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OPERABLE UNIT 4 TREATABILITY STUDY WORK PLAN FOR THE VITRIFICATION OF RESIDUES FORM SILOS 1, 2, AND 3 JANUARY 1992

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OPERABLE UNIT 4 TREATABILITY STUDY WORK PLAN FOR THE VITRIFICATION OF RESIDUES FROM SILOS 1, 2, AND 3

Fernald Environmental Management Project
Fernald, Ohio

January 1992

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Fernald Office
U.S. DEPARTMENT OF ENERGY

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Fernald Environmental Management Project

OPERABLE UNIT 4

TREATABILITY STUDY WORK PLAN
FOR THE VITRIFICATION OF RESIDUES FROM SILOS 1, 2, AND 3

January 1992

Fernald Office
Department of Energy

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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
ASI/IT	Advanced Sciences, Inc./International Technology Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	Department of Energy
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FFCA	Federal Facilities Compliance Agreement
FS	Feasibility Study
HSL	Hazardous Substance List
mL	milliliters
mrem	millirem
mTCLP	Modified Toxicity Characteristic Leaching Procedure
Pb	Lead
pCi/m^2-s	picoCuries/meter^2 per second
pCi/L	picoCuries/liter
PCi/hr	picoCuries/hour
pCi/g	picoCuries/gram
PNL	Pacific Northwest Laboratory
Po	Polonium
ppm	parts per million
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Program Plan
Ra	Radium
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
Th	Thorium
U	Uranium
WEMCO	Westinghouse Environmental Management Company of Ohio

LIST OF APPENDICES

1.0 PROJECT DESCRIPTION

1.1 SITE DESCRIPTION

The Fernald Environmental Management Project (FEMP) is a contractor-managed federal facility once used for the production of purified uranium metal for the U.S. Department of Energy (DOE). The FEMP is located on 1050 acres in a rural area approximately 20 miles northwest of downtown Cincinnati, Ohio. On July 18, 1986, a Federal Facilities Compliance Agreement (FFCA) was jointly signed by the U.S. Environmental Protection Agency (EPA) and DOE to ensure that environmental impacts associated with past and present activities at the FEMP are thoroughly investigated so that appropriate remedial actions can be assessed and implemented.

A Remedial Investigation/Feasibility Study (RI/FS) has been initiated to develop these remedial actions. The FEMP has been segregated into five operable units. Operable Unit 4 consists of Silos 1 and 2 (K-65 Silos), Silo 3 (metal oxide silo), the unused Silo 4, and their ancillary structures and the surrounding berms. Operable Unit 4 is located at the western periphery of the site, south of the waste pit area. The Feasibility Study (FS) for Operable Unit 4 is considering remedial actions for the silo structures, for wastes stored in the silos and for contaminants in the surrounding berms.

1.2 BACKGROUND INFORMATION

Silos 1 and 2 were used for the storage of radium-bearing residues formed as by-products of uranium ore processing. Silos 1 and 2 received approximately 7,200 cubic yards of residues from 1952 to 1958. Raffinates (residues resulting from uranium solvent extraction) were pumped into the silos as a slurry where the solids would settle. The free liquid was decanted through a series of valves and piping placed at various levels along the height of the silo wall. This procedure, pumping of slurry, followed by the settling and decanting, continued until the waste material was approximately four feet below the top of the vertical wall. Historic analyses of the K-65 silo residues indicate that approximately 11,200 kilograms of uranium (0.71 percent U-235) is present in Silos 1 and 2. Analytical results of residue samples, taken in July 1988, indicated uranium concentrations was 1400 parts per million (ppm) in Silo 1 and 1800 ppm in Silo 2. In addition, the estimated concentration of radium was between 0.13 to 0.21 ppm in the K-65 residues.

In 1989, Westinghouse Environmental Management Company of Ohio (WEMCO) collected residue samples from Silos 1 and 2. The analyses of the samples indicate that the concentration of radium-226 (Ra-226) in Silo 1 ranges from 89,280 picoCuries/gram (pCi/g) to 192,600 pCi/g; in Silo 2 from 657 to 145,300 pCi/g. Thorium-230 (Th-230) concentrations in Silo 1 range from 10,569 to 43,771 pCi/g and from 8,365 to 40,124 pCi/g in Silo 2. The concentration of lead-210 (Pb-210) in Silo 1 ranges from 48,490 to 181,000 pCi/g and from

77,940 to 399,200 in Silo 2. Total uranium concentrations in Silo 1 range from 1,189 to 2,753 ppm and from 137 to 3,717 ppm in Silo 2.

Radon and the elements resulting from its decay (referred to as daughter products, or progeny) are the nuclides of concern from a health and environmental perspective. Radon is known to be emanating from the silos via cracks and at joints. Radon and its daughter products are relatively mobile and capable of migrating through air and water. Due to the probable diffusion of radon into the berms, it is believed that the berms and subsoils contain elevated levels of lead-210 (Pb-210) and polonium-210 (Po-210). Also, there may have been leakage from the existing leachate collection system beneath the silos into the surrounding soils. If this has occurred, the potential for uptake of long-lived radionuclides would be a major hazard. Sampling of the berms and soil beneath the silos is underway to confirm the nature and extent of any soil contamination.

Silos 3 and 4 were constructed in 1952 in a manner similar to Silos 1 and 2; however, the silos were designed to receive dry materials only. Raffinate slurries from refinery operations were dewatered in an evaporator and spray-calcined to produce a dry waste for removal to Silo 3. The material was blown in under pressure to fill Silo 3. Silo 4 was never used and, except for rainwater infiltration, remains empty today.

Silo 3 contains approximately 5,100 cubic yards of calcined residues consisting of silica, uranium (39,600 pounds), a very small amount of radium, thorium, and other metal oxides. Silo 3 is not a significant radon source because of the physical and chemical characteristics of its contents. Also, Silo 3 is not believed to be a source of contamination to the surrounding areas and underlying soils. Nevertheless, Silo 3 must be considered a potential hazard because its contents are radioactive and in its dry powdery state susceptible to airborne dispersal if exposed to wind.

Appendix C contains more detailed information on the radiological, organic, and inorganic constituents of the silo material. However, these results do not fully characterize the contents of Silos 1 and 2. The variability and inconsistency of results from previous sampling efforts and the lack of material from the lower areas of the silos precludes the use of these data for fully characterizing the silos' contents. Therefore, a resampling program was conducted (and completed in August 1991), but analytical results are not available for inclusion into this document. The results will be documented in the Operable Unit 4 Remedial Investigation (RI) Report.

1.3 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) are medium-specific cleanup goals for protecting human health and the environment. The RAOs address the contaminants of concern as well as exposure routes and receptors identified in the baseline risk assessment. The primary purposes of RAOs are to ensure site-wide compliance with:

- Chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) guidelines

- U.S. EPA guidance for risk to public health from hazardous substances

- Regulatory standards for control of radiation and radioactivity in the environment

The remediation objectives for Operable Unit 4 must cover all constituents (radiological and chemical) that contribute to a reasonable maximum exposure (RME) scenario. RAOs for Operable Unit 4 are given in Figure 1-1. Alternatives for remediation must meet airborne and direct radiation RAOs at a point immediately adjacent to the silos, as well as drinking water RAOs in any perched water that might be encountered directly below the silos. The treatability study goals are given in Section 1.5.

Ten remediation alternatives for Operable Unit 4 are listed in the DOE report "Initial Screening of Alternatives for Operable Unit 4, Task 12 Report, October 1990." Nine of these alternatives are still under consideration. Laboratory data are required to evaluate the alternatives, eliminate alternatives that are not technically feasible, and aid in the selection of the preferred alternatives(s). Further details of the alternatives are given in Section 2.0.

1.4 TREATABILITY STUDY

1.4.1 Justification

The justification to conduct these tests is provided by EPA in "Guide for Conducting Treatability Studies Under CERCLA." Treatability studies can provide the critical performance and cost information needed to evaluate and select treatment alternatives. The document recommended treatability tests for those substances that do not have standard treatment methods or supporting data in the literature that prove the material of interest can be effectively treated to render it nonhazardous. More explicitly in the case of Operable Unit 4, the purpose of treatment is to render the residues from Silos 1, 2, and 3 nonleachable so that it is not classified as characteristic waste under the Resource Conservation and Recovery Act (RCRA). However, the primary goal of these treatability studies will be to develop a stable waste form with minimal leachability of all contaminants, including radionuclides. Among the studies being conducted is the vitrification of the K-65 and metal oxide materials. These studies will provide information in determining the impacts of the effectiveness of vitrification.

The laboratory testing previously accomplished by Battelle Pacific Northwest Laboratory (PNL) in Richland, Washington provides a basis that the K-65 material has the capabilities to be vitrified. In the vitrification process, the waste material is combined with glass forming reagents, mixed together and placed into a crucible. The crucible and its contents are

MEDIA		REMEDIAL ACTION OBJECTIVES
1. SILO CONTENTS		<u>For Human Health:</u>
	1-1	Prevent exposures to non-carcinogens which would result in a Hazard index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	1-2	Prevent migration of contaminants which would result in groundwater concentrations greater than the MCLs or non-zero MCLGs, that would result in a Hazard Index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	1-3	Prevent current and future direct radiation doses from exceeding 100 mrem/yr.
		<u>For Environmental Protection:</u>
	1-4	Prevent migration of contaminants that would result in surface water levels greater than ambient water quality criteria.
	1-5	Prevent current and future direct radiation doses from causing detectable chronic effects.
2. AIR		<u>For Human Health:</u>
	2-1	Prevent inhalation of contaminants which would result in a Hazard index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	2-2	Prevent doses from radionuclide emissions at the FEMP from exceeding 10 mrem/yr, and radon flux from exceeding 20 pCi/square meter-second.
		<u>For Environmental Protection:</u>
	2-3	Prevent current and future radiation emissions from causing detectable chronic effects.

FIGURE 1-1. REMEDIAL ACTION OBJECTIVES

MEDIA		REMEDIAL ACTION OBJECTIVES
3. SOILS		<u>For Human Health:</u>
	3-1	Prevent inhalation of/ingestion of/direct contact with soils surrounding the silos which would result in a Hazard Index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	3-2	Prevent migration of contaminants which would result in groundwater concentrations greater than the MCLs or non-zero MCLGs, that would result in a Hazard Index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	3-3	Prevent radium concentrations from exceeding 5 pCi/g in the first 15 cm of soil, and 15 pCi/g at lower depths. Prevent concentrations of other nuclides from exceeding levels that would result in doses greater than 100 mrem/yr.
		<u>For Environmental Protection:</u>
	3-4	Prevent migration of contaminants that would result in surface water contamination levels greater than ambient water quality criteria.
4. SEDIMENTS		<u>For Human Health:</u>
	4-1	Prevent ingestion of/direct contact with sediment contaminants which would result in a Hazard Index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
		<u>For Environmental Protection:</u>
	4-2	Prevent releases of contaminants from sediments that would result in surface water contamination levels greater than ambient water quality criteria.

FIGURE 1-1.
(CONTINUED)

MEDIA		REMEDIAL ACTION OBJECTIVES
5. SURFACE WATER	5-1	For Human Health: Prevent exposures to non-carcinogens which would result in a Hazard Index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	5-2	For Environmental Protection: Restore surface water to below ambient water quality criteria.
6. GROUNDWATER	6-1	For Human Health: Prevent ingestion of water having contaminant levels greater than the MCLS, non-zero MCLGs, TBCs, or which would result in a Hazard Index greater than or equal to unity (1), and/or combined risks from exposure to carcinogens greater than or equal to 1.0E-04, using 1.0E-06 as the point of departure.
	6-2	For Environmental Protection: Restore groundwater aquifer to contaminant concentration below the MCLs.

FIGURE 1-1.
(CONTINUED)

gradually heated up and brought to its melting temperature. During the heating process, some compounds in the waste will decompose or chemically react, often releasing off-gases. After the waste has been at its melting temperature long enough for the rock, debris, and other large particles to dissolve into the glass phase, the power will be shut off and it will be allowed to cool down.

In order to be able to compare the effectiveness of vitrification to stabilization and metal extraction as treatment options for the remedial alternatives for Silo 3 and the K-65 Silos in the feasibility studies and in the subsequent engineering designs, vitrification tests must be performed on the metal oxide residues (Silo 3 material) and additional data must be obtained for the K-65 residues. It is planned to utilize PNL to accomplish the treatability studies outlined in this document. PNL has extensive experience in conducting vitrification tests and has developed the laboratory bench-scale apparatus and the necessary experimental procedures for meeting quality assurance (QA) requirements.

The objectives of the previous laboratory tests were to determine the quantity and composition of the off-gas (including radon concentration) generated during vitrification of K-65 residue, the radon emanation rate from the vitrified K-65 waste, and the leachability of the vitrified K-65 waste. The test results from the previous laboratory tests have been documented in "Characteristics of Fernald's Silos 1 and 2 Residue Before, During and After Vitrification." Due to unforeseen laboratory conditions, inadvertently, the total volume of the generated off-gas during vitrification and, therefore, the total emanation of radon during vitrification, was not accurately measured. During the bench-scale treatability tests outlined in this document, special effort will be made to obtain accurate measurements of the total volume of the off-gas during vitrification and the emanation of radon during vitrification. The composition of the off-gas generated from the previous laboratory tests and the composition of the condensate from the previous laboratory tests are presented in Table 1-1.

During the previous vitrification tests, the radon emanation rate from the vitrified K-65 waste indicated that the radon concentration, which began at 0 pCi/L, averaged about 4 pCi/L. For the once through open loop system used, this represents an emanation rate of 48 pCi/hr or 1.56 pCi/m^2-s. This is an order of magnitude lower than the EPA limit of 20 pCi/m^2-s (40 CFR Part 61, Subpart Q).

Also, the Toxicity Characteristic Leaching Procedure (TCLP) leachate results from the previous laboratory test for the vitrified K-65 waste are presented in Table 1-2. The results are well below the established TCLP limits.

1.4.2 EPA Treatability Guidance

EPA's "Guide for Conducting Treatability Studies Under CERCLA" outlined a three-tiered approach to conducting treatability studies for a SUPERFUND site. The approach is exhibited in Figure 1-2. The evaluation of remedial alternatives phase of the RI/FS may require as many as three tiers of treatability testing:

TABLE 1-1
Composition of the Vitrification Off-Gas

COMPONENT	VOLUME %
Nitrogen	77.2%
Oxygen	17.1%
Other Ions	3.4%
Water	1.4%
Argon	0.9%
Carbon Dioxide	0.06%
Organic Compounds	None Detected

Condensate Composition

COMPONENT	(mg/L)
Aluminum	<0.1
Antimony	0.04
Arsenic	<0.01
Barium	0.07
Cadmium	<0.01
Calcium	14.1
Chromium	<0.01
Cobalt	0.01
Iron	0.06
Lead	0.09
Magnesium	3.7
Mercury	0.0029
Nickel	0.1
Phosphorus	0.2
Potassium	0.7
Selenium	0.19
Sodium	3.2
Total Uranium	0.011

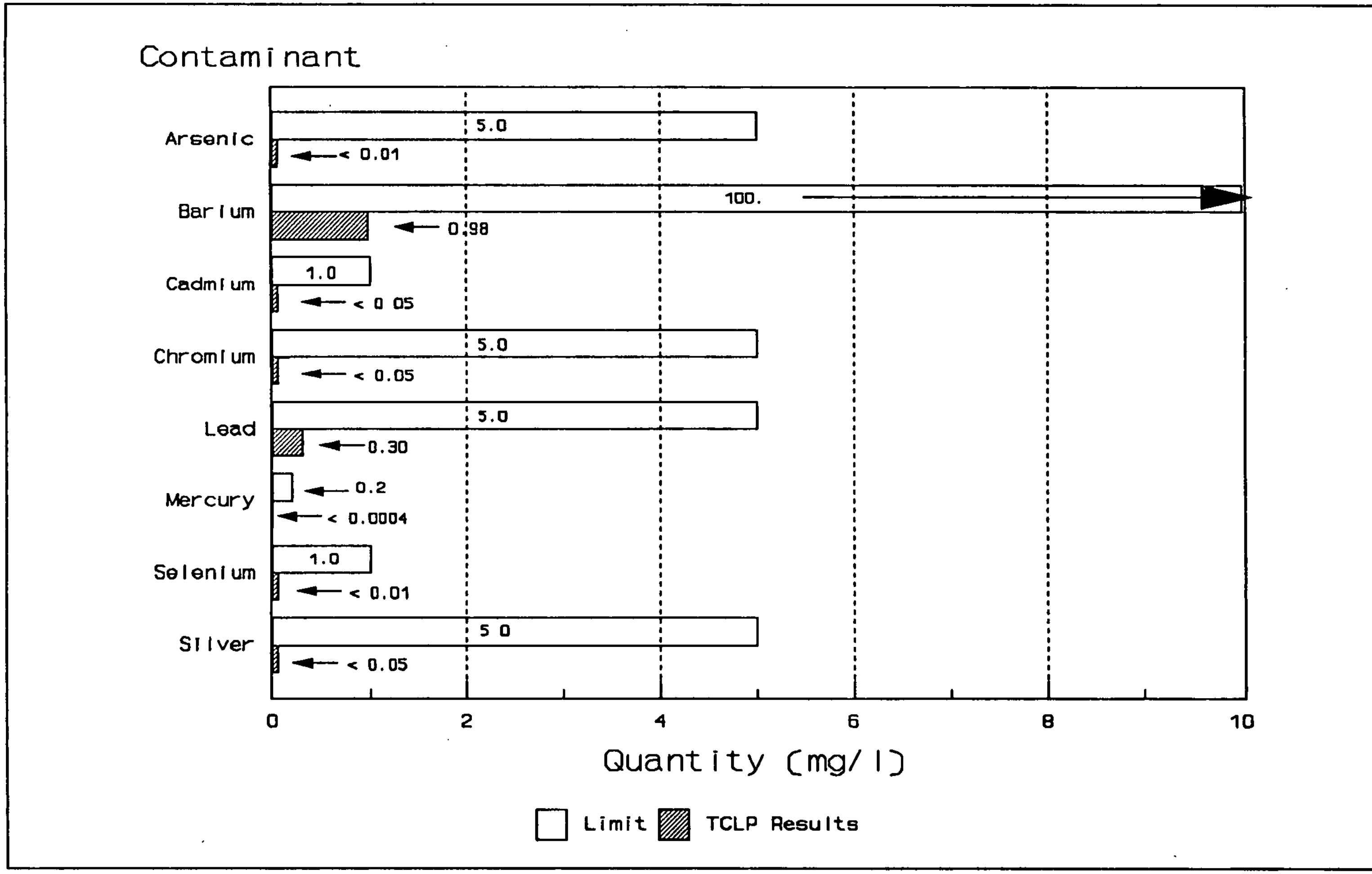

TABLE 1-2
Previous Laboratory Vitrification Tests
TCLP Leachate Results for Vitrified K-65 Material:
Concentration of Metals in Leachate

