Health & Safety Plan and assist the contractor in understanding the requirements of the project. This document does not relieve the contractor of planning for or providing a safe work area. This document does not relieve the contractor from recognizing and complying with other appropriate State and Federal regulations.

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D.6 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS; OTHER CRITERIA TO BE CONSIDERED

The ARARs identified for this project include regulations resulting from the implementation of the Clean Air Act (CAA). The CAA's objective is to protect and enhance the quality of the nation's air resources in order to promote and maintain public health and welfare and the productive capacity of the population. ARARs for the Vitrification include standards from the National Ambient Air Quality Standards and for the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for all radionuclides except radon, radon, and asbestos.

The Resource Conservation and Recovery Act (RCRA) also resulted in implementation of regulations that have been identified as ARARs for the management of containers prior to the treatability study and potentially to any new waste streams generated during this treatability study. The goals of RCRA are to protect human health and the environment, to conserve energy, and to reduce or eliminate the generation of hazardous waste. Promulgated requirements under RCRA were identified as ARARs for this study for waste characterization, container management, and storage.

Requirements from the Toxic Substances and Control Act (TSCA) are also included as ARARs for this action. TSCA authorizes USEPA to establish regulations governing testing of chemicals and substances, premanufacture notification for new substances and mixtures, control of chemicals and substances that pose an imminent hazard, and reporting and record keeping requirements. ARARs from the TSCA regulations identified for this treatability study are for the storage of asbestos-containing materials.

Other standards from requirements such as DOE Orders and NEPA, identified as ARARs or criteria to be considered (TBCs), include standards for radiation exposure, endangered species protection, solid waste management, and radioactive waste management at Federal facilities.

Potential contaminant-specific and potential action-specific ARARs and TBCs are listed in the Tables D.6.1 and D.6.2, respectively.

TABLE D.6.1 Potential Contaminant-Specific Requirements

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
40 CFR 61, Subpart H	Radionuclides (except radon-222)	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem.	Potentially applicable	Radioactive materials within this operable unit could contribute to the dose to members of the public from the air pathway during this treatability study.
DOE Order 5400.5, Chapter II, Section 1a	Radiation	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 could contribute to the total dose to members of the public from this DOE facility.
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment	Various in air	Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following. (For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.)	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

Isotope	Derived Concentration Guide* (μCi/mL) D	W	Y
Actinium-227	4×10^{-16}	1×10^{-16}	1×10^{-14}
Actinium-228	4×10^{-11}	1×10^{-10}	1×10^{-10}
Americium-241	-	2×10^{-12}	-
Bismuth-210	9×10^{-10}	6×10^{-11}	-
Bismuth-212	6×10^{-10}	7×10^{-10}	-
Bismuth-214	2×10^{-9}	2×10^{-9}	-
Cesium-137	4×10^{-10}		
Cobalt-60	4×10^{-10}	8×10^{-11}	
Europium-152	-	5×10^{-11}	-

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TABLE D.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment Continued	Various in air			

Isotope	Derived Concentration Guide[a] (μCi/mL) D	W	Y
Lead-210	9×10^{-13}	-	-
Lead-212	8×10^{-11}	-	-
Lead-214	2×10^{-9}	-	-
Neptunium-237	-	2×10^{-14}	
Plutonium-238[c]	-	3×10^{-14}	4×10^{-14}
Plutonium-239[c]	-	2×10^{-14}	4×10^{-14}
Plutonium-240[c]	-	2×10^{-14}	4×10^{-14}
Plutonium-241[c]	-	1×10^{-14}	2×10^{-12}
Plutonium-242[c]	-	1×10^{-12}	2×10^{-12}
Polonium-210	1×10^{-12}	1×10^{-12}	
Protactinium-231	-	9×10^{-16}	1×10^{-14}
Protactinium-234	-	-	-
Radium-223	-	2×10^{-12}	-
Radium-224	-	4×10^{-12}	-
Radium-226	-	1×10^{-12}	-
Radium-228	-	3×10^{-12}	-
Radon-220[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}
Radon-222[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}
Technetium-99	1×10^{-8}	2×10^{-9}	-
Ruthenium-106	2×10^{-10}	1×10^{-10}	3×10^{-11}
Strontium-90[c]	5×10^{-11}	-	9×10^{-12}
Thorium-227	-	8×10^{-13}	7×10^{-13}
Thorium-228	-	5×10^{-14}	4×10^{-14}
Thorium-229	-	6×10^{-16}	7×10^{-16}
Thorium-230	-	4×10^{-14}	5×10^{-14}
Thorium-232	-	7×10^{-16}	1×10^{-14}
Thorium-natural	-	7×10^{-15}	1×10^{-14}
Thorium-234	-	5×10^{-10}	4×10^{-10}
Uranium-231[c]	2×10^{-8}	1×10^{-8}	1×10^{-8}
Uranium-233[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-234[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}
Uranium-235[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-236[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-238[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}
Uranium-natural[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}

TABLE D.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment Continued	Various in air	[a] D, W, and Y represent lung retention classes; removal half-times 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 yearly DCG is for plutonium radionuclides with an absorption factor (f_1) value of 1×10^{-6}. The value shown for weekly DCG is for plutonium radionuclides with a f_1 value of 1×10^{-3}. The value shown for daily and weekly DCG is for Uranium radionuclides with a f_1 value of 5×10^{-2} and for yearly DCG is for uranium radionuclides with a f_1 value of 2×10^{-3}. 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}. [d] Still being assessed.		
	Radon-222	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	Although not promulgated standards, these constitute requirements for protection of the public with which the proposed action will comply.
	Radon-220, -222	The immersion derived concentration guide for both radon-220 and radon-222 in air in an uncontrolled area is 3 pCi/L.	To be considered	Although not promulgated standards, these constitute requirements for protection of the public with which the proposed action will comply.
	External gamma radiation	The level of external gamma radiation in any occupied or habitable building must not exceed the background level by more than 20 μR/h.	To be considered	Pertinent to the proposed action if habitable buildings are involved in the proposed action.

TABLE D.6.2 Potential Action-Specific Requirements

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 261.7	Empty containers	Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if: • no more that 2.5 cm (one inch) of residue remains on bottom of inner liner; and • less than 3% by weight of total capacity remains (less than 110 gallon container); or • less than .3% by weight of total capacity remains (greater that 110 gallon container).	Potentially relevant and appropriate	Containers used to treat or store waste from this treatability study may contain hazardous substances which must be removed before the containers may be re-used or disposed of. No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.
40 CFR 264.171-.175, .177, and .178 and OAC 3745-55-71 through -78	Container storage	Containers of RCRA hazardous waste must follow these guidelines: • Containers must be maintained in good condition; • Type of containers must be compatible with hazardous waste to be stored; • Containers must be closed during storage (except to add or remove waste); • Inspect container storage areas weekly for deterioration; • Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers 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; and • At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Potentially relevant and appropriate	No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate for container management. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.
10 CFR 1021.2	Treatment	DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR 1500-1508.	Potentially applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.

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TABLE D.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
DOE Order 5820.2A, Chapter III	Management of low level and mixed wastes	DOE solid low-level wastes shall be managed in accordance with DOE Order 5820.2A, Chapter III and the additional requirements cited therein. Low-level radioactive wastes must be sufficiently characterized as to: • Physical and chemical characteristics; • Total volume (container); • Total weight (container); and • Major radionuclides and concentrations in order to permit proper segregation treatment, storage, and disposal. Prior to disposal, LLRW shall be treated as appropriate: • To meet performance objectives; and • To reduce volume, improve stability, and reduce potential for water infiltration.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radioactive materials within this operable unit may exhibit the characteristics of low level waste and require management as required by this chapter.
Solid Waste Disposal Act, as amended (42 USC 6901, et seq.); Solid Wastes (40 CFR 262.11), Ohio Hazardous Waste Management Regulations; OAC 3745-52-11.	Waste characterization and management	A waste must be evaluated to determine if it is a hazardous waste, i.e. either a waste listed in 40 CFR 261 or a characteristic waste. A characteristic waste is determined by its (1) ignitability (defined by flash point, oxidizer, and other); (2) corrosivity (defined by pH ≤ 2 or ≥ 12.5, rate of steel corrosion, and others); (3) reactivity (defined by instability, violent reaction with water, explosivity, cyanide- or sulfide-bearing nature and vapor generation potential, and other); or (4) leachability, as defined by 40 CFR 261.24 for the constituents identified by TCLP.	Potentially applicable	These requirements are applicable to the characterization and management of waste generated by this action as a requirement of the stipulated Amended Consent Decree with the State of Ohio.
Radiation Protection of the Public and the Environment (DOE Order 5400.5, Chapter IV)	Decontamination	Structural debris that is released from DOE facilities for reuse without radiological restrictions shall be decontaminated to specified levels.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

TABLE D.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
Radioactive Waste Management (DOE Order 5820.2A, Chapter III)	Waste management	External exposure to radioactive waste (including releases) should not result in an effective dose equivalent of >25 mrem/yr to any member of the public; releases to the atmosphere are to meet the requirements of 40 CFR 61 and an environmental monitoring program must be implemented to address compliance with performance standards.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

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D.7 PERMIT INFORMATION SUMMARY

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As stated in Section 10.2 of the TSWP, according to CERCLA statutes, no permits are required for treatability studies conducted entirely on site. CERCLA and a similar requirement in the Amended Consent Agreement make it clear that the substantive requirements of the appropriate permits, that would otherwise be required, must be submitted.

Table D.7.1 identifies the permits that would be required to obtain, the standards, requirements, criteria or limitations that would have had to be met to obtain each such permit, and provides an explanation of how the response action will meet the standards, requirements, criteria or limitations. The substantive or technical requirements have been integrated into the study-specific test design.

For treatability studies conducted off-site, CERCLA exemptions for permitting does not apply to the vendor. The vendor or treatability laboratory must obtain all applicable local, state, and federal permits. Any potential vendor which may be contracted to perform treatability studies will supply copies of all relevant permits.

TABLE D.7.1 Permit Information Summary

Identification of permits for which the administrative requirements have been waived by CERCLA Section 121(e)(1)	Identification of standards, requirements, criteria, or limitations normally required by the waived permits	Actions used to meet the requirements of the waived permits
40 CFR 61 (NESHAP), Subpart M: National emission standard for hazardous air pollutants: asbestos.	40 CFR 61.150 requires proper labeling and handling of asbestos material.	Proper shipping documentation and labeling will be used.

D.8 RESIDUALS MANAGEMENT

As discussed in Section 11.2 of the TSWP, the vendor will be responsible for collecting, segregating, packaging, and shipping the resulting test residuals back to FEMP in accordance with the FEMP Waste Acceptance Criteria. The estimated types and quantities of vitrification treatability test residuals are presented in Table D.8.1. Residuals generated from the vitrification study will be managed in accordance with Section 11.0 of the TSWP. The vitrification treatability study may generate residuals in the following forms:

- glass formations from vitrification of ACM and glass;
- unformed glass (including cold-cap formations);
- unused test media;
- sample materials (e.g., leachates) from the treatability analytical laboratory; and
- used equipment (e.g., used crucibles and mini-melter), containers, protective clothing, paper products, and other expendables.

The formed, unformed glass, and unused test media from the treatability study are anticipated to be low-level waste which may be dispositioned under Removal Action 9 or stored at the FEMP pending future disposition.

PCT/TCLP leachates from the proposed treatability study is anticipated to be disposed of by placing the leachates back into the mini-melter process, if possible, or packaging/shipping the leachates back to the FEMP.

Compactable contact wastes generated (e.g., used containers, protective clothing, paper products, other expendables, debris) will be accumulated, packaged in drums, and dispositioned by an approved site program or stored on-site until ultimate disposition is determined by the OU3 final ROD. Any residuals determined to contain hazardous and low-level radioactive waste (mixed waste) will be placed in drums and stored at the FEMP pending disposition. The material will be managed according to CERCLA requirements and the Site Treatment Plan (STP) will be consistent with those requirements.

TABLE D.8.1 Estimated Treatability Study Residuals

Residual Description	Estimated Quantity
Glass Formation	50 kilograms
Unformed Glass	Less than 1 kilogram
Unused Test Media	50 kilograms
Analytical Materials	50 kilograms
Compactable Contact Wastes	10-55 gallon drums

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APPENDIX E

VITRIFICATION OF MIXED WASTE

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APPENDIX E
VITRIFICATION OF MIXED WASTE

As stated in Section 1.4.1 of this TSWP, Operable Unit 3 is responsible for the remediation of all containerized backlog mixed waste/debris at the FEMP. As required for the extension of the national capacity variance for mixed waste to May of 1994 [58FR 28506 and 40 CFR 268.35(e)], the FEMP is making a good faith effort to locate treatment capacity for disposition of this backlog waste (DOE 1993g). Any backlog waste which cannot be dispositioned by the above effort will be dispositioned under the OU3 final ROD along with any additional mixed waste and debris generated through remediation of OU3.

The Department of Energy is required by Section 3021(b) of the Resource Conservation and Recovery Act, as amended by the Federal Facilities Compliance Act (FFCA) to prepare a Site Treatment Plan describing the development of treatment capacities and technologies for remediating mixed waste. All FEMP mixed waste is subject to the requirements of the FFCA and the regulations of CERCLA. Development of the OU3 TSWP is being coordinated with the site efforts to meet the FFCA milestones.

The backlog mixed waste is comprised of a wide variety of mixed waste streams and is anticipated to represent the types of mixed wastes streams which may be identified during site remediation. Consequently, treatment technologies developed for the remediation of backlog waste streams should also be applicable to remediation-generated mixed wastes.

Backlog mixed waste represents less than ten percent by weight, approximately seven million pounds, of the total backlog of radiologically contaminated waste at the FEMP. The mixed waste inventory consists of 297 mixed waste streams which were declared hazardous because they contain listed contaminants or because they exhibit hazardous characteristics.

A significant portion of the backlog mixed waste is already being addressed by other approved FEMP projects. A combined Removal Number 20/Closure Plan has been approved by USEPA and OEPA to stabilize uranyl nitrate hexahydrate (UNH) inventories at the FEMP. When completed, Removal Action 20 and RCRA closures of the Nitric Acid Tank Car, Hazardous Waste Management Unit (HWMU) #9, and the HF Tank Car, HWMU #38, will have treated approximately 2.5 million pounds of the total backlog of mixed waste. This equates to about 35% by weight of the total backlog of mixed waste.

Approximately 700 drum equivalents (DEs) of ignitable organic liquid mixed wastes have been shipped to Oak Ridge for thermal destruction in the TSCA Incinerator and the balance of ignitable organic liquids have been scheduled for shipment. In addition, 700 DEs of mixed debris are scheduled for shipment to a commercial landfill before May, 1994, as allowed under the extension of the national capacity variance for mixed waste. These two actions account for approximately nine percent of the total inventory of backlog mixed waste. Miscellaneous waste totals less than one percent of the backlog mixed waste and includes materials such as magnesium metal, organic solids, and wastes containing mercury. These small quantity wastes will require separate treatment methods.

The balance of the total backlog of mixed waste (approximately 55% by weight) requires treatment for RCRA metals only (27%), or RCRA metals and trace organics (28%). The proposed treatability test for OU3 mixed wastes will focus on the treatment, removal and/or stabilization of the mixed waste streams contaminated only with RCRA metals (i.e.,

characteristic wastes). Mixed waste streams which are contaminated with RCRA Listed Hazardous Wastes as defined in 40 CFR 261 are not proposed as test media for this phase of treatability testing. The mixed waste streams proposed for this treatability test are described in Table E.2.1. If this test demonstrates that vitrification is an effective treatment technology for waste streams contaminated with RCRA metals and radiological components, an additional vitrification treatability test may be proposed to treat mixed waste streams which contain RCRA metals and trace organic contaminants (the mixed waste streams (28%) described above).

It is anticipated that the vitrification treatability study will be performed in several phases. The scope of this proposed treatability study consists of Phase I. Phase I shall be conducted by an off-site treatability laboratory[1] and has been divided into two stages at the bench-scale level. The first stage of Phase I includes vitrifying the mixed waste streams described above in crucible melts to optimize the formation of glass. The second stage of Phase I will utilize the crucible melt results to perform 10 kg mini-melts[2]. The 10 kg melts will be performed to collect performance and cost data. Future proposed treatability testing (Phase II) may include additional bench-scale testing on mixed waste streams that are contaminated with RCRA metals and organic contaminants and/or pilot-scale testing.

