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(FDF)

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CONTRACT NO. FSC 624

Silos 1 and 2 Accelerated Waste Retrieval (AWR) Project

March 23, 1998
DRAFT

Work located at The Department of Energy's
Fernald Environmental Management Project
Fernald, Hamilton County, Ohio

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PART 6
STATEMENT OF WORK

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STATEMENT OF WORK
SILOS 1 AND 2 AWR PROJECT

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PART 6
CONTRACT NO. FSC 624
STATEMENT OF WORK
SILOS 1 AND 2 AWR PROJECT

1.0 PROJECT SCOPE

1.1 Background

During the period of 1951 to 1960 the United States Department of Energy (DOE) produced approximately 6,800 (m^3) cubic meters of K-65 material. To support the storage of residue and other material four silos were erected at the Fernald Environmental Management Project (FEMP). Silo 1 and Silo 2 contain the residues generated from the processing of high grade uranium ores. This process was completed to extract the uranium compounds from the natural ores. The residues contain high activity concentrations of radionuclides, including radium (the contaminate of concern because it produces Radon) and thorium and are classified as by-product material. The FEMP site is included on the National Priorities List of the U.S. Environmental Protection Agency (U.S. EPA) to ensure the expedient cleanup of the FEMP. The Accelerated Waste Retrieval Project (AWR) is an interim step in the cleanup and disposition of the residue in Silos 1 and 2.

Over the years the silos have shown visible signs of deterioration and have undergone the following repairs:

1963 Silo walls were given a waterproof coating;

1964 A soil berm was built around the silos to the top of the walls at a slope of 1.5 to 1 ratio;

1983 The soil berm slope was increased to 3 to 1 ratio;

30 foot diameter protective covers constructed of steel and plywood were added to the domes to spread the load distribution on the domes; and

1998 The silos structural integrity is continually monitored.

The silos residue contains radium and one of radium's daughter products, radon. Over time the radon concentration in the silos is increasing. To mitigate the uncontrolled release of radon gas, the following removal actions were taken:

1987 3 inches of polyurethane foam were placed on the domes;

1987-1991 A Radon Treatment System utilizing radon adsorption carbon beds was initiated; and

1991 Layer of BentoGrout Clay™ was added to the silos.

1998 The layer of BentoGrout™ is degrading, drying, cracking and separating therefore the efficiency of the BentoGrout™ barrier is becoming inefficient and the radon concentration in the silos is increasing.

1.2 Objective

The objective of the AWR Project is to transfer approximately 6,800 m^3 [8,900 cubic yards (yd^3)] of material (to include residue, water, discrete objects and BentoGrout™ and heels) from Silos 1 and 2 to temporary transfer tanks. The composition of the contents in Silos 1 and 2 is primarily a wet, gray, silty claylike material (Reference the **Technical Requirements Document (TRD) in Part 7, Section 2.5.1**). The Contractor will be responsible for designing, constructing, testing, maintaining and operating the systems and subsystems associated with the AWR Project. The Contractor shall also be responsible for the completion and maintaining all supporting documentation of each project task and/or activity to support readiness assessments required prior to Operations. The AWR Project will consist of the following major systems:

Silos Waste Retrieval System (SWRS)

The SWRS shall retrieve all materials from the silos. The SWRS shall transfer the residues, BentoGrout™, and heel material to temporary transfer tanks. Discrete objects shall be retrieved and packaged in accordance with the FDF Waste Management Program (Reference **Part 7-TRD, Section 5.3**). The SWRS shall perform gross decontamination of the silos.

Decant Sump Waste Retrieval System (DWRS)

The DWRS shall retrieve all materials from the Decant Sump. The decant sump collects decant liquids from the silos. The DWRS shall segregate materials and transfer/package them as appropriate (Reference **Part 7-TRD, Section 2.3.1.3**). The DWRS shall perform gross decontamination of the Decant Sump.

Transfer Tank Area (TTA)

The TTA consists of temporary transfer tanks. The TTA is a temporary staging area for the residue and BentoGrout™ which will be transferred to a Full-Scale Remediation Facility under a separate contract. (Reference **Part 7-TRD, Section 2.3.1.4**).

Transfer Tank Waste Retrieval System (TWRS)

The TWRS shall retrieve the residue and BentoGrout™ from the TTA and transfer them to the Full-Scale Remediation Facility. (Reference **Part 7-TRD, Section 2.3.1.5**).

Radon Control System (RCS)

RCS Phase 1 will treat the silo headspace radon concentration.

RCS Phase 2 will treat the radon associated with silo retrieval, storage in the TTA, and Full-Scale Remediation Facility.

Full-Scale Mock-Up System (FSMS)

To validate the Contractor's design and residue retrieval method, a Full-Scale Mock-Up demonstration will be performed with the Silo 4 FSMS. This system will also be utilized for operator training and for troubleshooting during SWRS operations.

1.3 General Scope of Work

The Contractor shall furnish labor, supervision, administration, material, tools and equipment to design, construct, test and direct the operation of the AWR Project. Fluor Daniel Fernald (FDF) shall provide operations labor and technical support. The work shall be performed in accordance with the requirements listed in **Part 7-TRD; Part 8 -(ES&H/TRM), Part 9 - Quality Assurance Requirements**, and provisions of this statement of work. This work is divided into base requirements and optional items to adhere to DOE's site funding strategy. The requirements are described in more detail in the following sections.

2.0 BASE REQUIREMENTS

2.1 Project Management Program

The Contractor shall develop and submit for FDF concurrence, a Project Management Plan (PMP), which defines the Contractor's management approach organizational structure, methodologies, practices, and plans for managing this project. The PMP shall include the document submittals defined in **Part 7-TRD, Section 3.1.**

2.2 Design

The Contractor shall provide conceptual, preliminary and final design, and engineering reports for the AWR Project. The design shall be in accordance with the requirements and criteria set forth in **Part 7-TRD, Section 3.2.**

The Contractor may utilize any FDF design information referenced in **Part 7, Table of Contents.** Although this design is available, it is not the intent of FDF to influence the design process. (An exception to this is that the Contractor must use the pre-conceptual design for the Phase 1, RCS which is being provided by FDF in **Part 7-TRD, Appendix F).** When the Contractor uses any of the FDF design information (including the RCS Phase 1), the Contractor shall validate, certify, and assume all responsibilities for this design and any modifications. FDF will provide review and concurrence of the Contractor's design.

2.3 Safety Documentation

The Contractor shall provide the safety analysis documentation and Health and Safety Plans required for the AWR Project. The safety documentation shall be in accordance with the criteria set forth in **Part 7-TRD, Section 3.2** and **Part 8.**

3.0 OPTIONAL REQUIREMENTS

3.1 RCS Phase 1, Construction

The Contractor shall construct the RCS Phase 1 in accordance with the general construction and design requirements defined in **Part 6, Section 4.1; Part 7-TRD, Section 2.3.1.2,** and **Part 8.**

This option is considered complete with the successful completion of the RCS Phase 1 ICAT defined in **Part 6, Section 4.1.5.**

3.2 RCS Phase 1 Readiness Prep and Systems Operability Testing

The Contractor shall provide Standard Operating Procedures (SOP) maintenance procedures, training, startup plan, and System Operability Testing (SOT) for RCS Phase 1 in accordance with the requirements defined in **Part 6, Section 4.2; Part 7-TRD, Section 3.5** and **Section 3.6,** and **Part 8.**

This option is considered complete with the successful completion of the RCS Phase 1 readiness assessment defined in **Part 6, Section 4.3.**

3.3 RCS Phase 1 Operation

The Contractor shall operate the RCS Phase 1 in accordance with the requirements defined in **Part 6, Section 4.4; Part 7-TRD, Section 2.3.1.2 , Section 3.6 and Section 4.0, Appendix F;** and **Part 8.**

This option is considered complete when RCS Phase 2 becomes operational.

3.4 RCS Phase 2 Construction

The Contractor shall construct the RCS Phase 2 in accordance with RCS Phase 2 general design and construction requirements defined in **Part 6, Section 4.1; Part 7-TRD, Section 2.3.1.2;** and **Part 8.**

This option is considered complete with the successful completion of the RCS Phase 2 ICAT defined in **Part 6, Section 4.1.5.**

3.5 RCS Phase 2 Readiness Prep and System Operability Test

The Contractor shall provide SOPs, maintenance procedures, training, startup plan, and

SOTs for RCS Phase 2 in accordance with the requirements defined in **Part 6, Section 4.2**; **Part 7-TRD, Section 3.5** and **Section 3.6**; and **Part 8**.

This option is considered complete with the successful completion of the RCS Phase 2 readiness assessment defined in **Part 6, Section 4.3**.

3.6 RCS Phase 2 Operation

The Contractor shall operate the RCS Phase 2 in accordance with the requirements defined in **Part 6, Section 4.4**; **Part 7-TRD, Section 3.6** and **Section 4.0**; and **Part 8**.

This option is considered complete upon isolation of Silos 1 and 2 from the RCS after the successful transfer of all materials to the TTA.

3.7 FSMS Construction

The Contractor shall construct the FSMS in accordance with requirements defined in **Part 6, Section 4.1**; and **Part 8**.

This option is considered complete with the successful completion of the FSMS ICAT defined in **Part 6, Section 4.1.5**.

3.8 FSMS Readiness Prep and System Operability Test

The Contractor shall provide operating procedures, maintenance procedures, training, startup plan, and system operability testing for FSMS in accordance with the requirements defined in **Part 6, Section 4.2**; **Part 7-TRD, Section 3.5** and **Section 3.6**; and **Part 8**.

This option is considered complete with the successful completion of the FSMS readiness assessment defined in **Part 6, Section 4.3**.