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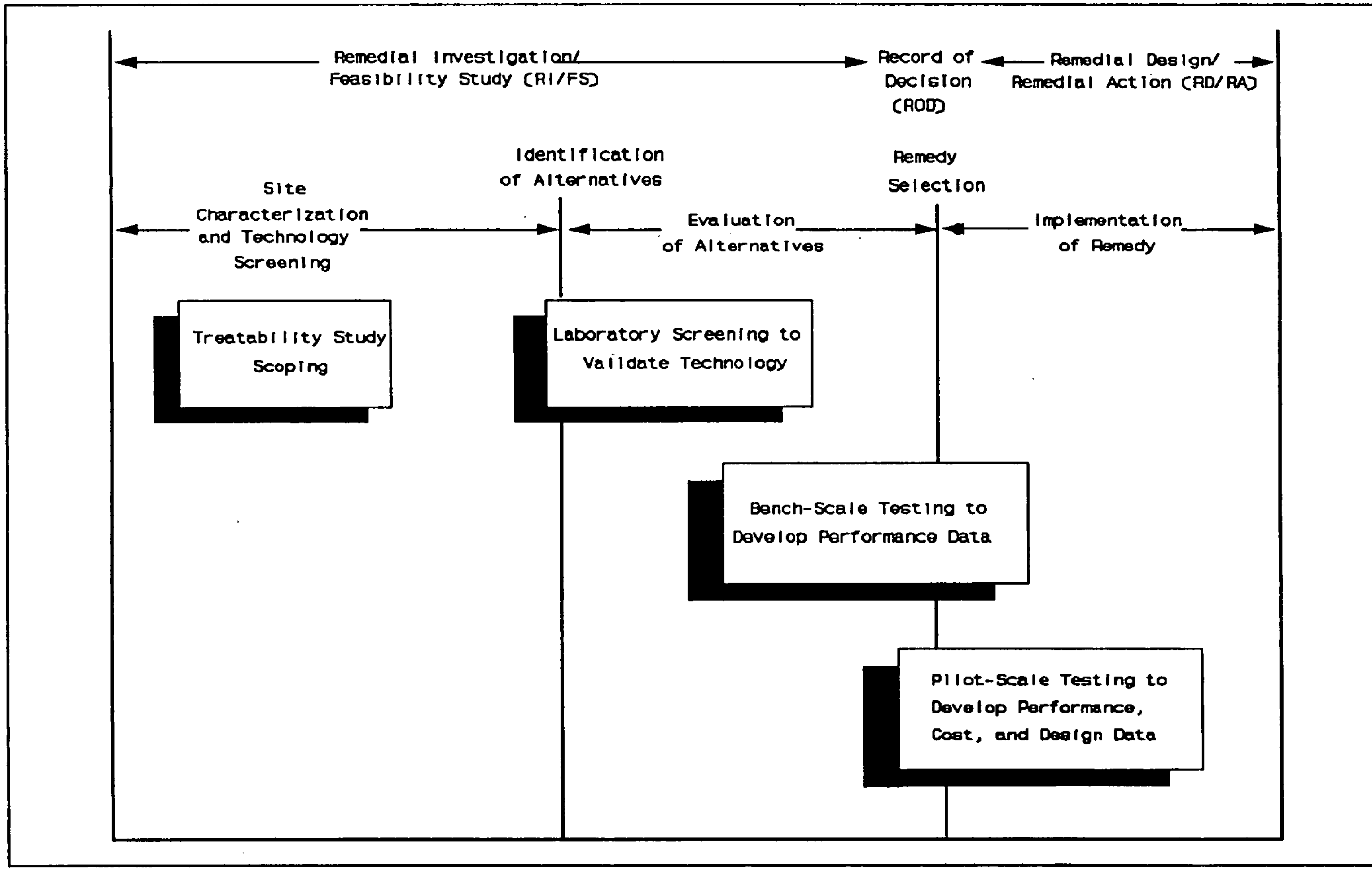

FIGURE 1-2
The Role of Treatability Studies in the RI/FS and RD/RA Process

- Laboratory Screening
- Bench Scale Testing
- Pilot-scale Testing

Laboratory screening and bench-scale testing are usually performed during evaluation of remedial alternatives. Pilot-scale testing is generally accomplished during remedy implementation. Laboratory screening has been performed on the K-65 material (Silos 1 and 2 material) during the previous laboratory testing accomplished by PNL. Additional laboratory screening of the K-65 material will be completed, as described in this work plan, prior to the bench-scale vitrification testing of the K-65 material. Laboratory screening of the metal oxide material (Silo 3 material) will be outlined in this document and will be performed prior to the bench-scale vitrification testing of the metal oxide material. The completion of the RI/FS detail analysis of remedial alternatives will determine if pilot-scale testing of the vitrification treatment option is required. Figure 1-3 illustrates the relationship of the completed, planned, and to be determined Operable Unit 4 vitrification treatability studies to the RI/FS process.

The detailed analysis of alternatives phase of the RI/FS follows the development and screening of alternatives and precedes the actual selection of a remedy in the Record of Decision (ROD). During the detailed analysis of alternatives, all remedial alternatives are evaluated based on nine RI/FS evaluation criteria.

Results of the treatability studies should address seven of these criteria:

1) Overall protection of human health and the environment
2) Compliance with ARARs
3) Implementability
4) Reduction of toxicity, mobility, or volume
5) Short-term effectiveness
6) Cost
7) Long-term effectiveness

1.4.3 Approach

Treatability studies on the K-65 materials and the metal oxides will be performed as part of the evaluation of remedial alternatives phase of the RI/FS. The vitrification treatability studies described in this work plan and the stabilization and metal extraction treatability studies outlined in the "Treatability Study Work Plan for Operable Unit 4" prepared by Advanced Sciences, Inc./International Technology Corporation (ASI/IT), dated July 1991, will aid in the selection of a remedial alternative that is feasible, implementable, and cost effective.

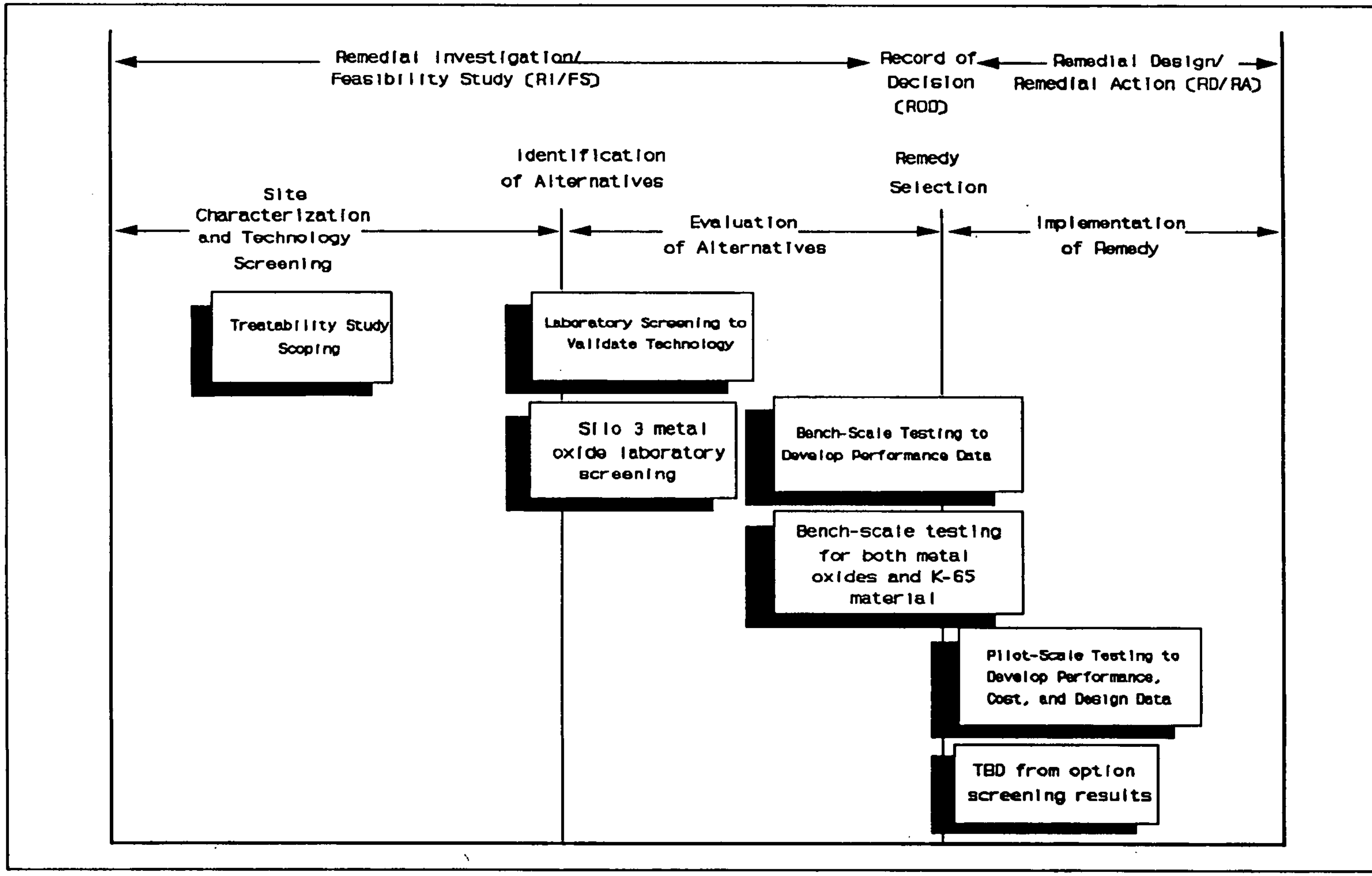

FIGURE 1-3
Relationship of the Operable Unit 4 Vitrification Treatability Studies to the RI/FS

The vitrification treatability studies described in this work plan will involve the vitrification of K-65 material from Silos 1 and 2 and the metal oxide material from Silo 3. Vitrification studies will be performed on the K-65 material by itself, the K-65 material with added Bento-grout, the metal oxide material by itself, and a predetermined mixture of K-65 material and metal oxide material.

A forthcoming Operable Unit 4 removal action is the addition of a layer of Bento-grout to Silos 1 and 2. The Bento-grout layer retards the diffusion of radon being produced during the uranium decay sequence. Consequently, the Bento-grout layer with its trapped hazardous and radiological constituents will require the same treatment option as that of the K-65 material. To determine the impacts of this Bento-grout layer, one testing sequence will include Bento-grout added to the K-65 material prior to the vitrification.

The method used to collect residue samples from Silos 1 and 2 was to use the Vibra-Corer Unit. These samples were collected according to the methods and procedures detailed in the "Revised K-65 Silo Sampling and Analysis Plan" issued by ASI/IT on July 15, 1991. PNL will receive samples of the K-65 material from sections "A", "B", and "C" for each Silo 1 and 2 and one composite sample from each of the K-65 Silos. Metal oxide material from Silo 3 is available from cores archived during previous sampling operations. PNL will receive composite material from Silo 3 for use in the bench-scale tests for the metal oxide material.

Prior to performing vitrification testing on the metal oxide material, laboratory screening of the metal oxide material will be accomplished to determine the optimum glass forming material(s) to be added to the metal oxide material during vitrification. Also using existing K-65 material, tests will be conducted on the off-gas collection system and the radon adsorption system to optimize the bench-scale design of these systems.

1.4.4 Verification of Results

After a successful test run of the following vitrification sequences; K-65 material, K-65 material/Bento-grout mixture, and metal oxide material/K-65 material mixture, analyses will be conducted on the vitrified residues to determine the leachability of hazardous constituents, the leachability of radionuclides and the radon emanation of the vitrified residues. These tests will include the standard EPA TCLP protocols, radionuclide analyses per the Quality Assurance Project Plan (QAPP) approved by the U.S. EPA as part of the RI/FS Work Plan, and determining the radon emanation with appropriate instrumentation. Utilizing the laboratory equipment and instrumentation available, PNL will monitor the vitrified K-65 waste to determine the radon emanation (at 7 days and 30 days). Determining the radon emanation will not be performed for Sequence C vitrified material. After a successful test run, PNL will send duplicate samples of the vitrified waste from each vitrification sequence to an independent laboratory for the TCLP analysis as established in the QAPP approved by the U.S. EPA as part of the RI/FS Work Plan.

Also, for each vitrification sequence, the liquid collected from separating the moisture from the off-gas will be sent to an independent laboratory as established in the QAPP approved as part of the RI/FS Work Plan. The liquid will then be analyzed for constituents as identified in the QAPP and will include: general water quality parameters, Hazardous Substance List (HSL) parameters, gross alpha, gross beta, gamma spectral analysis, and the following radionuclides:

- Radium-224
- Radium-226
- Radium-228
- Actinium-227
- Protactinium-231
- Polonium-210
- Lead-210
- Isotopic Thorium
- Isotopic Uranium
- Total Uranium

The analysis of the liquid effluent will aid in determining the required treatment or evaporation of the liquid. This data will aid in implementation of the design for the vitrification treatment option for the preferred alternative.

Information obtained for the identified vitrification treatability studies will aid in estimating the cost of implementation of the vitrification treatment option of remedial Alternatives 6 and 7 for the Silos 1 and 2, the vitrification treatment option of remedial Alternatives 3 and 4 for Silo 3, and the vitrification treatment of the leaching/stabilization of the contaminant separation stage of Alternatives 8 and 9 for the Silos 1 and 2.

1.5 GOALS OF THE TREATABILITY STUDY

The primary goal of the treatability study is to support remedy selection during the feasibility study (FS). It supports the FS by providing data about the waste treatment under consideration by the FS. This information is used to select the most promising treatment technologies for further consideration, in conjunction with other aspects of the proposed alternative designs.

This treatability study is designed to provide data for technologies that lower the leachability of contaminants vitrifying them into an altered material. These data will be compared to preliminary remediation goals, toxic constituent regulatory limits (TCLP limits), and site background concentrations to determine if attainment of any or all of these goals is feasible using the vitrification technology. These quantitative goals are developed in Section 3.0, which outlines the treatability study's specific performance objectives.

2.0 REMEDIAL TECHNOLOGY DESCRIPTION

Several remediation technologies are being considered for Operable Unit 4. These alternatives have been described in detail in the DOE report "Initial Screening of Alternatives for Operable Unit 4, Task 12 Report, October 1990." In the Task 12 Report, Silos 1 and 2 are treated by the same alternatives because the materials in the structures are similar. Silo 3 is treated in separate alternatives.

The vitrification technology considered in the following alternatives consists of heating the residues to sufficient temperatures to induce the formation of glass-like mass. The resulting vitreous solid will have a reduced volume, be less likely to leach hazardous and radioactive components, and have a greatly reduced radon emanation rate. The vitrified material would be well suited for long-term disposal.

2.1 SUMMARY OF ALTERNATIVES - SILOS 1 AND 2

Alternative 0A - No Action

This alternative calls for no action and provides a baseline against which the other alternatives can be compared. It provides for the silos and its contents to remain unchanged without the implementation of any removal, treatment, containment, or mitigative measures. However, it does include the installation of long-term monitoring equipment and the implementation of a monitoring program.

Alternative 1A - Nonremoval and Silo Isolation

This nonremoval alternative for Silos 1 and 2 consists of enhancing the containment integrity of the silos and utilizing them as permanent disposal facilities. An impermeable clay cap and slurry walls are among the technologies considered for this alternative.

Alternative 2A - Nonremoval, In Situ Stabilization, and Capping

This nonremoval alternative for Silos 1 and 2 consists of in situ stabilization and capping. Conventional physical stabilization and vitrification were considered as options. However, vitrification was screened out as a process option due to concerns about the difficulty of implementability. The capping and isolation technologies, with the exception of the slurry wall, are identical to those described for Alternative 1A.

Alternative 6 - Removal, Treatment, and On-Property Disposal

This alternative for Silos 1 and 2 calls for the removal and conventional stabilization or vitrification of the silo contents before on-property disposal in an engineered disposal facility.

This alternative includes silo demolition and disposal of the debris. Figure 2-1 is a flow diagram of Alternative 6.

Alternative 7 - Removal, Treatment, and Off-Site Disposal

This alternative is identical to Alternative 6 except that the material would be packaged for shipment to an approved off-site disposal facility. A flow diagram for Alternative 7 is provided in Figure 2-2.

Alternative 8 - Removal, Contaminant Separation, and On-Property Disposal

This alternative is similar to Alternative 6 but adds an additional step of contaminant separation to remove various radionuclides and metals before stabilization or vitrification and on-property disposal. A potential volume reduction of material to be disposed of as radioactive waste. The waste materials will be subjected to acid and EDTA leaching processes to dissolve the radioactive and hazardous metals, including lead, uranium, thorium, and radium. This leaching process is based on data from Seeley (1977), Mound Laboratories (1951), and Battelle (1981). Lead, barium, copper, and other metals will also be dissolved in the extraction fluid. Following this leaching stage, the remaining solids will enter a solid/liquid separation stage, and the leachate containing the radioactive and hazardous materials will be sent to a precipitation stage. This precipitation stage will add selected anions to yield a radioactive/hazardous precipitate to be solidified or stabilized for disposal. With the successful leaching process, the raffinate residues remaining after the acid or EDTA leaching processed will be disposed of as a nonhazardous waste. A flow diagram of this alternative is presented in Figure 2-3.

Alternative 9 - Removal, Contaminant Separation, and Off-Site Disposal

This alternative is identical to Alternative 8, except that the solidified/vitrified material would be packaged and shipped to an approved off-site disposal facility while the nonhazardous portion is sent to a landfill or is used as backfill on the property. See Figure 2-4 for the Flow diagram.