Vitrification is a technology which is currently being tested or utilized at several DOE sites. Previous vitrification testing at Savannah River, Idaho National Engineering Laboratory, West Valley, and Hanford has been concerned primarily with stabilization of high-level radioactive waste. Currently, Hanford is planning the vitrification of low-level wastes from underground storage tanks and Savannah River has begun treatability testing for the vitrification of low-level mixed waste streams. A liaison has been established between other DOE sites utilizing vitrification and the FEMP vitrification testing efforts to ensure complete coordination and integration between DOE vitrification projects. OU3 Treatability Programs will also integrate with other vitrification projects (e.g., OU4 and the MAWS project) currently being performed at the FEMP. OU3 efforts will be integrated with efforts of other operable units to achieve common goals.

Vitrification has been selected from Table 2.1 as a treatability study for mixed waste contaminated with RCRA metals for the following reasons.

- Vitrification may demonstrated as a viable treatment technology for OU3 media (mixed waste streams) which currently have limited treatment options.
- Vitrification has not yet been accepted as a Best Demonstrated Available Technology (BDAT); consequently tests must be designed to obtain data of sufficient quality and quantity to demonstrate equivalent technology.
- All eight RCRA metals were collectively present in the mixed waste streams contaminated with metals, although no more than six of the metals were present in any single waste stream. The desired treatment

1 "Off-site treatability laboratory" is also referred to as "treatability laboratory" and/or "vendor".
2 The term "10 Kg mini-melter" is also referred to as "joule-heated continuous melter" and "mini-melter".

technology would potentially be able to simultaneously separate and/or stabilize all of the RCRA metals. Although other extraction technologies have the potential for separating these elements individually or in a series of processes, no single extraction/separation process has been demonstrated for complete treatment of all RCRA contaminants. Vitrification will potentially be able to simultaneously separate and/or stabilize all of the RCRA metals.

The potential advantages for performing vitrification of FEMP mixed waste contaminated with RCRA metals are:

- significant reduction in volume of contaminated media remaining for final disposition;
- stabilization and containment of hazardous constituents (metals) and radionuclides;
- potential EPA acceptance of vitrification as a BDAT equivalent; and
- potential eventual disposition of treated wastes at a non-subtitle "C" landfill.

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E.1 TEST OBJECTIVES

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Although the vitrification process is similar to that being tested for asbestos-containing material (Appendix D), DOE proposes to perform studies with mixed waste which is estimated to be less than five percent of the OU3 remediation waste. The objectives of Phase I of the OU3 mixed waste vitrification studies are:

- to determine the compositions of mixed waste feed blends which can be melted to form glass;
- to determine if the glass formed effectively stabilizes/immobilizes the hazardous and radiological constituents;
- to quantify any reduction in volume of contaminated media;
- to determine if vitrification of mixed waste can be performed in a conventional joule-heated melter;
- to determine what glass forms may be synthesized (e.g. monoliths, gems, etc.); and
- to develop preliminary cost data and test parameters for subsequent pilot-scale testing.

The OU3 mixed waste vitrification treatability study will consist of two stages at the bench-scale level:

- *Remedy Screening Bench-Scale Testing*
  Crucible melts will be conducted on varied blends of mixed waste/debris to optimize blends for formation of glass. The wastes and blend ratios will be based on analytical data and process knowledge of the wastes, and prior experience of the vitrification laboratory. The tentative number of crucible melts is given in Table E.2.3. The actual number will be determined by the number of tests required to optimize waste blends for stabilization of all wastes listed in Table E.2.2. After feed blends are optimized, the selected feed blends will be prepared and analyzed to establish hazardous constituent concentrations. Using these feed blends, additional crucible melts will be made to form acceptable glass. The resulting glass will be analyzed to establish material balances and leachability.

- *Remedy Selection Bench-Scale Testing*
  Based on results of the crucible melts described above, additional laboratory tests will be made using a scaled-up melter facility which accommodates batches of approximately ten kilograms and which has capability for the continuous production of glass at a rate of approximately 0.5 kilogram/hour. It is expected that several preliminary melts will be needed to "fine tune" operating parameters for the up-scaled melter. The off-gas stream will be analyzed and operating parameters will be optimized for compliance with clean air regulations. If initial characterization of the feed blends indicates that certain elements/compounds of concern are not present at or above concentration levels listed in Table E.2.4, the feed blends may be spiked

with known concentrations so that material balances can be established for all constituents of concern. As needed, separate tests will be performed for each waste blend.

Upon completion of Phase I of the bench-scale studies, a cost/benefit analysis will be completed. Based on the study results and cost analysis, a recommendation to proceed with further testing will be given in the bench-scale treatability report. The OU3 vitrification of mixed waste streams will attempt to integrate with several other FEMP vitrification projects whenever possible. Future testing may utilize OU3 mixed waste as feed material and/or mixed waste may be utilized in pilot-scale tests to form glass using the OU4 and/or MAWS facility at the FEMP. OU3 efforts will be integrated with efforts of other operable units to achieve common goals.

E.2 EXPERIMENTAL DESIGN AND PROCEDURES

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The objective of the study is to collect performance data and develop process information for the vitrification of mixed waste. The study is intended to determine the optimum blending and melting conditions to vitrify FEMP mixed waste to produce a glass. The test must produce data to demonstrate that the glass produced is resistant to leaching of hazardous constituents. This study deals only with bench-scale testing and will focus on establishing optimum blends of mixed waste, optimum operating parameters for vitrification of FEMP wastes, and on obtaining data demonstrating the effectiveness of vitrification of hazardous constituents. If the data from bench-scale testing supports continued evaluation, a pilot-scale testing plan may be initiated for scaled-up testing of the vitrification of mixed wastes. If needed, the pilot-scale test design will be submitted prior to implementation.

E.2.1 Selection and Collection of Test Media

As described in the introduction to this appendix, part of the FEMP backlog mixed wastes have 1) already been shipped to the TSCA Incinerator, 2) been scheduled for burial at a commercial landfill in compliance 40 CFR 268.35(e) and the extension of the national capacity variance, or 3) are scheduled for treatment under Removal Action No. 20. This treatability study will address treatment of approximately half of the remaining mixed wastes (27% of the total backlog mixed waste) as shown in Table E.2.1. Separate treatment methods will be needed for remaining 28% of the wastes which include wastes contaminated with organics and RCRA metals, and the following, which together comprise less than one percent of the backlog mixed waste total: magnesium metal, U_3O_8 contaminated with organics, organic solids, and wastes contaminated with mercury. Waste identifications and Material Evaluation Form (MEF) numbers in Table E.2.1 are as presented in the Facility Annual Hazardous Waste Report to the Ohio EPA.

As presented in Table E.2.1, the wastes are grouped according to "Blend Groups" which were established using criteria such as uranium or thorium content, chemical or physical characteristics, process knowledge, and expected ease/difficulty of vitrification. Wastes in Blend Groups 11-13 are expected to be easily vitrified and can be used as glass forming additives to facilitate vitrification of waste Blend Groups 1-5. Blend Group 5 is comprised of chloride salts which might cause equipment corrosion if used in high concentrations. As long as there is no significant corrosion impact, Blend Group 5 will be added to each melt in a quantity equal to one percent of the total weight of the melt. For an individual waste identified in the table, the number of containers of that waste may range from one drum to hundreds of drums. The wastes shown in bold print represent quantities in excess of one percent (by weight) of the total waste in the corresponding blend group. Certain constraints were necessary to control costs as follows.

Because of the large number of waste streams, only the wastes which exceed one percent of the total weight of the blend group (shown in bold in Table E.2.1) will be sampled to represent each blend group. Furthermore, only one drum will be sampled to represent all of the waste in all of the drums of that waste material. The wastes and quantities to be sampled and shipped to an off-site vendor to represent each blend group are listed in Table E.2.2. The entire quantity of each waste received at the treatability laboratory will be homogenized before sampling. Each waste blend will also be homogenized before test melts.

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TABLE E.2.1 Proposed Mixed Waste Blends for Vitrification

MEF#	Waste Identification	Blend Group	Waste Weight (lbs)	% of Blend Group Total[1]	%U	%Th	EPA Waste Code
	Blend Group 1 - High Uranium						
20046	Non-metallic miscellaneous samples	1	78	0.0%	20.2		D007
20047	Scrap salts and floor sweepings, low fluoride	1	507	0.2%	23.6		D004, D008
20139	Samples, non-metallic	1	185	0.1%	50		D005
30036	Dust collector residues, high fluoride	1	1,213	0.5%	36.3		D006, D008
50063	**Roasted MgF_2, other material**	**1**	**5,174**	**2.0%**	**28.8**		**D004, D008**
50091	Dust collector residues, pyrophoric	1	138	0.0%	40.5		D004, D008
50148	**Scrap U_3O_8, high fluoride**	**1**	**242,466**	**92.3%**	**77.7**		**D004**
50185	Scrap salt, high fluoride	1	12	0.0%	55.7		D009
50188	**Scrap salts, high fluoride**	**1**	**4,153**	**1.6%**	**71.9**		**D004, D007, D008, D010**
50293	**U_3O_8 for reoxidation**	**1**	**7,841**	**3.0%**	**81.7**		**D004**
50349	Dust collector residues, high fluoride	1	192	0.1%	20		D008
50351	**Dust collector residues, high fluoride**	**1**	**588**	**0.2%**	**62.5**		**D004, D008**
	Blend Group 1 Total Weight (lbs)		262,547				
	Blend Group 2 - Thorium						
40122	**Thorium trailer cake waste slurry**	**2**	**402**	**3.4%**		**0.01**	**D002, D005, D009**
40152	**Scrap ThO_2, high fluoride**	**2**	**128**	**1.1%**		**19.8**	**D005**
40181	**Thorium nitrate solution**	**2**	**5,022**	**42.6%**		**41**	**D002, D007, D008**
40185	**Impure thorium nitrate solid**	**2**	**1,845**	**15.6%**			**D001, D007, D008**
40186	**Impure thorium nitrate**	**2**	**4,405**	**37.3%**			**D001, D007, D008**
	Blend Group 2 Total Weight (lbs)		11,802				

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TABLE E.2.1 Proposed Mixed Waste Blends for Vitrification (Cont'd)

MEF#	Waste Identification	Blend Group	Waste Weight (lbs)	% of Blend Group Total[1]	%U	%Th	EPA Waste Code
	Blend Group 3 - Low Uranium						
383	X-ray fixer and developer	3	271	0.4%	0.01		D011
594	Sodium hyposulfide developing solution	3	527	0.8%	0.01		D011
873	**Spent fixer**	**3**	**1,347**	**2.1%**	**0.01**		**D011**
1185	Type 028 fixer, CD-5 (developer)	3	524	0.8%			D011
1297	PC 49896 itek universal developer	3	20	0.0%			D011
1751	Spent fixer	3	126	0.2%			D011
20024	**Scrap salts and floor sweep, low fluoride**	**3**	**2,233**	**3.4%**	**12.5**		**D007, D008**
20027	Dust collector residues, high fluoride	3	540	0.8%	38		D004, D011
20033	**Discard process residues**	**3**	**845**	**1.3%**	**1**		**D008**
20035	**Dust collector residues, high fluoride**	**3**	**1,231**	**1.9%**	**9.31**		**D007**
20058	Dust collector residues, high fluoride	3	6	0.0%	2.08		D004, D008
30009	**Scrap salts and floor sweepings, high fluoride**	**3**	**16,878**	**25.8%**	**14.3**		**D008**
30081	**Discard process residues**	**3**	**851**	**1.3%**	**0.4**		**D002**
40137	Unfired reduction charges and CaF_2	3	2	0.0%		49.7	D001
50068	**Non-oily sludge for roasting**	**3**	**30,881**	**47.2%**	**0.1**		**D001**
50169	Non-oily sludge for roasting	3	445	0.7%	13		D007
50314	Scrap salts and floor sweepings, high fluoride	3	251	0.4%	3.39		D010
50347	Discard process residue	3	395	0.6%	0.01		D001
50355	**Discard process residue**	**3**	**8,095**	**12.4%**	**0.1**		**D001**
	Blend Group 3 Total Weight (lbs)		65,468				

TABLE E.2.1 Proposed Mixed Waste Blends for Vitrification (Cont'd) - 5299

MEF#	Waste Identification	Blend Group	Waste Weight (lbs)	% of Blend Group Total[1]	%U	%Th	EPA Waste Code
	Blend Group 4 - Miscellaneous Debris						
659	Lead and wood shavings	4	19	0.0%			D008
817	**Paint chips from sand filter, Water Plant**	**4**	**389**	**1.0%**	**0.01**		**D008**
1271	**Lead solder joints**	**4**	**14,688**	**37.8%**	**0.01**		**D008**
1731	Lead	4	168	0.4%	0.01		D008
1987	Lead/lead seals	4	17	0.0%	0.01		D008
20107	**Contaminated non-burnables**	**4**	**601**	**1.5%**	**0.01**		**D008**
30065	**Contaminated non-burnables**	**4**	**15,081**	**38.8%**			**D008**
50031	**Contaminated metallic filter elements**	**4**	**2,848**	**7.3%**	**2**		**D008, D010**
50358	**Contaminated non-burnables**	**4**	**3,183**	**8.2%**	**0.01**		**D001**
50361	**Non-recoverable trash**	**4**	**603**	**1.6%**	**0.01**		**D009**
50367	**Non-recoverable trash**	**4**	**428**	**1.1%**			**D008**
50405	**Non-recoverable trash**	**4**	**661**	**1.7%**	**0.01**		**D006, D007**
50407	Non-recoverable trash	4	218	0.6%	0.01		D001
	Blend Group 4 Total Weight (lbs)		38,904				
	Blend Group 5 - Chloride Salts						
50173	**Salt sludge, chloride**	**5**	**10,570**	**28.5%**			**D007**
50174	**Salt sludge, chloride**	**5**	**19,342**	**52.1%**			**D007**
50387	**Salt sludge, chloride**	**5**	**713**	**1.9%**	**0.01**		**D005**
50406	**Furnace salt, chloride**	**5**	**6,486**	**17.5%**	**0.1**		**D004, D011**
	Blend Group 5 Total Weight (lbs)		37,111				
	Blend Groups 1 - 5 Total Weight (lbs)		421,537				

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TABLE E.2.1 Proposed Mixed Waste Blends for Vitrification (Cont'd)

MEF#	Waste Identification	Blend Group	Waste Weight (lbs)	% of Blend Group Total[1]	%U	%Th	EPA Waste Code
	Blend Group 11 - Filter Cake						
10013	**Sump cake**	**11**	**14,423**	**11.1%**	**0.01**		**D005, D007**
20145	Wet sump or filter cake, oil contaminated	11	596	0.5%	1		D002, D007
30060	Wet sump or filter cake, non-oily, non-fluoride	11	542	0.4%	7.26		D005
50008	**Sump cake, copper contaminated**	**11**	**81,151**	**62.6%**	**0.5**		**D001**
50102	Process residues, trailer cakes, slurries	11	118	0.0%	9.34		D008
50165	**Roasted off-site sump cake**	**11**	**32,917**	**25.4%**	**55.6**		**D007**
	Blend Group 11 Total Weight (lbs)		129,747				
	Blend Group 12 - Soil, Rock, Grit						
538	Boring #1508	12	652	0.1%	0.01		D006, D007, D008
539	Boring #1509	12	1,522	0.1%	0.01		D004, D006, D007, D008
540	Boring #1512	12	728	0.1%	0.01		D004, D005, D006, D007, D008, D011
541	**Boring #1513**	**12**	**410,382**	**39.0%**	**0.01**		**D005, D006, D007, D008**
542	Boring #1514	12	670	0.1%	0.01		D004, D005, D006, D007, D008
543	Boring #1515, from fire training grounds	12	570	0.1%	0.01		D004, D005, D006, D007, D008
545	Boring #1511	12	670	0.1%	0.01		D004, D005, D006, D007
10022	**Grit blast**	**12**	**626,893**	**59.6%**	**0.1**		**D008**
20151	Contaminated bricks, soil, rocks, sand, etc.	12	1,026	0.1%	2		D004, D008, D011
30027	Contaminated soil, rocks, bricks, ceramics	12	6,314	0.6%	4.78		D004, D005, D007, D008, D010, D011
30039	Contaminated rocks, soil, no free liquids	12	989	0.1%	1.67		D011
30080	Uranium contaminated soil, rocks, etc.	12	503	0.0%	1		D002, D004, D007, D008, D011
	Blend Group 12 Total Weight (lbs)		1,050,919				