3.9 FSMS Demonstration

The Contractor shall conduct a FSMS demonstration utilizing Silo 4 and the AWR surrogate as defined in **Part 7-TRD, Appendix G** and **Section 3.4.3**, and the test requirements defined in **Part 6, Section 4.1.6**.

This option is considered complete with the following:

- Successful demonstration of proof of principle testing of the AWR systems; and
- Issuance of final FSMS demonstration report.

3.10 FSMS Operations

The Contractor shall operate the FSMS as required for training, problem solving, and test runs in accordance with the requirements defined in **Part 6, Section 4.4**; **Part 7-TRD, Section 3.6** and **Section 4.0**; and **Part 8**.

This option is considered complete with the successful completion of AWR operation, **Part 6, Section 3.15.**

3.11 TTA and TWRS Construction

The Contractor shall construct the TTA and TWRS in accordance with the requirements defined in **Part 6, Section 4.1**;and **Part 8.**

This option is considered complete with the successful completion of the TTA and TWRS ICAT as defined in **Part 6, Section 4.1.5.**

3.12 TTA and TWRS Readiness Prep and System Operability Test

The Contractor shall provide SOP's maintenance procedures, training, startup plan, and system operability testing for TTA and TWRS in accordance with the requirements defined in **Part 6, Section 4.2; Part 7-TRD, Section 3.5** and **Section 3.6**; and **Part 8.**

This option is considered complete with the successful completion of the AWR readiness assessment defined in **Part 6, Section 4.3.**

3.13 SWRS and DWRS Construction

The Contractor shall construct the SWRS and DWRS in accordance with requirements defined in **Part 6, Section 4.1**;and **Part 8.**

This option is considered complete with the successful completion of the SWRS, DWRS and ICAT as defined in **Part 6, Section 4.1.5.**

3.14 SWRS and DWRS Readiness Prep and System Operability Test

The Contractor shall provide maintenance procedures, training, startup plan, and system operability testing for SWRS and DWRS in accordance with the requirements defined in **Part 6, Section 4.2; Part 7-TRD, Section 3.5** and **Section 3.6**; and **Part 8.**

This option is considered complete with the successful completion of the AWR readiness assessment.

3.15 AWR Operation

The Contractor is responsible for the operation and maintenance activities associated with the AWR Project. The Contractor shall provide technical oversight and direction for the operation and maintenance in accordance with the requirements defined in **Part 6, Section 4.4; Part 7-TRD, Section 3.6** and **Section 4.0; Part 8.**

The Contractor is responsible for the direction of and technical guidance for silo berm removal during silo residue removal action using SWRS in accordance with **Part 6, Section 4.4; Part 7-TRD, Sections 3.1.1.1, 3.6,** and **5.0.**

This option is considered complete with the successful gross decontamination of the silos after transfer of silo materials from the silos to the TTA, Reference **Part 6, Exhibit 6.8.**

3.16 System Closure

The following activities comprise the system closure phase of this project:

- Submittal of closure request and safe workplan for closure; and
- System closure.

The Contractor shall perform these activities as defined in **Part 6, Exhibit 6.8** and **Part 8.**

3.16.1 Pre-requisites to System Closure

This activity applies only to the FSMS, SWRS, RCS Phase 1, and the DWRS. The RCS Phase 2, TTA, and TWRS shall remain operational. Prior to requesting approval to begin system closure and dismantlement activities, the following requirements must be satisfied:

- Retrieval of all materials in Silos 1 and 2 and the Decant Sump;
- Gross decontamination of interior of Silos 1 and 2 and the Decant Sump;
- Removal of contaminated material from equipment;
- System closure of waste retrieval equipment;
- Silos 1 and 2 - as is after completion of retrieval process and removal of all materials; and
- Silo 4 - Removal of AWR surrogate used for demonstrating equipment from Silo 4.

3.16.1.1 Concurrence to Begin System Closure

The Contractor shall submit written request and receive written concurrence from FDF prior to beginning system closure activities.

3.16.2 System Closure Activities

System closure includes activities to place the system in a controlled state ready for dismantlement. Activities included within this task are removal of contaminated material, cleaning of interior surfaces, disconnection of utilities (e.g., water, electricity, and communications), and gross decontamination of exterior surfaces.

3.16.2.1 Flush and Drain

The Contractor shall remove and treat all residual material contained within the process

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equipment and support systems and transfer it the TTA. The Contractor shall remove materials, debris, and contaminants on equipment using methods that minimize the generation of secondary waste.

The Contractor shall flush all process equipment and support systems to remove loose contaminants and process residues. Flush water that can not be treated at the Advanced Wastewater Treatment System (AWWT) shall be treated by the Contractor prior to discharge. Equipment and systems shall then be drained.

3.16.2.2 Utility Disconnection

Following system closure, the Contractor shall perform all utility disconnect activities associated with its facilities at the point provided by FDF. Utilities shall be isolated and visibly air gapped at the tie-in points and where the utilities enter the facility. The Contractor shall also ensure that tie point isolations are performed in such matter that system and personnel safety are not compromised.

3.16.2.3 Decontamination

Gross decontamination shall be performed on the exterior of equipment and process systems, and the interior of building surfaces, including floors.

3.16.3 Demobilization Phase

Demobilization shall consist of removal of the Contractor's temporary facilities and equipment and submittal of all required documentation to close out the project.

3.16.3.1 Authorization to Demobilize

The Contractor shall submit written request and receive written concurrence from FDF prior to beginning demobilization activities.

3.16.3.2 Removal of Temporary Facilities

The Contractor shall remove from the FEMP all temporary facilities and equipment installed under this contract. Items leaving the site must pass a radiological survey, and otherwise meet the criteria for release in this contract.

3.16.3.3 Site Restoration

The Contractor shall restore the physical conditions within the Silos 1 and 2 work zone area and any areas disturbed by the Contractor outside of the work zone area, prior to demobilization as directed by FDF.

4.0 GENERAL REQUIREMENTS

The following general requirements shall be applicable to all of the specific phases of the

project including construction, testing, readiness, startup and operations.

4.1 General Construction Requirements

4.1.1 Safe Work Plans

The Contractor shall develop and issue Safe Work Plans for each task associated with construction. The Safe Work Plan will provide instructions and provide documentation/records to document construction activities, including in-process testing, refer to **Part 7-TRD, Section 3.4.1.2** and **ACR-002-Silos** safe work plan format.

Safe Work Plans are documentation packages assembled for each system or subsystem. These packages shall contain all related documentation/records, material receipt inspections, equipment repairs, drawings, specifications, manufacturer instructions, etc. as required to construct all parts of the system or subsystem.

Each Safe Work Plan not in use in the field shall be returned to the designated, secured, and controlled storage location. These documentation files shall be maintained current by the Contractor.

FDF shall review and concur with each Safe Work Plan prior to implementation. Prior to the issuance of the Safe Work Plan, FDF has the option to identify and note hold points on the documentation/records. The Contractor shall provide FDF with copies of the Safe Work Plans.

Submittal of the Safe Work Plan(s) shall be in accordance with the Contractor's Submittal Register EXHIBIT 6.2.

4.1.2 Construction Waste Management

The Contractor shall be responsible for the proper disposal of all waste materials generated from construction activities. Material disposition shall be in accordance with **Part 7-TRD, Section 5.0** and **Part 7, ACR-007** "Waste Material Handling Criteria for Construction Projects".

4.1.3 Site Preparation

The Site Preparation activities shall include relocation of any existing items (such as fencing or storm drains) required to provide space to construct the Contractor designed facilities. This includes grading and paving of all access roads extending from the existing site roads to the Contractor's temporary and permanent facilities; all site work such as storm water management, grading, soil characterization, seeding, etc. required in the work area; Construction and maintenance of gravel lay down and staging areas for materials and equipment; temporary warehousing; and extension of all utilities from the tie in points. (Refer to **Part 6, Section 7.0** and **Part 7-TRD, Sections 2.3.2.1.**

4.1.4 Construction Acceptance Testing (CAT)

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The Contractor shall develop a Construction Acceptance Test (CAT) Plan in accordance with the requirements identified **Part 7-TRD, Section 3.4.1** and submit the CAT Plan for FDF concurrence review. The Contractor shall utilize the Safe Work Plans as identified in **Part 6, Section 4.1.1** to perform and document the CAT activities. All of the initial calibration verifications, and equipment check out and setup will be completed as part of CAT.

4.1.5 Integrated Construction Acceptance Testing

ICAT shall be performed for each system, or sub-system, from control switch to component. ICAT activities shall ensure that each system is tested to verify that it performs within design specifications and operating parameters and shall provide the Contractor and FDF with a high degree of confidence that each system can be started in a manner that is safe to personnel, equipment and environment. Each system, or sub-system, shall be tested to the fullest extent possible using a compatible process medium. Water may be substituted for the AWR surrogate except as noted in **Part 6, Section 3.9**. Breaching of the silos will not be performed as part of the testing. Any waste generated during the ICAT shall be disposed of in accordance with **Part 7-TRD, Section 5.0**.

4.1.5.1 ICAT Plan

The Contractor shall prepare and submit for FDF concurrence an ICAT Plan to identify the systems and sub-systems which shall be tested during construction. The ICAT Plan shall address completion of all ICAT activities. The Contractor shall prepare the plan in accordance with the FDF requirements defined in the **Part 7-TRD, Section 3.4.2.1.**

4.1.5.2 ICAT Procedures

The Contractor shall develop and issue ICAT procedures in accordance with the FDF procedure format as identified in the **Part 7-TRD, Section 3.4.2.3.** The ICAT procedures shall be developed in such a manner that the Contractor may easily convert them into System Operability Test (SOT) procedure format, as applicable. FDF shall review and concur with the procedures.

4.1.5.3 ICAT Prerequisites

The Contractor shall perform the activities required to satisfy all prerequisites as identified in the ICAT Plan.