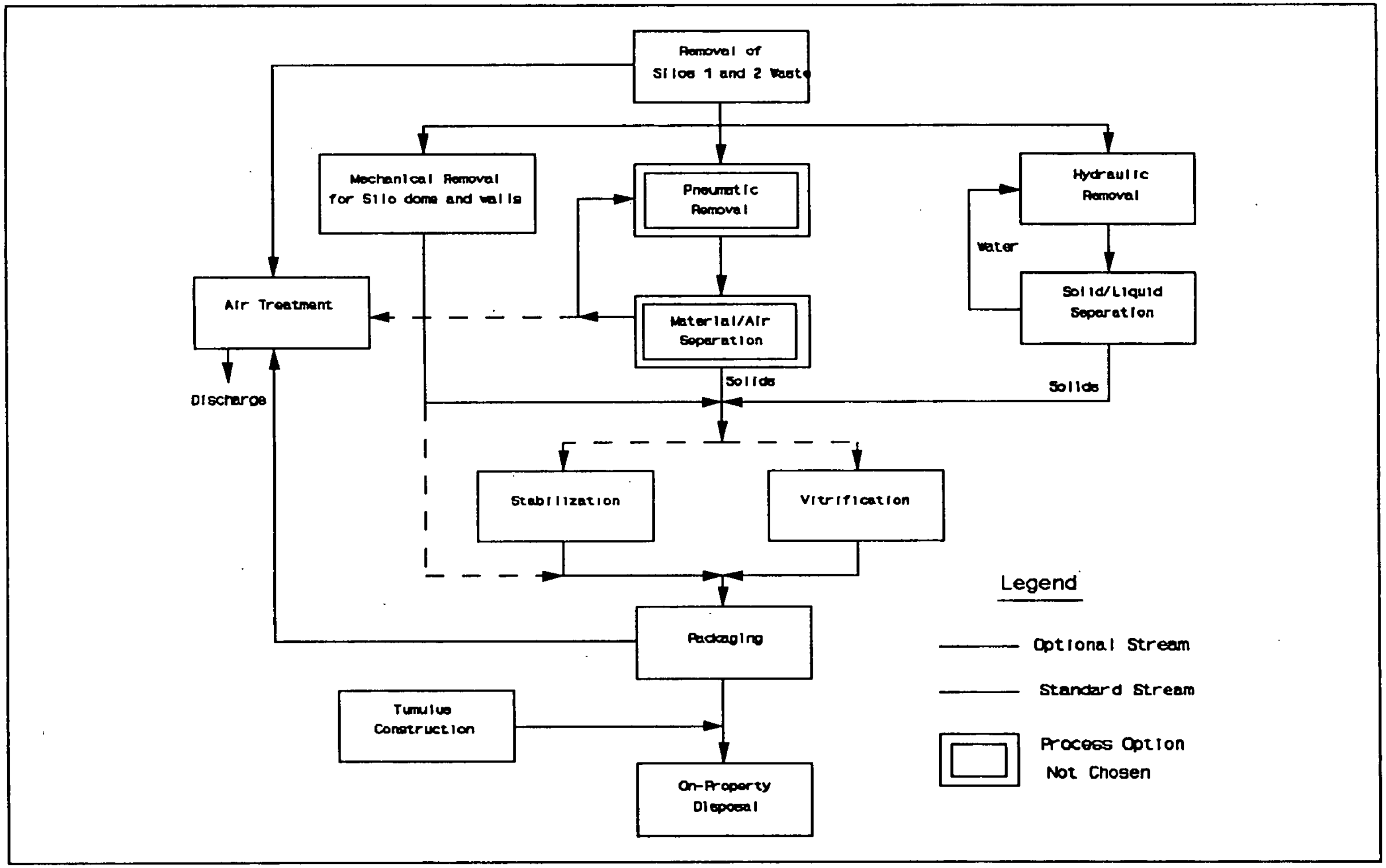

FIGURE 2-1
ALTERNATIVE 6: REMOVAL, TREATMENT, ON-PROPERTY DISPOSAL

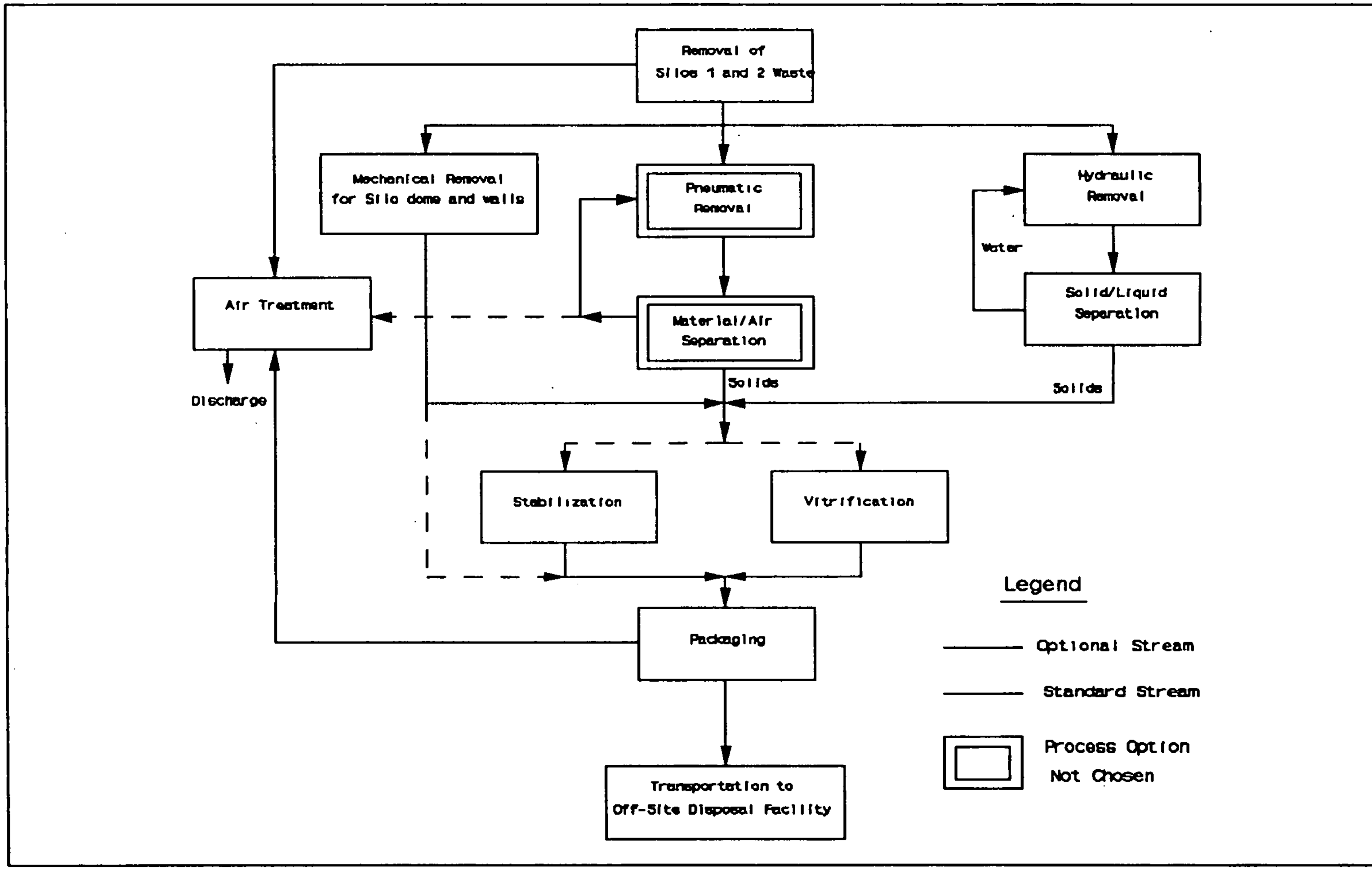

FIGURE 2-2
ALTERNATIVE 7: REMOVAL, TREATMENT, OFF-SITE DISPOSAL

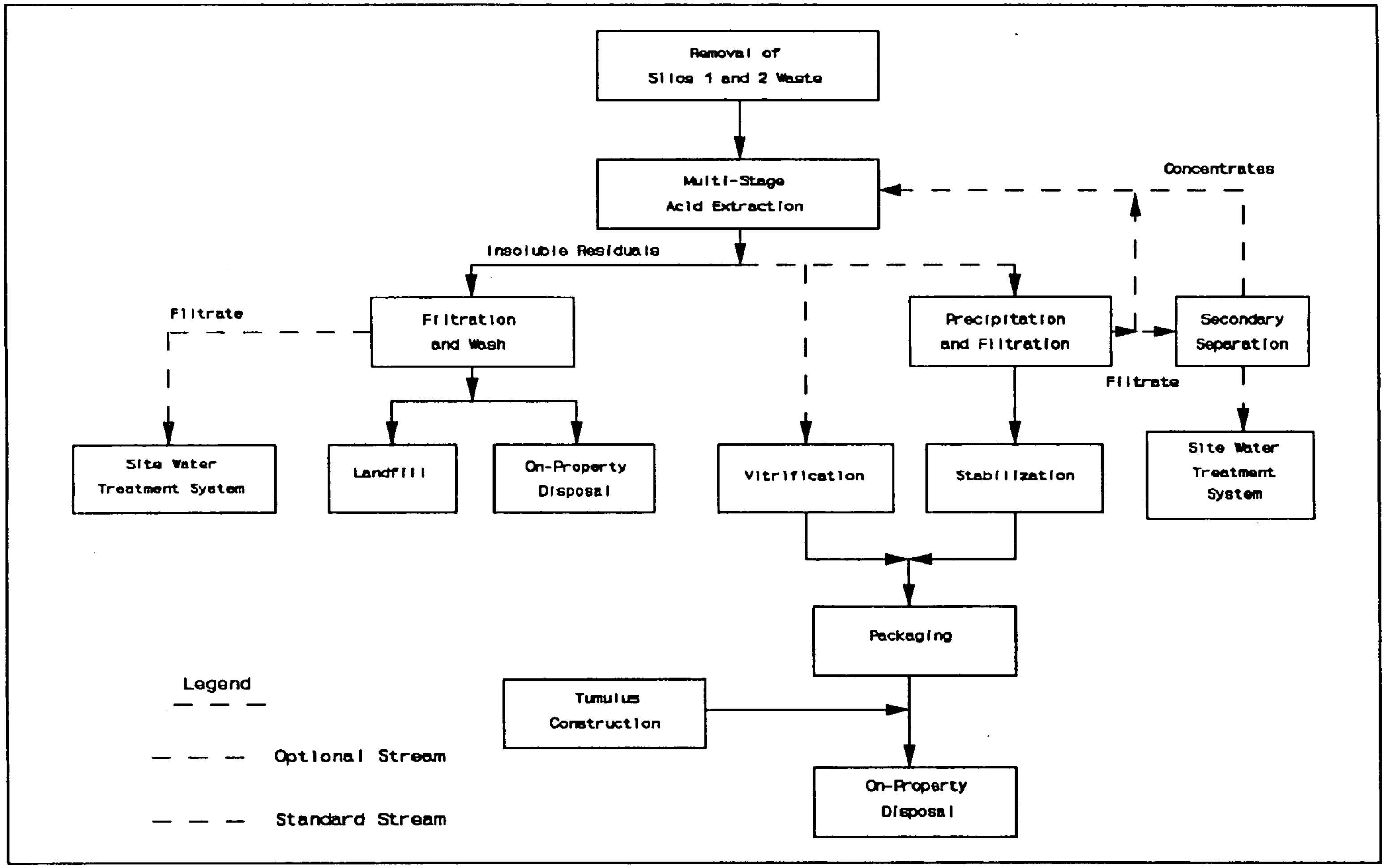

FIGURE 2-3
ALTERNATIVE 8: REMOVAL, CONTAMINANT SEPARATION, ON-PROPERTY DISPOSAL

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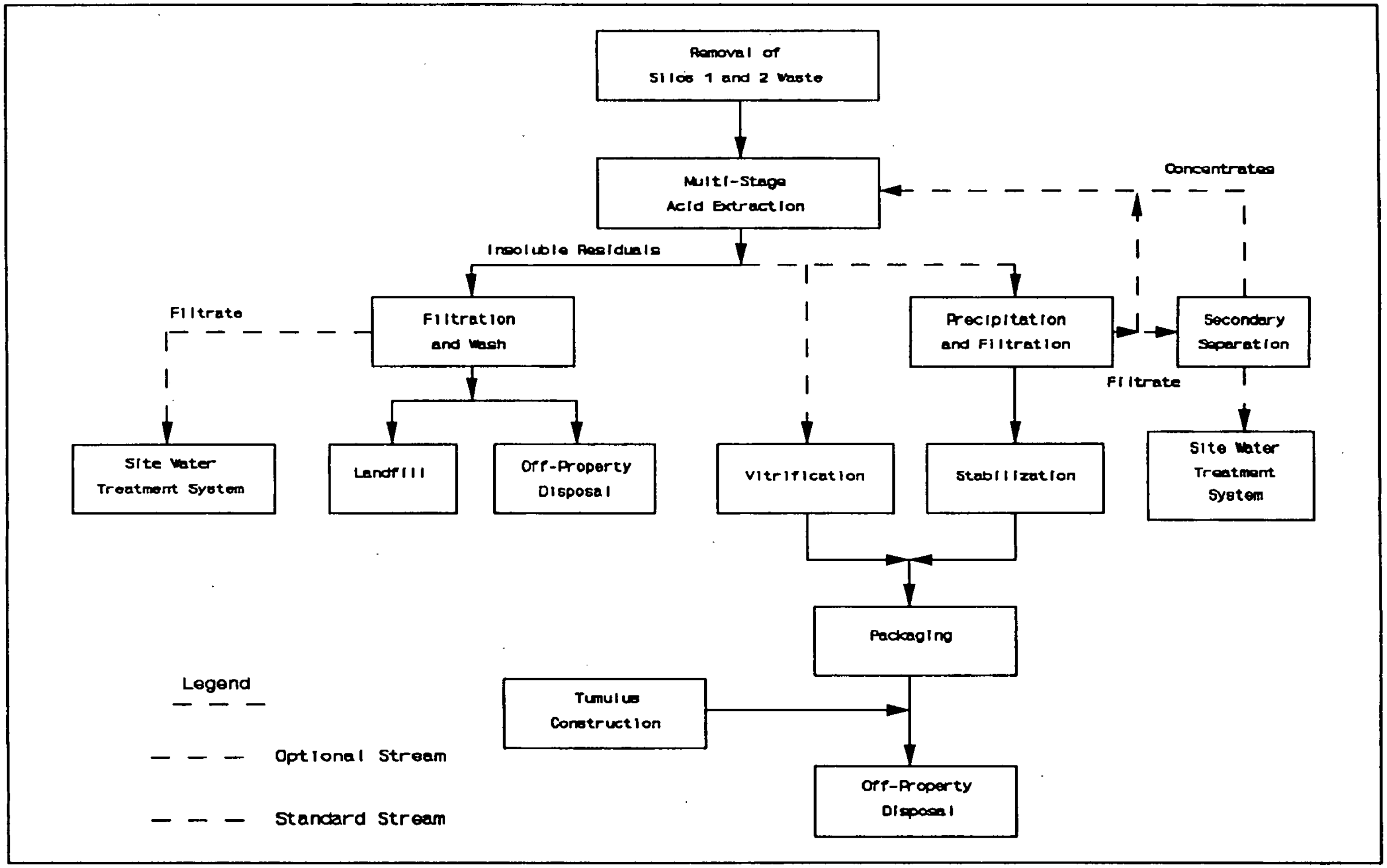

FIGURE 2-4
ALTERNATIVE 9: REMOVAL, CONTAMINANT SEPARATION, OFF-SITE DISPOSAL

2.2 SUMMARY OF ALTERNATIVES - SILO 3

Alternative 0B - No Action

The no-action alternative for Silo 3, as was the case for Silos 1 and 2, provides a baseline, but no remedial action. Only installation of long-term monitoring equipment and the implementation of the monitoring program are included.

Alternative 1B - Nonremoval and Silo Isolation

This nonremoval alternative for Silo 3 consists of enhancing the containment integrity of the silo and utilizing it as a permanent disposal facility. An impermeable clay cap and slurry walls are among the technologies considered for this alternative.

Alternative 2B - Nonremoval, In Situ Stabilization, and Capping

This nonremoval alternative for Silo 3 consists of in situ stabilization and capping. The capping and isolation technologies, with the exception of the slurry wall, are identical to those described in Alternative 1B.

Alternative 3 - Removal and On-Property Disposal

This alternative for Silo 3 calls for removal and conventional stabilization or vitrification before disposal in an engineered on-property disposal facility. This alternative includes silo demolition and disposal of the debris. The flow diagram for Alternative 3 for Silo 3 is identical to Alternative 6 for the K-65 silos except that the feed for the process is from Silo 3.

Alternative 4 - Removal of Metal Oxides and Off-Site Disposal

This alternative for Silo 3 is identical to Alternative 3, except that the material would be packaged for shipment to an approved off-site disposal facility. The flow diagram for Alternative 4 is analogous to that for Alternative 7.

Alternative 5 - Removal and Replacement in Rehabilitated Silos

This alternative for Silo 3 provides for the removal of the metal oxides and their return to a rehabilitated Silo or Silo 4 reconstructed as a permanent disposal facility. This alternative was not carried through to detailed analysis because of its inadequate effectiveness and implementability.

Four alternatives for the three silos are considered non-viable. These alternatives are the "No Action" alternatives, OA (K-65 Silos) and OB (Silo 3); Alternative 2B "Nonremoval, In Situ

Stabilization, and Cap," (Silo 3); and Alternative 5 "Removal and Replacement in Rehabilitated Silo 3" Alternative 5.

The treatability tests described in this work plan will provide data for evaluating the performance of the remedial alternatives for both the K-65 residues (Silos 1 and 2) and the metal oxide waste stored in Silo 3. The treatability testing will be conducted to determine the effectiveness and long-term stability of; the vitrification treatment option of remedial Alternatives 6 and 7 for the Silos 1 and 2, the vitrification treatment option of remedial Alternatives 3 and 4 for Silo 3, and the vitrification treatment of the leaching/stabilization of the contaminant separation stage of Alternatives 8 and 9 for the Silos 1 and 2.

3.0 TEST AND DATA QUALITY OBJECTIVES

The purpose of the proposed vitrification tests is to obtain quantitative data for assessing the performance of the process in support of the RI/FS. The operational and performance information resulting from the proposed bench-scale test will permit more accurate full-scale cost and schedule estimates than those that can be made from laboratory screening information. The bench-scale tests will also provide information to configure and size unit operation for pilot scale testing.

3.1 PERFORMANCE OBJECTIVES AND DESIRED DATA

Specific test objectives have been identified so that the performance of this process can be readily compared to other remediation technologies under investigation. Leachability and volume reduction are two aspects on which this technology will be evaluated. The objectives of the test, both laboratory screening and bench-scale testing, are listed below:

Laboratory Screening

- To determine the chemical inorganic composition of samples from both K-65 material and the metal oxides
- To determine the anions present in both primary waste streams (K-65 and metal oxide materials)
- To determine the concentration of radioactive isotopes in both primary waste streams
- To measure radon emanation of untreated K-65 material
- To measure the bulk density of untreated wastes
- To determine the percent moisture of untreated wastes
- To measure the specific gravity of untreated wastes

Bench-Scale Testing

- To determine the composition of the off-gas
- To determine the radon emanation during vitrification of the K-65 material
- To measure the radon emanation from the vitrified K-65 material

- To ensure the final waste product meets the leaching criteria established in 40 CFR 261.24 by performing the TCLP on final waste products

- To evaluate the volume reduction potential of the vitrification process for the two primary waste streams

- To determine the chemical composition of the condensate

- To measure the specific gravity of vitrified waste

3.2 DATA QUALITY OBJECTIVES

The establishment of data quality objectives (DQOs) is part of the process that defines the data quality needs of the project. The implementation of an appropriate quality assurance/ quality control (QA/QC) program is required to ensure that data of known and documented quality are generated. Establishment of the DQOs will determine the level of QA/QC required for the treatability testing and analysis. DQO analytical levels are defined in EPA's guidance document "Guide for Conducting Treatability Studies Under CERCLA" (EPA/540/2-89-058). Table 3-1 summarizes the DQO levels. A list of tests and associated DQOs is delineated in Table 3-2.

3.3 PROCEDURES

The procedures specific to the Operable Unit 4 vitrification treatability studies are currently being developed by PNL and will be submitted when they become available. The following procedures will be submitted:

- Physical properties of the untreated waste

- Radon emanation from untreated K-65 waste

- Radon emanation during vitrification of K-65 material

- Radon emanation from treated K-65 waste

- Modified TCLP for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver

- Method for determining volume reduction

- Method for determining gamma dose rates of vitrified waste

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Level I	
Type of analysis	Field Screening or analysis with portable instruments.
Limitations	Usually not compound-specific, but results are available in real time. Not quantifiable.
Data Quality	Can provide an indication of contamination presence. Few QA/QC requirements.
Level II	
Type of analysis	Field analysis with more sophisticated portable instruments or mobile laboratory. Organics by GC; inorganics by AA, ICP, or XRF.
Limitations	Detection limits vary from low parts per million to low parts per billion. Tentative identification of compounds. Techniques/instruments limited mostly to volatile organics and metals.
Data Quality	Depends on QA/AC steps employed. Data typically reported in concentration ranges.
Level III	
Type of analysis	Organics/inorganics performed in an off-site analytical laboratory. May or may not use CLP procedures. Laboratory may or may not be a CLP laboratory.
Limitations	Tentative compound identification in some cases.
Data Quality	Detection limits similar to CLP. Rigorous QA/QC.
Level IV	
Type of analysis	Hazardous Substances List (HSL) organics/inorganics by GC/MS, AA, ICP. Low parts-per-billion detection limits.
Limitations	Tentative identification of non-HSL parameters. Validation of laboratory results may take several weeks.
Data Quality	Goal is data of known quality. Rigorous QA/QC.
Level V	
Type of analysis	Analysis by nonstandard methods.
Limitations	May require method development or modification. Method-specific detection limits. Will probably require special lead time.
Data Quality	Method-specific.