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TABLE E.2.1 Proposed Mixed Waste Blends for Vitrification (Cont'd)

MEF#	Waste Identification	Blend Group	Waste Weight (lbs)	% of Blend Group Total[1]	%U	%Th	EPA Waste Code
	Blend Group 13 - Carbonate Salts						
2021	**Barium carbonate**	**13**	**4,081**	**1.4%**	**0.01**		**D005**
10002	**Scrap salts**	**13**	**16,903**	**5.7%**	**0.01**		**D005, D008**
50177	Furnace salt, non-chloride	13	1,838	0.6%	59.1		D001, D004, D008
50178	Furnace salt, non-chloride	13	169	0.1%	33.8		D001
50180	**Furnace salt, non-chloride**	**13**	**24,102**	**8.1%**	**13.1**		**D007, D008, D010**
50323	**Solidified furnace salts, non-chloride**	**13**	**246,357**	**82.7%**	**33.8**		**D004**
50408	**Furnace salt, non-chloride**	**13**	**4,486**	**1.5%**			**D008, D010**
	Blend Group 13 Total Weight (lbs)		297,936				
	Blend Groups 11-13 Total Weight (lbs)		1,478,602				

[1] Bold entries identify those waste streams which exceed 1% of the *% of Blend Group Total* category. These waste streams will be utilized as test media and are also identified in Table E.2.2

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TABLE E.2.2 Wastes and Quantities To Be Sampled

MEF#	Waste identification	Blend Group	Sample Weight (lbs)
50148	Scrap U3O8 high fluoride	1	15
50293	U3O8 for reoxidation	1	15
50063	Roasted MgF_2, other material	1	15
50188	Scrap salts, high fluoride	1	15
50351	Dust collector residues, high fluoride	1	15
40122	Thorium trailer cake waste slurry	2	15
40152	Scrap THO2 -high F	2	15
40181	Thorium nitrate solution	2	15
40185	Impure thorium nitrate solid	2	15
40186	Impure thorium nitrate	2	15
30009	Scrap salts and floor sweep high fluoride	3	15
50068	Non-oily sludge for roasting	3	15
50355	Discard process residue	3	15
873	Spent fixer	3	15
20024	Scrap salts and floor sweep, low fluoride	3	15
20033	Discard process residues	3	15
20035	Dust collector residues, high fluoride	3	15
30081	Discard process residues	3	15
817	Paint chips from sand filter, Water Plant	4	20
1271	Lead solder joints	4	20
20107	Contaminated non-burnables	4	20
30065	Contaminated non-burnables	4	20
50031	Cont. metallic filter elements	4	20
50358	Contaminated non-burnable	4	20
50367	Non-recoverable trash	4	20

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TABLE E.2.2 Wastes and Quantities To Be Sampled (Cont'd)

MEF#	Waste Identification	Blend Group	Sample Weight (lbs)
50361	Non-recoverable trash	4	20
50405	Non-recoverable trash	4	20
50173	Salt sludge, chloride	5	10
50174	Salt sludge, chloride	5	10
50387	Salt sludge, chloride	5	10
50406	Furnace salt, chloride	5	10
10013	Sump cake	11	40
50008	Sump cake - copper contaminated	11	40
50165	Roasted off-site sump cake	11	40
541	Boring # 1513	12	40
10022	Grit blast	12	40
2021	Barium carbonate	13	40
10002	Scrap salts	13	40
50180	Furnace salt, non-chloride	13	40
50323	Solidified furnace salts non-chloride	13	40
50408	Furnace salt, non-chloride	13	40

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E.2.2 Operation Parameters and Optimizing the Test Design

Activities in this task will be directed toward the development of optimum feed make-up for vitrification of OU3 wastes to a stable glass form which is sufficiently leach-resistant to allow compliant land disposition under CERCLA. Makeup of feed blends will be based on process knowledge of the waste, silicon content of the diluent waste blend groups (#11-#13) and on results of initial and succeeding tests. Waste minimization will be a prime consideration in make-up of the blends. The use of chemical additives which cannot be achieved by substitution of other FEMP hazardous wastes is to be avoided.

For each waste feed blend, operating parameters will be optimized to achieve:

- Formation of a glass which will pass the TCLP test for hazardous constituents and radionuclides; and
- Compliance with clean air standards.

A flow-diagram illustrating the sequential steps in glass preparation and glass characterization is given in Figure E.2.1. Initial and final characterization of the test media will be performed along with analytical testing designed to evaluate the performance during operations. Analytical testing for the vitrification of mixed waste is discussed in further detail in Section E.4, Sampling and Analysis Plan Addendum.

E.2.2.1 Crucible Melts

Crucible melts will be conducted on varied blends of mixed waste/debris to optimize blends for formation of glass. The wastes and blend ratios will be based on analytical data and process knowledge of the wastes, and prior experience of the vitrification laboratory. The tentative number of crucible melts is given in Table E.2.3. The actual number will be determined by the number of tests required to optimize waste blends for stabilization of all wastes listed in Table E.2.2. After feed blends are optimized, the selected feed blends will be prepared and analyzed to establish hazardous constituent concentrations. Using these feed blends, additional crucible melts will be made to form acceptable glass. The resulting glass will be analyzed for total metals and TCLP to establish material balances and leachability.

E.2.2.2 Mini-Melter

Based on results of the crucible melts described above, additional laboratory tests will be made using a scaled-up melter facility which accommodates batches of approximately ten kilograms and which has capability for the continuous production of glass at a rate of approximately 0.5 kilogram/hour. It is expected that several preliminary melts will be needed to "fine tune" operating parameters for the up-scaled melter. The off-gas stream will be analyzed and operating parameters will be optimized for compliance with clean air regulations. If initial characterization of the feed blends indicates that certain elements/compounds of concern are not present at or above concentration levels listed in Table E.2.4, the feed blends may be spiked with known concentrations so that material balances can be established for all constituents of concern. As needed, separate tests will be performed for each waste blend. Samples of feed and product will be analyzed at

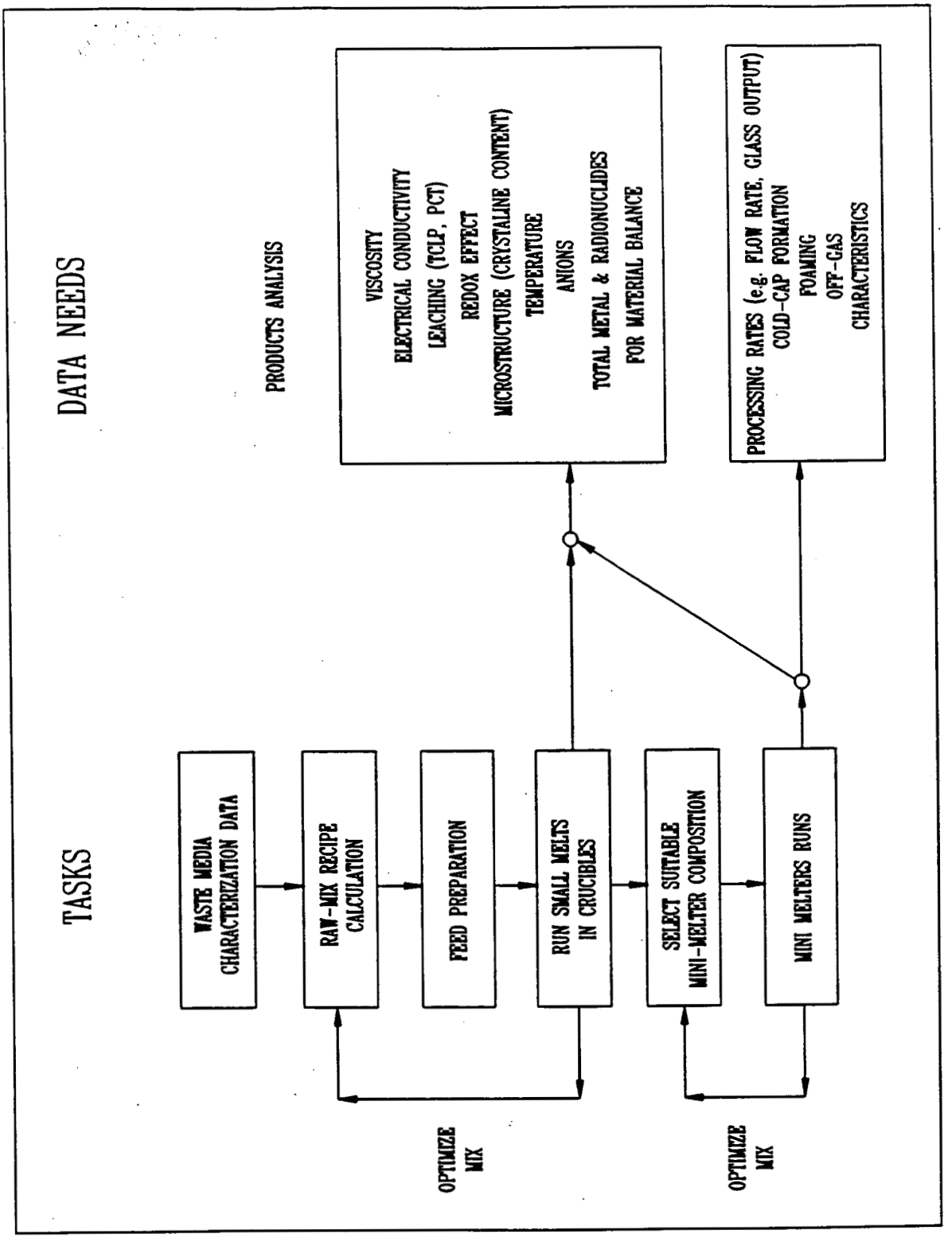

FIGURE E.2.1 Sequential Steps for Glass Preparation

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TABLE E.2.3 Number of Crucible and 10 Kg Melts

Melt Group	No of Melts	Waste Blend Group No.[1]	Diluent Waste Blend Group No.[2]	Purpose
Crucible Melts:				
A	5	1-High Uranium	11, 12, 13	To optimize uranium loading
B	2	2-Thorium	11, 12, 13	To optimize thorium loading based on uranium loading
C	2	1 & 2 Uranium & Thorium	11, 12, 13	To optimize loading of a uranium-thorium blend
D	5	3-Low Uranium & 4-Miscellaneous Debris	11, 12, 13	To optimize treatment of all backlog waste
X[3]	4	TBD	TBD	
Total:	18			
10 Kg Mini-melt:				
E	1	As for Optimized A	11, 12, 13	Mini-melter test of optimized crucible conditions
F	1	As for Optimized B	11, 12, 13	Mini-melter test of optimized crucible conditions
G	2	As for Optimized C	11, 12, 13	Mini-melter test of optimized crucible conditions
H	2	As for Optimized D	11, 12, 13	Mini-melter test of optimized crucible conditions
Total:	6			

1 As long as there is no negative impact, Waste Blend 5 is to be added to each melt in a quantity equal to 1% of the total weight.

2 Equal amounts from each blend group except that barium carbonate (from blend group 13) is not to exceed 1% of total blend weight.

3 Four contingency crucible melts may be made based on results from tests A through D.

TABLE E.2.4 Contaminants of Concern and Potential Spiking Levels

Waste Code	Element/Compound	Potential Spiking Levels (μg/Kg)
N/A	Uranium	N/A
N/A	Thorium	N/A
D004	Arsenic	100
D005	Barium	2000
D006	Cadmium	50
D007	Chromium	100
D008	Lead	30
D009	Mercury	10
D010	Selenium	50
D011	Silver	100

ASL C. Product samples will be analyzed both for total metals (for material balance) and TCLP. Product samples will also be submitted for the Savannah River Product Consistency Test (PCT).

The mini-melter runs will be used to collect data on processing parameters that cannot be obtained from crucible melts alone. These runs will provide data on processing rates, cold-cap formation, foaming, and off-gas characteristics. Processing rates will be determined in terms of both kilogram/hour of feed material fed to the melter and kilogram/hour of glass produced. Cold-cap formation is the accumulation of unmelted feed on top of the glass pool which occurs at high feed rates and ultimately limits the maximum throughput that is achievable. Cold-cap residuals are handled as unformed glass as described in Section E.8. Foaming events will be recorded if they occur together with current process parameter measurements. These include temperature, current, and voltage readings, feed rates, and concentrations of significant species in the off-gas steam. Species in the off-gas may include trace organics, oxides of nitrogen (NOx), fluorides, chlorides and oxides of sulfur.

E.2.3 Process Design and Comparative Analysis

The data obtained from the crucible melts and mini-melter runs will help provide the technical and economic basis for scale-up studies for the vitrification of FEMP wastes. The technical assessment will include an analysis of the effect of glass composition on key glass properties (viscosity, electrical conductivity, and leach resistance) and, therefore, the likely achievable waste loadings that are consistent with processability and leach resistance constraints.

Preliminary waste form criteria for the vitrified material will be developed based on the data obtained and model studies and assessments performed. The process assessments performed and the preliminary waste form criteria developed will be documented in the reports described in Section 13.0 of the TSWP.

E.2.4 Implementation

Implementation requirements and logistics will be assessed. The effects of meeting the As Low As Reasonably Achievable (ALARA) and shielding requirements on the melter design and construction, special handling systems and fugitive emissions control will be incorporated in this evaluation. Both technical and cost considerations will be incorporated into the development and assessment of the implementation requirements.

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E.3 TEST EQUIPMENT AND MATERIALS

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The major operations of this test are intended to be performed at an off-site treatability laboratory. The activities include mixed-waste and glass analysis and characterization, glass melting, standard leach tests on the vitrified product, analysis of the materials and leachates, and end-product characterization. The equipment for these studies is listed in Table E.3.1.

Initial tests to optimize feed blends will use small scale (400-500 gram) crucible melting facilities in preparation for larger-scale continuous melts. A joule-heated ceramic mini-melter will be used for the up-scaled melts at the treatability laboratory. The mini-melter will have a capacity of about six liters and is capable of producing glass on a continuous basis at a rate of approximately 0.5 kilogram/hour. The melter will provide an enclosed feed system capable of accepting feed slurries or solids to accept the various physical forms of FEMP mixed waste. The mini-melter will be capable of processing low-level radioactive waste feeds. A similar system has been used in tests of FEMP Pit Waste from the FEMP OU1. Other features of the melter include lid heaters that allow operation with either a hot or cold top and an off-gas system incorporating an oil scrubber and a three-stage High Efficiency Particulate Air (HEPA) filter assembly and off-gas monitoring. Standard glass characterization techniques, including viscosity, conductivity, and microstructure determination using SEM-EDX will also be performed by the vendor.

The treatability analytical laboratory will be used to dissolve and analyze mixed waste samples. Facilities in this laboratory include a microwave oven for acid solubilization of solid samples, ion chromatography equipment, direct current plasma (DCP), atomic absorption (AA) and inductively coupled plasma-mass spectrometers (ICP-MS) that can provide a complete analysis of the inorganic components of the samples and can detect radionuclides, such as uranium, thorium, and plutonium in the parts per trillion range. Standard laboratory equipment including ovens, balances, sieves, and additional equipment for physical characterization of the samples are available. Modern radioactive counting equipment is also available in the laboratory for analysis of low levels of the radionuclides. Analysis of the leachate solutions will be carried out in the analytical laboratory.