4.1.5.4 ICAT Performance

The Contractor shall conduct ICAT as a construction activity prior to turnover to Startup. The Contractor shall perform ICAT utilizing Contractor personnel. FDF will provide review and concurrence of test completion during the performance of the ICAT activities.

4.1.5.5 Final ICAT Report

The Contractor shall prepare and receive FDF concurrence on a Final ICAT Report. The

report shall document lessons learned and satisfactory completion of the ICAT activities. The Final ICAT Report shall be developed as identified in the **Part 7-TRD, Section 3.4.2.4.**

4.1.6 Full-Scale Mock-Up System (FSMS) Demonstration

4.1.6.1 FSMS Demonstration Readiness Assessment

The Contractor shall complete a Readiness Assessment prior to the performance of the FSMS demonstration. The Readiness Assessment is required to determine that the FSMS equipment is ready to support the required FSMS demonstration. The Readiness Assessment shall meet all of the requirements of the readiness process as identified in **Part 6, Section 4.3.**

4.1.6.2 FSMS Demonstration Program

As a final part of ICAT activities, the Contractor shall perform and document the FSMS demonstration to validate the design of the AWR. FSMS testing shall demonstrate the retrieving, transferring, settling, decanting, and storing of the AWR surrogate. Any design changes that may result from FSMS demonstration shall be incorporated and redemonstrated before completion of this process.

4.1.6.3 FSMS Demonstration Procedures

The Contractor shall develop procedures that will be used to implement the FSMS demonstration activities. The FSMS procedures shall provide specific guidance to safely direct the performance of the FSMS demonstration activities. The FSMS demonstration procedures shall be developed in accordance with guidelines identified in **Part 7-TRD, Section 3.4.3.4.** FDF shall review and concur with the FSMS demonstration procedures.

4.1.6.4 FSMS Demonstration Training

The Contractor shall ensure that all personnel involved in the performance of the FSMS demonstration are trained and qualified to perform the FSMS demonstration procedures. This training shall be coordinated as identified in **Part 6, Section 4.4.3** and **Part 7-TRD, Section 3.6.2.**

4.1.6.5 FSMS Demonstration

The Contractor's FSMS demonstration for retrieval of AWR surrogate from Silo 4 shall include as a minimum: 1) the use of AWR equipment as would be used during operations; 2) retrieval from various strategic areas within the silo; 3) removal from the heel area; 4) removal; and separation of discrete objects from the surrogate stream; 5) retrieval of settled surrogate from the TTA to simulate removal and transfer to the full-scale remediation facility; 6) BentoGrout™ and water separation and processing (reference **Part 7-TRD, Section 5.0**); 7) demonstration of sample collective method for obtaining archive samples of AWR surrogate from transfer line between FSMS and TTA; and 8) gross decontamination of the silos interior walls as required, **Part 6, Exhibit 6.8.** The Contractor shall transfer the

AWR surrogate from Silo 4 to the TTA and if hydraulic retrieval is used, decant the free liquids.

The Contractor shall verify the performance of the TWRS once the AWR surrogate has been stored in a steady-state condition for a minimum of one week. Following the FSMS demonstration activities, the Contractor shall transfer the AWR surrogate to a holding facility until final disposition of the AWR surrogate can be determined. The Contractor shall be responsible for final disposal of the AWR surrogate once it has been determined by the Contractor that it is not required or that it is no longer cost effective to maintain. The Contractor shall direct the disposal of the AWR surrogate in accordance with the FDF waste management program after verification that the AWR surrogate is not contaminated. Silo 4 FSMS equipment shall be maintained so that it may be used for future activities such as training, problem solving, and test runs. The Contractor shall be responsible for directing the operations of Silo 4 equipment if it is determined that training, problem solving, and test runs are required during AWR residue retrieval operations. The Contractor shall provide all materials (e.g. AWR surrogate if previously disposed of, tools, discrete objects, etc.) required to support the Silo 4 FSMS demonstration activities. The Contractor shall demonstrate the operation of SWRS for decanting of free liquids from the TTA (if the proposed SWRS uses hydraulic retrieval). This shall be completed before the start of the one week AWR surrogate steady-state period. The Contractor shall submit a FSMS Demonstration Plan to FDF for review and approval as stated in **Part 7-TRF, Section 3.4.3.1.**

The Contractor shall submit a FSMS Demonstration Plan to FDF for review and approval as stated in **Part 7-TRD, Section 3.4.3.1.**

4.1.6.6 FSMS Demonstration Report

Upon successful completion of the FSMS demonstration activities, the Contractor shall prepare a Final FSMS Demonstration Report in accordance with the FDF requirements defined in the **Part 7-TRD, Section 3.4.3.5.** The final report shall detail the successful completion of the demonstration activities and the lessons learned. FDF will review and concur with the final report prior to issuance.

4.1.7 Calibration, Grooming and Alignment (CG&A)

The Contractor shall identify the SOT prerequisite activities identified as CG&A in **Part 7-TRD, Section 3.5.1.** The Contractor shall direct the performance of these CG&A activities to ensure that all equipment is ready to support SOT activities as defined in **Part 7-TRD, Section 3.5,** prior to turnover from construction to start up.

4.2 General Readiness Prep and Startup Requirements

4.2.1 Startup and Turnover Program

Startup and Turnover Program responsibilities shall begin at the turnover from construction to startup and shall end with the turnover to operations. The Contractor shall have the responsibility for the implementation and coordination of all startup and turnover activities.

Startup and turnover activities shall ensure that each system is tested to verify that it performs within design specifications and operating parameters and shall provide FDF with a high degree of confidence that each system can be started in a manner that is safe to personnel, equipment and environment.

4.2.1.1 Startup and Turnover Plan

The Contractor shall prepare and submit for FDF concurrence a Startup and Turnover Plan in accordance with the FDF requirements defined in the **Part 7-TRD, Section 3.5.1.** The Startup and Turnover Plan shall document the formalized process by which the AWR will be turned over to Operations. The Startup and Turnover Plan shall address all of the activities beginning with construction turnover and ending with turnover to Operations. During startup/turnover activities, Fernald Atomic Trades and Labor Council (FAT&LC) shall be utilized to perform the equipment and system operation using the procedures as guidelines (Refer to EXHIBIT 6.6, Labor Utilization).

4.2.1.1.1 System Operability Test Plan

As part of the overall Startup and Turnover Program, the Contractor shall prepare and submit for FDF concurrence a Plan as specified in the **Part 7-TRD, Section 3.5.2.** The SOT Plan shall define the testing organization, responsibilities, methodologies, acceptance criteria, documentation, reporting, and activities for each AWR system.

4.2.1.1.2 SOT Specification

The Contractor shall develop and document the SOT specifications to identify the tests to be performed, the systems or components to be tested, the justification for performing the test, and the information to be generated by the test. The SOT specifications shall be developed in accordance with **Part 7-TRD, Section 3.5.1.** FDF shall review and concur with this document.

4.2.1.1.3 System Operability Test Procedures

The Contractor shall develop SOT procedures as identified in the **Part 7-TRD, Section 3.5.3.** SOT procedures shall test each system or sub-system from the control switch to system components of the AWR systems. FDF shall review and concur with the procedures prior to issuance.

4.2.1.1.4 System Operability Testing

The Contractor shall direct SOT activities with FDF oversight during the performance of the SOT activities. The Contractor shall ensure that all SOT activities are completed and thoroughly documented as defined in **Part 7-TRD, Section 3.5.2.** The SOT activities shall include utilization of all site interfaces as identified in **Part 6, Section 5.0,** FDF Responsibility Interfaces.

4.2.1.1.5 System Operability Test Final Report

The Contractor shall prepare a SOT Final Report in accordance with the FDF requirements defined in the **Part 7-TRD, Section 3.5.4.** The report shall detail successful completion of the testing activities, satisfaction of the acceptance criteria, test exceptions, relative changes, and the lessons learned. FDF will review and concur with the final report prior to issuance.

4.3 Readiness Assessment

FDF will perform Readiness Assessment of the AWR. Readiness Assessment is required by Part 7, DOE Order 425.1, "Startup and Restart of Nuclear Facilities", and Part 7, RM-0025 "Pre-Operational Assessment Program." Using the graded approach, the appropriate level of RA shall be performed for the RCS, TTA, SWRS, TWRS, and DWRS before operations may begin and for the FSMS prior to performance of the Full-Scale Mock-Up Demonstration. The readiness assessment process provides a systematic approach for independently verifying that required actions have been completed and recorded to confirm that a satisfactory state of readiness to proceed with operation (or FSMS demonstration) exists..

Based on the graded approach, FDF will generate a Readiness Plan of Action and Readiness Implementation Plan defining the detail readiness requirements. The Contractor shall provide all necessary technical support to meet the readiness requirements.

The Contractor shall be responsible for organizing and maintaining the readiness assessment support documentation on an ongoing basis throughout the AWR project. This includes readiness assessment related documentation for the AWR design, construction, testing, and operations support (e.g. training, qualifications, procedures, plans, etc.).

During the AWR Project a Contractor readiness coordinator shall interface with FDF for file development to support the readiness assessment requirements. FDF will have the responsibility for DOE compliance with the readiness assessment requirements. The DOE will provide oversight of the readiness assessment process. Authorization to operate is provided to the Contractor by FDF following successful completion of the required readiness assessment process. The DOE will provide FDF concurrence to operate the AWR Systems.

4.4 Operations

Operations responsibilities shall begin at the turnover from startup to operations. The Contractor shall have the responsibility for the implementation and coordination of all operations activities involved with the AWR. FDF shall provide oversight during the operations activities. Operations activities will be performed using FDF FAT&LC in accordance with **Part 5, "Project Labor Agreement"** and **Part 6, EXHIBIT 6.6,** Labor Utilization.