TABLE 3-1
SUMMARY OF ANALYTICAL LEVELS

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TEST	DQO/COMMENT	DQO LEVEL
LABORATORY SCREENING		
Chemical Inorganic composition by Inductively Coupled Plasma (ICP)	Prior to vitrification tests, samples of both K-65 material and metal oxides will be analyzed to determine their inorganic components. This information will be used to predict the type and quantity of glass forming agents required.	II
Anion composition by Inductively Coupled Plasma Mass Spectrometer (ICPMS)	Anion composition analysis will give a basis from which to predict some general off-gas characteristics.	II
Radioactive isotope composition by Gamma scan	Determining the quantity of some pertinent isotopes will aid in predicting radon concentration in the off-gas.	II
Physical Property Determination (percent moisture, bulk density, and specific gravity)	Determining the physical properties of the untreated wastes will aid in predicting vitrification process parameters.	V
Radon emanation from untreated K-65 material	This information will be used as a comparison to the radon emanation from the vitrified material.	V
BENCH-SCALE TESTING		
Elemental composition of the off-gas by Mass Spectrometric Gas Analysis	Characterization of the off-gas is important in determining the best additives for vitrifying that waste stream.	II
Radon emanation during vitrification	Determining the amount of radon contained in the off-gas is critical in designing the off-gas treatment system for full-scale implementation.	II
Measurement of the radon emanation from the vitrified product	This quantity will be used to evaluate the effectiveness of vitrification in reducing radon emanation.	II
Modified Toxicity Characteristic Leaching Procedure (mTCLP)	The MTCLP will be used as a preliminary test to determine if the vitrified product should be accepted as a satisfactory test. A sample from the product that passes this test will be sent to an independent lab for the full TCLP.	V
Full TCLP	To determine if the vitrified product meets the TCLP criteria. This test will provide data for the FS risk assessment calculations.	III
Volume reduction	To quantify vitrification's ability to reduce the volume of waste requiring disposal.	V

TABLE 3-2

ANALYTICAL TESTS AND ASSOCIATED DQO LEVELS

4.0 EXPERIMENTAL DESIGN AND PROCEDURES

4.1 LABORATORY SCREENING

Laboratory screening will be performed on the metal oxide material from Silo 3 and the K-65 material from Silos 1 and 2. The laboratory screening will be used to establish the validity of vitrifying the metal oxide material. This screening study will yield data that will be used as indicators of the vitrification technology to meet performance goals and will identify parameters for investigation during the bench-scale testing outlined in Sections 4.2.2 through 4.2.5.

Laboratory screening of the metal oxide material will involve analytical tests to determine the chemical inorganic and anion composition of the metal oxide material. Table 4-1 lists the elements that will be included in the inorganic analysis of the metal oxide material. The results of the analysis will be expressed in weight percent (wt%) as oxides. Table 4-2 specifies the chemicals to be included in the analyses for anions in the metal oxide material. The analytes listed in Tables 4-1 and 4-2 are the specific elements that affect the feasibility of the vitrification technology as determined by PNL. Also during the laboratory screening of the metal oxide material, a gamma scan will be conducted on the metal oxide material that will be used in the bench-scale vitrification testing to determine the radionuclide isotopic content of the material. The isotopes that will be identified by each gamma scan during laboratory screening are as follows:

- Actinium-227
- Protactinium-231
- Lead-210
- Polonium-210
- Radium-224
- Radium-226
- Radium-228
- Thorium-228
- Thorium-230
- Thorium-232
- Uranium-234
- Uranium-235/236
- Uranium-238

During the previous laboratory tests on the K-65 residue material that was supplied to PNL, analytical tests were performed to determine the chemical inorganic composition of the K-65 residue. The sample material provided to PNL for these previous laboratory tests was understood not to be representative of the material in Silos 1 and 2. Since this sample was from the 1989 sampling effort, it is understood that most of this sample came from Zone A. Current vitrification samples are identified as Zone A, B, and C, as well as a composite and are, therefore, considered representative. Therefore, the laboratory screening tests to be executed per this work plan will include analyses to determine the chemical inorganic composition of the K-65 material to be supplied to PNL, which includes samples from sections "A", "B", and "C" for each Silo 1 and 2 (six separate samples). PNL will be required to extract material from each of the samples provided to form a composite sample for each silo. Each of these composite samples will be analyzed for chemical inorganic composition of the material. Table 4-1 specifies the elements that will be included in the inorganic analysis of the K-65 material.

During the previous laboratory test on the K-65 material, the analytical tests did not include determining the anion composition of the K-65 material. The laboratory screening tests to be executed per this work plan will also include analytical tests to determine the anion composition of the K-65 material to be supplied to PNL. Each sample from sections "A", "B", and "C" for each Silo 1 and 2 and the composite sample formed from the samples provided will be analyzed for anion composition. Table 4-2 specifies the chemicals to be included in the analyses for anions in the K-65 material.

Also, during the previous laboratory tests on the K-65 residue material, a gamma scan was conducted to determine the isotopic content of the material. Table 4-3 represents the isotopic content of the K-65 material that was vitrified during the previous laboratory tests.

A gamma scan will also be conducted on the K-65 material samples from sections "A", "B", and "C" for Silo 1 and 2 and the composite sample for each of the K-65 Silos that will be vitrified as outlined in this work plan. The isotopes that will be identified by each gamma scan during laboratory screening are as follows:

- Polonium-210
- Actinium-227
- Protactinium-231
- Lead-210
- Radium-224
- Radium-226
- Radium-228
- Thorium-228
- Thorium-230
- Thorium-232
- Uranium-234
- Uranium-235/236
- Uranium-238

Also, during the previous laboratory tests on the K-65 residue material, radon emanation was determined on the untreated K-65 material. Radon emanation from the untreated K-65 material will be determined for the composite sample for each of the K-65 Silo composite samples that will be vitrified as outlined in this work plan.

TABLE 4-1
Laboratory Screening

Inorganic Chemical Analyses of Metal Oxide Material
and K-65 Material:
(weight % as oxides)

Silica	Copper
Lead	Cerium
Iron	Vanadium
Barium	Lanthanum
Aluminum	Uranium
Calcium	Manganese
Magnesium	Zirconium
Sodium	Neodymium
Phosphorus	Strontium
Titanium	Beryllium
Potassium	Thorium
Nickel	Tin
Cobalt	Selenium
Molybdenum	Zinc
Chromium	Chlorine
Sulfur	Fluorine

TABLE 4-2
Laboratory Screening

Characterization of Anions in Metal Oxide Material
and K-65 Material

Sulfate
Sulfide
Sulfite
Chloride
Nitrate
Carbonate

TABLE 4-3
Isotopic Content of K-65 Material
from Previous Laboratory Testing

ISOTOPE	ACTIVITY (nCi/g)
Th-230	264.7
Ra-226	479.4
Pb-214	297.8
Bi-214	280.0
PB-210	338.2
Pa-231	29.8
Th-227	21.1
Ra-223	22.4
Rn-219	20.8
Pb-211	65

4.2 BENCH-SCALE TESTING

The bench-scale tests are designed to verify whether the alternatives which include vitrification as a treatment option described in Section 2 can meet the performance goals established by the ARARs. These tests will provide a quantitative evaluation of the performance of the vitrification treatment option as well as minimal cost and design information. The general objectives of the following tests are to: determine the composition of the off-gas generated during vitrification, the radon emanation rate from the vitrified K-65 material, and the leachability of the vitrified material. Quantifying the amount of radon during vitrification of the K-65 material will be determined by utilizing an open system, therefore, it will not be required to determine the quantity of off-gas generated. Figure 4-1 illustrates the equipment flow diagram for the open system.

The first test run for each of the Sequences involving K-65 material will be performed utilizing the open system equipment set-up. This is to enable continuous monitoring of the radon emanation during the vitrification process. The second test run for each of the Sequences involving K-65 material will be performed utilizing the closed system equipment set-up. This is to allow for sufficient collection of off-gas to determine off-gas chemical composition. A closed system will be used to ensure a representative sample of the off-gas will be collected. Figure 4-2 illustrates the equipment flow diagram for the closed system.

Prior to performing the testing identified in the following sections, the K-65 material and metal oxide material will be separated into batches. The bench-scale vitrification tests will be conducted by batch operations. The material will not be dried or sieved to remove rocks and other extraneous items as done in the previous vitrification testing. A batch of material from each testing sequence will be processed through the entire bench-scale system. Tests using specific components of the bench-scale system will be required to determine ideal melting temperatures for the various blends of material in Test Sequence B (K-65 material/Bento-grout) and Test Sequence D (K-65 material/Silo 3 material). These tests may also be required to determine ideal melting temperatures for Test Sequence C. These tests, if required, will utilize approximately 100 grams of material per test. Also, open system tests using specific components of the complete system may be performed for Test Sequence C (Silo 3 material) to determine process parameters prior to performing a complete bench-scale system test. Table 4-4 outlines the vitrification tests and identifies the type of material for each testing sequence. The amount of material listed on Table 4-4 for each test sequence is the estimated quantity of material required to complete each test sequence. This estimate will determine the amount of K-65 material and Silo 3 material to be shipped to PNL in support of the vitrification testing. The batch material will be melted in a 4-inch diameter by 12-inch tall (about 2.5 liters) inconel crucible, or relative equal, in a bench-scale furnace. The following data will be recorded for each batch of material tested (the specific data to be recorded for each test is included in Section 8.0):

TABLE 4-4
Operable Unit 4
Vitrification Tests for K-65 Material and Metal Oxide Material

SEQUENCE	TEST	TYPE OF MATERIAL	APPROX. AMOUNT OF MATERIAL	DESCRIPTION
0		K-65	0 kg	Off-gas collection/radon adsorption system testing using 900 grams of material at PNL. Remaining tests will use modified system.
A	1	K-65	2.0 kg	K-65 material and glass forming reagents based on previous tests and chem. composition analyses.
A	2	K-65	2.0 kg	Duplicate of Test 1.
B	3	K-65	1.0 kg	Test to determine the influence of Bento-grout on the vitrification of K-65 material. 50/50 ratio is max. on removal of material from Silos 1 and 2.
		Bento-grout	1.0 kg	
B	4	K-65	1.0 kg	Duplicate of Test 3.
		Bento-grout	1.0 kg	
C	5	Silo 3	1.5 kg	Initial trial run of metal oxide to glass forming reagents. Ratio determined during the laboratory screening.
C	6	Silo 3	1.5 kg	If Test 5 results are within specified bounds, this test will be a duplicate of Test 5. Or if initial ratio is revised per Test 5 results, Test 7 will be required.
C	7	Silo 3	1.5 kg	Duplicate of Test 6, if required.
D	8	K-65	2.0 kg	Initial trial run of 70/30 ratio to determine characteristics on vitrified product of mixing waste streams.
		Silo 3	1.0 kg	
D	9	K-65	2.0 kg (max)	If Test 8 results are within specified bounds, this test will be a duplicate of Test 8. Or if initial ratio is revised per Test 8 results, Test 10 will be required.
		Silo 3	2.0 kg (max)	
D	10	K-65	2.0 kg (max)	Duplicate of Test 9, if required.
		Silo 3	2.03 kg (max)	
	Total estimated amount of K-65 sample required: 12.0 kg Total estimated amount of Silo 3 metal oxides required: 9.5 kg			

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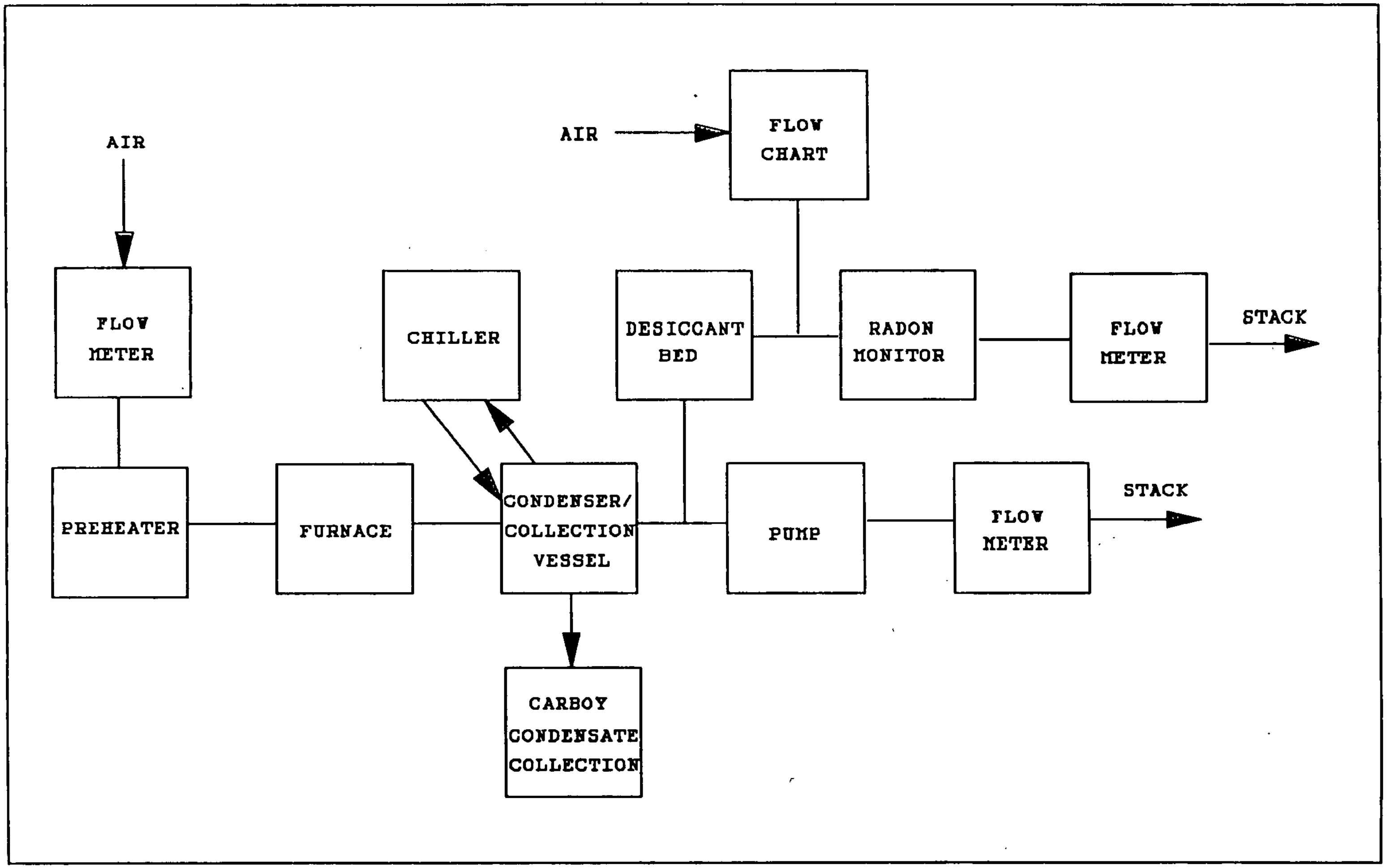

FIGURE 4-1
Equipment Flow Diagram Open System
Operable Unit 4 Vitrification Treatability Studies

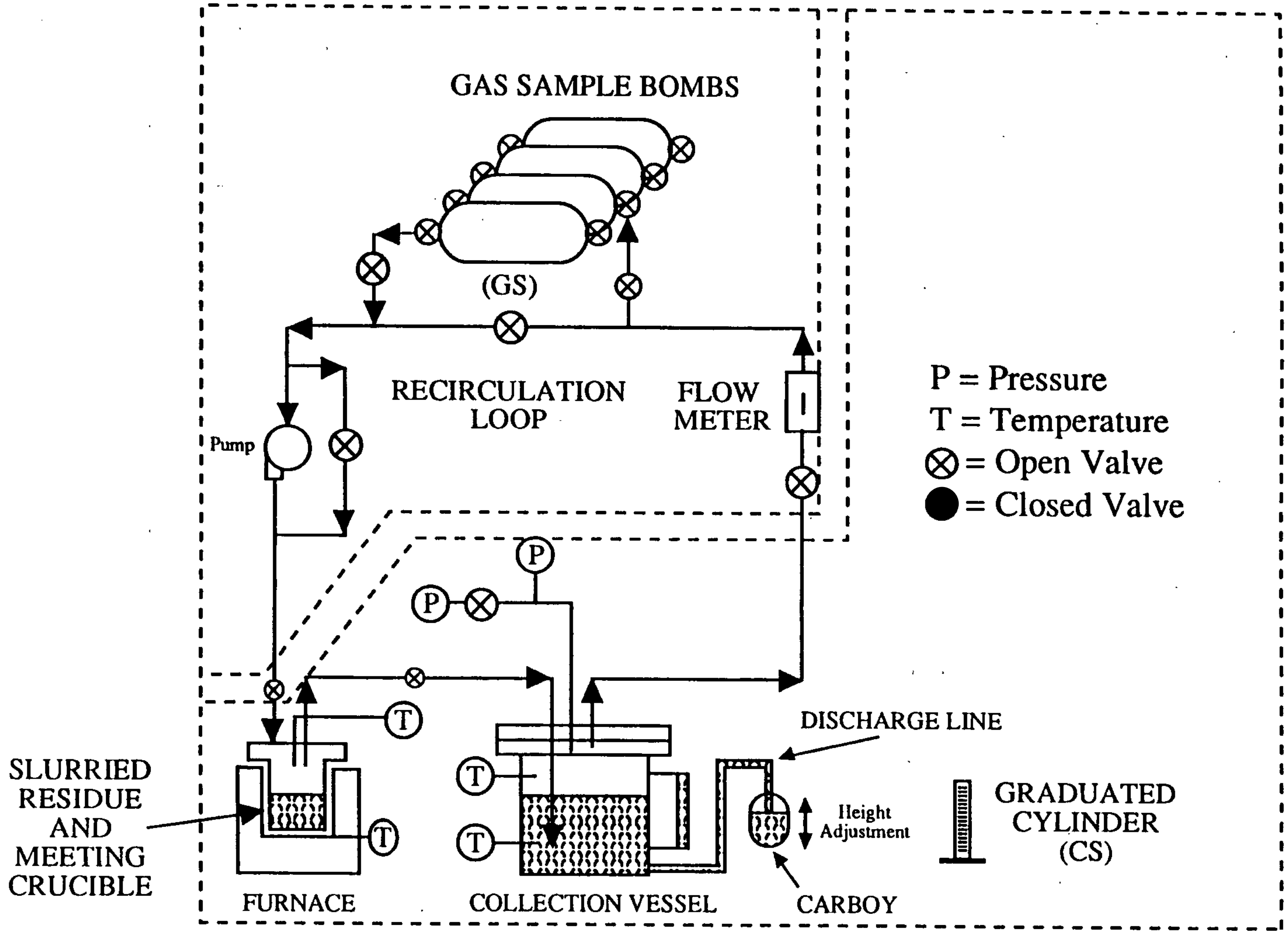

FIGURE 4-2
Equipment Flow Diagram Closed System
(Off-Gas Collection System)
Operable Unit 4 Vitrification Treatability Studies

- The chemical composition of the collected off-gas;

- The resulting vitrified K-65 material from each batch will be monitored for radon emanation;

- The leachability of the vitrified material, including TCLP and radionuclides; and

- The composition of the condensate will be determined as defined in Section 1.3.4.