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Table E.3.1 List of Equipment

Equipment/Instrument	Application
Glove Box	radioactive sample preparation
ASTM Sieves	particle size analysis
Flasks, balances, ram	density determination
Sandbath, microwave	sample sludge dissolution for analysis
DC-Plasma Spectrometer	inorganic analysis
Ion Exchange Chromatograph	anion analysis
TOC-Analyzer	total organics analysis
Inductively Coupled Plasma-Mass Spectrometer	radionuclide analysis
Germanium Spectrometer with Marrinelli beaker	Gamma counting
TGA Furnace, crucibles, platinum spindles and graphite casting molds: temperature and power measuring devices, heaters	prepare crucible melts
Joule-heated continuous ceramic melter	continuous melting (vitrification)
Viscometer, furnace	viscosity measurements
Conductivity measuring (Hewlett Packard Bridge furnace) Device	conductivity measurements
Scanning Electron Microscope with Energy Dispersive Analyzer	microstructure analysis
Rotary Agitator, zero-headspace extraction vessel, pH meter, oven	TCLP tests

E.4 SAMPLING AND ANALYSIS PLAN ADDENDUM

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Section 6.0 of the TSWP describes the modifications to the *OU3 RI/FS Work Plan Addendum* SAP. The sampling and analysis described in Section 6.0 is generic and applicable to any treatability study performed for the OU3 Treatability Program. Section 6.0 presents general protocols and procedures which may be implemented in full or in part by any study conducted. This Sampling and Analysis Plan Addendum presents the detailed protocols and procedures that will be used to collect data during the Vitrification of Mixed Waste Treatability Study.

E.4.1 Data Quality Objectives

The development of the DQO for the Mixed Waste Vitrification Treatability Study, in accordance with the SCQ eight-step process, is summarized in the following subsections.

E.4.1.1 Problem Statement

Remediation of hazardous waste is driven by RCRA and CERCLA regulations. The national lack of treatment capacity for treatment of mixed waste has resulted in the accumulation of mixed waste at the FEMP as well as at other DOE facilities. Under the Amended Consent Agreement, OU3 is responsible for treatability testing for the FEMP's backlog mixed waste as well as for any mixed waste to be generated by remediation under the ROD for OU3.

Vitrification is the process of melting silica-containing material at a very high temperature to form a non-porous solid (glass) which can immobilize and contain the material contained in the glass. Since the CERCLA decision-making process places large emphasis on reduction in toxicity, mobility, and/or volume of the contaminants, vitrification has been identified as the focus of this study.

Currently, the MAWS program is conducting a treatability study for the vitrification of OU1 pit waste and OU4 residues from the K-65 Silos. OU3 may integrate with the MAWS vitrification study wherever feasible to avoid duplication of effort and expense and to share all applicable data.

E.4.1.2 Identification of a Decision that Addresses the Problem

The decisions to be made during the conductance of this treatability study include: whether the OU3 mixed waste can be used as a feed material to form glass during the vitrification process; whether there is a significant volume reduction of OU3 mixed waste; whether complete melting of the mixed waste occurs; and whether immobilization and containment of hazardous constituents and radionuclides is accomplished.

E.4.1.3 Identification of Inputs that Affect the Decision

The inputs required to make a decision concerning the feasibility of the treatability study include but are not limited to: extent to which product glass immobilizes hazardous constituents, extent of volume reduction, and performance of the glass product in TCLP and PCT leachability testing.

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E.4.1.4 Specification of the Domain of the Decision

In this treatability study, the media will define the domain to which the decision will be applied. The media included in this treatability study represent most of the backlog mixed waste at the FEMP.

E.4.1.5 Development of Logic Statements

The major use of this data will be to determine the effectiveness of this treatability study on the media and contaminants of concern. The purpose of the bench-scale testing is to determine if the treatment technology is feasible, to attempt to optimize the process to determine the best that this technology can perform consistently, and whether the treatment technology is cost effective for the FEMP. The criteria for a successful treatability study includes (1)the development of operating parameters which enable vitrification of blends of mixed wastes of concern to form a glass which resists leaching of radiological and hazardous constituents; (2) demonstration that off-gas streams meet emission standards. If this can be determined at the bench-scale level, the treatability study has the potential to proceed to the pilot-scale level for more detailed evaluation.

E.4.1.6 Establishment of Constraints on Uncertainty

The purpose of this step is to establish an acceptable probability of making an incorrect decision based on study findings. For the treatability studies, a decision error would be the selection of an inappropriate treatment technology. A false positive error would be the selection of a treatment technology, based on the results obtained in the bench-scale study, that is not truly effective on either OU3 media or the contaminants of concern. A false negative error would be to disregard a treatment technology, based on the results obtained in the bench-scale study, that could prove effective in treating OU3 mixed waste. At this stage of the treatment study, the consequence of a decision error could be increased cost and/or loss of credibility as well as schedule slippage in a worst case assumption. In the case of a false positive error, the consequence would be continuing the study into the pilot-scale level which could be costly and when/if the study then proved to be ineffective, could affect the credibility of the FEMP. In the case of a false negative error, the consequence could be having to begin another treatability study with a different technology which could delay final remediation. While neither error is desirable, a false negative error is considered somewhat greater concern because of the potential of discarding effective treatment technologies that could result in cheaper, more effective disposition of wastes. Because the treatability study is only at the bench-scale level at this point, it is assumed that any false positives may be discovered at the pilot-scale level. The level of concern increases in the magnitude of both types of errors because, in the case of a false negative, only treatability studies that prove to be even effective against OU3 contaminants of concern will proceed into the pilot-scale study and a treatability study that shows to be highly effective, in the case of a false positive, could displace a technology that is in effect a better choice.

E.4.1.7 Development of a Cost-Effective Design for Obtaining Data 299

The bench-scale study for vitrification will be divided into two phases:

- *Remedy Screening Bench-Scale Testing, Phase I*
  Crucible melts will be conducted on varied blends of mixed waste/debris to optimize blends for formation of glass. Quantitative data generated by these tests will establish whether acceptable-quality glass can be produced from the OU3 mixed waste listed in Table E.2.2 while maintaining air quality standards.

- *Remedy Selection Bench-Scale Testing, Phase II*
  Based on results of the crucible melts described above, additional laboratory tests will be made using a scaled-up melter facility which accommodates batches of approximately 10 kilograms and which has capability for the continuous production of glass at a rate of approximately 0.5 kilogram/hour. It is expected that several preliminary melts will be needed to "fine tune" operating parameters for the up-scaled melter. Samples of feed and product will be analyzed at ASL C. Product samples are to be analyzed both for total metals and TCLP. Product samples are also to be submitted for the Savannah River Product Consistency Test (PCT). Material balances will demonstrate the effectiveness of the technology.

After the vitrification process has been optimized, it will be important to characterize the leachability of the vitrified material to determine the effectiveness of the treatment study on all of the contaminants of concern. Due to the importance of this information in making final decisions about the treatment study, this data must be a high quality level ASL C/D (ASL E will be used for non-standard methods).

During the optimization process of both the crucible melts and the 10 kilogram melter studies, however, the level of QA/QC may be lower, ASL A or B (ASL E will be used for non-standard methods), because this data will be used to measure ongoing conditions or to "tweak" the process, not to make any final decisions.

Precision will be assessed through the use of duplicate or triplicate sampling or analyses during the remedy selection study. Accuracy will be evaluated through the establishment of a routine program involving the assessment of analytical results for method blanks, matrix spike/matrix spike duplicates, and laboratory control samples as directed in the SCQ. Sensitivity will be monitored through the achievement of specified detection limits and quantitation limits as summarized in Section 7. Completeness will be assessed based on the percentage of usable data points from the total set of data points collected. Pursuant to the SCQ, completeness is expected to be at least 90%. If sufficient valid data points are not obtained to meet project objectives, additional sampling and analysis may be considered. Comparability will be maintained through the use of standard sampling, analytical, and verification and/or validation procedures.

E.4.1.8 Data Quality Objective Summary

To support the above approach, ASLs A though E will be required. The optimization process of remedy selection phases is expected to be mostly ASL A or B. Initial and final characterization analyses is expected to be ASL C, with 10% ASL D for confirmation, to allow for use in the OU3 Feasibility Study risk assessments as well as to allow for validation of the treatability study data. Any non-standard procedures used for evaluation of the treatment technology would be performed at ASL E. The analytes of concern for the vitrification study include arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, uranium, and thorium. Laboratory QA/QC types and frequencies shall follow those prescribed in the SCQ. All non-standard methods shall include similar types and frequencies of QA/QC samples.

E.4.2 Field and Laboratory Sampling

A total of 41 waste streams will be collected and shipped to the treatability laboratory for treatability testing. The waste streams and quantities to be shipped are identified in Table E.2.2. The quantities were selected based on anticipated melter and analytical consumption during testing, possible heterogeneity and need to size-reduce/homogenize, and the possible need for contingency melts. These 41 wastes were selected because they represent more than 1% of the total weight of the blend group. Regardless of the number of drums of a specific waste in the inventory, only one drum of that waste will be sampled.

E.4.3 Initial Characterization

Historical information on the waste streams will be supplied to the vendor. Makeup of the feed blends to optimize uranium/thorium loading will be based on this historical information, silicon content of the diluent waste blend groups (#11-#13) and on results of the initial and each succeeding melt test. Table E.4.1 lists the initial characterization test parameters, numbers of samples, analytes, and ASLs.

It has been determined from Table E.2.3 that 24 samples or blends will undergo initial characterization; 18 samples from the crucible melt blends and six samples from the mini-melt blends. Due to the large number of crucible melts anticipated, a reduced list of analytical parameters (e.g. total uranium and thorium instead of isotopic radionuclides) will be determined at a lower analytical quality level to control cost. Full-scale analysis (e.g., isotopic radionuclides, etc.) will be performed for all mini-melt tests. The initial characterization data will also be compared to final characterization data obtained on the final product to evaluate the effectiveness of the vitrification process on immobilizing the hazardous and radioactive constituents of the mixed waste.

Other initial characterization testing required for performing the vitrification treatability study, which are considered to be non-standard, non-SCQ approved procedures include:

TABLE E.4.1 Initial Characterization of Test Media

Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
Parameters To Determine Melt Matrix Formulations: (To Be Performed on Blend Groups 11, 12, and 13 Only)						
3	Diluent Feed Blends	Silica	TBD[1]	Non-SCQ, non-standard	To determine concentration of silica present in the diluent groups.	E
Parameters For Crucible Melts Only:						
18	Feed Blends	RCRA metals	ICP, GFAAS	SCQ Appendix G	To determine nature & concentration of RCRA metals contamination and material balance.	B
18	Feed Blends	Total Uranium & Total Thorium	TBD[1]	SCQ Appendix G	To determine nature & concentration of uranium/thorium contamination and material balance.	B
Parameters For Mini-Melts Only:						
6	Feed Blends	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine nature & concentration of metals contamination and material balance.	C/D
6	Feed Blends	Radionuclides	TBD[1]	SCQ Appendix G	To determine nature & concentration of radiological contamination and material balance.	C/D
Parameters For All Melts:						
24	Feed Blends (dissolved blends)	Anions (nitrate, fluoride, chloride, sulfate)	IC, Ion Selective Electrode	Non-SCQ, non-standard	To determine concentration of anions	E
24	Feed Blends	Carbon Content	TOC	SCQ Appendix G	To determine total organic and inorganic carbon content.	B
24	Feed Blends	Specific Gravity (wet/as is and dry)	Pycnometer	ASTM D854-83	To assist in feed system development.	E
24	Feed Blends	Thermogravimetric Analysis	Furnace for crucible melts	Non-SCQ, non-standard	To determine weight loss vs. temperature.	E

[1] Analytical instrumentation is to be selected by the vendor; data generated from the selected analytical instrumentation must meet the Performance Specifications as described in the SCQ, Appendix G, or performance specifications described in appropriate procedure (e.g., ASTM procedure).

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- Silica: SiO_2 content will be determined by one of the following ASTM methods: ASTM C146-80, C25-93, C169-92 or equivalent methods.

- Specific Gravity: determined by weighing a known volume of the sample and determining the weight/volume ratio following the ASTM D854-83 procedure. Tests will be carried out on wet (as received) samples and oven-dried (110 ± 5°C) for at least 12 hours. The expected uncertainty is estimated to be within a standard deviation of 0.021 g/cm^3, as described in ASTM D854-83.

- Carbon Content: measured using a Carbon Analyzer with a Boat Sampling Module (BSM). This system is capable of measuring the total carbon (TC), total organic carbon (TOC), and the inorganic carbon (IC) content. The estimated analytical error of measuring the carbon content on solid material to be within ±10%.

- Anions: testing for anions shall be conducted for fluoride, sulfate, nitrates, and chloride using an IC or an ion selective electrode to determine the concentration of anion content in the blend groups.

- Thermogravimetric Analysis (TGA): weight loss data will be obtained by heating representative samples of the media: 110°C for 18 hours; 450°C for four hours; and 1150°C for four hours. Programmable TGA furnaces will be used for the weight loss measurements assuring control of time and heating rates. The estimated analytical error is ±5% which is due to errors in weighing.

Copies of the non-standard procedures are contained in *Treatability Study Work Plan For Operable Unit 1*, November 1992 (OU1 TSWP).

E.4.4 Optimization of Test Parameters

Although the vitrification treatability study will be conducted in two phases (crucible melts and 10 kilogram mini-melter), the testing for optimization of the test parameters remain the same. Samples may be spiked only for the mini-melter tests. The optimization parameters include the estimated number of samples, analytes, procedures and methods, objectives of the testing, and the analytical support levels. Tests involved in optimization are summarized in Table E.4.2. Activities during this task will be directed toward the monitoring of test conditions and "tweaking" those conditions to optimize the vitrification test process.

E.4.5 Final Characterization

After the crucible melt phase and the 10 kilogram melter phase of this treatability study, both the chemical characterization and leachability testing of the final product will be performed. The test parameters for the final characterization are given in Table E.4.3. The parameters include the estimated number of samples, analytes, procedures and methods, objectives of the testing, and the ASLs. These characterization studies will provide the data necessary to 1) evaluate the effectiveness of using OU3 mixed waste blends to form glass,

TABLE E.4.2 Optimization of Test Design

Number of Samples	Matrix	Analytes	Instrumentation	Procedure	Objective/Intended Use	ASI
10/melt	Glass melt	Temperature	Thermocouples	SCQ Appendix G	To determine melt pool temperature in various locations.	B
5/melt	Feed slurry	Flow rate	Metering pump	Non-SCQ, non-standard	To determine feed rate to melter.	E
10/melt	Glass melt	Current and Voltage	Ammeters, voltmeters	Non-SCQ, non-standard	To determine power input to glass melt.	E
5/melt	Glass	Glass output	Balance	Non-SCQ, non-standard	To determine glass production rates.	E

TABLE E.4.3 Final Characterization

Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
Parameters For Crucible Melts Only:						
18	Glass	RCRA Metals	ICP, GFAAS	SCQ Appendix G	To determine leachability of RCRA metals in final product.	B
18	Glass	TCLP Preparation - Total Uranium & Total Thorium	TBD[1]	SCQ Appendix G	To determine leachability of uranium & thorium in final product.	B
Parameters For Mini-Melts Only:						
6	Glass	TCLP Preparation - TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine leachability of TAL metals in final product.	C/D
6	Glass	TCLP Preparation - Radionuclides.	TBD[1]	SCQ Appendix G	To determine leachability of radionuclides in final product.	C/D
6	Glass	PCT (standard) - TAL Inorganics (samples will be extracted at 90°C)	ICP, GFAAS	Non-SCQ, non-standard	To determine leachability of TAL metals in final product.	E/C/D
6	Glass	PCT (standard) - Radionuclides, (samples will be extracted at 90°C)	TBD[1]	Non-SCQ, non-standard	To determine leachability of radionuclides in final product.	E/C/D
6	Glass	TAL Inorganics	ICP, GFAAS	SCQ Appendix G	To determine material balance.	C/D
Parameters For All Melts:						
24	Solution (dissolved glass)	Anions (nitrate, fluoride, chloride, sulfate)	IC, Ion Selective Electrode	Non-SCQ, non-standard	To determine concentration of anions in final product.	E

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TABLE E.4.3 Final Characterization (Cont'd)

Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
Parameters For All Melts:						
24	Glass	Temperature	Thermocouples	SCQ Appendix G	To determine melt pool temperature in various locations.	B
24	Glass	Crystal content	SEM-EDX	Non-SCQ, non-standard	To determine extent and type of devitrification.	E
24	Glass melt	Viscosity	Rotating spindle	Non-SCQ, non-standard	To determine melt viscosity vs. temperature.	E
24	Glass melt	Electrical conductivity	AC bridge	Non-SCQ, non-standard	To determine melt conductivity vs. temperature.	E
24	Glass	Redox state	Mossbauer Spectroscopy	Non-SCQ, non-standard	To determine effect of Redox state on glass properties.	E

[1] Analytical instrumentation is to be selected by the vendor; data generated from the selected analytical instrumentation must meet the Performance Specifications as described in the SCQ, Appendix G.