4.4.1 Operations Waste Management

The Contractor shall be responsible for all waste management issues during the performance

of operations activities. The Contractor shall coordinate with operations supervision and waste management personnel as necessary on waste management issues in accordance with the Waste Management Plan, **Part 7-TRD, Section 5.0.**

4.4.2 *Standard Operating Procedures*

The Contractor shall develop Standard Operating Procedures (SOP) for each task associated with the normal operation of the AWR Systems. SOPs include procedures for normal operations functions, alarm response, and emergency response. The Contractor shall prepare the procedures in accordance with the FDF procedure format **Part 7-TRD, Section 3.6.1.** Prior to the issuance of the SOPs, FDF shall provide review and concurrence.

4.4.3 Operations Training

The Contractor shall be responsible for the preparation and implementation of an operations training plan and associated lesson plans as identified in **Part 7-TRD, Section 3.6.2.** Training includes classroom instruction, on-the-job training and drills. The Contractor shall be responsible to provide the training subject matter expert(s) as instructors for the training classes. The Contractor shall provide a training coordinator and all training activities shall be coordinated through the FDF Training Department. FDF shall review and concur with the training plan and lesson plans prior to being issued. FDF shall provide oversight during the training activities.

4.4.4 AWR Operations Activities

Operations activities are identified as the successful and safe transfer of silos residues to the TTA through the implementation of all related operations activities. The Contractor shall direct the AWR operations activities to be performed in accordance with SOPs. The Conduct of Operations (CONOPS) program elements as identified in DOE Order 425.1; and **RM-0029**, shall be implemented during operations activities. The Contractor shall provide an Operations Coordinator to interface with the FDF Operations supervision. FAT&LC shall be utilized to perform the equipment and system operations using the SOPs as a guideline. (Refer to **Part 6, EXHIBIT 6.6, Labor Utilization**)

4.4.5 AWR Operations Progress Reporting

The Contractor shall conduct daily Operations meetings. Contractor and FDF Operations management personnel, as well as any FDF interface organization personnel, shall attend the meetings. Operations progress, issues, obstacles, maintenance items, short-term objectives, and conduct of operations issues shall be discussed and the status shall be documented. The Contractor shall document the meeting minutes to include issues discussed, resolution of issues and open items.

The Contractor shall complete a weekly report to document Operations progress, issues, path forward, and a summary of the daily meetings. The report shall be issued each Monday before 12:00 p.m. (or the next work day if operations activities are not being performed).

4.4.6 Maintenance/Preventative Maintenance Program and Procedures

The Contractor shall prepare and submit for FDF concurrence, Maintenance/Preventative Maintenance Plan, and related Procedures in accordance with the requirements stated in **Part 7-TRD, Section 4.0.**

4.4.6.1 AWR Maintenance Activities

The Contractor shall direct all of the Maintenance Activities involved with the AWR. The Contractor shall utilize the FDF FAT&LC for the maintenance activities of the facility in accordance with **Part 6, EXHIBIT 6.6,** Labor Utilization.

4.4.7 AWR Sampling Plan and Procedures

The Contractor shall prepare and submit for FDF concurrence, a sampling plan and sampling procedures in accordance with **Part 7-TRD, Section 3.6.4**

4.4.7.1 AWR Sampling Activities

The Contractor shall direct the sampling activities involved with the AWR. The Contractor shall utilize FDF FAT&LC personnel to perform all sampling activities in accordance with the sampling plan and sampleing requirements defined in, **Part 6, Section 4.5.3; Part 7-TRD, Section 3.1.2 and Section 3.6.4.**

4.5 Special Requirements

4.5.1 Off Site Fabrication

The Contractor shall exercise to the fullest extent possible off site fabrication, modularization and testing. At the time of delivery to the site, the Contractor shall provide thorough and complete documentation for each module to verify compliance with the design requirements identified in the **Part 7-TRD, Section 2.0.**

4.5.2 Waste Minimization

The Contractor shall be responsible for minimizing waste from the retrieval, transferring, decanting, and storing process, in accordance with the Waste Management Plan (refer to **Part 7-TRD, Section 5.0).**

4.5.3 Sampling

The Contractor shall also be responsible for directing the collection, analyzing, storage and dispositon of any samples required by the Contractor for process control of the AWR. The Contractor shall also be responsible for directing the collection and storage of archived samples required by FDF. The Contractor shall be responsible for providing sample storage facilities for interim and archive samples in accordance with **Part 7-TRD, Section 2.3.1.1** and **Section 2.3.1.4.**

4.5.4 System Responsibility

After completion of system operations and system closure activities identified in **Part 6, Section 3.15** and **Section 3.16**; FDF will assume responsibility for operation and maintenance of all remaining systems that are required for future operations.

4.5.5 Fugitive Dust Control

The Contractor shall submit a Fugitive Dust Control Plan and perform fugitive dust control and in accordance with **Part 6, EXHIBIT 6.5.**

4.5.6 Consumables

The Contractor shall be responsible for the supply and disposal, as applicable, of consumables required to support construction, startup testing, and operations in accordance with **Part 8, Section B.3.7.** Examples of these consumables include paper, logbooks, duct tape, absorbent materials (rags) and other material not identified in **Part 7-TRD** and **Part 8.** Disposal of used materials shall be in accordance with waste management program, identified in **Part 7-TRD, Section 5.0.**

4.5.7 Signs and Labels

The Contractor shall install all required signs, labels, equipment tags, etc. and shall paint color codes on PIV's, hydrants and valve boxes in accordance with **Part 7-TRD, Section 2.3.3.6.**

4.5.8 Contractor Furnished FDF Office Space

Contractor shall provide office space for three FDF personnel, beginning with Notice to Proceed through completion of final design. Offices shall contain furniture, computers with network connections, and telephones. It is expected that FDF will station one resident engineer in the Contractor's office full time, with others visiting periodically for over-the-shoulder reviews.

4.6 Work Not Included

4.6.1 Maintenance

Maintenance of existing site roads, area lighting, existing utilities up to the tie in points, existing storm water control, etc. will be the responsibility of FDF.

4.6.2 Air Sampling/Monitoring

Air sampling and monitoring at the site boundary will be the responsibility of FDF.

4.7 Radiological Isotope of Concern

A description of the composition of the contents in Silos 1 and 2 is provided in **Part 7-TRD, Appendix A.**

5.0 FDF RESPONSIBILITY INTERFACES

As indicated throughout this contract, FDF has various responsibilities associated with planning and the implementation of this project, some of which may affect the time it takes the Contractor to perform activities. Table 6-1 provides a listing of various tasks to be performed by FDF, which may impact the Contractor's activities. For each interface task identified, the table also provides information relative to the frequency that the interface can be expected, the approximate duration of the interface activity, and the FDF organization specifically involved. These interfaces are being identified so that the Contractor can factor them into the planning/sequencing of activities.

During the expected time of the FSMS demonstration, the Silo 3 Remediation Contractor will be in operation; requiring advance coordination and possibly off normal shift work to minimize delays. The following table, 'Group Work Tasks', provides the responsible group for various work tasks along with the approximate duration and frequency of the task.

GROUP WORK TASKS TABLE

TASK	FREQUENCY	APPROX. DURATION	RESPONSIBLE GROUP
Respirator Issue	As Required	.25 hrs.	Rad Safety
Haul Road Crossings (Note 1)	As Required	.5 hrs	FDF Rad Safety
Tool & Equipment Entry Inspection	Per Delivery	1.5 hrs.	FDF Health and Safety
Delivery Truck Inspections	Per Delivery	.5 hrs.	FDF Health and Safety
Confined Space Monitoring	Daily	.5 hrs.	FDF Health and Safety
Exit Monitoring	As Required	1.5 hrs.	Rad Safety
Removal of Tool & Equipment from Site	As Required	Up to 5 Days	Rad Safety
Container Prep Material	As Required	2 Days	Waste Management
Delivery of Washable PPC	Daily	2 Days	FDF Construction Coordinator
Container Delivery	As Required	10 Days After Notification	Waste Management
Berm Soil Sampling and Characterization	As Required	10 Days	FDF Waste Management
Analytical determination of effluent for delivery to AWWT	As Required	2 Days	FDF AWWT Group/Waste Management
Employee Training	As Required	Note 2	FDF Training Dept.
Work Permits	As Required	5 Days	FDF Construction Coordinator
Other Permits (Note 3)	As Required	2 Days	FDF Construction Coordinator
Swipe Test for Equipment and Material Release	As Required	2 hrs.	Rad Safety/Waste Management

Note 1 - The OU2 Haul Road, shown on 94X-5500-G-5000X, space allocation site plan OU4, which is used for across site soil transport, and is forecast to be in use during AWR construction activities as follows (approximate periods subject to change): March 1999 to November 1999 and March 2000 to November 2000.

Note 2 - Refer to Part 8, EXHIBIT 8.2, for training requirements and durations.

Note 3 - Refer to Part 8, Section 8.2.7, for listing of additional permits.

5.1 Delivery of Contractor Waste Water to the AWWT

The AWWT is designed to only remove uranium from the waste stream. The Contractor is responsible for any pre-treatment of waste water prior to transfer to the AWWT. Flow rates into the AWWT are influenced by other feed streams and therefore will vary. The Contractor is responsible for proper waste water management per the Waste Management Plan (**Part 7-TRD Section 5.0**) until it is transferred to the AWWT. Refer to the **Part 7-TRD, Section 2.3.2.2** for wastewater system requirements.

5.2 Delivery of Contractor Furnished Material and Equipment

All shipments to the Contractor shall be marked with the Contractor's name and FDF contract number.

Upon arrival of common carrier or Contractor delivery shipments, FDF will notify the Contractor by radio or phone.