After a successful test run from each vitrification sequence, PNL will send samples of the vitrified residues from both the successful test run and the duplicate test run to an independent laboratory for the TCLP analysis as established in the QAPP approved as part of the RI/FS Work Plan. The Decision Analysis Tree for Vitrification Treatability Studies for Silos 1, 2 and 3 Material is shown on Figure 4-3.

4.2.1 Preliminary Off-gas Testing

Based on results of the previous vitrification testing from the used off-gas collection system and radon adsorption system, PNL has evaluated the results of the previous vitrification testing. It was determined that the modifications best suited to radon measurement would be a continuous measurement of radon in the off-gas stream as opposed to a determination of the radon content based on collection of the total quantity of off-gas. Therefore, the total volume of off-gas will not be measured.

Laboratory equipment designed for the continuous monitoring of radon in the off-gas will be used to verify the methodology in determining the amount of radon generated for the identified vitrification sequences. This preliminary testing of the off-gas stream may require several trail test runs to determine the exact equipment set-up of the open system. The material to be used during this testing will be approximately 900 grams of untreated K-65 material previously shipped to PNL that was not used during the previous vitrification tests on the K-65 material.

All subsequent sequence tests to determine the radon emanation during vitrification will use an open system equipment set-up which was determined by the preliminary testing of the off-gas.

4.2.2 Sequence A - Vitrification of K-65 Material

The batch of material for the first vitrification test (Test 1) will consist of approximately 2000 grams (2 kg) of K-65 material and the identified glass forming reagents based on the previous vitrification testing and laboratory screening results. It is estimated that approximately 10-15% (by weight) of reagent grade NaOH will be added to the K-65 material to form a

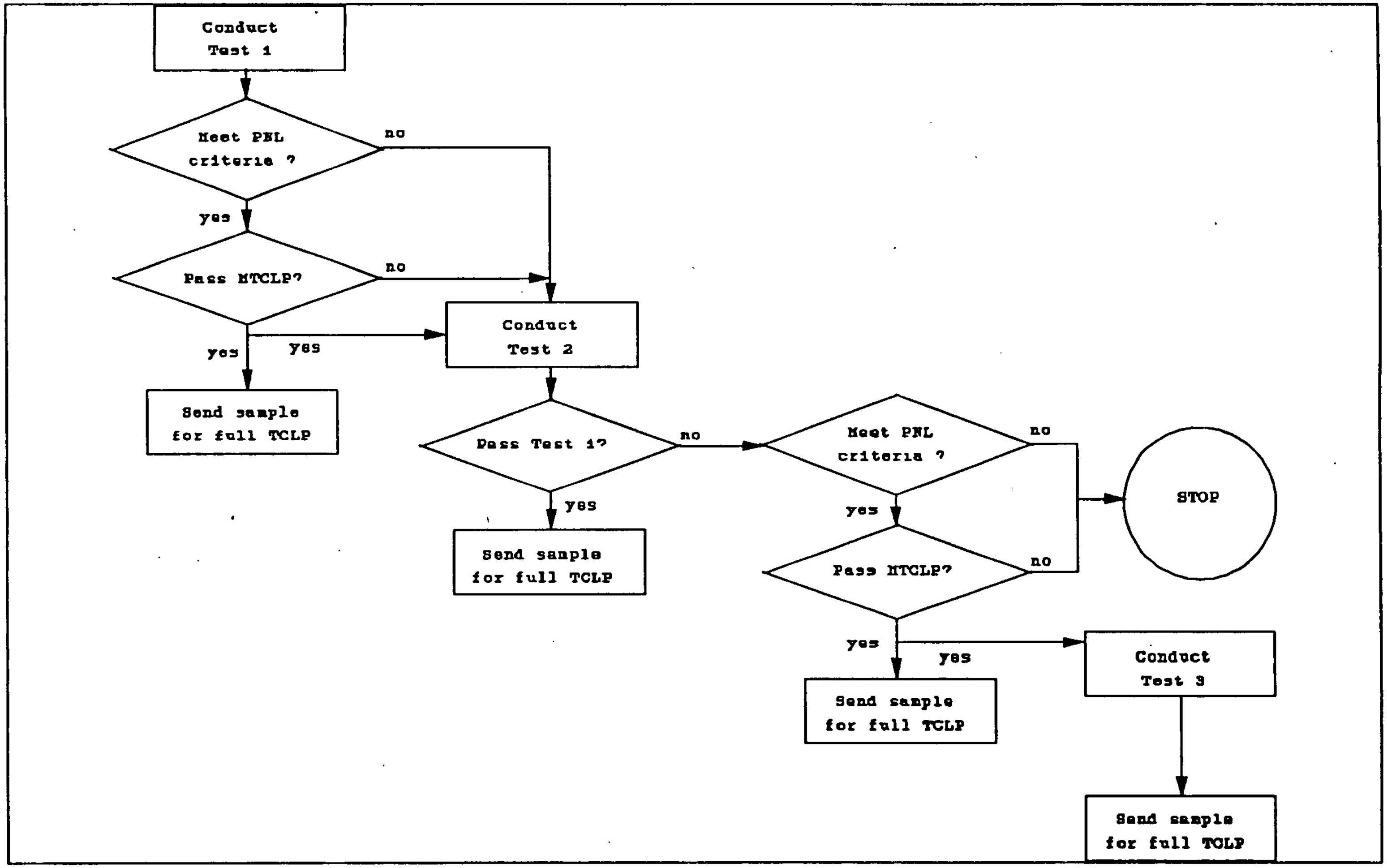

FIGURE 4-3
Decision Analysis Tree for Vitrification Treatability Studies
for Silos 1, 2 and 3 Material

silicate glass. Previous vitrification testing utilized reagent grade NaOH for the K-65 material. Particular attention will be given to the continuous measurement of the radon concentration of the off-gas. Samples of the vitrified waste will be analyzed for TCLP concentration of metals in the leachate. Test 2 will duplicate Test 1 to verify the results. Test 2 will use the closed system equipment set-up. Duplicating or triplicating each successful test for performing bench-scale tests is recommended by the EPA "Guide for Conducting Treatability Studies Under CERCLA."

4.2.3 Sequence B - Vitrification of K-65 Material Mixed with Bento-grout

A forthcoming Operable Unit 4 removal action is the addition of a layer of Bento-grout to Silos 1 and 2. The Bento-grout layer retards the diffusion of radon produced during the decay of radium-226. Consequently, the Bento-grout layer, with its trapped hazardous and radiological constituents, will require the same treatment option as that of the K-65 material. To determine the impacts of this Bento-grout layer, testing Sequence B will include Bento-grout added to the K-65 material prior to the vitrification process. It is estimated that approximately 10-15% (by weight) of reagent grade NaOH will be added to the K-65 material/Bentonite mix to form a silicate glass. Testing the K-65 material/Bento-grout mix will determine the influence of Bento-grout on the vitrified product. Preliminary tests may be performed to determine ideal melting temperatures, the suitable glass forming reagents and the blend of K-65 material to Bento-grout.

The initial test run (Test 3) will involve a mix ratio by mass of K-65 material to Bento-grout. The initial mix ratio by mass will be based on the maximum amount of Bento-grout that possibly could be in the waste stream upon removal of the top layer of material from Silos 1 and 2 and the results of the preliminary open system tests.

Test 4 will duplicate Test 3 to verify the results.

4.2.4 Sequence C - Vitrification of Metal Oxide Material

Sequence C tests will determine if it is possible to obtain an acceptable vitrified metal oxide product. The specific glass forming reagents that are required will be calculated based on the results of the laboratory screening of the metal oxide material. It is anticipated that glass forming reagents such a silica, iron, aluminum, boron, and calcium will be added to the metal oxide material to form a phosphate glass. Preliminary tests will be performed using the Silo 3 material to determine the initial process parameters prior to performing a complete system test to vitrify the Silo 3 materials. If the identified test for Sequence C is in compliance with the PNL specific criteria for vitrification, the vitrified product will be analyzed for leachability by PNL or their subcontractor by conducting a modified TCLP[1] (mTCLP) on the vitrified material.

PNL specific criteria for vitrification will be PNL's best engineering judgment of the vitrification process parameters. PNL specific criteria is based on approximately 30 years of experience in performing vitrification studies. The PNL specific criteria would include items such as:

- Melting temperature to form glass would indicate the comparability with the vitrification
- Presence of spinels, crystals, or other observable non-homogeneities would indicate an inadequate waste form
- Possible slag (e.g., sulfate layer) on top of the vitrified waste form would indicate possible incompatibility with the vitrification process
- Presence of heavy metals, sulfides, etc. on bottom of the melted material would indicate possible incompatibility with the vitrification process

A successful test run will be defined as meeting the PNL specific criteria and the leachability of the heavy metals are within regulatory requirements as determined by the modified TCLP.

After further review of the 1989 sampling data for the metal oxide material included in the Draft Operable Unit 4 Remedial Investigation Report, it has been found that due to the sulfur content of the material, vitrification may not be a feasible treatment technology. If vitrification is determined not to be a feasible alternative, no further testing will be performed after the laboratory screening of the Silo 3 material.

If the initial test run, Test 5, is compliant with the PNL specific criteria for vitrification and results of the mTCLP comply with 40 CFR 261.24g, Test 5 will be considered a successful test run and a sample of the vitrified product will be sent to the independent laboratory as established in the QAPP. Test 6 will be performed as a duplicate test of Test 5 and a sample of the vitrified product also sent to the independent laboratory as established in the QAPP.

1

[1]The modified TCLP, as it applies to the identified vitrification tests, is defined as analysis of the vitrified product for leachability of the following heavy metals; Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver. Based on the available EP toxicity data (Buelt, 1989) from the previous vitrification test, all of the heavy metals from the EP toxicity list, with the exception of lead were below the regulatory limits.

If the initial test run, Test 5, is compliant with the PNL specific criteria for vitrification or the vitrified product from the Test 5 does not meet the TCLP leach rates limits, the appropriate modifications based on the results of Test 5 will be made for conducting Test 6. The modifications could involve revising the glass forming reagents or altering the vitrification process parameters, or modifying the bench-scale equipment set-up. Modification of the process parameters will be a major factor in determining whether the same process facility could be utilized for the vitrification of the K-65 material and the metal oxide material.

If required, the appropriate modifications will be made and Test 6 will be performed. If Test 6 is compliant with the PNL specific criteria for vitrification and the mTCLP results meets TCLP leach rates limits, Test 6 will be considered a successful test run and a sample of the vitrified product will be sent to the independent laboratory as established in the QAPP. Test 7 will be performed as a duplicate test of Test 6 and a sample of the vitrified product also sent to the independent laboratory as established in the QAPP.

There is a possibility that based on the results of Test 5, 6 and 7, PNL will determine that vitrification of the metal oxide material is not a technically feasible treatment option for the remediation of the Silo 3 material.

4.2.5 Sequence D - Vitrification of Metal Oxide Material Mixed with K-65 Material

The mixture of Silo 3 and K-65 material has been proposed for the purpose of reducing costs of remediation. The specific glass forming reagents and the amounts that are required will be calculated based on the laboratory screening of the metal oxide material and the K-65 residues. It is not known nor is it assumed that the mixture of K-65 and Silo 3 material will easily vitrify. If an incompatibility of this mixture is determined during laboratory screening tests, further studies will not be conducted (Bench-scale testing Sequence D will not be conducted).

Sequence D tests will determine if it is possible to obtain an acceptable vitrified product by mixing the K-65 material and the metal oxide material. The initial test run of Sequence D (Test 9) will involve a 70/30 mix ratio[2] by mass of K-65 material to metal oxide material. The 70/30 mix ratio by mass is based on the estimated total mass of the two primary Operable Unit 4 waste streams: the K-65 material and the metal oxide material. To conduct Sequence D tests, the specific glass forming reagents will be calculated using the results of the laboratory screening of the metal oxide material and results from Sequence A and C tests. If the identified test for Sequence D is compliant with the PNL specific criteria for vitrification, the vitrified product will be analyzed for leachability by PNL or their subcontractor by conducting a modified TCLP on the vitrified material.

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[2]Unless determined otherwise after reviewing the laboratory screening analytical results.

If the initial test run, Test 8, is compliant with the PNL specific criteria for vitrification and the mTCLP results meets the TCLP leach rate limits, Test 8 will be considered a successful test run and a sample of the vitrified product will be sent to the independent laboratory as established in the QAPP. Test 9 will be performed as a duplicate test of Test 8 and a sample of the vitrified product also sent to the independent laboratory as established in the QAPP.

If the initial test run, Test 8, is not satisfactory, the appropriate modifications based on the results of Test 8 will be made for conducting Test 9. The modifications could involve revising the glass forming reagents or altering the vitrification process parameters or modifying the bench-scale equipment set-up. Results of these tests will be a major factor in determining whether the same process facility could be utilized for the vitrification of the K-65 material and the metal oxide material.

If required, the appropriate modifications will be made and Test 9 will be performed. If Test 9 is satisfactory, this test will be considered a successful test run and a sample of the vitrified product will be sent to the independent laboratory as established in the QAPP. Test 10 will be performed as a duplicate test of Test 9 and a sample of the vitrified product will also be sent to the independent laboratory as established in the QAPP.

There is a possibility that based on the technical results of Test 8, 9, and 10, a determination by PNL will be made that vitrification of the identified waste streams is not a technically feasible treatment option for the remedial alternatives for Operable Unit 4.

5.O EQUIPMENT AND MATERIALS

Table 5-1 provides a preliminary list of equipment and materials required to complete the bench-scale tests. All the items listed, in addition to those identified by PNL, will be provided by PNL.

TABLE 5-1
EQUIPMENT AND MATERIALS

- Air Heater
- Furnace
- Furnace Temperature Controller
- Thermowells and Thermocouples
- Moisture Analyzer
- Scale (Weight Measurement)
- Flow Meters
- Crucibles with Sealing Flanges and Unique Label
- Gas Sample Bombs
- Oil-Less Vacuum Pump
- Chiller
- Condenser/Collection Vessel
- Seal Materials for Crucibles, Collection Vessel, etc.
- Glass Forming Reagents
- Carboys, Sample Bottles, Beakers, and Other Common Lab Equipment
- Activated Carbon Cartridges
- Desiccant Beds
- Radon Monitors
- Computer with Printer
- Any Other Equipment that Becomes Necessary to Perform the Work

6.0 SAMPLING AND ANALYSIS

The sampling and analysis plan for the acquisition of residue samples for Silos 1 and 2 is contained in the "Implementation Plan for the K-65 and Metal Oxide Sampling Project at the Feed Materials Production Center, Fernald, Ohio," Addendum-SAP, October 10, 1990.

7.0 DATA MANAGEMENT

The collection and preparation of silo residues for shipment to PNL shall be according to procedures developed by ASI/IT and WEMCO as contained in the "Implementation Plan for the K-65 and Metal Oxide Sampling Project at the Feed Materials Production Center, Fernald, Ohio," Addendum-SAP, October 10, 1990. The vitrification data will be acquired in accordance with the PNL Vitrification QA Plan WTC-060 as presented in Appendix A. PNL shall provide a records-turnover-package which contains all raw data generated during the vitrification project, all calculations performed, plus all QA documentation specified in the above mentioned QA Project Plan.

Laboratory notebooks will be used for this project. All laboratory notebooks are uniquely numbered and permanently bound with sequentially numbered pages. The notebook will be a project-specific notebook which will be assigned to the individuals working on the project. All daily laboratory activities associated with the project will be recorded in the project-specific notebooks.

The all records management and reporting for the TCLP analyses performed on the vitrified material will follow standard QA/QC protocol in the QAPP and Volume 4 on the RI/FS Work Plan.

8.0 DATA ANALYSIS AND INTERPRETATION

8.1 EFFECTIVENESS OF WASTE FORM

The results of the TCLP in determining the leach rates of the vitrified material will be used to evaluate the long-term effectiveness of each sequence of testing. The concentrations of radioactive and hazardous constituents in the leachate will be used as input into the geochemical models described in the RI/FS Work Plan Addendum on risk assessment methodology. These models will be used with groundwater fate and transport models, which will then be used to calculate concentrations of contaminants in the aquifer at the reasonable maximum exposure, and the resulting risks to human health and the environment.

8.2 LABORATORY SCREENING

8.2.1 Metal Oxide Material From Silo 3

The following data will be presented in tabular form for the metal oxide material provided to PNL:

- General description of the waste
- Chemical inorganic composition as listed in Table 4-1
- Anion composition as listed in Table 4-2
- Radionuclide isotopic content as listed in Table 4-3
- Physical characteristics: percent moisture, bulk density, specific gravity

8.2.2 K-65 Material From Silos 1 and 2

The following data will be present in tabular form for each of the six samples provided to PNL from section "A", "B", and "C" of each Silo 1 and 2 and the composite samples for each K-65 Silo PNL made from the samples provided (8 sets of data will be provided):

- General description of the waste
- Chemical inorganic composition as listed in Table 4-1
- Anion composition as listed in Table 4-2
- Radionuclide isotopic content as listed in Table 4-3
- Physical characteristics: percent moisture, bulk density, specific gravity
- Radon emanation of composites of untreated sample material

8.3 BENCH-SCALE TESTS

The following data will be presented for the bench-scale vitrification Sequence A tests:

- Formula of glass forming reagents and weights

- Percent moisture versus percent solids content of the glass forming reagents
- Amount of water added to form a 45% moisture content slurry
- Weight of K-65 waste material
- Size of furnace/crucible
- Temperature of furnace
- Heating time of sample (elapsed time vs temperature)
- Electrical conductivity of molten material
- Viscosity as a function of temperature for molten material
- Composition of off-gas from vitrification
- Radon released during vitrification
- Composition of condensate
- Radon released from vitrified waste
- Specific gravity of vitrified waste
- TCLP leachate results for metals from vitrified waste
- TCLP results from vitrified waste
- Radionuclide leachate results from vitrified waste
- Gamma dose rates of vitrified waste

The following data will be presented for the bench-scale vitrification Sequence B tests:

- Formula of glass forming reagents and weights
- Percent moisture vs percent solids content of glass forming reagents
- Amount of water added to form a 45% moisture content slurry
- Weight of K-65 waste material
- Dry weight of Bento-grout
- Bento-grout slurry composition
- Physical characteristics of K-65 material/Bento-grout mix: percent moisture, bulk density
- Size of furnace/crucible
- Temperature of furnace
- Heating time of sample (elapsed time vs temperature)
- Electrical conductivity of molten material
- Viscosity as a function of temperature for molten material
- Composition of off-gas from vitrification
- Radon released during vitrification
- Composition of condensate
- Radon released from vitrified waste
- Specific gravity of vitrified waste
- TCLP leachate results for metals from vitrified waste
- TCLP results from vitrified waste
- Radionuclide leachate results from vitrified waste
- Gamma dose rates of vitrified waste

The following data will be presented for the bench-scale vitrification Sequence C tests:

- Formula of glass forming reagents and weights
- Amount of water added to form a 45% moisture content slurry
- Percent moisture vs percent solids content of glass forming reagents
- Weight of metal oxide material
- Size of furnace/crucible
- Temperature of furnace
- Heating time of sample (elapsed time vs temperature)
- Electrical conductivity of molten material
- Viscosity as a function of temperature for molten material
- Composition of off-gas from vitrification
- Composition of condensate
- Specific gravity of vitrified waste
- TCLP leachate results for metals from vitrified waste
- TCLP results from vitrified waste
- Radionuclide leachate results from vitrified waste
- Gamma dose rate of vitrified waste

The following data will be presented for the bench-scale vitrification Sequence D tests:

- Formula of glass forming reagents and weights
- Percent moisture vs percent solids content of glass
- Amount of water added to form a 45% moisture content slurry forming reagents
- Weight of K-65 waste material
- Weight of metal oxide material
- Temperature of furnace
- Size of furnace/crucible
- Heating time of sample (elapsed time vs temperature)
- Electrical conductivity of molten material
- Viscosity as a function of temperature for molten material
- Volume of off-gas from vitrification
- Composition of off-gas from vitrification
- Radon released during vitrification
- Composition of condensate
- Radon released from vitrified waste
- Specific gravity of vitrified waste
- TCLP leachate results for metals from vitrified waste
- TCLP results from vitrified waste
- Radionuclide leachate results from vitrified waste
- Gamma dose rate of vitrified waste

9.0 HEALTH AND SAFETY

PNL will conduct the vitrification studies outlined in this work plan in accordance with the applicable OSHA requirements thereby ensuring worker protection in the workplace. The Waste Technology Center component of Battelle Northwest is responsible for vitrification studies at PNL. The Safety Plan for the Waste Technology Center is found in Appendix B.