2) evaluate the effectiveness of the vitrification process on immobilizing OU3 mixed waste (the test media), and 3) to determine the handling, storage, and disposition requirements for the final product. To establish material balance, the final product will be analyzed for TCLP and total metals.

As with the initial characterization, the concentration of contaminants of each melt will be determined by performing a variety of analytical tests. Samples will be taken for final characterization as listed in Table E.4.3. Correlations and trends in the initial data collected will help focus the scope of final characterization. The scope of final characterization may be modified based on data collected from prior analyses to achieve a more efficient and effective sampling program.

Other final characterization testing required for performing the vitrification treatability study, which are considered to be non-standard (non-SCQ approved) procedures include:

- Savannah River Product Consistency Test (PCT): this test is the present standard for high-level waste glasses. This test evaluates the relative chemical durability of glasses by measuring the concentration of the chemical species released from crushed glass (75-150 microns) to the test solution (deionized water in this case) at 90°C. All tests are conducted in triplicate with a standard glass included in each test batch. The overall uncertainty in the test results is estimated to be ±15%. In addition, data from this test will permit direct comparison of the glass leaching behavior with that of high-level nuclear waste glasses.

- Viscosity Measurement: to be measured from the calculation from measurements of the torque and rotation speed of a spindle attached to a viscometer. Measurements are taken over a range of temperatures, typically from 1000°C to 1150°C. The overall uncertainty is estimated to be ±10%.

- Conductivity Measurement: to be determined by measuring the resistance of the glass melt as a function of frequency using a calibrated platinum electrode probe. The results are extrapolated to zero frequency to obtain the DC conductivity. The measurements are taken over a temperature range, typically from 1000°C to 1150°C. The overall uncertainty is estimated to be ±-5%.

- Crystal Content: to be determined using Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS). This procedure characterizes the microstructure of the glasses and permits analysis of the glassy and crystalline phases using energy dispersive x-ray spectrometry. This equipment permits determination of both the volume fractions and compositions of crystalline phases in both as-melted and heat treated glasses. The percentage of crystals is estimated by examining several samples with regions of approximately one square centimeter. The overall uncertainty is estimated to be ±20%.

- Anions: testing for anions shall be conducted for fluoride, sulfate, nitrates, and chloride using an IC or an ion selective electrode to determine the concentration of anion content in the final product.

- Redox state: to be determined using Mossbauer spectroscopy. This procedure measures the effect of reduction/oxidation state on the glass properties.

Copies of the non-standard procedures described above are listed in the following tables as non-SCQ, non-standard and are contained in OU1 TSWP.

E.4.6 Characterization of Secondary Waste

It is anticipated that most residuals generated as a result of the vitrification of mixed waste will be characterized as a part of the analysis performed during the optimization testing or final characterization testing described above. Characterization of the off-gases generated from the vitrification process is described in Table E.4.4. The vendor shall provide a detailed description of the anticipated off gas produced and the required monitoring characterization. Mixed waste residuals and analytical laboratory mixed waste residuals must be packaged and returned to the FEMP as discussed in Section 11.

TABLE E.4.4 Residuals Characterization

Number of Samples	Matrix	Analytes	Analytical Instrumentation	Procedure	Objective/Intended Use	ASL
1/melt	Off-gas	Off-gas composition	Specific absorption tubes, sampling train-ICPMS, DCP	Non-SCQ, non-standard	To determine concentrations of selected components in off-gas streams.	E
3/melt	Off-gas	Off-gas flow rate	Flow meter, thermocouple	Non-SCQ, non-standard	To determine flow rate for calculation of emission rates.	E

E.5 OU3 TREATABILITY STUDY HEALTH AND SAFETY PLAN ADDENDUM

Appendix F contains the OU3 Treatability Studies Health and Safety Plan. This document has been developed under the OU3 lead health and safety plan, the CERCLA/RCRA Unit #3 (CRU3) Health and Safety Plan. The OU3 Treatability Studies Health and Safety Plan contains health and safety information which may apply to any treatability study conducted.

Table E.5.1 contains information which identifies potential hazards and procedure-specific health and safety guidance for the vitrification treatability study. The vitrification treatability study will be performed off-site. On-site activities include test media collection, packaging, shipping, and residual management and storage/disposition. Treatability personnel will only observe the on-site activities. Therefore, the only health and safety requirements applicable to the treatability personnel are general site requirements (e.g., training, medical, personal protection, and decontamination procedures).

TABLE E.5.1 Treatability Study Health and Safety Requirements

Activity	Hazard Identification	Personnel Monitoring	Personal Protective Equipment	Training	Medical Monitoring & Surveillance	Administrative & Engineering Controls	Decontamination & Disposal Procedures
1) General Information about tasks specified in this summary of Health and Safety Plan requirements.	Hazards identified for each task to be performed. NOTE: Not all hazards are specified on this summary.	Permits will specify type. Air and personnel monitoring may be performed.	Minimum PPE required for each identified task will be indicated as well as other equipment to be utilized in the event of upgrade.	Site access training required: Radiation Worker II, GET and Site Worker Training, Respirator training and fit test. 24 hour supervised field experience. Supervisors must have 8-hour Supervisor Training. Site access training required: Radiation Worker II, GET and Site Worker Training, Respirator training and fit test.	Proof of medical examination signed by doctor must be maintained for all personnel. After initial bio-assay, bio-assay is required bi-monthly and with exit in-vivo.	Provide warning signs and barricades to protect existing construction and equipment, pedestrians and vehicular traffic from falling material. Two access points to each study area, one control point, and orange fencing to define construction work area. Materials, equipment and personnel monitoring required prior to leaving controlled area.	FERMCO supplies a respiratory cleaning facility. FERMCO supplies bags and drums for disposition of contaminated disposables and water.
2) Sampling and Packaging of mixed waste for treatability study	Heat/cold stress.	Personnel monitoring as required by Industrial Hygiene.	Safety glasses w/ rigid side shields; steel toed safety boots; hard hat.	Site access training required: Radiation Worker II, GET and Site Worker Training, Respirator training and fit test. Orientation on project-specific Health and Safety Plan.	Proof of medical examination signed by doctor must be maintained for all personnel. After initial bio-assay, bio-assay is required bi-monthly and with exit in-vivo.	Provide warning signs and barricades to protect existing construction and equipment, pedestrians and vehicular traffic during the transport of materials on-site. FERMCO Work Permit and RWP required.	Personnel should wash hands and face prior to any hand to mouth contact. At exit of controlled area personnel will be required to conduct a full body frisk and/or PCM survey.

The requirements of this document are based upon current conditions and/or planned on current operations in areas near the treatability study area. This document is to be used as an aid in conjunction with the OU3 Treatability Studies Health & Safety Plan and assist the contractor in understanding the requirements of the project. This document does not relieve the contractor of planning for or providing a safe work area. This document does not relieve the contractor from recognizing and complying with other appropriate State and Federal regulations.

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E.6 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS; OTHER CRITERIA TO BE CONSIDERED

The ARARs identified for this project include regulations resulting from the implementation of the Clean Air Act (CAA). The CAA's objective is to protect and enhance the quality of the nation's air resources in order to promote and maintain public health and welfare and the productive capacity of the population. ARARs for the OU3 Vitrification include standards from the National Ambient Air Quality Standards and for the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for all radionuclides except radon, radon, and asbestos.

The Resource Conservation and Recovery Act (RCRA) also resulted in implementation of regulations that have been identified as ARARs for the management of containers prior to the treatability study and potentially to any new waste streams generated during this treatability study. The goals of RCRA are to protect human health and the environment, to conserve energy, and to reduce or eliminate the generation of hazardous waste. Promulgated requirements under RCRA were identified as ARARs for this study for waste characterization, container management, storage and land disposal.

Under the NCP, ARARs apply only to on-site activities. However, these ARARs are applicable requirements for the off-site vendor performing treatability tests. The vendor is responsible for obtaining all applicable permits. All materials will be packaged in DOT approved containers and shipped in conformance with applicable DOT regulations.

Other standards from requirements such as DOE Orders and NEPA, identified as ARARs or criteria to be considered (TBCs), include standards for radiation exposure, endangered species protection, solid waste management, and radioactive waste management at Federal facilities.

ARARs and TBCs are listed in the Table E.6.1, Potential Contaminant-Specific Requirements, and Table E.6.2, Potential Action-Specific Requirements.

TABLE E.6.1 Potential Contaminant-Specific Requirements

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
40 CFR 61, Subpart H	Radionuclides (except radon-222)	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem.	Potentially applicable	Radioactive materials within this operable unit could contribute to the dose to members of the public from the air pathway during this treatability study.
DOE Order 5400.5, Chapter II, Section 1a	Radiation	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 could contribute to the total dose to members of the public from this DOE facility.
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment	Various in air	Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following. (For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.)	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

Isotope	Derived Concentration Guide* (μCi/mL) D	W	Y
Actinium-227	4×10^{16}	1×10^{-16}	1×10^{-14}
Actinium-228	4×10^{11}	1×10^{-10}	1×10^{-10}
Americium-241	-	2×10^{-12}	-
Bismuth-210	9×10^{-10}	6×10^{11}	-
Bismuth-212	6×10^{-10}	7×10^{-10}	-
Bismuth-214	2×10^{-9}	2×10^{-9}	-
Cesium-137	4×10^{-10}		
Cobalt-60	4×10^{-10}	8×10^{-11}	
Europium-152	-	5×10^{-11}	-

TABLE E.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement				Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment (Cont'd)	Various in air		Derived Concentration Guide[a] (μCi/mL)				
		Isotope	D	W	Y		
		Lead-210	9×10^{13}	-	-		
		Lead-212	8×10^{11}	-	-		
		Lead-214	2×10^{9}	-	-		
		Neptunium-237	-	2×10^{-14}			
		Plutonium-238[c]	-	3×10^{14}	4×10^{-14}		
		Plutonium-239[c]	-	2×10^{14}	4×10^{-14}		
		Plutonium-240[c]	-	2×10^{-14}	4×10^{-14}		
		Plutonium-241[c]	-	1×10^{-14}	2×10^{-12}		
		Plutonium-242[c]	-	1×10^{-12}	2×10^{-12}		
		Polonium-210	1×10^{12}	1×10^{-12}			
		Protactinium-231	-	9×10^{-15}	1×10^{-14}		
		Protactinium-234	-	-	-		
		Radium-223	-	2×10^{-12}	-		
		Radium-224	-	4×10^{-12}	-		
		Radium-226	-	1×10^{-12}	-		
		Radium-228	-	3×10^{-12}	-		
		Radon-220[d]	3×10^{9}	3×10^{-9}	3×10^{-9}		
		Radon-222[d]	3×10^{-9}	3×10^{-9}	3×10^{-9}		
		Technetium-99	1×10^{-8}	2×10^{-9}	-		
		Ruthenium-106	2×10^{-10}	1×10^{-10}	3×10^{-11}		
		Strontium-90[c]	5×10^{-11}	-	9×10^{-12}		
		Thorium-227	-	8×10^{-13}	7×10^{-13}		
		Thorium-228	-	5×10^{-14}	4×10^{-14}		
		Thorium-229	-	6×10^{-15}	7×10^{-15}		
		Thorium-230	-	4×10^{-14}	5×10^{-14}		
		Thorium-232	-	7×10^{-15}	1×10^{-14}		
		Thorium-natural	-	7×10^{-15}	1×10^{-14}		
		Thorium-234	-	5×10^{-10}	4×10^{-10}		
		Uranium-231[c]	2×10^{-8}	1×10^{-8}	1×10^{-8}		
		Uranium-233[c]	4×10^{-12}	2×10^{-12}	9×10^{-14}		
		Uranium-234[c]	4×10^{-12}	2×10^{12}	9×10^{-14}		
		Uranium-235[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}		
		Uranium-236[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}		
		Uranium-238[c]	5×10^{12}	2×10^{-12}	1×10^{-13}		
		Uranium-natural[c]	5×10^{-12}	2×10^{-12}	1×10^{-13}		

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TABLE E.6.1 Potential Contaminant-Specific Requirements (Cont'd)

Potential ARAR	Contaminant	Requirement	Preliminary Determination	Remarks
DOE Order 5400.5, Chapter III, Radiation Protection of the Public and the Environment (Cont'd)	Various in air	[a] D, W, and Y represent lung retention classes; removal half-times 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 yearly DCG is for plutonium radionuclides with an absorption factor (f_1) value of 1×10^{-5}. The value shown for weekly DCG is for plutonium radionuclides with a f_1 value of 1×10^{-3}. The value shown for daily and weekly DCG is for Uranium radionuclides with a f_1 value of 5×10^{-2} and for yearly DCG is for uranium radionuclides with a f_1 value of 2×10^{-3}. 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}. [d] Still being assessed.		
	Radon-222	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	Although not promulgated standards, these constitute requirements for protection of the public with which the proposed action will comply.
	Radon-220, -222	The immersion derived concentration guide for both radon-220 and radon-222 in air in an uncontrolled area is 3 pCi/L.	To be considered	Although not promulgated standards, these constitute requirements for protection of the public with which the proposed action will comply.
	External gamma radiation	The level of external gamma radiation in any occupied or habitable building must not exceed the background level by more than 20 μR/h.	To be considered	Pertinent to the proposed action if habitable buildings are involved in the proposed action.

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TABLE E.6.2 Potential Action-Specific Requirements

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 268 (OAC 3745.59)	Land Disposal Restrictions	Generally prohibits the placement of restricted RCRA hazardous wastes inland-based units such as landfills, surface impoundments, waste piles and land facilities, unless: • Wastes have been treated in accordance with technology-based or treatment based standards specified under 40 CFR 268-41; 268-42; 268-43; • Wastes remain hazardous but treatment has been waived under a "National Capacity Extension" as specified under 40 CFR 268.30 through 40 CFR 268.35 and the receiving unit meets the RCRA Sec. 3004(O) minimum technology; requirements including double liner, leachate collection system and groundwater monitoring. • A no-migration petition has been approved in accordance with 40 CFR 268.6 • A treatability variance has been set for the waste in accordance with 40 CFR 268.44 or • The site manager can demonstrate that another technology can achieve an equivalent measure of performance in accordance with 40 CFR 268.42; or • The site manager has demonstrated that the waste does not meet any of the criteria under which the waste was listed and other factors (including additional constituents) will not cause the waste to be hazardous.	Potentially Relevant & Appropriate	Waste managed under this project that is hazardous waste will not be "placed" in a land-based unit unless the waste has been determined to meet the treatment requirements of this LDR rule. The mixed waste vitrification study will optimize the vitrification process in treating the mixed waste to ensure the processed wastes no longer exhibit a characteristic of hazardous waste.
40 CFR 261.7	Empty containers	Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if: • no more than 2.5 cm (one inch) of residue remains on bottom of inner liner; and • less than 3% by weight of total capacity remains (less than 110 gallon container); or • less than .3% by weight of total capacity remains (greater that 110 gallon container).	Potentially relevant and appropriate	Containers used to treat or store waste from this treatability study may contain hazardous substances which must be removed before the containers may be re-used or disposed of. No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.

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TABLE E.6.2 Potential Action-Specific Requirements

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
40 CFR 264.171-.176, .177, and .178 and OAC 3745-55-71 through -78	Container storage	Containers of RCRA hazardous waste must follow these guidelines: • Containers must be maintained in good condition; • Type of containers must be compatible with hazardous waste to be stored; • Containers must be closed during storage (except to add or remove waste); • Inspect container storage areas weekly for deterioration; • Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers 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; and • At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Potentially relevant and appropriate	No hazardous waste will be generated by this study; however asbestos is a hazardous substance which requires proper storage. Therefore RCRA requirements might be relevant and appropriate for container management. Closure of the treatment unit under technical requirements as a RCRA unit might be relevant and appropriate.
10 CFR 1021.2	Treatment	DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR 1500-1508.	Potentially applicable	This requirement is applicable because the FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities.