For all shipments, the Contractor shall provide a qualified escort (refer to note below) and escort the carrier to the Contractor's unloading point for unloading by the Contractor.

Deliveries by the Contractor's truck shall be made at the main gate. FDF will contact the Contractor who is required to send an escort within one-half hour. The Contractor shall escort the truck to the Contractor's unloading point for unloading by the Contractor.

Contractor shall provide trained personnel to serve as escorts and coordinate the dates and times that escorts will be required. Escorts are to be RAD I trained to enter Controlled Zones and RAD II trained to enter Contamination Zones.

NOTE: The Contractor is responsible for the following:

1. All drivers must be escorted unless they are trained in accordance with the site requirements.

2. The driver must be issued a TLD badge.

6.0 TEMPORARY FACILITIES AND UTILITIES

6.1 Utilities

The Contractor will be given access, without charge, to limited electrical, and water services in the vicinity of his work site. The quantities and characteristics of these utilities will be limited to that which is available from existing outlets in the following locations:

Power: 6 MVA @ 13.2 kV is available at an overhead distribution line located near the project. The location of the distribution line is identified on project drawing 94X-5500-E-SK-4000. Refer to **Part 7-TRD, Section 2.5.4.**

Non-Potable Water: Water line available at a location identified on project drawing 94X-5500-M-SK-7033. The Contractor shall be responsible for maintaining this line during the project including cold weather protection during the winter. Refer to **Part 7-TRD, Section 2.5.4.**

6.2 Telephone Lines

FDF will provide 2 telephone lines and a facsimile line to the Contractor's office trailer. This service includes two telephones and telephone service. Only FDF telephone equipment shall be used at the site; upon request, additional telephone equipment will be made available to the Contractor if possible. FDF will also provide the Contractor with use of a computer connected to the site FDF computer system in the Contractor's office. Additional FDF computers may be made available to the Contractor upon request, if available. FDF will also provide all wiring required to connect the computer to the site computer system at no cost to the Contractor or liability to FDF. The Contractor must adhere to all rules concerning use of this computer. THE CONTRACTOR WILL NOT BE ALLOWED TO INSTALL ANY SOFTWARE ON A FDF COMPUTER.

6.3 Drinking Water

The Contractor shall furnish all drinking water. Locations for drinking water shall be submitted to FDF in accordance with **Part 8, Section B.3.3.**

6.4 Temporary Buildings

The Contractor shall provide temporary field offices, tool trailers, warehouse for spare parts or equipment, etc., on-site for use during performance of the Contract. A general location of these facilities is shown on Drawing No. 94X-5500-G-5000X. The Contractor shall submit the number, type, size and a sketch of the proposed location of each facility for approval by FDF prior to mobilization. These temporary facilities shall meet the requirements outlined in **Part 7, ACR-006 "Contractor Portable Structures."**

6.5 Protection of Utilities

The Contractor shall install barricades, bollards, steel plates, signage, etc. as required to protect utilities from damage

7.0 SITE LOCATION, ACCESS, LAY DOWN AREAS AND LIMITS OF CONSTRUCTION AREA

7.1 Job-Site Location

The exact job-site location and access to the job-site is shown on Drawing 95X-5500-G-SK-7034.

7.2 FDF Address

The FDF address is:

Mailing:	Shipping:
Fluor Daniel Fernald Attn.: William B. Hensley Mail Stop 52-3 P. O. Box 398704 Cincinnati, OH 45239-8704	Fluor Daniel Fernald Attn.:_____ 7400 Willey Road Fernald, OH 45030

7.3 Construction Boundaries

Contractor's activities and storage area shall be limited to the construction boundaries shown on Drawing 94X-5500-G-5000X. The Contractor shall install construction zone fencing (orange snow fence) around the work area as identified on the drawing.

7.4 Work Area Boundaries

The Contractor shall establish, within the work area boundaries, the proposed radiological boundaries for review by FDF.

The Contractor is to install and maintain yellow snow fencing to outline the radiological work areas if physical boundaries do not exist.

The snow fencing shall be four feet high and orange for construction fencing or yellow for radiological boundaries. Fencing material shall be secured and made of high density polyethylene.

Snow fence posts shall be No. 5 rebar with orange plastic protective end caps spaced no more than eight feet apart with electric tie-wraps to secure fencing.

The fence line must surround all contamination area and areas with the potential to be contamination areas. In situations where chain-link fence and yellow snow fence requirements overlap, the chain-link fence is required and will be posted by FDF RCTs.

Yellow snow fencing shall not be used to define the boundary between controlled areas and uncontrolled areas.

At the time when any physical boundary which served as a boundary to a contamination area is removed, it must be replaced with a yellow snow fence.

All areas encompassed within the yellow fenced boundary will be considered a radiological contamination area and will be posted (yellow-and-magenta or yellow-and-black signs indicating such things as the isotope of concern, whether an RWP is required to enter, etc.) by FDF Radiological Control. The radiological access control point will be supplied by FDF and will be located at the boundary of the area and will serve as the normal access/egress point to the contamination area and will be shared with other contractors.

For outdoor work, high contamination areas within contamination areas must also be defined by yellow snow fencing. FDF RCTs will be responsible for the signs which label the areas. The Contractor shall be responsible for the fencing itself. The Contractor may elect to have areas defined above the necessary level (e.g., as a High Contamination Area when only a contamination area is required) in order to improve logistics on the project.

Any boundary that separates contamination areas of differing isotopes (e.g., a uranium contamination area and a radium contamination area) must also be separated by yellow fencing. Survey requirements and anti-contamination clothing changes (e.g., removal of an outer set of anti-Cs when going from the radium area to the uranium area) will be required.

7.5 Internal Project Control Points

The Contractor shall submit anticipated locations where internal control points will be required with the preliminalry design. FDF will provide all materials required for surveying of equipment and material. The Contractor will provide Personnel Contamination Monitors (PCMs) in accordance with **Part 8, Section C.2.1.1.**

All control points/radiological areas boundaries (with step-off pads) that are within the work area, beyond the control point trailers, shall be enclosed and of sufficient size (shed, containment, etc.) to contain and cover those necessary materials and equipment for monitoring of personnel, personal items, or equipment (when necessary), collection of any PPE that may be donned or doffed at this point, etc. Any temporary structure required for an internal control point must be provided by the Contractor in accordance with **Part 7, ACR-006.** A control point shall be established for all radiological area boundaries.

8.0 PAY ITEM DESCRIPTIONS

8.1 Descriptions

The Pay Item Descriptions as defined in **Part 6, EXHIBIT 6.1** lists the activities for which the Contractor shall report progress and use for invoicing.

8.2 Values

The Contractor shall submit a proposed value for each pay item with his proposal. The value shall correspond to the descriptions of the activities in the Pay Item Description. The Pay Item Description including profit, overhead, insurance, HEPA vacuums, air filtration devices, training and submittal documents not specifically listed as a pay item, and shall be allocated to each pay item proportional to its value. FDF will review each pay item value to ensure that the value is consistent with the work to be performed. FDF will consider the majority of the value of construction as payable upon successful completion of the Contractor's Integrated Construction Acceptance Testing. FDF will consider the majority of the value of Operations as payable upon successful completion of material transfer into the TTA. Pay item values not found acceptable shall be revised and resubmitted. Payments cannot be made until FDF approves the pay item values.

8.3 Facility Ownership

FDF will assume facility ownership for facilities and systems as final payments are made to the Contractor based on pay item descriptions identified in **Part 6, EXHIBIT 6.1** and **Part 6, Section 3.16.1.** The Contractor shall be responsible for procurement and control of spare parts for all the facilities and systems.

9.0 CONTRACTOR'S PROJECT SCHEDULE

The Subcontractor's Project Schedule shall be a Critical Path Method (CPM) Schedule with two levels that clearly identify all logic ties, and project critical path from Notice to Proceed through project completion. The first level being at the pay item level (Pay Item Layout) and the second level at the activity level (Detailed Layout). Activities will roll up to support the pay items.

The schedule shall be submitted with the proposal. Items not found acceptable shall be revised and resubmitted. The initial Subcontractor's Project Schedule, once approved by FDF, will be known as the Baseline Schedule. This schedule will be used for comparison with the updated monthly project schedule and shall not be revised without concurrence from FDF.

9.1 Schedule Layouts

- Pay Item Layout

The Pay Item Layout is a roll up of the Subcontractor's Detailed Layout by pay item. This layout will only contain pay item activities sorted by early start dates. The percent complete of these pay items will be the basis for determining percent complete and dollar value earned on the monthly invoice.

- Detailed Layout

This schedule layout will show activities and provide the ability to: analyze schedule performance, analyze trends, identify recovery/corrective action plans, identify opportunities for improvement and forecast future achievements. Activities are defined as schedule

elements of sufficient detail to adequately evaluate percent of activity completion on a weekly basis. Activities shall, at a minimum, be grouped by pay items and sorted by early start dates. The activity may be a pay item when it is of sufficient detail to meet the definition of the activity. The schedule activities shall also be coded with their corresponding pay item ID code.

The Detailed Layout shall be resource loaded by activity to show man-hours by craft (carpenters, laborers, operators, etc.) expected to be utilized for each activity. Activities will also be resource loaded with a breakdown of pay item values.

9.2 Monthly Updates

The Project Schedule shall be updated monthly with the baseline schedule shown as target in each layout.

Approximately 5 working days prior to the monthly invoice cut-off dates (refer to **Part 4 EXHIBIT 5**), the Contractor shall schedule a "progress review meeting" with FDF. The percent complete for each activity will be summarized by pay item in the Contractor's Project Schedule, and shall be the basis for the amount invoiced for that pay item. A final copy of the updated Project Schedule shall be submitted to FDF by the month end cut-off date.