10.0 RESIDUALS MANAGEMENT

The vitrified residues and any untreated K-65 material and Silo 3 material will be returned to the FEMP for disposal. All other operationally derived waste material generated as part of the vitrification treatability testing will also be disposed of by the FEMP.

Operationally derived wastes are wastes generated in the performance of various activities. These wastes include, but are not limited to:

- Disposable personal protective equipment such as Tyvek coveralls, gloves, and booties

- Disposable decontamination supplies

Protective clothing will be place in plastic bags, in a B-25 box, or metal drum for disposal as compactible, potentially contaminated waste by Westinghouse Environmental Management Company of Ohio (WEMCO).

Operationally derived wastes are the property of the client and are to be shipped back to Fernald unless otherwise specified in the written contract.

The client will be responsible for proper transport, shipment, or disposal unless otherwise specified in the written contract.

11.0 REPORTS

An interim draft report will be prepared by PNL personnel and transmitted to WEMCO within 45 calendar days, or no later than November 9, 1992, of completing the laboratory screening and the bench-scale tests. This report will present the data identified in Section 8 and detail the vitrification process employed, along with any problems. The report will be generated utilizing Section 3.12 of the "Guide for Conducting Treatability Studies Under CERCLA". The results of the leachate from the TCLP analyses performed per the QAPP will be incorporated into the interim report. The interim draft report will be reviewed by WEMCO, and PNL personnel will incorporate the WEMCO comments and submit a final report to WEMCO on or before December 30, 1992. This final report will be reviewed internally by WEMCO, ASI, and DOE prior to final submittal to the U.S. EPA.

12.0 COMMUNITY RELATIONS

The vitrification treatability study for Silos 1, 2, and 3 material and community information and involvement activities are required in the CERCLA process. Community Relations activities shall be conducted; to support treatability studies for Operable Unit 4 to explain the role of treatability studies in the RI/FS, and to raise the public's confidence in cleanup alternatives and technologies identified in the alternatives screening/analysis process and in the preferred alternative for this operable unit. The Treatability Study Community Relations activities for Operable Unit 4 will comply with the Community Relations Plan (CRP) -- Remedial Investigation/Feasibility Study and Removal Actions at the U.S. Department of Energy Feed Materials Production Center (now called Fernald Environmental Management Project), Fernald, Ohio, August 1990. At a minimum, the following Community Relations activities will be conducted to explain treatability studies for Operable Unit 4.

- Community Meeting - Held a minimum of three times per year to provide status on cleanup issues, and to ensure that interested area residents have a routine public forum for receiving new information, expressing their views, and getting answers to their questions. The meetings shall focus on operable unit updates, removal actions, major RI/FS documents, and other appropriate topics. During the July 1991 community meeting, an initial discussion of treatability was held to make the community aware of treatability studies underway.

- Publication - RI/FS materials such as progress reports, facts sheets and a community newsletter, Fernald Cleanup Report, provide updates of CERCLA-related activities at the FEMP and will include information on treatability study activities for this operable unit.

- Presentations to Community Groups - Information about treatability studies for this operable unit shall be included in briefings to community groups in Ross, Crosby, and Morgan townships, and to Fernald Residents for Environmental Safety and Health, as appropriate. Also, this information shall be included in presentations to other organizations, as requested.

Key milestones in treatability studies have been identified through negotiations for the Amended CERCLA Consent Agreement and are included in the schedule in Figure 14-1. These milestones include:

- Submittal of this Work Plan to the DOE and U.S. EPA
- U.S. EPA approval of this Work Plan
- Treatability Testing
- Submittal of Treatability Testing Report

The progress of these key milestones will be reported to the community through the above mentioned presentations and publications.

13.0 MANAGEMENT AND STAFFING

Personnel involved in the management of the overall RI/FS process include: J. R. Craig, DOE Project Director; R. B. Allen, DOE Operable Unit 4 Manager; John Wood, ASI/IT Project Director; D. J. Carr, WEMCO RI/FS Contract Technical Monitor; Susan Rhyne, Acting ASI/IT Operable Unit 4 Manager; and D. A. Nixon, WEMCO Operable Unit 4 Manager.

The principal parties included in the management of the Operable Unit 4 Vitrification Treatability Study are DOE Fernald, WEMCO, ASI/IT, PNL, and Parsons. Personnel involved in the specific management of the Operable Unit 4 Vitrification Treatability Study include: R. B. Allen, DOE Operable Unit 4 Manager; D. A. Nixon, WEMCO Operable Unit 4 Manager; L. A. Heckendorn, WEMCO Operable Unit 4 Program Engineer; C. C. Chapman, PNL, Manager of Operable Unit 4 Vitrification testing; and D. A. Janke, PNL, responsible for WEMCO Operable Unit 4 Vitrification testing and reporting.

14.0 OPERABLE UNIT 4 VITRIFICATION TREATABILITY STUDY SCHEDULE

Figure 14-1 includes the schedule of activities required to complete the Operable Unit 4 treatability studies for vitrification treatability studies for Silos 1, 2, and 3 material. The schedule of activities in Figure 14-1 are part of the RI/FS schedules that were agreed to between the U.S. DOE and the U.S. EPA during negotiations of the Amended CERCLA Consent Agreement.

REM DUR	EARLY START	EARLY FINISH	ACTIVITY
0	17JUN91A	30JUL91A	PREPARE TS WORK PLAN - VIT (4205W31305)
0	31JUL91A	31JUL91A	SUBMIT TS WORK PLAN TO WEMCO - VIT (4205W31320)
0	1AUG91A	29AUG91A	WEMCO REVIEW OF TS WORK PLAN - VIT (4205W31325)
0	30AUG91A	2OCT91A	INCORPORATE WEMCO COMMENTS - VIT (4205W31330)
0	14SEP91A	10OCT91A	SHIP RESIDUE TO SUBCONTRACTOR (4205W31402)
0	3OCT91A	3OCT91A	SBMT REV TS WP TO DOE/WEMCO/ASI-VIT (4205W31340)
0	4OCT91A	21OCT91A	DOE/WEMCO/ASI RVW REVISED WP - VIT (4205W31345)
0	22OCT91A	11NOV91A	INCORP COMMENTS TO REVISED WP - VIT (4205W31350)
0	12NOV91A	12NOV91A	SBMT REVISED TS WP TO DOE/WEMCO-VIT (4205W31355)
0	13NOV91A	13NOV91A	SUBMIT TS WORK PLAN TO EPA - VIT (4205W31360)
0	14NOV91A	30DEC91A	EPA REVIEW OF TS WORK PLAN - VIT (4205W31370)
7	31DEC91A	29JAN92	INCORPORATE EPA COMMENTS - VIT (4205W31380)
5	30JAN92	5FEB92	DOE/WEMCO RVW OF FINAL TS WP-VIT (4205W31385)
1	6FEB92	6FEB92	SUBMIT FINAL WORK PLAN TO EPA - VIT (4205W31390)
21	7FEB92	6MAR92	EPA REVIEW OF FINAL TS WORK PLAN (4205W31395)
1	9MAR92	9MAR92	EPA APPROVAL OF TS WORK PLAN - VIT (4205W31400)
147	10MAR92	30SEP92	CONDUCT TREATABILITY STUDY - VIT (4205W31405)
10	1OCT92	14OCT92	COMPILE TEST RESULTS FROM TS - VIT (4205W31410)
21	15OCT92	12NOV92	PREPARE TS REPORT - VIT (4205W31415)
1	13NOV92	13NOV92	TRANSMIT TS REPORT TO WMCO - VIT (4205W31417)
21	16NOV92	14DEC92	WMCO REVIEW OF TS - VIT (4205W31420)
15	15DEC92	4JAN93	INCORP WEMCO COMMENTS TO TS RPT-VIT (4205W31425)
1	5JAN93	5JAN93	SUBMIT REVISED TS RPT TO WEMCO-VIT (4205W31430)
10	6JAN93	19JAN93	WEMCO FINAL RVW/APPRV OF TS RPT-VIT (4205W31432)

WESTINGHOUSE ENVIRONMENTAL MGMT CO
OPERABLE UNIT 4 - SILOS 1,2,3, AND 4
TREATIBILITY STUDY - VITRIFICATION

Sheet 1 of 1

Project Start : 30JUN86
Project Finish: 31JAN02

Primavera Systems, Inc.

FIGURE 14-1
Operable Unit 4 Vitrification Treatability Study Schedule

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REFERENCES

Dettorre, J. F., B. S. Ausmus, E. P. Stambaugh, A. A. Lawrence and K. R. Yates, 1981, "Preliminary Assessment of Alternatives for Processing and Disposal of the Afrimet Residues," BMI-2083, UC-11, prepared by Battelle Columbus Laboratories for the U.S. Department of Energy.

McLean, R. A., Anderson, V. L., "Extreme Vertices Design of Mixture Experiments," Techometrics, Vol. 8, No. 3, August 1966.

Fergl, F., Anger, V., Spot Tests in Inorganic Analysis, Elsevier Publishing Company, 1972.

Jungreis, E., Spot Test Analysis, Clinical, Environmental, Forensic, and Geochemical Applications, John Wiley and Sons, 1984.

ASTM D2166-85, Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.

Method 1311 Toxicity Characteristic Leaching Procedure (TCLP), Federal Register, Vol. 55, No. 126, pp 26986-26998.

Barretto, P.M.C. "Radon-222 Emanation Characteristics of Rocks and Minerals," Radon in Uranium Mining, IAEA-PL-565/6, International Atomic Energy Agency, Vienna, 1975.

U.S. Department of Energy, Evaluation and Selection of Borosilicate Glass as the Waste Form for Hanford High-Level Radioactive Waste, DOE/RL-90-27, 1990.

Chapman, C. C., and J. L. McElroy, "Slurry-Fed Ceramic Melter - A Broadly Accepted System to Vitrify High-Level Waste." High Level Radioactive Waste and Spent Fuel Management, Volume II, American Society of Mechanical Engineers Book No. 10292B, 1989.

APPENDIX A

PNL PROJECT QA PLAN

PROJECT IMPACT LEVEL II

TITLE: Vitrification Tests on K-65 Residue Material

SCOPE:

a: Characterize and determine the amount of the off gases evolved during vitrification of the K-65 sample (WBS-02).

b: Define the rate of release of radon and other radioactive products from the solid glass product (WBS-02).

CLIENT: Westinghouse Materials Company of Ohio (WMCO)

AUTHORIZING DOCUMENT: WMCO Purchase Order No. 412387-00; Project No. 16611

QA REQUIREMENT SPECIFICATION(S):

[x] ANSI/ASME NQA-1 as delineated in PNL-MA-70

[ ] Other

Impact Level II WBS element activities shall comply with the applicable requirements, as appropriate for the work being performed, in Parts 1 and 3 of PNL-MA-70. Impact Level III activities shall comply with the GPS Standards located in Part 2 of PNL-MA-70. This QA Plan also identifies client QA requirements, if applicable, and any client imposed exclusions or limitations to PNL procedure requirements. If other quality-related activities are later performed, the appropriate PNL-MA-70 requirements and procedures shall be applied, unless specifically excluded.

CONCURRENCES AND APPROVAL:

CC Chapman — Cognizant Manager (Concurrence) — Date: 8-2-90

JW Smith/KR Martin — Quality Engineering (Concurrence) — Date: Aug 3 1990

HC Burkholder — Line Manager (Approval) — Date: 8-2-90

QA PROGRAM/ORGANIZATION:

The PNL Quality Assurance Program conforms to the requirements of NQA-1 as interpreted by parts 1 and 3 of PNL-MA-70, Quality Assurance Manual. This QA Plan applies only the project Impact Level II WBS Elements, as noted in Exhibit A. WBS elements identified as Impact Level III shall comply with the requirements of PNL-MA-70, part 2. The project organization with key personnel is shown below.

Department Manager: JL McElroy
Project Manager: CC Chapman
Task Leader: DS Janke
Test Plan/Procedure Author: LD Anderson, DS Janke
Test Results Evaluator: CC Chapman, DS Janke, LD Anderson
M&TE Custodian: DS Janke
Records Custodian: DS Janke
Quality Engineer: KR Martin

IMPACT LEVEL:

This QA Plan has been assigned an overall Impact Level of II.

SPECIAL CLIENT REQUIREMENTS:

A. Covered by Part(s) 1 and/or 3 of PNL-MA-70

Client Requirements — Where Covered

- Test Plans shall be planned and executed per PAP-70-1101. Data Sheets incorporated in test plans shall be used to record pertinent test data, and will be traceable to the project LRB.

- Evaluation of test results shall be reviewed and approved through independent technical reviews per PAP-70-604.

- Measuring and test equipment shall be calibrated in accordance with PAP-70-1201.

- All sample material will be treated (tested) and returned to WMCO (per WMCO instructions in a vitrified form (except small portions used to determine material composition or to determine the appropriate glass forming additives). Materials will be controlled per PAP-70-601.

B. Not covered by Part(s) 1 and/or 3 of PNL-MA-70

- Review and Approval of Test Plan by WMCO personnel

C. Client required exclusions or limitations of procedure applicability

- None

OTHER REQUIREMENTS, DIRECTION OR PLANNING:

a) Procurement of an appropriate radon monitor per PAP-70-401.

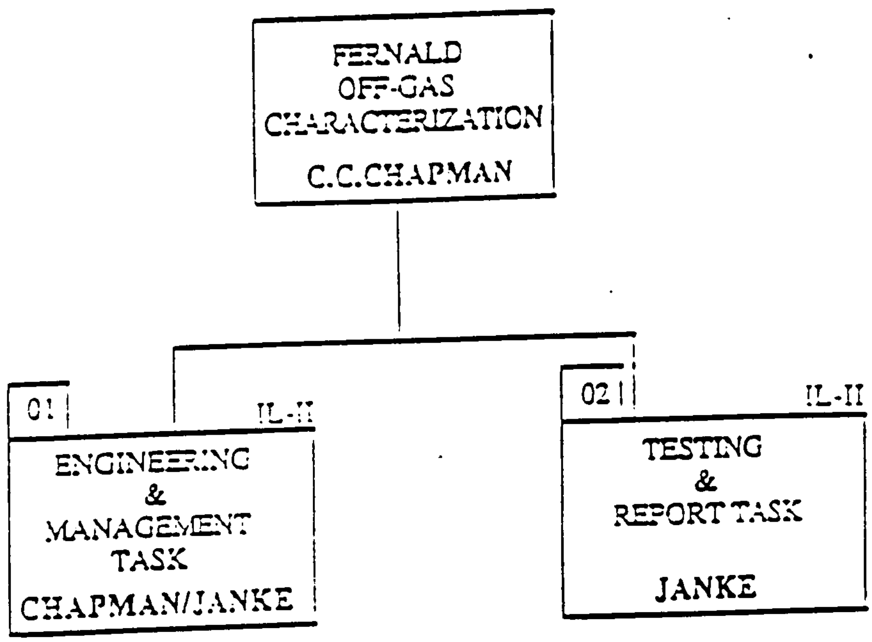
b) There are no known activities which require qualified and certified inspection personnel per PAP-70-203.

c) There are no known controlled processes or special processes to be performed within the scope of this QA plan per PAP-70-901 or PAP-70-902.

d) Records will be indexed and maintained per PAP-70-1701. Records will be designated for single storage and nonpermanent. Records will be maintained by assigned records custodian(s) until turnover to Building 712. Records turnover, including generic records, will be within 90 days of the termination of the project. The cognizant QE will be required to review and concur with the completed project RIDS form. Each record generated will have a activity identifier task number, subtask number, and file classification in the upper right hand corner.

e) Procedures, plans, or instructions will be in accordance with PAP-70-1101 as applicable.

Exhibit A


FERNALD
OFF-GAS
CHARACTERIZATION
C.C.CHAPMAN
01
IL-II
ENGINEERING
&
MANAGEMENT
TASK
CHAPMAN/JANKE
02
IL-II
TESTING
&
REPORT TASK
JANKE

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Analytical Request Form

To: ____________ Date: ________ WP/WO Number: ________

Requested by: ____________ (name) ____________ (signature) ________ (phone) ________ (mail stop)

Analysis Requested:

Identification Numbers:

Material Description:

Special Storage or Handling Requirements: _____ None, _____ Other:

Disposal of Samples: ___ Discard, ___ Return, ___ Other:

Requested Reports/Additional Instructions:

QA Requirements: Impact Level: I II (indicate level)
_____ SOW number
_____ Other:

Results must be signed and dated by the analyst and reviewer, identifing the measuring and test equipment and the procedure used (including revision).

____
QP Representative sign/date

QP Representative approval required only for the first ARF in a series for internal work. Approval not required for external work.

To the best of my knowledge, this work was accomplished in accordance with the requirements of this Analytical Request Form:

By: ____________ Date: ________
Responsible Analyst or Group Manager

(Return this form or a copy to the requestor).

The report/data furnished has been reviewed and to the best of my knowledge complies with the above request.

By: ____________ Date: ________
Requestor

This is a recommended format. Other forms may be used if they provide information which is equivalent to that required by this exhibit.

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Statement of Work

SOW number and revision: (may use the work order or work package number)

Title: type of service, performed by, for what project or organization

Review by: (QP Representative) Date: ____________

Concurred by: (Cognizant Scientist/Engineer) Date: ____________

Approved by: (Recipient/Person Performing Work) Date: ____________

Note: The following is intended as an example only. Each SOW will be written to fit the scope of the work involved.

A. Scope of Work

Include the following:

1. A complete description of the technical work authorized by the SOW including schedule and cost requirements as appropriate. Where necessary, technical requirements shall be specified by reference to drawings, specifications, codes, standards, procedures or instructions.

B. QA Requirements

Include the following:

1. The Impact Level

2. For internal organizations any specific guidance related to the PNL-MA-70 Administrative Procedures.

3. When applicable for other Hanford Contractors, a subsection detailing the applicable QA requirements.

4. A statement that work is to be conducted in accordance with the Service Organizations's activity QA Plan if appropriate. Note, the SOW may act as the QA Plan.

5. A statement allowing Impact Level III scoping studies or preparation activities prior to performing the Impact Level I or II service if necessary to develop methods, procedures, etc.

6. A statement (when applicable) that individual units of work will be (e.g., an Analytical Request Form) transmitted to the recipient. If applicable, identify documentation that will accompany each unit of work.