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TABLE E.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
DOE Order 5820.2A, Chapter III	Management of low level and mixed wastes	DOE solid low-level wastes shall be managed in accordance with DOE Order 5820.2A, Chapter III and the additional requirements cited therein. Low-level radioactive wastes must be sufficiently characterized as to: • Physical and chemical characteristics; • Total volume (container); • Total weight (container); and • Major radionuclides and concentrations in order to permit proper segregation treatment, storage, and disposal. Prior to disposal, LLRW shall be treated as appropriate: • To meet performance objectives; and • To reduce volume, improve stability, and reduce potential for water infiltration.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment. Radioactive materials within this operable unit may exhibit the characteristics of low level waste and require management as required by this chapter.
Solid Waste Disposal Act, as amended (42 USC 6901, et seq.); Solid Wastes (40 CFR 262.11), Ohio Hazardous Waste Management Regulations; OAC 3745-52-11.	Waste characterization and management	A waste must be evaluated to determine if it is a hazardous waste, i.e. either a waste listed in 40 CFR 261 or a characteristic waste. A characteristic waste is determined by its (1) ignitability (defined by flash point, oxidizer, and other); (2) corrosivity (defined by pH ≤ 2 or ≥ 12.5, rate of steel corrosion, and others); (3) reactivity (defined by instability, violent reaction with water, explosivity, cyanide- or sulfide-bearing nature and vapor generation potential, and other); or (4) leachability, as defined by 40 CFR 261.24 for the constituents identified by TCLP.	Potentially applicable	These requirements are applicable to the characterization and management of waste generated by this action as a requirement of the stipulated Amended Consent Decree with the State of Ohio.
Radiation Protection of the Public and the Environment (DOE Order 5400.5, Chapter IV)	Decontamination	Structural debris that is released from DOE facilities for reuse without radiological restrictions shall be decontaminated to specified levels.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

TABLE E.6.2 Potential Action-Specific Requirements (Cont'd)

Potential ARAR	Action	Requirement	Preliminary Determination	Remarks
Radioactive Waste Management (DOE Order 5820.2A, Chapter III)	Waste management	External exposure to radioactive waste (including releases) should not result in an effective dose equivalent of >25 mrem/yr to any member of the public; releases to the atmosphere are to meet the requirements of 40 CFR 61 and an environmental monitoring program must be implemented to address compliance with performance standards.	To be considered	Although not promulgated standards, DOE Orders represent contractual obligations for DOE contractors and subcontractors, and therefore constitute requirements that the facility and its contractors must comply with. Requirements in DOE Orders are derived from promulgated standards generated by the USEPA, NRC, OSHA, and other regulatory authorities. Compliance with these orders in lieu of the similar regulations results in an equal level of protectiveness. Additionally, compliance with alternate standards during an interim action is, according to the NCP, an acceptable demonstration of compliance if those standards are protective of human health and the environment.

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E.7 PERMIT INFORMATION SUMMARY

As stated in Section 10.2 of the TSWP, according to CERCLA statutes, no permits are required for treatability studies conducted entirely on site. CERCLA and a similar requirement in the Amended Consent Agreement make it clear that the substantive requirements of the appropriate permits, that would otherwise be required, must be submitted.

Table E.7.1 identifies the permits that would be required to obtain, the standards, requirements, criteria or limitations that would have had to be met to obtain each such permit, and provides an explanation of how the response action will meet the standards, requirements, criteria or limitations. The substantive or technical requirements have been integrated into the study-specific test design.

For treatability studies conducted off-site, CERCLA exemptions for permitting does not apply to the vendor. The vendor or treatability laboratory must obtain all applicable local, state, and federal permits. Any potential vendor which may be contracted to OU3 to perform treatability studies will supply copies of all relevant permits.

TABLE E.7.1 Permit Information Summary

Identification of permits for which the administrative requirements have been waived by CERCLA Section 121(e)(1)	Identification of standards, requirements, criteria, or limitations normally required by the waived permits	Actions used to meet the requirements of the waived permits
40 CFR 261 Identification and listing of hazardous waste	40 CFR 261.4(f) exempts samples undergoing treatability studies at laboratories and testing facilities	Waste volumes will be kept below the limits set in 40 CFR 261.4(f) of initiating treatment of 250 Kgs/day of "as received" waste, and no more than 1000 Kg/day of waste stored at the facility for evaluation of which 500 Kgs can be soils, water, or debris contaminated with acute hazardous waste or 1 Kg of acute hazardous waste.

E.8 RESIDUALS MANAGEMENT

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As discussed in Section 11.2 of the TSWP, the off-site treatability laboratory will be responsible for collecting, segregating, packaging, and shipping the resulting test residuals back to FEMP in accordance with the FEMP waste acceptance criteria. The estimated types and quantities of vitrification treatability test residuals are presented in Table E.8.1. Residuals generated from the vitrification study will be managed in accordance with Section 11.0 of the TSWP. The vitrification treatability study may generate residuals in the following forms:

- Glass formations from vitrification of mixed waste;
- Unformed glass;
- Unused test media;
- Sample materials (e.g., leachates) from the treatability analytical laboratory; and
- Used equipment (e.g., used crucibles and mini-melter), containers, filters, traps, protective clothing, paper products, and other expendables.

The formed, unformed glass (including cold-cap formations), and unused test media from the treatability study are expected to be low-level mixed-waste solids which will be returned for storage at the FEMP pending future disposition. PCT/TCLP leachates from the proposed treatability study are to be packaged and returned to the FEMP as described in Section 11.2.

Compactable contact wastes generated (e.g., used containers, protective clothing, paper products, other expendables, debris) will be accumulated, packaged in drums, and will be shipped to the FEMP for storage on-site until ultimate disposition is determined by the OU3 final ROD.

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TABLE E.8.1 Estimated Treatability Study Residuals

Residual Description	Estimated Quantity (pounds)
Glass Formation	250
Unformed Glass	50
Compactable Contract Waste	500
Analytical Samples, Rinseate, etc.	500
Unused Test Media	1000

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APPENDIX F

OU3 TREATABILITY STUDIES HEALTH AND SAFETY PLAN

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OU3 TREATABILITY STUDIES HEALTH AND SAFETY PLAN

FINAL

February 1994

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
Fernald Environmental Restoration Management Corporation
P.O. BOX 398704
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PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
FERNALD SITE OPERATIONS OFFICE
UNDER CONTRACT DE-AC05-880R21734

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F.1 BACKGROUND INFORMATION

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F.1.1 FEMP Site History

The Fernald Environmental Management Project is located in Southwestern Ohio, approximately 20 miles northwest of downtown Cincinnati near the communities of Miamitown and Ross, Ohio. Of the total site area of 1,050 acres, 850 acres are in Crosby Township of Hamilton County and 200 acres are in Ross and Morgan Townships of Butler County, Ohio.

The FEMP is owned by the United States Department of Energy and operated by the Fernald Environmental Restoration Management Corporation.

The FEMP was built in 1951 and full operation began in 1953. The purpose of the facility was to establish an in-house integrated production complex for processing uranium and its compounds from natural uranium ore concentrates for use in government defense programs. A wide variety of chemical and metallurgical process steps were used. The present mission focuses on waste management and environmental restoration.

F.1.2 Operable Unit 3 History

Operable Unit 3 encompasses the former production area of the FEMP and associated facilities and equipment. The production area contained all of the buildings and machinery used to produce uranium and its products from the raw materials. Processes conducted included conversion of Uranyl Nitrate to Uranium Tetrafluoride and conversion of Uranium Hexafluoride to Uranium Tetrafluoride. The Uranium Tetrafluoride was then reduced by heating it in the presence of Magnesium. Uranium metal resulted. The metal was then cast into the shapes which were used by the Department of Defense and Department of Energy.

Because of the similarities in general activities, original construction materials and processes at the FEMP, a base group of potential contaminants applicable to all process-related components has been identified: uranium, asbestos, lead, PCB's, and mercury. The same base group of potential contaminants applies to most non-process related components also. However, administrative buildings are not expected to contain significant levels of hazard substances.

F.1.3 OU3 Treatability Studies Health and Safety Plan

The OU3 Treatability Studies Health and Safety Plan complies with the OSHA requirements of 29 CFR 1910.120 as it discusses the health and safety issues related to performance of treatability studies. This plan supplements and expands upon the OU3 Health and Safety Plan. This Health and Safety Plan contains general information relevant to all of the treatability studies. Study-specific information is contained within the treatability study-specific appendices. Specifically, this plan provides the following:

- Controls for the prevention of occupational accidents and injuries;
- Communication to all employees involved with the project with regard to foreseeable safety and/or health hazards; and
- The mechanism(s) necessary for minimization of exposure risk to hazardous substances and unsafe conditions.

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F.1.4 Scope of OU3 Treatability Studies

- Perform treatability studies to determine technology feasibility on OU3 media and contaminants.
- Perform treatability studies to determine if technology can meet predetermined cleanup goals and criteria.

F.1.5 Goal of OU3 Treatability Studies

- Data from treatability studies aids detailed analysis of alternatives performed during the Feasibility Study.
- Data from treatability studies aid in the selection of the final remedial alternatives during the Record of Decision.
- Once the remedy has been selected Remedial Design/Remedial Action (RD/RA) treatability studies can be performed to aid in the implementation of the remedy.

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F.2 HEALTH AND SAFETY RESPONSIBILITIES

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F.2.1 Manager of Compliance for Occupational Health and Safety

- Responsible for overall Construction Safety and Health-related activities/issues for the site.

F.2.2 CRU3 Treatability Study Health and Safety Manager

- Responsible for implementation and audit of all RI/FS safety programs.
- Acts as the single point contact for all Environmental, Safety, Industrial Health, Fire, and Radiological issues.

F.2.3 Treatability Study Project Manager

- Directs all project activities associated with treatability studies.
- Ensures compliance with all regulations and standards as they affect the project.

F.2.4 Treatability Personnel

- Responsible for knowing and understanding the OU3 Treatability Studies Health and Safety Plan, as is evidenced by the signing of the "compliance sign-off" contained in section F.13. The OU3 Treatability Studies Health and Safety Plan compliance sign-off only needs to be signed once.
- Responsible for knowing and understanding the Treatability Study-Specific Appendix for each treatability study they will be working on as evidenced by the signing of the "compliance sign-off" contained in each appendix.
- Responsible for complying with all safety requirements necessary to protect themselves, other workers, and the environment as directed by the CRU3 RI/FS Health and Safety Manager.
- Responsible for seeking guidance from their immediate supervisor or field lead in the event there is any question or uncertainty about the safety of a treatability study project.

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F.3 GENERAL SAFETY REQUIREMENTS

F.3.1 Permits and Postings

F.3.1.1 Permits

Permits shall be posted in accordance with policy RPR 3-1 for Radiation Work Permits and SPR 2-13 for general permits, both found in ESH-1-1000, Comprehensive Environmental Occupational Safety and Health Program.

Prior to the implementation of project specific work, issuance of the following FERMCO permits may be required:

- FERMCO Work Permit (Form FS-F-2939);
- Construction Excavation/Penetration Permit (Form FSF-F-2711);
- Radiation Work Permit (Form FMPC-ES&H-1372);
- Confined Space and Chemical Hazardous Materials Work Permit (FS F-2745); and
- Asbestos Work Permit (Form FS-F-2940).

Permits required for specific treatability study activities are identified in the Health and Safety section of each Treatability Study-Specific Appendix.

F.3.1.2 Postings

The following areas shall be clearly defined and posted by FERMCO:

- Radiological Control Area(s);
- Exclusion area(s); and
- Confined Space(s).

The following areas shall be clearly defined and posted by the subcontractor according to FERMCO procedures:

- Asbestos abatement regulated area(s);
- Construction area(s); and
- Hazardous noise area(s).

F.3.2 Safety Equipment List

The safety equipment to be available for use in the treatability studies' activities may include, but is not necessarily limited to, any of the following: latex, nylon, natural rubber, nitrile, neoprene, viton, cotton and leather gloves; latex shoe covers; caution tape; back belts; safety glasses, cover goggles, face shields; hard hats; cool vests; saranex anti-contamination clothing (or equivalent); coated Tyvek and/or other types of disposable coveralls (if conditions permit use); eye wash stations; ear plugs; winter coveralls; steel toed boots; fire extinguishers; safety harnesses; respirators; shin guards; one piece leather aprons; GFCI extension and equipment cords; dust containment cloth; men working signs; traffic cones; radiation survey equipment; in addition to standard personal equipment (e.g. dosimeters).

F.3.3 Material Safety Data Sheets (MSDS) Locations

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Material Safety Data Sheets shall be available to employees according to SPR 5-6 in ESH-1-1000. Industrial Hygiene keeps a copy of all site Material Safety Data Sheets in a centralized location. Material Safety Data Sheets for building-specific chemicals and compounds are kept in binders in the respective buildings. The location of such manuals and identification of potential chemical hazards at the treatability study locations will be reviewed with the field team prior to initiation of activity.

In addition, each individual treatability study crew shall keep a binder with it at all times, containing the MSDS sheets for all compounds used by the crew during Treatability Study activities.

F.3.4 Illumination

The illumination standards of 29 CFR 1926.56 shall be adhered to as described in Table F.3.1. In areas of suspected insufficient lighting, Industrial Hygiene shall be contacted prior to implementation of work activities and temporary lighting will be provided as needed.

F.3.5 Sanitation at Temporary Worksites

For this project, portable toilets may not be available in some treatability study locations. Personnel shall be provided a means to travel to a toilet facility when required. The sanitation requirements found in ESH-1-1000, SPR 5-4 shall be followed.

An adequate supply of potable water shall be provided on the site. The containers used to dispense drinking water shall be capable of being closed and equipped with a tap. Any container used to distribute water shall be clearly marked for this purpose and not used for any other purpose. FERMCO Radiological Control Department shall approve all drinking water locations within a Radiologically Controlled area and shall post approved locations as designated break areas.

F.3.6 Operating Procedures and Other Requirements

All work conducted on-site shall comply with all the safety and health procedures in the FERMCO COMPREHENSIVE SAFETY AND HEALTH PROGRAM (ESH-1-1000).

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TABLE F.3.1 Minimum Illumination Intensities in Foot-Candles (29 CFR 1926.56)

Foot-candles	Area or Operation
5	General site areas
3	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and fuel maintenance areas.
5	Indoors: warehouses, corridors, hallways, and exitways.
5	Tunnels, shafts, and general underground work areas: (exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.)
10	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active storerooms, barracks, or living quarters, locker or dressing rooms, mess halls, and indoor toilets and workrooms.)
30	First aid stations, infirmaries and offices.

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F.4 SITE ACCESS CONTROL

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F.4.1 FEMP Requirements

Each treatability study area will be clearly identified by barrier tape and signs. Visitors to the treatability study areas will be restricted to outside of the work area unless the CRU3 RI/FS Health and Safety Manager determines that access is allowed and proper escort is maintained.

The FEMP requirements for access to a controlled area are as follows:

- a thermoluminescent dosimeter shall be worn;
- a respirator shall be worn when required in all areas of known or areas which have the potential for airborne contamination;
- medical requirements (INVIVO and general physical) shall be met as determined by Medical Services; and
- any component-specific requirements as defined in this Health and Safety Plan and Treatability Study-Specific Appendices shall be adhered to.

F.4.2 Defining Work Sites

Task-specific work areas shall be delineated at the time of treatability study. Each area shall have a designated entrance and exit, as designated by Radiological Control. Areas will be contained by ropes, barricades, etc. All such treatability study areas will have their own decontamination lines.