Monthly Project Schedule Update shall include:

- Actual or projected start and finish dates;
- Activity complete percentage and remaining duration;
- Bar chart schedule comparing the current schedule to the baseline schedule; and
- Revisions to the craft resource requirements, actual to date and estimate to complete in; man-hours.

9.3 Four Week Schedule

The Contractor shall develop a rolling schedule which windows four (4) weeks of the Contractor Detailed Layout. This schedule shall consist of the past week, present week and the next two weeks to come. The Contractor shall meet with the FDF construction scheduler to review/prepare the weekly Four Week Schedule prior to the weekly or biweekly Contractor coordination meeting throughout the duration of the project. The format is shown in **Part 6, EXHIBIT 6.4.**

9.4 Contractor's Schedule Software

The Contractor is required to use the preferred Primavera's P3 software or software with compatibility (Version 1.1 for Windows) or (Suretrack for Windows Version 1.5) to prepare the required project schedules. A computer disk containing the updated project schedule

shall be submitted along with the schedule update.

10.0 SUBMITTALS

- Contractor Submittal Register: The Contractor shall make all submittals as listed on **Part 6, EXHIBIT 6.2** or as otherwise specified by this document.

- The Contractor shall provide submittals in accordance with **Part 3 General Provisions article A.59**, "Specifications and Drawings," and **Part 7, ACR-001.**

- The Contractor is responsible for making all submittals required to perform the work as specified in this Contract.

EXHIBIT 6.1
PAY ITEM DESCRIPTION

PAY ITEM NO.	PAY ITEM DESCRIPTION	DETAILED PAY ITEM DESCRIPTION
		BASE REQUIREMENTS
1.0	Pre-notice to Proceed	(Milestone payment) This Pay Item covers submittals of Performance Bond, Payment Bond, Insurance Certificate as required by the contract.
2.0	Project Management Program	(Milestone payment) This Pay Item covers the completion and submittal of the documents that make up the Contractor's Project Management Program.
2.1		Project Management Plan
2.2		Engineering Management Plan
2.3		Configuration Management Plan
2.4		Record Management Plan
2.5		System Engineering Management Plan
2.6		Independent Safety Review Plan
2.7		Procurement Plan
2.8		Contingency Plan & Emergency Response
2.9		Environmental Control Plan
2.10		Berm Excavation Plan
2.11		Sampling Plan
3.0	Design	(Milestone payment) This Pay Item covers the completion of the Contractor's Design Bases Documents and Design Packages from conceptual through final design.
3.1		Functional Requirements Document
3.2		Conceptual Design Report
3.3		Design Criteria Package

EXHIBIT 6.1
PAY ITEM DESCRIPTION
(Continued)

PAY ITEM NO.	PAY ITEM DESCRIPTION	DETAILED PAY ITEM DESCRIPTION
		BASE REQUIREMENTS
3.4		Structures Systems and Components (SSC) Performance Grading
3.5		Failure Modes and Effects
3.6		RAM Analyses
3.7		Preliminary Design
3.8		Final Design
3.8.1		RCS Phase 1
3.8.2		RCS Phase 2
3.8.3		TTA and TWRS
3.8.4		DSWR and SWRS
3.8.5		FSMS
4.0	Safety Documentation	(Milestone Payments)
4.1		ALARA Analysis
4.2		Environmental ALARA Report
4.3		Integrated Hazard Analysis
4.4		Preliminary Safety Analysis Report
4.5		Final Safety Analysis Report
5.0	Standby Base Requirements	This Pay Item covers the Contractor's daily overhead charges not to exceed 45 days, between completion of base requirements and FDF exercising the Options
6.0	Demob/Remob	(Milestone payment) This Pay Item is for the demob and remob cost between completion of the base requirements and FDF exercising the Options.

EXHIBIT 6.1
PAY ITEM DESCRIPTION
(Continued)

PAY ITEM NO.	PAY ITEM DESCRIPTION	DETAILED PAY ITEM DESCRIPTION
	CONTRACT OPTIONS	
7.0	:struction	(Progress payments) This Pay Item covers all construction activities as defined below including the required documentation. Prior to authorization to mobilize, the Contractor must complete all of the pre-requisites as identified on the submittal register.
7.1	Pre-mobilization	Sample Plan Data Quality Objective
7.2	Mobilization	Receipt of equipment, material, placement of Contractor's office and storage facility, installation of temporary utilities.
7.3	Site Preparation	Relocation of existing items, grading and paving, storm water management, seeding, installation of lay down and staging areas, extension of utilities.
8.0	Radon Control System Phase 1 Construction	(Process Payments)
8.1		Phase 1 RCS CAT Plan
8.2		Phase 1 RCS ICAT Plan
8.3		Phase 1 RCS Safe Work Plan
8.4		Phase 1 RCS ICAT Final Report
8.5		Phase 1 Installation
9.0	Radon Control System Phase 1 Readiness Prep/Startup	(Milestone Payments)
9.1		Phase 1 RCS Operating Procedures
9.2		Phase 1 RCS Maintenance Procedures
9.3		Phase 1 RCS System Operability Test Procedures
9.4		Phase 1 RCS Training
9.5		Phase 1 RCS System Operability Test

EXHIBIT 6.1
PAY ITEM DESCRIPTION
(Continued)

PAY ITEM NO.	PAY ITEM DESCRIPTION	DETAILED PAY ITEM DESCRIPTION
10.0	Phase 1 Radon Control System Readiness Review	(Milestone Payments)
11.0	Phase 1 Radon Control System Operation	(Milestone Payments)
12.0	Radon Control System Phase 2 Construction	(Progress Payments)
12.1		Phase 2 RCS CAT Plan
12.2		Phase 2 RCS ICAT Plan
12.3		Phase 2 RCS Safe Work Plan
12.4		Phase 2 RCS ICAT Final Report
12.5		Phase 2 RCS Installation
13.0	Phase 2 Radon Control System Readiness Prep/Startup	(Milestone Payment)
13.1		Phase 2 RCS Operating Procedures
13.2		Phase 2 RCS Maintenance Procedures
13.3		Phase 2 RCS System Operability Test Procedures
13.4		Phase 2 RCS Training
13.5		Phase 2 RCS System Operability Test
14.0	Full-Scale Mock-Up System Construction	(Progress Payment)
14.1		FSMS CAT Plan
14.2		FSMS ICAT Plan
14.3		FSMS Safe Work Plan
14.4		FSMS ICAT Final Report
14.5		FSMS Installation
15.0	Full-Scale Mock-Up System Readiness Prep	Milestone Payments

EXHIBIT 6.1
PAY ITEM DESCRIPTION
(Continued)

PAY ITEM NO.	PAY ITEM DESCRIPTION	DETAILED PAY ITEM DESCRIPTION
15.1		FSMS Test Plan
15.2		FSMS Training
15.3		FSMS Test Procedures
16.0	Full-Scale Mock-Up System Readiness Prep/Startup	(Milestone Payment)
16.1		FSMS Test Readiness Assessment
16.2		FSMS Test
16.3		FSMS Test Final Report
17.0	TTA and TWRS Construction	(Progress Payment)
17.1		TTA and TWRS CAT Plan
17.2		TTA and TWRS ICAT Plan
17.3		TTA and TWRS Safe Work Plan
17.4		TTA and TWRS ICAT Final Report
17.5		TTA and TWRS Installation
18.0	Transfer Tank Area and Transfer Tank Waste Retrieval System Readiness Prep/SOT	(Milestone Payment)
18.1		TTA and TWRS Operating Procedures
18.2		TTA and TWRS Maintenance Procedures
18.3		TTA and TWRS System Operability Test Procedures
18.4		TTA and TWRS Training
18.5		TTA and TWRS System Operability Test
19.0	Accelerated Waste Retrieval Operations	(Milestone Payment) The AWR operation consists of a combined payment for construction, readiness, and operation of the SWRS & DWRS based on percent of the contents removed from the silos.

EXHIBIT 6.1
PAY ITEM DESCRIPTION
(Continued)

PAY ITEM NO.	PAY ITEM DESCRIPTION	DETAILED PAY ITEM DESCRIPTION
19.1		25%
19.2		50%
19.3		75%
19.4		100%
20.0	Standby	This pay item addresses the potential daily rate for standby time between release of the Options, not to exceed 45 days.
21.0	Demobilization / Remobilization	(Milestone Payment) This pay item addresses the potential demob/remob costs between the release of the Options.
22.0	Demobilization	(Milestone Payment) This pay item includes clean-up of job site, removal from the FEMP of Contractor owned equipment, materials, trailers, return of GFE, approval of required closeout.

EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER

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P= 30 days prior to turnover to start up
Q= 10 days prior to readiness review
R= Upon completion of project
S= 2 days prior to site access
T= 10 days after Notice to Proceed
U= 60 days prior to scheduled use

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Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P21-01	INF	Procurement	Performance Bond	A	N/A
40710-624-P22-01	INF	Procurement	Payment Bond	A	N/A
40710-624-P23-01	INF	Procurement	PLA Letter of Assent	A	N/A
40710-624-P24-01	INF	Procurement	Statement of Acknowledgment	A	N/A
40710-624-P26-01	INF	Procurement	Subcontracting Plan	A	N/A
40710-624-P4SC5-01	INF	Construction	* Entry Check List	J	N/A
40710-624-P4SC8-01	INF	Engineering	Red Line Drawings	N	N/A
40710-624-P4SC10-01	INF	Construction	List of Contractor Tools and Equipment	L	N/A
40710-624-P4SC13-01	INF	Procurement	* Invoices	Monthly	N/A

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

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40710-624-P4SC14-01	INF	Construction	* Daily Reports	Daily	N/A
40710-624-P4SC22-01	INF	Construction	* Exit Check list	K	N/A
40710-624-P4SC28-01	INF	Construction	Fuel storage tank	K	N/A
40710-624-P4SC30-01	INF	Construction	Fastener Quality Act	R	N/A
40710-624-P621-01	CFC	Engineering	Project Management Plan	B	30 days
40710-624-P621-02	CFC	Engineering	Engineering Management Plan	B	30 days
40710-624-P621-03	CFC	Engineering	Configuration Management Plan	B	30 days
40710-624-P621-04	CFC	Engineering	Record Management Plan	B	30 days
40710-624-P621-05	CFC	Engineering	System Engineering Management Plan	B	30 days
40710-624-P621-06	CFC	Engineering	Independent Safety Review Plan	B	30 days
40710-624-P621-07	CFC	Engineering	Procurement Plan	B	30 days
40710-624-P621-08	CFC	Engineering	Human Factors Program Plan	B	30 days
40710-624-P621-09	CFC	Engineering	Contingency Plan and Emergency Response	I	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

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40710-624-P621-10	CFC	Engineering	Environmental Control Plan	B	30 days
40710-624-P621-11	CFC	Engineering	Berm Excavation Plan	B	30 days
40710-624-P621-12	CFC	Engineering	Sampling Plan	B	30 days
40710-624-P622-01	CFC	Engineering	Conceptual Design Package	C	30 days
40710-624-P622-02	CFC	Engineering	Functional Requirements Document	C	30 days
40710-624-P622-03	CFC	Engineering	Design Criteria Package	C	30 days
40710-624-P622-04	CFC	Engineering	Functional Analysis	C	30 days
40710-624-P622-05	CFC	Engineering	Process Flow Diagrams	C	30 days
40710-624-P622-06	CFC	Engineering	Heat and Material Balance	C	30 days
40710-624-P622-07	CFC	Engineering	Piping and Instrumentation Diagrams	C	30 days
40710-624-P622-08	CFC	Engineering	Performance Grading	C	30 days
40710-624-P622-09	CFC	Engineering	Control System Block Diagram	C	30 days
40710-624-P622-10	CFC	Engineering	ALARA Plan (Environmental & Radiological)	C	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
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40710-624-P622-11	CFC	Engineering	Tie In Drawings	C	30 days
40710-624-P622-12	CFC	Engineering	General Arrangement Drawings	C	30 days
40710-624-P622-13	CFC	Engineering	Electrical Load Summary	C	30 days
40710-624-P622-14	CFC	Engineering	Electrical One line diagrams	C	30 days
40710-624-P622-15	CFC	Engineering	Retrieval Design	C	30 days
40710-624-P622-16	CFC	Engineering	Site Plot Plan	C	30 days
40710-624-P622-17	CFC	Engineering	Storm water Drainage Plans	C	30 days
40710-624-P622-18	CFC	Engineering	Data Sheets & Specifications for Key Equipment & Long Lead Items	C	30 days
40710-624-P622-19	CFC	Engineering	Equipment List	C	30 days
40710-624-P622-20	CFC	Engineering	Instrument List	F	30 days
40710-624-P622-21	CFC	Engineering	Full-Scale Mock-Up Test Plan	C	30 days
40710-624-P622-22	CFC	Engineering	Timed Estimate of Secondary Waste	C	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

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40710-624-P622-23	CFC	Engineering	Control Room Arrangement	F	30 days
40710-624-P622-24	CFC	Engineering	List of Required Drawings, Specs & Documents	C	30 days
40710-624-P622-25	CFC	Engineering	Line List	F	30 days
40710-624-P622-26	CFC	Engineering	Metallurgical Diagrams	F	30 days
40710-624-P622-27	CFC	Engineering	Radiation Zone Drawings	F	30 days
40710-624-P622-28	CFC	Engineering	Shielding Calculations	F	30 days
40710-624-P622-29	CFC	Engineering	Underground Piping Drawings	F	30 days
40710-624-P622-30	CFC	Engineering	System Design Descriptions	F	30 days
40710-624-P622-31	CFC	Engineering	Cathodic Protection Design	F	30 days
40710-624-P622-32	CFC	Engineering	Lightening Protection Design	F	30 days
40710-624-P622-33	CFC	Engineering	Grounding Design	F	30 days
40710-624-P622-34	CFC	Engineering	Paving and Grading Plans	F	30 days
40710-624-P622-35	CFC	Engineering	Final Design Report RCS Phase 1	H	30 days

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EXHIBIT 6.2
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Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P622-36	I	Engineering	Final Design Report All Systems	H	30 days
40710-624-P622-37	CFC	Engineering	Design Closeout Report	Q	10 days
40710-624-P622-38	INF	Engineering	Failure Modes & Effects Analysis	G	N/A
40710-624-P622-39	INF	Engineering	Reliability Availability & Maintainability Analysis	G	N/A
40710-624-P622-40	INF	Engineering	Value Engineering Review	G	N/A
40710-624-P622-41	INF	Engineering	Energy Conservation Report	G	N/A
40710-624-P622-42	CFC	Engineering	Fire Hazard Analysis	G	30 days
40710-624-P622-43	INF	Engineering	Constructability/Operability Review	G	N/A
40710-624-P622-44	CFC	Engineering	Safety Basis Documentation Implementation Plan	B	30 days
40710-624-P622-45	CFC	Engineering	Preliminary Hazard Assessment	G	30 days
40710-624-P622-46	CFC	Engineering	Hazard Category Calculations	G	30 days
40710-624-P622-47	CFC	Engineering	Safety Assessment	G	30 days
40710-624-P622-48	CFC	Engineering	Safety Basis Document	G	30 days

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EXHIBIT 6.2
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40710-624-P631-01	CFC	Construction	RCS Phase 1 Safe Work Plans	D	30 days
40710-624-P631-02	CFC	Construction	RCS Phase 1 Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P631-03	CFC	Construction	RCS Phase 1 Integrated Construction Acceptance Test Plans (ICAT)	D	30 days
40710-624-P631-04	CFC	Construction	RCS Phase 1 ICAT Procedures	D	30 days
40710-624-P631-05	INF	Construction	RCS Phase 1 Final ICAT Report	M	N/A
40710-624-P632-01	CFC	Operations	RCS Phase 1 Startup and Turnover Plan	I	30 days
40710-624-P632-02	CFC	Operations	System Operability Test (SOT) Plan	O	30 days
40710-624-P632-03	INF	Operations	RCS Phase 1 System Operability Test (SOT) Specifications	P	N/A
40710-624-P632-04	CFC	Operations	SOT Procedures	O	30 days
40710-624-P632-05	INF	Operations	RCS Phase 1 SOT Final Report	M	N/A
40710-624-P633-01	CFC	Operations	RCS Phase 1 Operating Procedures (SOP)	O	30 days

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40710-624-P633-02	CFC	Operations	RCS Phase 1 Operations Training Plan	O	30 days
40710-624-P633-03	CFC	Operations	RCS Phase 1 Operations Training Lesson Plans	O	30 days
40710-624-P633-04	INF	Operations	RCS Phase 1 Operations Weekly Report	Weekly	NA
40710-624-P633-05	CFC	Operations	RCS Phase 1 Maintenance Plan	O	30 days
40710-624-P633-06	CFC	Operations	RCS Phase 1 Maintenance Procedures	O	30 days
40710-624-P634-01	CFC	Construction	RCS Phase 2 Safe Work Plans	D	30 days
40710-624-P634-02	CFC	Construction	RCS Phase 2 Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P634-03	CFC	Construction	RCS Phase 2 Integrate Construction Acceptance Test Plans	D	30 days
40710-624-P634-04	CFC	Construction	RCS Phase 2 ICAT Procedures	D	30 days
40710-624-P634-05	INF	Construction	RCS Phase 2 Final ICAT Report	M	N/A
40710-624-P635-01	CFC	Operations	RCS Phase 2 Startup & Turnover Plan	I	30 days
40710-624-P635-02	CFC	Operations	System Operability Test (SOT) Plan	O	30 days

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EXHIBIT 6.2
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40710-624-P635-03	INF	Operations	RCS Phase 2 System Operability Test (SOT) Specifications	P	N/A
40710-624-P635-04	CFC	Operations	SOT Procedures	O	30 days
40710-624-P635-05	INF	Operations	RCS Phase 2 SOT Final Report	M	N/A
40710-624-P636-01	CFC	Operations	RCS Phase 2 Operating Procedures	O	30 days
40710-624-P636-02	CFC	Operations	RCS Phase 2 Operations Training Plan	O	30 days
40710-624-P636-03	CFC	Operations	RCS Phase 2 Operations Training Lesson Plans	O	30 days
40710-624-P636-04	INF	Operations	RCS Phase 2 Operations Weekly Report	Weekly	N/A
40710-624-P636-05	CFC	Operations	RCS Phase 2 Maintenance Plan	O	30 days
40710-624-P636-06	CFC	Operations	RCS Phase 2 Maintenance Procedures	O	30 days
40710-624-P637-01	CFC	Construction	Full Scale Mock-Up System (FSMS) Safe Work Plan	D	30 days
40710-624-P637-02	CFC	Construction	FSMS Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P637-03	CFC	Construction	FSMS Integrated Construction Acceptance Test (ICAT) Plans	D	30 days