7. Identification, by name and/or title of personnel who may authorize subsequent changes to the SOW, or related documents. 68

8. A statement that no subcontracting of the work shall be allowed without prior approval of the cognizant engineer and a QP Representative.

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9. A statement requiring QP Representative surveillance prior to or during the performance of the service if appropriate. Identify hold points if appropriate.

C. Reports

1. Define what is to be reported and/or provided and by what date.

2. State that reported results are to be in writing and provided to the individual requesting the work.

3. State that the reported results are to reference the SOW number and are to include the dated signature of the person responsible for the work.

D. Records

1. For work performed by PNL organizations, identify what supporting records are to be submitted to the person requesting the work. Alternately, the organization performing the work may maintain the supporting records in accordance with PAP-70-1701. In either case, specify what records will be maintained and by whom. Examples of supporting records may include:

   - indoctrination and training records
   - calibration records
   - technical procedures
   - raw data including instrument printout
   - other documents required by the applicable PNL-MA-70 Administrative Procedures (unless included as part of the reported results)
   - nonconformance or deficiency reports.

2. For SOWs for other Hanford contractors, identify the records and the retention requirements that apply to the person or organization providing the service. As an alternate, specify the records to be transferred to the requester at the completion of the work.

APPENDIX B

WASTE TECHNOLOGY CENTER SAFETY PLAN

WASTE TECHNOLOGY CENTER

SAFETY PLAN

March 1991

Approved: J. L. McElroy, Manager
Waste Technology Center

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON 99352

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WASTE TECHNOLOGY CENTER
SAFETY PLAN

BACKGROUND

Implementation of the safety aspects of the WTC Environment, Safety, and Health Plan is described in this plan. Many existing safety requirements are incorporated into the plan by reference. Primary emphasis is placed on motivation and attitude, as safety performance can best be improved by frequent and visible management attention to safety.

OBJECTIVES

The objectives of this Safety Plan are to:

- assist in providing and maintaining a safe working environment for Center Staff
- clearly define Center safety policy and the responsibilities of WTC staff concerning safety matters
- motivate all staff members to a high level of safety consciousness
- assist in ensuring good communication between staff members and management on safety matters
- provide an annotated list of sources of safety guidance

CENTER SAFETY POLICY

The Waste Technology Center's safety policy can be summarized in two words: SAFETY FIRST. It is the duty of every staff member to follow established procedures and to continually evaluate potential risks associated with any activity. The individual is not to rely solely on others to define how to perform a job, but must evaluate the directions received and proceed in accordance with safe practices. Staff members will not knowingly engage in unsafe practices--regardless of who instructed them to do so. It is the duty and right of each staff member to know the health aspects (hazards) of the working environment and not to undertake any work that is perceived to be unsafe. Work will be halted until the individual's concern is addressed. The individual is not to restart that work until the situation is evaluated and action is taken.

No individual or manager will take lightly or dismiss the safety concerns of another. No staff member will be ordered to do a task he/she feels might be unsafe. Such intimidation tactics or dismissals of concerns will be reported to the cognizant line manager and project manager or task leader. Resolution will be achieved by working simultaneously through both lines of responsibility, with escalation to higher management levels, if needed, to achieve prompt resolution.

Policies and responsibilities assigned in applicable PNL and WTC specific safety guidance (see Appendix A) will be fulfilled. Because of the wide range of activities within the Center and new activities that are continually being initiated, flexibility is required within the Center and within individual organizational components. Safety is not "ensured" by adopting unnecessary rules and procedures. The only uniform inviolable policy is--SAFETY FIRST.

Management recognition will be given for demonstrating on the job safety. The safety record, attitude, and awareness of each individual will be evaluated in the yearly Staff Development Review process. Appropriate SDR safety goals will be included in each SDR. Line managers will periodically review the safety performance of their staff during routine and special activities to verify that safe practices are being employed.

The Department Manager will periodically review the safety of each project. If a project has a number of mishaps, it may be caused by excessive emphasis placed on schedules and budgets at the expense of safety. Such a situation shall be corrected immediately.

It is anticipated that this plan will be fully integrated into the WTC Environment, Safety and Health (ES&H) Plan for 1992.

Center Safety Goals

The following six general safety goals are identified for the WTC for CY-1991:

1. Zero Loss Time Accidents

2. Skin contaminations will show a reduction over CY-1990.

3. No reportable occurrences classified as an Emergency or Unusual Occurrence

4. No vehicular accidents

5. First Aid cases will show a reduction over CY-1990.

6. No occurrences or audit deficiencies resulting from the lack of safety training or an appropriate training plan

The following eight specific safety related goals are identified for CY-1991:

1. ES&H training requirements for each WTC staff will be documented by May 14, 1991.

2. ES&H qualifications for each staff position will be documented by April 15, 1991.

3. Scheduled safety meetings will be completed on a timely basis (by December 15, 1991).

4. A management inspection schedule to evaluate and monitor ES&H performance for the facilities operated by the WTC will be completed by April 1, 1991.

5. WTC facility ES&H oversight inspections will be conducted and documented by December 15, 1991.

6. ES&H goals will be included for each Staff in the CY-1991 performance appraisals (by March 31, 1991).

7. By December 31, 1991, complete an evaluation of the performance of all staff in the area of ES&H.

8. Implement an evaluation, control, and decontamination program. (By June 1, 1991)

GENERAL IMPLEMENTATION REQUIREMENTS

Training

Staff assigned to work in laboratory areas will receive training for the specific facility, equipment, and hazards associated with the work they are to perform. Line (Department) Managers are responsible for ensuring that staff receive the necessary safety training. Documentation and status of safety training for staff members is maintained by the PNL Training Coordinator. Duplicate records to provide easy day-to-day reference will be maintained by the Department Manager. Attendance at safety training meetings and should also be documented.

Job Specific Safety Training--

Job-specific safety training requirements apply to both on site and off site research facilities under the control of the WTC. The Department Training Plan will address the job-specific training requirements of assigned staff. Typical areas that the plan might address are: radiation work considerations, facility/equipment SOPs, hazardous chemical handling, crane operation, pollution prevention, and waste minimization.

Training on PNL/WTC Safety Policies/Requirements/Procedures--

Under the direction of the Department Manager, the designated Organizational Safety Representative or other qualified individuals will review general safety policies and procedures with each new staff member. The review will include the information listed under the employee orientation in PNL-MA-43, Section 1, as well as the information contained in the WTC Environment, Safety and Health Plan and this Plan. This orientation should be accomplished and documented within 1 week of the arrival of new staff. The Hazard Materials Custodian will, on request, provide an orientation on the Chemical and Waste Management Plan, Waste Minimization and Pollution Prevention Plan, and PNL-MA-50, Facility Operational Controls, and Industrial Hygiene Plan.

Emergency Preparedness Training--

Every year and upon initial hire/building reassignment, each staff member should obtain the latest copy of his/her assigned building "Procedures for Emergencies." Annual retraining on the building emergency procedures will, at a minimum, address emergency alarms, procedures, staging areas, and location of fire alarm pull boxes and fire extinguishers. For WTC components occupying space in facilities managed by another contractor or DOE, WTC staff will comply with the requirements of the respective building safety plan/emergency procedures regarding training relating to emergency response.

Vehicle and Office Safety Training--

Vehicle operations, office safety and housekeeping will be periodically reviewed with all staff members.

Safety Meetings--

Documented safety meetings for all WTC staff will be held periodically to carry out appropriate safety training. The minimum frequency of safety meetings for each WTC organizational component is defined in Appendix C. Safety meetings may be part of a periodic organizational staff meeting.

Occurrence Reporting and Investigating

Prompt and accurate reporting of incidents is the basis for early resolution and recovery. After first attempting to stabilize and control any off-normal event, the WTC staff should then contact the immediate line manager. (Call the single point of contact [SPC] on 375-2400 if the line manager is not available.) The line manager will take appropriate additional action. Investigation and reporting shall be in accordance with the requirements of PNL-MA-7, Off-Normal Event Reporting System. Temporary and permanent corrective action for off-normal events will be developed by WTC line management in consultation with appropriate support organizations.

Inspections

Department Managers should inspect all offices and assigned work areas on a periodic basis. Appendix C provides a general schedule of safety related inspections.

SPECIFIC IMPLEMENTATION RESPONSIBILITIES

Building upon the above general guidelines, the roles of WTC management and staff in implementing the WTC Safety Plan are defined below. Appendix C provides a matrix outlining Center management responsibility for safety inspection and safety meetings.

Center Manager:

The WTC Manager has overall responsibility for implementation of all safety programs within the Center, for proper execution of all safety assignments delegated to others within the Center, and for coordinating multi-center facility and ONE reporting activities in the 324 Building. This responsibility is primarily fulfilled by specific delegation, together with personal involvement in evaluating the effectiveness of the Center safety program. Assuring that all staff members achieve a high level of safety awareness and performance is a major area of concern to the Center Manager. Specific responsibilities include:

- Selectively participates in WTC-wide safety inspections including a quarterly audit of compliance to the 324 Building Operational Safety Requirements (OSRs).
- Maintains an open door policy for safety concern and ensures prompt corrective action in response to these concerns, inspections or occurrence reports.
- Ensures that resources are available to Department Managers to implement necessary safety measures.
- Serves on the Center Safety Committee. Ensures that concerns expressed by the committee are promptly addressed.
- Serves as the Lead Facility Manager for the 324 Building and implements provisions of ACT Now Directive 90-7 pertaining to reporting of Off-Normal Events.

Operations Manager:

The Operations Manager has oversight responsibility to the Center Manager for implementation of the ES&H program. Specific responsibilities include:

- Assists in conducting safety inspections of Center facilities and coordinates Center Manager involvement in planned inspections.
- Chairs the WTC Safety Committee. Ensures that safety suggestions/concerns are brought up for discussion in committee meetings.
- Assists, on request, departments with their training plans and safety meetings agendas.
- Provides support to WTC staff thorough the Environmental Compliance Manager, Industrial Hygiene Specialist, NEPA Representative, and Hazardous Material Custodian for chemical and waste management, waste minimization, industrial hygiene, and OSHA compliance activities.
- Reviews all Center staff radiation exposures
- Acts by assignment as a 324 Building Facility Manager.
- Maintains an open door policy concerning safety issues.

Department Manager:

Department Managers are responsible for duties assigned 1) through this Plan, 2) through guidance documents listed in Appendix A (especially PNL-MA-42 and PNL-MA-43), and 3) by the Center Manager. As with the Center Manager, many of these responsibilities are fulfilled through delegation supplemented by significant personal involvement. Specific responsibilities include:

- Reviews and approves a Preliminary Safety Review and Risk Assessment for each project.
- Reviews and approves the Project Management Plan (PMP) or equivalent document for each project and assures that any unusual safety issues are appropriately addressed.
- Ensures that appropriate safety documentation, (e.g., Safety Analysis Report (SAR), Operational Readiness Plan (ORP), Safety Evaluation Document (SED), etc., is in place before beginning work and ensures that all work is carried out in compliance with these requirements.
- Ensures that Laboratory Safety has been made aware of any proposed project that involves a significant safety issue.
- Acts by assignment as a Facility Manager for the 324 Building.
- Interfaces with Building Manager concerning significant changes in programmatic requirements that may impact the building emergency procedures or have significant safety implications to the facility, occupants, equipment, or environment.
- Approves safety related procedures and other operational documents as required.
- Maintains an open-door policy for safety issues and resolves safety issues promptly.
- Reports safety related inspection findings to the WTC Compliance Tracking System. Sets specific schedules for resolving findings and ensures prompt follow up action.
- Ensures that ONE action is timely and thorough and communicates the results of safety audits/inspections and ONEs to the staff.
- Ensures that a Laboratory Manager and Monitor are assigned to each work area.
- Ensures that planned organizational safety meetings are held.
- Visits all department-responsible facilities on site at least bimonthly to verify that safe practices are being employed and to identify and evaluate hazards in the work place. Assures that staff are informed about all hazards associated with their activities.
- Conducts, with the Building Manager, quarterly, documented safety inspections of facilities occupied by the department.
- Appoints a Departmental Organizational Safety Representative from D7W10, D7W20, D7W30.
- Ensures that staff exposure to ionizing radiation and nonradiological hazards is maintained as low as reasonably achievable (ALARA) and that appropriate dosimetry is being used. Assures that the ALARA concept is covered at safety meetings at least annually (D7W20 and D7W30).
- Maintains a current Training Plan addressing the safety training requirements and training status for all assigned staff and assures that all staff receive the appropriate training to perform the assigned work.

- Ensures that new center staff and staff assigned from other organizations receive timely and appropriate safety orientation.

The Department Manager has shutdown authority for operations and activities that pose immediate threat to safe operations.

Group Leader

Group Leader safety responsibilities are focussed on day-to-day operations. Specific responsibilities include:

- Conducts frequent walk-through inspections of work areas.
- Ensures that work is carried out in compliance with all procedures Operational Safety Requirements or other limits and controls necessary to assure safe operations.
- Maintains an open-door policy for safety issues.
- Identifies and evaluates hazards in the work place. Ensure that staff are informed about hazards associated with these tasks.
- Confirms that assigned operating space/space facilities are appropriately posted with emergency information.
- Confirms that staff assigned to work on the project have the required training for the job.
- Confirms that all safety related procedures are approved and posted, where appropriate, before initiation of the work.

The Group Leader has shutdown authority for operations and activities that pose immediate threat to safe operations.

Project Manager or Task Leader

A successful project requires that the Project Manager be concerned about the safety of those working on the project. This requires care in up front planning; and during the project, day-to-day attention to safety in the work place. The Project Manager should know what the safety related issues are with respect to the project and what has and is being done to address them. Specific responsibilities include the following:

- Conducts frequent walk-through inspections of work areas.
- Prepares the preliminary safety review and risk assessment documents for a project and informs Laboratory Safety if the project will generate solid, gaseous, or liquid effluent.
- Prepares and obtains the necessary approvals for safe operating procedures to support the project.
- Ensures that the PMP describes all significant safety issues in the project.
- Identifies job-specific training required for the work and assure that it is complete and properly documented before initiating work.
- Confirms that all physical controls are in place prior to initiation of work.
- Initiates Operational Readiness Reviews (ORR's) if required.
- Resolves promptly safety concerns expressed by project staff.

- Preplans for project safety, including such items as: waste disposal during and after the project; adequacy of facilities to safely house the project (ventilation, fire protection, sewers, etc.); and personnel exposure where hazardous materials are involved.
- Regularly monitors project activities to ensure that all safety issues are addressed and procedures and requirements are complied with.
- Maintains an open door policy for safety issues.

The Project Manager or Task Leader has shutdown authority for operations and activities that pose immediate threat to continued safe operations.

Laboratory Manager

A laboratory manager is designated for each lab. This individual is typically a line manager and is responsible for ensuring that the laboratory/facility has a safe working environment and that those working in the facility have addressed all safety issues related to the work to be performed. The Laboratory Manager delegates day-to-day operating responsibility and authority to the Laboratory Monitor. See Appendix B for a list of assigned Laboratory Managers and Monitors. Specific Laboratory Manager responsibilities are as follows:

- Coordinates external audits and surveillances of the laboratory.
- Ensures that any deficiencies noted during safety audits are addressed promptly and correctly.
- Ensures that the laboratory has a qualified Laboratory Monitor.
- Exercises shutdown authority for the laboratory if unsafe conditions are noted.
- Ensures issues have been satisfactorily resolved before authorizing start up of a laboratory that has been shutdown for safety reasons.

The Laboratory Manager has shutdown authority for operations and activities within the laboratory that pose immediate threat to the laboratory's continued safe operation and to its occupants.

Laboratory Monitor

The Laboratory Monitor is assigned by the Department Manager and will be familiar with the laboratory equipment, ongoing processes, and utilities that are available in the laboratory. The assigned Laboratory Monitor, acting under the direction of the Laboratory Manager, has the responsibility and authority to ensure safety within a specific laboratory or work area. Duties and responsibilities of the Laboratory Monitor are as follows:

- Takes the lead, consistent with Hazardous Material Custodian (HMC) guidance, to maintain a current inventory of the chemicals and other materials under their cognizance.
- Posts and maintains current emergency notification listings by the main entry door of the laboratory consistent with PNL-wide guidelines.
- Acts as the principal contact for proposed or ongoing laboratory work and coordinates facility and maintenance activities. Ensures that new

work to be introduced into the laboratory or work area is consistent with the intended use of the work area.

- Resolves with responsible staff any deficiencies noted by safety and housekeeping inspections and ensures issues have been satisfactorily resolved before authorizing start up of a laboratory that has been shut down for safety reasons.
- Is familiar with any job specific training required for work in the laboratory and ensures that all staff working with equipment, chemicals, materials, and generated waste in the laboratory have received the necessary job-specific training.
- Ensures that all staff assigned to work in the laboratory maintain their work area in a safe and orderly manner.
- Monitors work and ensures that it is performed consistent with procedures and requirements of the laboratory.
- Coordinates audits of assigned space.

The Laboratory Monitor has shutdown authority for operations and activities within the laboratory that pose immediate threat to the laboratory's continued safe operation and to its occupants and also the authority to obtain assistance in housekeeping.

Individual Contributor

The attitude and commitment of the individual to safety is the crucial element to assure that activities are performed safely. The individual contributor is expected to take the initiative in ensuring that he/she is prepared to undertake work that involves a hazard and that a continued attention to safe practices and procedures is maintained throughout the project. Specific responsibilities include the following:

- Participates in the preparation of safety documentation, procedures, etc.
- Completes job specific safety training before initiating work.
- Refers any safety inquiries from the public or news media to Press Relations and WTC line management.
- Maintains own exposure to radiological and nonradiological hazards to levels consistent with ALARA.
- Is familiar with the PMP and performs assigned work safely and responsibly according to applicable limits, PNL Manuals, SOPs, JHBs (or JSAs), RWPs, CSSs, etc.
- Observes the local safety program when visiting or working off site.
- Informs the immediate line manager and project manager or task leader about any safety concerns.
- Provides safety guidance for, and reviews safety performance of less experienced personnel working near you.
- Ensures good housekeeping in the work area and that equipment is maintained and properly identified.
- Reports any off-normal events to his/her immediate line manager. For emergencies or where the line manager is not immediately available, contacts 375-2400.

Organizational Safety Representative:

Organizational Safety Representatives are assigned from and represent the following WTC organizational components:

- 07W10, 11, 12, & 13. (Represented by one individual)
- 07W20, 07W30.

The specific duties and responsibilities of the Organizational Safety Representative are as follows:

- Represents WTC organizational components on the WTC Safety Committee.
- Keeps informed of current safety morale, awareness and implementation/concerns within organization(s) represented.
- Provides feedback to the Department Manager and staff regarding safety issues.
- Assists management on inspections and corrective actions.
- Under the direction of the Department Manager, provides a safety orientation to all new center staff.

Center Safety Committee:

The Center Safety Committee provides a forum to address specific safety issues. It meets approximately every 2 months to discuss grassroots-level safety morale, safety awareness, and specific safety concerns within the Center. The Committee is chartered to facilitate two-way communications about safety throughout the Center.

The roles of the Environmental Compliance Manager, Hazardous Materials Custodian, and Industrial Hygiene Representative are described in the Waste Technology Center Chemical and Waste Management Plan.

PRINCIPAL SAFETY INTERFACES

The Facilities Management, Technical Services, and Laboratory Safety Departments all provide resources necessary to support line management in carrying out their safety responsibilities. These resources provide information on safety criteria, training methods, and inspection techniques. They are also charged with performing safety appraisals and audits and for follow-up to ensure that corrective actions are completed.