- An exclusion zone or radiological contamination area (based on survey results) is a pre-established area of high potential hazard due to physical, radiological, or chemical dangers. Access to an exclusion zone or radiological contamination area is restricted to employees who are required to enter in order to perform their job functions. An exclusion zone or radiological contamination area will be marked with easily recognizable devices such as ropes, tape or fence. Signs posted indicating the type of exclusion zone or radiological contamination areas may be expanded or upgraded as airborne hazards, contamination, or radiation levels increase due to work activities. Radiological areas will be established, controlled and marked as required by DOE/EH-0256T. For OU3 treatability study activities, each treatability study area will be an exclusion zone.

Exclusion zones shall be defined by Industrial Hygiene and Safety or Radiological Control on a changing schedule to be determined by survey results.

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F.5 TRAINING

F.5.1 Required Training For Entry To Site

To conduct work in an area not designated as a radiological controlled area or an exclusion zone, the employee shall receive the following:

- General Employee Training.

In addition, the following training may be required:

- FEMP Respirator Training and quantitative fit test (Five hour for Asbestos Workers.)

In order to meet the requirements of OSHA 1910.120, occasional site workers shall also complete the following training:

- Site worker training; and
- Radiation Worker I Training.

All FERMCO and FERMCO subcontractor personnel assigned to the various tasks associated with the OU3 treatability study shall require the following additional training requirements:

- Radiation Worker II (in place of Radiation Worker I Training);
- Three (3) days supervised field experience; and
- Subcontractors with proof of successful completion of OSHA 29 CFR 1910.120 (e)(3)(i) training are required to take GET, Site Worker and Radiation Worker I or II as determined by the FERMCO Training Department on a case-by-case basis to comply with FERMCO requirements.

Supervisors shall, in addition to above training requirements, receive the following training:

- OSHA 29 CFR 1910.120 (e) (4) - Eight (8) hour Training for Supervisors involved in the project.

Note: In the event that subcontractors are used for the OU3 Treatability Study, each subcontractor shall be responsible for certifying that their employees meet the requirements of pre-assignment training and all OSHA training.

F.5.2 Required Training To Perform Work In The Defined Work Zones

All procedure training for the various treatability study tasks and treatability study equipment associated with the work shall be in compliance with FERMCO Site Requirements for training. The training must cover job analysis and task assignment as required to develop and implement job and task-specific training. Records indicating successful completion of training shall be maintained by the training department.

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All personnel will be trained to the information contained within this plan. The Health and Safety Compliance Sign-off Sheet will document this training and understanding of the plan provisions.

Special training requirements for each specific treatability study are identified in the Health and Safety section of each Treatability Study-Specific Appendix. The Treatability Study Compliance Sign-off contained in each appendix will document the treatability study specific training and understanding of the appendix.

F.5.3 Required Safety Meetings

Treatability study personnel shall be required to attend short safety ("tailgate") meetings on a regular basis. These meetings may be conducted on a daily basis during field operations, when there is a change in scope of work, or where individuals not previously briefed on the activities join the field team. These meetings will be conducted by the CRU3 RI/FS Health and Safety Manager or designee and will be documented on form FSF-F-470 ("Minutes of Safety Meeting"). A copy of this form is attached as Attachment B. Documentation of all health and safety meetings shall be maintained by the CRU3 RI/FS Health and Safety Manager and will become part of the permanent file. Such meetings shall include but not be limited to:

- Review of chemical/radiological/health hazards which may be encountered in the day's work;
- Review of applicable MSDSs;
- Briefing on other activities which will be underway in the same area e.g. safe shutdown);
- Review of the governing OU3 Treatability Studies Health and Safety Plan and information contained within each Treatability Study-Specific Appendix; and
- The OU3 Treatability Studies Health and Safety Plan Compliance Sign-off shall be signed by the sampling personnel. The sheet becomes a permanent record to the Health and Safety Plan.

For briefing purposes treatability study-specific information will be retrieved from each treatability study appendix and combined with the general information provided within this plan.

- In addition to the Health and Safety Compliance Sign-off contained within this plan, personnel will be required to sign the Treatability Study-Specific Compliance Sign-off for each of the treatability studies they are to be involved in.

F.6 MEDICAL MONITORING AND SURVEILLANCE

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In accordance with 29 CFR 1910.120, all FERMCO and FERMCO subcontractor personnel assigned to the Site performing actual treatability study tasks, shall participate in a medical monitoring program which includes:

- A baseline medical examination;
- Periodic medical examination;
- Respirator medical approval;
- Medical-Bioassay examinations (may be required after potential exposures);
- Exit medical examination; and
- Any required monitoring denoted in the task-specific section of this HASP.

Personnel medical records shall be maintained by the FERMCO Medical Department. Personnel involved in a contamination event shall report to bioassay at the end of their shift, or as directed by the personnel performing the decontamination. A follow-up evaluation may be required depending on the type of contamination.

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F.7 PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIREMENTS

Protective clothing and equipment shall be tailored to the specific task(s) being performed. The equipment requirements shall be determined by the Radiological Control, Industrial Hygiene, and Fire & Safety departments. Personal protective Equipment shall be worn in accordance with SPR 2-14 and RPR 3-3 in ESH-1-1000.

Personal Protective Equipment specific to activities of each treatability study is identified in the Health and Safety section of each Treatability Study-Specific Appendix.

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F.8 REQUIRED MONITORING AND ACTION LIMITS

It is the policy of the FEMP to maintain radiation exposures and exposures to toxic substances and combustible gases As Low As Reasonably Achievable (ALARA). Air monitoring shall be performed to ensure that contaminant concentrations in the breathing zone do not exceed the concentrations as specified by established exposure levels. Personnel shall be monitored when appropriate in compliance with the radiation protection standards, in order to estimate the dose equivalents received from external and internal sources of radiation.

Personnel dosimetry programs shall be adequate to demonstrate compliance with the radiation protection standards and will be performed by the Dosimetry Department personnel. Personnel dosimeters shall be routinely calibrated and maintained.

External radiation hazards are identified by FERMCO personnel as they perform the survey required for a radiation work permit. Stay times will be measured and assigned for all activities by a Radiological Control Technician. Measures such as increasing shielding, increasing distance or reducing exposure time will be taken to minimize exposures.

F.8.1 Air Monitoring

Air monitoring shall be conducted in accordance with SPR 5-1.

A Photoionization Detector (PID) may be used periodically to test for organic vapors and measure breathing zone contaminants. It's use as well as monitoring frequency will be based upon recommendation of the Industrial Hygiene Department. If organic vapors are detected, they will be treated as unknowns. Colorimetric indicating detector tubes may be used to measure levels of specific organic vapors as well as inorganic vapors, such as NO_2, Nitric Acid, etc. The MIE RAM-1 may be used to monitor for airborne particulates.

Combustible Gas Indicator (CGI)/(Oxygen) meters shall be used to check the atmosphere of confined spaces prior to entry. Personnel working in these spaces shall be required to wear the appropriate PPE, as directed by the Industrial Hygiene Section.

F.8.2 Radiation Monitoring

Control of contamination is a routine part of work at the FEMP. Contamination control zones have been established with specific entry and exit requirements.

Entry requirements include wearing designated protective clothing when entering a zone. Exit requirements include monitoring to ensure that personnel and equipment moving into another zone meet the requirements for contamination control. Personnel handling process materials or sample material (i.e., performing work) shall make a complete clothing change from personal clothing to protective clothing and shoes. Also they may shower prior to changing back into personal clothing.

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Upon leaving a "Radiologically Controlled Area" or "Contamination Area", Whole-Body Monitoring through a Personnel Contamination Monitor (PCM) or with a hand-held instrument is required, depending on the level of hazard or potential for personnel contamination present.

When frisking with a hand-held instrument the probe must be held within 1/2 inch of the surface that is monitored in order to measure contamination. Frisking will occur at one

inch per-second over the surface being monitored. In the event that contamination exceeds the action limit (100 cpm beta/gamma or detectable alpha above background), a Radiation Control Technician shall be notified immediately.

F.8.3 Action Limits

The Action Levels for activities conducted under each treatability study will be determined by Industrial Hygiene and/or Radiological Control and will be presented in the Health and Safety section of each treatability study-specific appendix.

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F.9 DECONTAMINATION

F.9.1 Site Decontamination Requirements

When working in Radiological Zones or Exclusion Zones, personnel decontamination equipment for radiological or chemical hazards shall be available in the area surrounding the Zone as determined necessary by Industrial Hygiene and/or Radiological Control.

OU3 Treatability Study personnel are required to contact Radiological Control Technicians in the event of a personnel contamination incident. Detection of a count rate above background with a field portable GM monitoring instrument ("frisker") should alert personnel of possible contamination. Ambient background count rate is not to exceed 300 counts per minute (CPM) in the location of the personnel monitoring. If background levels exceed 300 CPM, proceed to an area of lower background to perform the personal monitoring of the potentially contaminated individual. Ideal background levels would be less than 100 CPM.

Responding Radiological Control Technicians are to follow the instructions given in ES&H procedures SP-P-35-017, Personnel Decontamination and ED-0001, "Event Notification and Reporting." (Personnel involved in the incident are to follow the instructions given in Section 6.0 of the HASP for medical-bioassay evaluation of potential internal radiation hazard from possible inhalation, ingestion, or absorption of radioactive material.)

Vehicles and other equipment used on-site must be monitored by a Radiation Control Technician for contamination (and decontaminated, if necessary) before moving them to non-contaminated areas. Heavy equipment generally requires decontamination. Frisking and/or wipe tests will be used to confirm the effectiveness of decontamination, as required by Radiological Monitoring to determine when the equipment is safe to move to clean areas.

F.9.2 Lead Decontamination Requirements

For personnel working in lead regulated areas, a shower facility will be available. All personnel who may become contaminated with lead shall be required to shower upon exiting the area.

In addition, when a person exits a lead regulated area, they shall wash their face and hands prior to breaks, and shall shower before lunch and the end of their shift.

F.9.3 Asbestos Decontamination Requirements

For the asbestos abatement work covered by this HASP, a shower facility will be available. All personnel performing asbestos abatement activities and individuals who enter an asbestos regulated area shall be required to exit the area through the shower facility.

When personnel exit an asbestos regulated area, they shall vacuum their disposable coveralls with a HEPA filtered vacuum cleaner, remove their latex shoe covers, and proceed to the equipment room of the shower facility.

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When workers enter the equipment room, they shall remove their disposable coveralls, shoe covers, and gloves and place them in a labeled waste container located in the equipment room. They shall remove their safety shoes and leave them in a staging area in the equipment room. Any launderable clothing which is removed shall be placed in a separate labeled

container for delivery to the laundry. After all clothing has been removed and the worker is still wearing respirator, they shall proceed to the shower.

In the shower they shall rinse off their respirator, remove the respirator and then remove the cartridges from the respirator (cartridges to be disposed of as asbestos waste). Workers shall shower before entering the clean change area. Respirators shall be allowed to dry before being placed into a respirator recycling receptacle. Any towels used by workers shall be returned to laundry in labeled bags/containers.

The shower must be drained through a filtration system with a minimum of 5 micron final filter. If waste water is inadvertently released outside the shower area, it shall be cleaned up using a wet vacuums or wet mops to prevent any asbestos in the water from drying and becoming airborne in areas outside the work are. After clean up, the waste water shall be processed through the asbestos waste water filtration system, as described above.

F.10 HAZARD ASSESSMENT

Specific hazard assessment and identification for each treatability study is presented in the Health and Safety section of each Treatability Study-Specific Appendix.

The following sections provide a general overview of potential hazards for the project:

F.10.1 Industrial Hygiene Issues

F.10.1.1 Chemical Contaminants

- Asbestos - Asbestos can be found in transite siding and pipe insulation. Asbestos is a human carcinogen which mainly affects the respiratory system. When working with asbestos-containing materials (ACM), trained personnel, proper PPE, respiratory protection and an Asbestos Work Permit will be required.
- Carcinogens - A carcinogen is a chemical substance that causes or is suspected of causing cancer. When work with a carcinogen is conducted the requirements found in ESH-1-1000 SPR 5-12 shall be followed.
- Chemical Contaminants - Chemicals used in treatability study activities may be hazardous to employees. Copies of all MSDS are maintained by the Industrial Hygiene Department for review and determination of PPE requirements.
- Inorganic Lead - Paints containing lead oxide pigments have been used in many locations at the FEMP. Lead has also been used in it's metallic form in some construction applications (e.g. flashings, plumbing work, transite fasteners, and shielding blocks). Inorganic lead is harmful if it is ingested, or when dust or vapors containing lead are inhaled.
- Uranium - Uranium can be found in many of the buildings and the soil on site. Uranium is a radioactive material and in its soluble form is also toxic. Soluble uranium is absorbed through the skin and affects the kidneys. Nonsoluble uranium is an inhalation and radiation hazard. When working in areas where uranuim is present, proper PPE, respiratory protection and a RWP will be required.

F.10.1.2 Physical Hazards

- Noise - Operations being performed may present a potential noise hazard. Excessive noise can occur during the operation of drilling equipment, pneumatic tools, generators, and other machinery. The CRU3 RI/FS Health and Safety Manager will request FERMCO Industrial Health to evaluate suspect hazardous noise operations.
- Confined Space - A confined Space is an area not designed for continuous human occupancy, is large enough for a human to bodily enter and has limited means for entry and exit. All such operations which involve entry and work in a confined space are required to be evaluated by FERMCO Industrial Hygiene prior to entry to determine if a Confined Space Entry Permit is required for the work task. See ESH-1-100, SPR 5-13.

As part of the evaluation, all confined spaces will be monitored, as a minimum, for Oxygen, Carbon Monoxide, Hydrogen Sulfide, and Explosive Atmosphere. If a hazardous atmosphere or safety hazard exists within the space, the space will be classified as a permit-required confined space and a Confined Space Entry Permit shall be required.

- Heat Stress - Heat stress threshold limit values (TLVs) refer to conditions under which it is believed that nearly all OU3 treatability study personnel may be repeatedly exposed without adverse health effects. Possible heat stress causes include hard physical work and work under extra layers of personal protection equipment.

Heat Stress TLVs are based on the assumption that nearly all acclimated, fully clothed workers with adequate water and salt intake should be able to function effectively under given working conditions without exceeding a deep body temperature of 100.4°F (38°C).

Acclimatization can occur after just a few days of exposure to a hot environment. NIOSH recommends a progressive 6-day acclimatization period, for unacclimated workers, before allowing them to do full work on a hot job. Under this regimen, the first day of work on the site is begun using only 50% of the anticipated workload and exposure time, and 10% is added to each day through day 6. With fit or trained individuals, the acclimatization period may be shortened to two or three days.

Because measurement of deep body temperature is impractical for monitoring the site personnel's heat load, the measurement of environmental factors required must most nearly correlate with deep body temperature and other physiological responses to heat. A Wet Bulb Globe Temperature Index (WBGT) is the simplest and most suitable technique to measure the environmental factors.

The heat stress requirements and guidelines found in SPR 5-5 of ESH-1-1000 shall be followed. Furthermore, it shall be the policy of the OU3 personnel to contact the Industrial Hygiene Section to conduct a heat stress evaluation for a given project, whenever the ambient temperature exceeds 80°F.

- Cold Stress - The cold stress TLVs are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury, and to describe exposures to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse effects. The TLV objective is to prevent the deep body temperature from falling below 35°C (95°F) and to prevent cold injury to body extremities (deep body temperature is the core temperature of the body). In order to properly dress for cold weather situations, personnel shall wear several light layers of clothes. In this manner, personnel may add and remove layers as the weather changes. Cold weather clothes (coats, sweaters, etc.) shall be worn under anti-contamination clothing. For hands, gloves shall be worn when required by Industrial Safety. As in the case of heat stress, the requirements and guidelines cited in SPR 5-5 of ESH-1-1000 shall be followed at all times.

OU3 treatability study supervision shall contact Industrial Hygiene for protective measures when the equivalent chill temperature (or "wind chill" temperature) falls below 0°C (32° F). Provisions for additional total body protection for work that is performed in an environment at or below 4°C (39.2°F) shall be administered by Industrial Hygiene.

F.10.2 Radiological Safety Issues

The FEMP was a uranium processing facility since the early 1950s. Uranium and uranium-bearing materials are stored or have been processed in almost all parts of the FEMP

Production Area, Waste Storage Area and Laboratory Building. Uranium-bearing materials have been found buried or dumped at several locations outside the former Production Area, and the potential for contamination should be considered prior to penetration any surface or soils on the FEMP property.

Worker training, contamination control practices, and personal protective equipment are used to control inhalation and ingestion of radioactive particles. ALARA principles are used to control worker exposure to radiation fields in all Radiation areas. At the FEMP the policies and objectives for controlling personnel exposure to ionizing radiation are implemented through the issuance of Radiation Work Permits.

F.10.3 Industrial Safety Issues

- Electric Power - Ground fault circuit interrupters (GFCIs) are required on all 15 and 20 ampere, 120 volt circuits at all work sites. The GFCI will be placed at the source of the electrical service to protect both the cord and the devices connected.

All flexible cords (extension cords) shall be approved (UL listed) cord sets and be of a type rated for hard usage and damp location. Only purchased cord assemblies will be permitted, field made cord sets are not permitted. All cords shall run overhead to avoid damage from being on the ground.

All temporary wiring and lighting shall conform to the requirements of the latest edition of the National Electric Code, except Article 305-4(B) which shall not apply.

No work shall be permitted within 10 feet of any live exposed electrical device, unless approved by the CRU3 RI/FS Health and Safety Manager or the personnel involved are qualified for such work.

- Fall Protection - A positive means of fall protection is required for any fall of six (6) feet or more. This can be accomplished using appropriate barricades, full body harnesses, lanyards, etc. All work tasks shall have 100% fall protection. All work requiring fall protection shall be performed in accordance with OSHA requirements. See ESH-1-1000 SPR 2-17 for additional information.
- Heavy Equipment - The number of people working around heavy equipment shall be minimized at all times. All mobile equipment shall be supplied with an electronic back-up alarm. All operators will be qualified to operate their machine. Equipment will be inspected at the beginning of each shift by the equipment operator, prior to use, and the inspection results will be recorded on a daily check sheet to ensure that all safety equipment and devices are full operational. See ESH-1-1000 SPR 2-36, 2-38 and 2-39.
- Hidden and Underground Utilities - Project activities involving penetration/excavation into the surrounding earth, roof, floors and walls of the facility shall require a FERMCO permit. Due to serious injury potential from contacting or breaching existing utilities, a FERMCO Excavation/Penetration Permit with a complete mapping/drawing of all utilities and other potential is required prior to start of excavation.
- Lifting - Lifting is the most common task associated with lower back pain. Many of the injuries do not result from a single incident, but develop over a period of time. This type of injury may result from repetitive lifting.

Personnel should know their lifting limits, the proper way(s) to lift, and the object to be lifted should be limited by factors such as; the route and distance to be traveled, the amount of time required and the center of gravity necessary to handle the load safely.

A person shall not lift more that 50 lbs without assistance from another person or mechanical help.

- Lockout and Tagout - Subcontractor personnel working at the FEMP shall follow and be fully trained to the FEMP Energy Control Plan. Before commencing work on any energized system or circuit, a lockout/tagout is to be completed in accordance with the FEMP Energy Control Procedures. See EHS-1-1000 SPR 2-24.
- Material Handling Equipment - All equipment used for hoisting and rigging operations will be tested, inspected, and tagged with current annual test dates. All operators will be qualified to operate the equipment. Equipment will be inspected at the beginning of each shift by the equipment operator, prior to use, to ensure it is in proper operating condition and all safety equipment is in place and functional. The inspection results will be recorded on a daily check list.

All material handling equipment mobile personnel lifts (both powered and manual) and specialized hand operated powered equipment shall have the factory approved operator/safety manual for use by the operator. This manual shall be either with the equipment at the time of use or shall be on file, available for reference when requested. All material handling equipment shall only be used as the manufacturer intended and with the loading limits defined by the manufacturer. Safety requirements within the manual shall be followed.

All rigging operations shall be performed by persons that are qualified to safely execute such work. The supervisor in charge shall evaluate the training of all personnel involved in rigging operations and provide a letter to the FERMCO Construction Manager and CRU3 RI/FS Health and Safety Manager, stating who has been verified to be a competent rigger.

Any CRITICAL LIFT shall have an approved LIFT PLAN prior to the start of the lift. This plan shall be written the subcontractor or FERMCO supervisor performing the work and approved by FERMCO CRU3 Management and the CRU3 RI/FS Health and Safety Manager. See the "Hoist and Rigging Manual," DOE/ID-10500-Section 12.0, for additional information on the Critical Lift Requirements.

- Overhead Hazards - Before any activity is to take place, all overhead obstructions must be identified by the supervisor in charge. Where possible, the activity should be moved away from the obstruction. If the site cannot be moved and the obstruction contains electrical lines, then the overhead lines should be moved, de-energized, or guarded as to protect against contact.
- Power Tools - Proper eye and face protection shall be worn while using all hand and power tools. All tools shall be inspected before using. Defective tools will not be used. Only tools designed for the application in mind will be used. The proper strength tool will be used as specified for each job. The use of handle extenders or cheater bars is prohibited, due to the obvious excessive stresses applied to the tool from their use.

Tools and machines will be disconnected from their power source before making adjustments or attachment changes. Guards or safety devices will not be removed. All fuel powered tools will be shut off before refueling. Air powered tools must have safety clips or retainers on all hose connections. All portable electrically connected power equipment shall be protected by ground fault circuit interrupters (GFCI). See ESH 1-1000 SPR 2-23.

- Slips, Trips, and Falls - All personnel should always walk where firm footing is assured, taking short steps in slippery places. Carrying anything bulky that will obstruct vision will be avoided. Personnel will be cognizant of falling, slipping and tripping hazards. Climbing over equipment to get to other items and falling off/down steep slopes can cause serious and sometimes fatal accidents.

All work paths and work areas shall be kept clear of slip and trip hazards. If workers must work in or near areas where these hazards exist and the hazard cannot be removed, then proper barricades and signs shall be used to route personnel away from the hazards.

F.10.4 Fire Protection Issues

The potential for fires and explosions may occur during tasks. Explosions and fires can result in intense heat, open flames, smoke inhalation, flying objects and release of toxic chemicals. To protect against explosion and fires, the environment will be monitored for explosive atmospheres and flammable vapors; all potential ignition sources will be kept away from areas where explosive or flammable environments may occur; and work practices that will minimize the agitation or release of chemicals will be used.

Storage, use or transfer of flammable and/or combustible liquids shall be in accordance with NFPA 30, Flammable and Combustible Code, or approved by FERMCO Fire Protection.

Any task that involves the impairment of a sprinkler system or fire alarm system requires an Outage Permit issued by the FERMCO Fire and Safety Inspectors and signed off by FERMCO Fire Protection.

F.10.5 Natural Occurrence Issues (Weather)

Natural occurrences thought to affect the treatability study include, but are not limited to, extreme temperatures, snow, rain, thunderstorms, earthquakes, tornados, etc.

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F.11 EMERGENCY / CONTINGENCY PLANS

According to the OU3 Health and Safety Plan, in the event of injuries, site personnel will try to reduce or eliminate the consequences whenever possible. The process of determining what is appropriate requires that each situation be evaluated on a case-by-case basis. All injuries shall be reported immediately to FERMCO Medical for treatment/evaluation. The injured employee's supervisor shall be notified as soon as possible and must accompany the employee to FERMCO Medical. The CRU3 RI/FS Health and Safety Manager shall be notified as soon as possible. Minor injuries (sprains, strains, and cuts) are to be controlled by on-site medical personnel using standard first-aid practices.

Injuries complicated by chemical contamination will be evaluated after hazards associated with the contamination are considered. Injuries of persons contaminated with acutely toxic chemicals will be treated so as to minimize the hazard to both the rescuer and the victim. Refer to section 11.4.5 for more information on employee contamination by chemical agents. Note: In all cases, if a worker cannot safely attempt rescue, the rescue shall not be attempted.

All injuries within the process area will be assumed to involve radioactive contamination until proven otherwise. The injury is to be given the highest priority. The contamination shall be reduced as soon as practical. See section 11.4.5 for more information on employee contamination by radiological agents.

The nearest medical facility is the FERMCO Medical Facility. It is the primary choice for on-site injuries. The FERMCO ambulance will transport the injured to the nearest hospital, if necessary. FERMCO maintains an emergency response capability which includes an ambulance and Emergency Medical Technician (EMT) personnel.

F.11.1 Reporting

Table F.11.1 lists the emergency phone, radio, and pager numbers to be used in the event of an emergency.

F.11.1.1 Site Notification Procedure

Site notification shall be consistent with ED-0001, Event Notification and Reporting, and DOE Order 5000.3B, Occurrence Reporting and Processing of Operations Information.

F.11.1.2 What / How to Report

Notify the Communication Center of:

- Known chemical and/or radiologic involvement;
- Extent of injuries;
- Treatment that has been performed (including decontamination);
- Number of victims;
- Names and badge numbers of the victims;
- Location of the accident; and
- Telephone number.

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TABLE F.11.1 Emergency Numbers

Name	Phone	Radio	Pager
Ambulance/Hospital/Fire	6511	N/A	N/A
Communication Center	6511	Control/202	N/A
AEDO	6431/6295	Control/202	N/A
Industrial Hygiene	6207	357	N/A
Radiation Safety	6889	355	N/A
Fire & Safety	6235	303	N/A
Medical	6217	N/A	N/A
Dosimetry	6290	N/A	N/A
CRU3 Treatability Study Health and Safety Manager	6972	N/A	554-5034
Manager of Compliance for Occupational Health and Safety	8692	N/A	820-1320
Utility Engineer	6295	Control/202	N/A
Bioassay	6226	N/A	N/A

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Events to report:

- Serious injury;
- Injury complicated by contamination;
- Chemical / Radiation release;
- Chemical splash (Eye & Skin);
- Any fire; and
- Major property damage.

It is important to remember to stay on the phone until the Communications Officer hangs up. The Communications Officer is trained to be calm and ask for the appropriate information in the order that it appears on the form. Additional information such as cross streets or an escort from the entrance to the site, may be required in some instances.

F.11.2 Evacuation Routes / Plant Wide Accountability

During a Plant Wide Accountability all personnel shall either report to their Rally Points (section 11.2.1) or report to their supervisor (11.2.2) as per directions from the Emergency Notification System.

F.11.2.1 Rally Point Accountability

There are eight rally points located around the FEMP for the purpose of collection of and communication with personnel during the evacuation of facilities. After personnel have collected, the rally point coordinator, designated by an orange vest, shall take accountability. The coordinator will then forward the results of the accountability to the Accountability Center using the rally point telephone.

The building specific emergency plans give details as to the location of primary and alternate rally points in addition to the evacuation route. A copy of the map listing the various rally points is attached in the OU3 Health and Safety Plan.

When assembled at a rally point, personnel shall report their name, badge number and anything observed that they would consider unusual.

In the event of a building evacuation alarm or direction from the emergency message system, alerted personnel shall report to their assigned rally points.

F.11.2.2 In-Place Accountability

During an in-place accountability, all employees shall report to their immediate supervisor by radio or phone. These supervisors shall then communicate the names and badge numbers through departmental channels ultimately to the Accountability Center.

F.11.3 Available Emergency Equipment

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F.11.3.1 Site-Wide Equipment

Fire and rescue equipment at the FEMP includes several vehicles with forcible entry tools, communication equipment, electric lights and generators, portable pumps, and protective equipment.

F.11.3.2 Plant Equipment

Fire protection and extinguishing equipment at the FEMP includes building sprinkler systems (both wet-pipe and dry-pipe), fire and smoke alarm systems, hand-held fire extinguisher, and fire hydrants.

The plant also has the following safety/emergency systems:

- Radiation Detection Alarm (RDA);
- Evacuation System;
- Plant Alarm System; and
- Manual Fire Alarm System.

F.11.4 Emergency Response

F.11.4.1 Confined Spaces

At no time shall any personnel enter an unknown atmosphere in a confined space without proper respiratory equipment, even to rescue a person who has collapsed. Co-workers may perform non-entry rescues (removing victim by means of a safety line, etc.) if such rescues can be performed without endangering the rescuers or further endangering the victim. Co-workers should be familiar with SPR-5-13, Rescue Requirements for Confined Spaces.

F.11.4.2 Medical Emergencies

The FERMCO Medical Facility maintains an emergency life squad crew and ambulance for all shifts, seven days a week. Immediately notify the Communication Center by phone at 6511 (738-6511) or radio (call CONTROL) to contact them of any serious injury. The treatability study team may (if trained) use standard first aid procedures to stabilize the injury pending arrival of FERMCO response personnel.

F.11.4.3 Fire Emergencies

Resources such as water, fire extinguisher, and soil may be used to contain or extinguish small fires.

F.11.4.4 Chemical Emergencies

- Release - If a release in the form of a spill, leak or vapor cloud is observed, immediately move at least 300 feet upwind and immediately notify authorities. Radio to CONTROL or call 6511 (738-6511). CONTROL will dispatch the necessary personnel to handle the situation.

- Employee Contamination - Move the victim into an uncontaminated area and perform a preliminary decontamination. A more thorough decontamination can be performed at a later time. Radio to CONTROL or call x6511 for assistance. Preliminary decontamination generally consists of flushing with water to dilute and remove most of the chemical or contamination using such devices as a safety shower. Remove contaminated clothing and wash the affected skin areas. Flush the skin for 15-30 minutes and report to FERMCO Medical Department

immediately. Minimize the spread of contaminant run off by use of dikes and other engineered controls. As soon as the chemical hazard has been reduced to an acceptable level, stabilize the victim.

In the event of chemical contamination to the eyes, move the victim to an uncontaminated area if possible. Hold the victim's eyes open and flush the victim's eyes for 15 minutes with water (or isotonic saline solution). The natural response to eye pain is to close the eyes. Keep the victim's eyes open to remove chemical from under the victim's eyelids. Flushing solution should be maintained near body temperature because it can cause extreme discomfort if it is too hot or too cold.

F.11.4.5 Radiologic Emergencies

- Release - If any release is suspected to contain radiological components, immediately leave the area and travel at least 300 feet upwind. From there, radio to CONTROL or call x6511 and report the event according to ED-0001, Event Notification and Reporting.

- Employee Contamination - Follow the guidelines under 9.0 Site Personnel Decontamination Requirement and 11.4.4.2 Employee Contamination (Chemical).

F.11.4.6 Weather Limitations / Adverse Conditions

Weather guidelines and warnings shall be followed as given by the Emergency Message System. In the event of severe weather, supervision shall contact the Health and Safety Representatives of the Industrial Safety Department in order to obtain any special operating requirements during weather.

F.11.4.7 Occurrence Investigation

Accidents shall be investigated according to Event Notification and Reporting, ED-0001.

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F.12 CHANGES / AMENDMENTS TO HEALTH AND SAFETY PLAN

This Health and Safety Plan is based on information available at the time of preparation. Treatability study-specific information will be routinely reassessed by supervision and the CRU3 RI/FS Health and Safety Manager. In addition, unexpected conditions/events may arise which require reassessment of the health and safety issues. Upgrading or downgrading of precautions, personal protective equipment, etc. identified in this plan must be approved by the CRU3 RI/FS Health and Safety Manager, or designee, and can be implemented without an amendment.

Unplanned activities and/or changes in work scope shall require a review and may require an amendment to this Health and Safety Plan. All amendments must be approved by the CRU3 RI/FS Health and Safety Manager.

The Health and Safety Attachments found in each Treatability Study-Specific Appendix may be changed in response to changing worksite conditions by the Environmental Health and Safety Divisions which are responsible for the change with the written approval of the CRU3 RI/FS Health and Safety Manager. The divisions are Radiologic Control, Fire and Safety, Industrial Hygiene and Industrial Safety.

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F.13 HEALTH & SAFETY COMPLIANCE SIGN-OFF

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The undersigned persons have read and understand this OU3 Treatability Studies Health & Safety Plan and agree to follow all provisions [1].

Name (Printed)	Signature	Badge #	Date

1 Compliance with the provisions of this Plan may be audited through announced or unannounced site visits. Be sure that you are implementing the provisions of the safety plan and documenting the reasons for approved field actions/changes when they are necessary. Site visits may be performed by FERMCO, DOE and/or OSHA.

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