The Laboratory Safety Department (see Appendix D) is responsible for 1) assisting line management by serving as a technical safety resource and 2) conducting independent safety reviews and audits. These responsibilities include:

- Accident prevention (formal audits and appraisals, walk-through inspections, exercising "Stop Work" authority).
- General safety education and counseling (orientation for new staff members; conveying information on standards, requirements and

regulations; and conveying information on general safety and "lessons learned" from off-normal events either within or outside PNL).

- Occurrence reporting and investigation (determining classification of accidents, managing the Unusual Occurrence Reporting system, serving as technical experts during investigations).

The Building Manager is an immediate resource in maintaining safe operations. A key responsibility of the Building Managers (Facilities Management Department) is to identify potential safety problems through daily monitoring of activities and to communicate areas of concern to line management. Routine housekeeping functions, status change in experiments under way in the assigned facilities, and the start up of new operations are all monitored by the Building Managers.

Building Managers function as extensions of line management to ensure management awareness of any potential impacts on the safety of the facility. Their principal safety responsibility is to report directly to line management any unusual circumstances that might relate to the safety of that facility. Act Now Directive 90-2 defines the interaction of line and facility management in operation of building facilities and equipment.

The Laboratory Preparedness function within the Technical Services Department provides emergency planning, operational readiness review (ORR) management, and event management support; coordinates the Safety Review Council activity; and coordinates major accident investigations.

APPENDIX A

SOURCES OF SAFETY GUIDANCE

PNL Environment, Safety and Health Plan Issued by W. R. Wiley
Provides overall guidance for safety within PNL, stressing line management responsibility.

Management Guide 11.2 Safety, Summarizes PNL policies and responsibilities in assuring a safe working environment.

PNL-MA-6 Radiation Protection. Establishes basic radiation protection standards applicable to all PNL work with radioactive materials or radiation-generating devices. Designed to minimize radiation exposures of personnel and releases of radioactive material to the environment.

PNL-MA-7 Off-Normal Event Reporting System. Provides guidelines for reporting of all off-normal events, including unusual occurrences. Describes overall system, notifications, investigation, reporting, and recovery.

PNL-MA-8 Waste Management and Environmental Compliance. Presents procedures and requirements related to the handling and storage of radioactive and/or nonradioactive hazardous waste materials.

PNL-MA-25 Criticality Safety. Describes requirements for preventing accidental criticality in the handling, storage, and use of fissionable materials.

PNL-MA-42 Manager's Guide to Safety. Provides a concise summary of the information managers need to know or be aware of in establishing and maintaining safety programs. In addition, the "Guide" contains a list of the primary contacts in Laboratory Safety who can answer safety-related questions.

PNL-MA-43 Health and Safety Management. Gives guidance for industrial safety within PNL. Includes 28 chapters an Appendices on a variety of Safety related topics.

PNL-MA-50 Facility Operational Controls. Provides guidelines for integrating PNL facility operations and the individual operating occupant groups to ensure that; 1) the individual operations are each conducted in an effective, safe, secure and environmentally acceptable manner; 2) several individual operations are mutually compatible; 3) the facility systems (e.g., exhaust ventilation systems) are designed and operated to provide the necessary capacity and capability to support the needs of the individual operations and ensure the safe, secure, and environmentally acceptable operation of the combined operations. Defines

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APPENDIX B

WTC STAFF ASSIGNMENTS FOR CHEMICAL AND WASTE MANAGEMENT

324 Building/Facility Common Space - WTC Center Manager -- J. L. McElroy
Environmental Compliance Manager -- C. M. Andersen
324 Building/Facility - HAZARDOUS MATERIAL CUSTODIAN -- C. M. Andersen

SPACE	LABORATORY MONITOR	LABORATORY MANAGER
EDL-101	Tom Brouns	Harry Burkholder
EDL-102	Chris Chapman	Harry Burkholder
Module 1.	Dan Janke	Harry Burkholder
2, 3	Dan Janke	Harry Burkholder
4.	Tom Brouns	Harry Burkholder
5.	Bill Heath	Harry Burkholder
6.	Matt Cooper	Harry Burkholder
7, 8	Joe Perez	Harry Burkholder
11	Dan Janke	Harry Burkholder
12, 14	Greg Whyatt	Chuck Allen
13	Dan Janke	Harry Burkholder
15, 16, 17, 18	Joe Perez	Harry Burkholder
Tank Pit	Joe Perez	Harry Burkholder
Lab 115	Tom Brouns	Harry Burkholder
Lab 207/Lab 208	Tom Powell	Harry Burkholder
Lab 210	Mike Elliott	Harry Burkholder
Lab 212	Greg Whyatt	Chuck Allen
Room 145, 147	Jim Jarrett	Chuck Allen
Room 146	Dan Janke	Harry Burkholder
Room 18	Jim Jarrett	Chuck Allen
Room 309A	Cheryl Thornhill	Chuck Allen
Chem Makeup Room	Jeff Surma	Chuck Allen
Head Tank Room	Jeff Surma	Chuck Allen
3718E&G Warehouses	Cameron Andersen	Don Knowlton
324 Building Yard	Mike Pueschner	Lynn Eberhardt
High-Bay	Gary Ketner	Chuck Allen
Cask Handling	Jim Jarrett	Chuck Allen
Truck Lock	Jim Jarrett	Chuck Allen
324 Bldg. North LLW Storage	Jim Jarrett	Chuck Allen
ISV Site	Jim Jeffs/Tom Powell	Harry Burkholder
D Cell	Cheryl Thornhill	Chuck Allen
A, B Cells	Jim Jarrett	Chuck Allen
C Cell	Jeff Surma	Chuck Allen
Sky Park	Cameron Andersen	Don Knowlton

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Updated 3/22/91:Lab-Mntr.Asn

APPENDIX C

MATRIX OF SPECIFIC WTC INSPECTION AND SAFETY MEETING RESPONSIBILITIES

Org. Code	Documented Facility Inspections Freq per yr. Lab.*	Office	Safety Meetings Freq per yr.	Responsible Manager
7W00	2	1	1	JL McElroy
7W10		1	1	GW McNair
7W20	4	1	4	CR Allen
7W22	4	1	4	HC Burkholder

* These inspections are conducted with the Building Manager. Not included here are bimonthly walk through inspections of all experimental work areas by the Department Manager.

Primary Contacts in Laboratory Safety

Glenn Hoenes, Manager, 376-1137

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Occupational & Radiological Safety
Pat Wright, 376-1634

Fire Protection
Andy Minister, 376-4938

Occupational Safety
Bob Gough, 376-1886

Industrial Hygiene
Monty Rosbach, 376-3037

Radiological Engineering

Safety & Risk Assessment
Donna Lucas, 376-1331

Hazardous Waste Site Health & Safety
Jim Mohan, 376-8358

Injury or Illness Investigation
Patti Myers, 376-0918

ALARA
Cheryl Oxley, 376-0223

Criticality Safety
Les Davenport, 376-8388

Design Review, Mod Permits, & Nuclear Purchases
Russ Richman, 376-1887

Fire Extinguishers
Doug Clark, 376-2858

Explosives & Flammable Liquids
Scott Allen, 376-1042

Motor Vehicle Safety
Doug Wright, 376-4792

MSDSs & Chemical Hygiene
Rich Johanson, 376-1586

Rad. Air Emissions
Monte Sula, 376-0605

Respiratory Protection
Bob McDowell, 376-3331

Waste Management & Environmental Compliance
Bill Bjorklund, 376-4731

NEPA Reviews
David Guzzetti, 376-3752

Hazardous Material Shipping/Transportation
John Taylor, 376-1736

Regulatory Analysis
Harold Tilden, 376-0499

Oils, PCBs, & USTs
Brian Day, 376-3835

Compliance Inspections
Mike McCoy, 376-1483

Environmental Permits
Harold Tilden, 376-0499

Treatability Permits
Mike McCoy, 376-1483

Spill Reporting
Deanna Kages, 376-4088

Waste Minimization
Eric Hauth, 376-5631

Mixed Waste
Kevin Selby, 376-7223

TRU Waste Disposal
Kyle Webster, 376-1587

Low-Level Radioactive Waste and Radioactive Liquid Waste Disposal
Bruce Killand, 376-3158

Liquid or Airborne Releases
Deanna Kages, 376-4088

RCRA & Hazardous Waste Disposal
Glenn Thornton, 376-7638

Waste Designation
Gregg Barnet-Bailey, 376-41

Radiation Protection
Dave Higby, 376-3057

Field Dosimetry Services
Mary Ann Hensyel, 376-3538

Medical Scheduling
Stacy Berg, 376-3645

Radiation Instrumentation
Andy Mileham, 376-0942

RPT Supervision:

300 Area
Ron Schrotke, 376-4703

308, 324, 325 Bldgs.
Jerry Allen, 376-8502

331 Bldg., 3000, & Outer Areas
Jon Hudspeth, 376-3155

Safety Education
Jeene Hobbs, 376-1631

Female Rad Worker Concerns
Jean Buck, 376-8771

Variances
Jerri Weston, 376-1929

Emergency Assistance
375-2400

Alarm Review
375-2345

Employee Concerns Hotline
375-3999

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March, 1991

APPENDIX C

SILOS 1, 2 AND 3
RADIOLOGICAL AND CHEMICAL CONSTITUENTS

TABLE C-1

CHARACTERISTICS OF THE K-65 RESIDUES STORED AT THE FEMP

Silos 1 and 2					Silo 3
Characteristics	**Vitro (1952)**	**Litz[a] (1974)**	**NLO[a] (1980)**	**Gill (1988)**	**DOE (1987)**
Physical					
Dry Weight (kg)	1.59×10^6	--	8.79×10^6	--	--
Volume (m^3)	3,155	--	5,522	--	3,902
Density (kg/m^3)	1,179	--	--	--	--
Water content (%)	30	--	--	--	--
Radiological	(ppm)	(ppm)	(ppm)	(ppm)	(kg)
Raduim	0.3	0.28-0.36	0.2	0.13-0.21	0.015[b]
Uranium	2,110	1,800-3,200	600	1,400-1,800	18,000
Total thorium	--	--	--	301-322	--
Chemical					
Carbonates + Sulfates (%)	20				
Quartz (%)	25				
Muscovite clay (%)	60				

[a]As reported by Dettore et al., 1981.
[b]Assumes all radium in K-65 residues is Ra-226 with specific activity of 0.988 Ci/g.
Note: Data validation is currently in progress.

TABLE C-2

RADIONUCLIDE CONCENTRATIONS IN THE SILOS (1989 Sampling Program)

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SILO 1

Nuclide (pCi/g)	S1NE1A	S1NE1B	S1NE1C	S1SE1	S1SE2	S1SW1	S1NW1
Th-228	ND	ND	ND	ND	ND	ND	ND
Th-230	21,412	39,693	30,751	10,569	20,848	40,818	43,771
Th-232	ND	ND	ND	ND	ND	ND	766
Ra-226	108,100	192,600	166,400	116,800	89,280	181,200	163,300
Ra-228	ND	ND	ND	ND	ND	ND	ND
Pb-210	181,100	83,110	77,460	71,920	48,980	69,480	54,350
U-234	815	326	622	663	814	594	897
U-235/236	ND	ND	ND	ND	56	ND	50
U-238	920	398	610	545	758	532	687
U-Total (ppm)	2753	1189	1831	1633	2280	1602	2066

SILO 2

Nuclide (pCi/g)	S2SW1	S2NW1	S2NE2	S2SW2	S2NE1	S2NW2
Th-228	ND	ND	ND	411	ND	638
Th-230	31,825	32,784	8365	29,716	40,124	25,391
Th-232	ND	ND	ND	851	ND	ND
Ra-226	145,300	61,780	657	104,900	65,520	68,310
Ra-228	ND	ND	ND	ND	ND	ND
Pb-210	141,900	145,200	87,930	77,940	150,700	399,200
U-234	859	1107	974	121	848	1404
U-235/236	ND	74	47	ND	36	70
U-238	661	1069	874	46	814	1240
U-Total (ppm)	1972	3210	2620	137	2437	3717

ND = Not Detected
Note: Data validation is currently in progress.

TABLE C-3

RADIONUCLIDE CONCENTRATIONS IN THE SILOS
(1989 Sampling Program)

SILO 3

Nuclide (pCi/g)	# 21	# 22	# 23	# 24	# 25	# 26
Ac-227	523	416	234	1363	534	706
Pa-231	521	401	266	NA	556	889
Th-228	907	ND	554	ND	459	859
Th-230	41,911	33,881	21,010	71,650	40,968	41,555
Th-232	1451	ND	815	911	411	ND
Ra-224	453	451	64	213	295	335
Ra-226	2589	2192	467	6435	3073	1862
Ra-228	525	559	82	ND	392	441
Pb-210	2437	2221	454	6427	2493	1910
U-234	1935	1618	348	1524	1467	1910
U-235/236	152	117	ND	127	54	76
U-238	2043	1649	320	1600	1392	1860
U-Total (ppm)	4040	4305	738	2595	3064	4554

SILO 3

Nuclide (pCi/g)	# 27	# 28	# 29	# 30	# 33
Ac-227	421	412	443	773	566
Pa-231	458	NA	564	931	431
Th-228	ND	996	537	ND	949
Th-230	53,227	63,649	61,190	68,759	65,488
Th-232	ND	755	672	581	672
Ra-224	370	106	137	449	313
Ra-226	1518	3702	4169	2240	4451
Ra-228	325	ND	117	360	415
Pb-210	1084	2589	3553	1942	3674
U-234	1317	1052	1843	1643	1600
U-235/236	80	42	158	75	118
U-238	1243	994	1951	1574	1878
U-Total	2740	1463	1114	4050	3854

NA = Not Analyzed
ND = Not Detected

Note: Data validation is currently in progress.

TABLE C-4

ORGANICS CONCENTRATIONS IN THE SILOS

CONTAMINANT	Silo 1	Silo 2	Silo 3
VOLATILE ORGANICS ANALYSIS DATA (ppb)			
Methylene Chloride	840 - 4100	1100 - 6300	1000 - 2800
Acetone	140 - 5300	ND - 1600	3400 - 12000
Chloroform	480 - 1500	660- 1300	560 - 810
2-Butanone	7100 - 21000	7800 - 15000	9700 - 16000
4-Methyl-2-Pentanone	ND - 1400	ND - 2700	ND
Toluene	ND - 430	ND - 250	180 - 6800
Trichloroethane	ND	ND - 120	ND
Chloromethane	ND	ND	ND - 140
Styrene	ND - 350	ND - 200	ND
Total Xylenes	ND	ND - 200	ND
SEMIVOLATILE ORGANICS ANALYSIS DATA (ppb)			
Bis(2-Ethylhexyl)Phthalate	93 - 6000	ND - 560	ND - 40
Di-n-Octyl Phthalate	ND - 820	ND	ND
PESTICIDE ORGANICS ANALYSIS DATA (ppb)			
Aroclor-1248	ND - 8000	ND	ND
Aroclor-1254	1100 - 14000	420 - 6000	ND

ND = Not Detected
Note: Data validation is currently in progress.

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TABLE C-5

INORGANICS CONCENTRATIONS IN THE SILOS
(1989 Sampling Program)

Contaminant (ppm)	Silo 1	Silo 2	Silo 3
Aluminum	60.4- 1430	464 - 2570	10800 - 23700
Antimony	ND	ND - 7.2	ND
Arsenic	14.7 - 68.4	57.5 - 1960	532 - 6380
Barium	1970 - 7860	89.2 - 8370	118 - 332
Beryllium	0.88 - 2.8	0.66 - 6.0	10.0 - 39.9
Cadmium	2.1 - 8.0	3.4 - 19.1	21.5 - 204
Calcium	2150 - 5700	2430 - 301000	21300 - 39900
Chromium	21.0 - 165	12.9 - 68.8	139 - 560
Cobalt	349 - 1260	6.2 - 2430	ND - 3520
Copper	122 - 473	ND - 1790	1610 - 7060
Iron	4340 - 75100	4010 - 37800	13900 - 67600
Lead	35800 - 85100	153 - 29800	646 - 4430
Magnesium	1500 - 6020	1520 - 8740	38200 - 80900
Manganese	33.5 - 257	74.2 - 403	2420 - 6500
Mercury	0.23 - 2.8	ND - 2.3	ND - 0.69
Nickel	629 - 2580	14.6 - 2200	1200 - 6170
Potassium	158 - 492	37.8 - 289	1300 - 22800
Selenium	106 - 180	ND - 118	101 - 349
Silver	5.0 - 23.3	ND - 22.8	9.2 - 23.8
Sodium	360 - 13100	226 - 4070	22900 - 51700
Thallium	ND - 0.52	ND - 1.4	3.1 - 73.9
Vanadium	72.2 - 240	21.9 - 214	418 - 4550
Zinc	14.4 - 212	11.2 - 154	301 - 672
Cyanide	0.52 - 4.4	ND - 4.5	ND

ND = Not Detected
Note: Data validation is currently in progress

TABLE C-6

EP TOXIC METALS RANGE OF VALUES FOR K-65 AND METAL OXIDE SILOS
(1989 Sampling Program)

Analyte	Silo 1	Silo 2	Silo 3	Maximum Allowable Concentration
Arsenic (ppm)	ND - 0.484	0.163 - 0.592	ND - 41.5	5.0
Barium (ppm)	0.079 - 14.5	0.095 - 2.62	0.020 - 0.156	100
Cadmium (ppm)	ND - 0.100	0.017 - 0.278	0.108 - 6.32	1.0
Chromium (ppm)	0.020 - 0.964	ND - 1.02	0.336 - 11.9	5.0
Lead (ppm)	0.159 - 904	0.155 - 714	ND - 1.01	5.0
Selenium (ppm)	0.217 - 0.997	0.240 - 1.56	0.92 - 11.7	1.0
Silver (ppm)	ND - 0.121	ND - 0.213	ND - 0.032	5.0
Mercury (ppm)	ND	ND	ND - 0.003	0.2

ND = Not Detected
Note: Data validation is currently in progress.

TABLE C-7

GEOTECHNICAL ANALYTICAL RESULTS
(1989 Sampling Plan)

Sample ID	Color	Water Content (%)	Specific Gravity	Liquid Limit	Plastic Limit	Plasticity Index	200 Sieve (Percent Finer)
S1-NE-1A	Dark Brown	50.7	3.19	55.2	50.0	5.2	72.7
S1-NE-1C	Light Brown	71.5	2.74	70.3	66.6	3.7	71.5
S1-SE-2T	Sandy Brown	31.9	3.37	NP	NP	NP	43.9
S1-Compos.	NA	22.8	2.58	NP	NP	NP	54.5
S2-NW-1A	Brown	25.9	2.87	NP	NP	NP	39.8
S2-NE-2BT	White	21.8	2.59	NP	NP	NP	51.9
S2-SW-1A	Black	73.5	3.11	NP	NP	NP	63.3
S2-Compo	NA	34.2	2.78	NP	NP	NP	38.1
S3-NW-1A	Reddish Brown	7.4	2.35	NP	NP	NP	93.2
S3-NW-1C	Brown	3.7	2.08	NP	NP	NP	93.9
S3-SE-1A	Reddish Brown	10.2	2.58	NP	NP	NP	90.0
S3-SE-1C	Dark Brown	6.3	2.29	NP	NP	NP	92.9
S3-Compo	NA	3.8	2.75	NP	NP	NP	87.8

NA = Not Applicable
NP = Non-Plastic
Note: Data validation is in progress