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40710-624-P637-04	CFC	Construction	FSMS ICAT Procedures	D	30 days
40710-624-P637-05	INF	Construction	FSMS Final ICAT Report	M	N/A
40710-624-P310-01	CFC	Operation	FSMS Operating Procedures	O	30 days
40710-624-P310-06	CFC	Operation	FSMS Maintenance Procedures	O	30 days
40710-624-P638-03	INF	Operation	FSMS System Operability Test (SOT) Specifications	P	N/A
40710-624-P638-01	CFC	Operation	FSMS Startup & Turnover Plan	I	30 days
40710-624-P638-05	INF	Operation	FSMS SOT Final Report	M	N/A
40710-624-P637-06	CFC	Construction	FSMS Demonstration Procedures	O	30 days
40710-624-P637-07	CFC	Construction	FSMS Demonstration Training Plan	O	30 days
40710-624-P637-08	CFC	Construction	FSMS Demonstration Training Lesson Plans	O	30 days
40710-624-P637-09	INF	Construction	FSMS Demonstration Final Report	M	N/A
40710-624-P6102-01	CFC	Construction	Project Schedule	B	10 days
40710-624-P6103-01	INF	Construction	Rolling Four Week Schedule	Weekly	N/A

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40710-624-P6310-02	CFC	Operations	FSMS Operations Training Plan	O	30 days
40710-624-P6310-03	CFC	Operations	FSMS Operations Training Lesson Plans	O	30 days
40710-624-P6310-04	INF	Operations	FSMS Operations Weekly Report	Weekly	N/A
40710-624-P6310-05	CFC	Operations	FSMS Maintenance Plan	O	30 days
40710-624-P6311-01	CFC	Construction	TTA Safe Work Plans	D	30 days
40710-624-P6311-02	CFC	Construction	TTA Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P6311-03	CFC	Construction	TTA Integrated Construction Acceptance Test (ICAT) Plans	D	30 days
40710-624-P6311-04	CFC	Construction	TTA ICAT Procedures	D	30 days
40710-624-P6311-05	INF	Construction	TTA Final ICAT Report	M	N/A
40710-624-P6311-06	CFC	Construction	TWRS Safe Work Plans	D	30 days
40710-624-P6311-07	CFC	Construction	TWRS Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P6311-08	CFC	Construction	TWRS Integrated Construction Acceptance Test (ICAT) Plans	D	30 days

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O= 60 days prior to turnover to start up
P= 30 days prior to turnover to start up
Q= 10 days prior to readiness review
R= Upon completion of project
S= 2 days prior to site access

*Submitted directly to the FDF Project Manager or Contract Administrator

Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P6311-09	CFC	Construction	TWRS ICAT Procedures	D	30 days
40710-624-P6311-10	INF	Construction	TWRS Final ICAT Report	M	N/A
40710-624-P6312-04	CFC	Operations	TTA SOT Procedures	O	30 days
40710-624-P6312-02	CFC	Operations	TTA SOT Plan	O	30 days
40710-624-P6312-03	CFC	Operations	TTA System Operability Test (SOT) Specification	P	30 days
40710-624-P6312-01	CFC	Operations	TTA Startup & Turnover Plan	I	30 days
40710-624-P6312-05	INF	Operations	TTA SOT Final Report	M	N/A
40710-624-P6312-09	CFC	Operations	TWRS SOT Procedures	O	30 days
40710-624-P6312-07	CFC	Operations	TWRS SOT Plan	O	30 days
40710-624-P6312-08	CFC	Operations	TWRS System Operability Test (SOT) Specification	P	30 days
40710-624-P6312-06	CFC	Operations	TWRS Startup & Turnover Plan	I	30 days
40710-624-P6312-10	INF	Operations	TWRS SOT Final Report	M	N/A
40710-624-P6313-01	CFC	Construction	SWRS Safe Work Plans	D	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

CONTRACT No. _____

CONTRACT Title _____

CONTRACTOR _____

Submittal Due Dates

A = 10 days after award
B = 60 days from notice to proceed
C = 90 days from notice to proceed
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E = Prior to start of activity
F = 120 days after conceptual design
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*Submitted directly to the FDF Project Manager or Contract Administrator

Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P6313-02	CFC	Construction	SWRS Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P6313-03	CFC	Construction	SWRS Integrated Construction Acceptance Test (ICAT) Plans	D	30 days
40710-624-P6313-04	CFC	Construction	SWRS ICAT Procedures	D	30 days
40710-624-P6313-05	INF	Construction	SWRS Final ICAT Report	M	N/A
40710-624-P6313-06	CFC	Construction	DWRS Safe Work Plans	D	30 days
40710-624-P6313-07	CFC	Construction	DWRS Construction Acceptance Test (CAT) Plan	D	30 days
40710-624-P6313-08	CFC	Construction	DWRS Integrated Construction Acceptance Test (ICAT) Plans	D	30 days
40710-624-P6313-09	CFC	Construction	DWRS ICAT Procedures	D	30 days
40710-624-P6313-10	INF	Construction	DWRS Final ICAT Report	M	N/A
40710-624-P6314-04	CFC	Operations	SWRS SOT Procedures	O	30 days
40710-624-P6314-02	CFC	Operations	SWRS SOT Plan	O	30 days
40710-624-P6314-03	CFC	Operations	SWRS System Operability Test (SOT) Specification	P	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

CONTRACT No. _____

CONTRACT Title _____

CONTRACTOR _____

Submittal Due Dates

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*Submitted directly to the FDF Project Manager or Contract Administrator

Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P6314-01	CFC	Operations	SWRS Startup & Turnover Plan	I	30 days
40710-624-P6314-05	INF	Operations	SWRS SOT Final Report	M	N/A
40710-624-P6314-09	CFC	Operations	DWRS SOT Procedures	O	30 days
40710-624-P6314-07	CFC	Operations	DWRS SOT Plan	O	30 days
40710-624-P6314-08	CFC	Operations	DWRS System Operability Test (SOT) Specification	P	30 days
40710-624-P6314-06	CFC	Operations	DWRS Startup & Turnover Plan	I	30 days
40710-624-P6314-10	INF	Operations	DWRS SOT Final Report	M	N/A
40710-624-P6315-01	CFC	Operations	AWR Standard Operating Procedures (SOP)	O	30 days
40710-624-P6315-02	CFC	Operations	AWR Operations Training Plan	O	30 days
40710-624-P6315-03	CFC	Operations	TTA Operations Training Lesson Plans	O	30 days
40710-624-P6315-04	INF	Operations	TTA Weekly Report	Weekly	N/A
40710-624-P6315-05	CFC	Operations	TTA Maintenance Plan	O	30 days
40710-624-P6315-06	CFC	Operations	Maintenance Procedures	O	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

CONTRACT No. _____

CONTRACT Title _____

CONTRACTOR _____

Submittal Due Dates

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Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P6315-07	CFC	Operations	Sample Plan	B	30 days
40710-624-P6315-08	CFC	Operations	Sample Procedures	B	30 days
40710-624-P6316-01	CFC	Construction	Request to Begin System Closure	F	10 days
40710-624-P6316-02	CFC	Construction	Request to Begin Demobilization	F	10 days
40710-624-P6465-01	CFC	Construction	Fugitive Dust Control Plan	H	30 days
40710-624-P8B21-01	CFC	Health and Safety	Project Specific Health and Safety Plan	I	30 days
40710-624-P8B371-01	CFC	Health and Safety	Hazardous Chemical List	I	N/A
40710-624-P8B61-01	CFC	Health and Safety	Lifting Plan	E	10 days
40710-624-P8B621-01	INF	Health and Safety	Level 1 Rigger Verification	S	N/A
40710-624-P8B622-01	INF	Health and Safety	Level 2 Rigger Verification	S	N/A
40710-624-P8B623-01	INF	Health and Safety	Level 3 Rigger Verification	S	N/A
40710-624-P8B63-01	INF	Health and Safety	Annual Crane Inspection	E	N/A
40710-624-P8B18-01	INF	Health and Safety	Substance Abuse Program	E	N/A

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

CONTRACT No. _____

CONTRACT Title _____

CONTRACTOR _____

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*Submitted directly to the FDF Project Manager or Contract Administrator

Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-P8B34-01	CFC	Health & Safety	Hearing & Conservation Program Plan	I	30 days
40710-624-P8C212-01	INF	Health and Safety	Daily Activity List	Daily	N/A
40710-624-P8D-01	CFC	Health and Safety	Contractor's Health and Safety Program	A	30 days
40710-624-P8E1-01	INF	Health and Safety	Certification of Training	E	N/A
40710-624-P8E21-01	INF	Health and Safety	Request for Site Access	J	N/A
40710-624-P9	CFC	Quality	Quality Assurance Program	B	60 days
40710-624-ACR001-01	INF	Construction	Submittal Register	T	N/A
40710-624-ACR001-02	INF	Construction	Samples	U	N/A
40710-624-ACR001-03	INF	Construction	Material Certifications	U	N/A
40710-624-ACR001-04	INF	Construction	Laboratory Test Reports	U	N/A
40710-624-ACR004-01	INF	Construction	Ladder Competent Person Training Documentation	E	N/A
40710-624-ACR005-01	CFC	Construction	PPE	D	30 days
40710-624-ACR006-01	CFC	Construction	Portable Structures Sketch	K	30 days

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EXHIBIT 6.2
CONTRACTOR SUBMITTAL REGISTER
(Continued)

Submittal Due Da

CONTRACT No. _____

CONTRACT Title _____

CONTRACTOR _____

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*Submitted directly to the FDF Project Manager or Contract Administrator

Submittal No. (1)	Submittal Type (2)	Document Family (3)	Document Description (4)	Submittal Due Date (5)	FDF Review (6)
40710-624-ACR006-02	CFC	Construction	Portable Structure Anchoring System	K	30 days
40710-624-ACR007-01	CFC	Construction	Waste Handling Work Plan	B	30 days

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EXHIBIT 6.2 (continued)

Instructions For Completing the Submittal Register

1. FDF insert the submittal number as follows:

   - Project number (a number assigned to the project by FDF)

   - Contract number (a number assigned by FDF)

   - Submittal number (specification number, contract part number and from which the submittal is derived from will be assigned by FDF). The contract part number PSC23 is shown as "P" of part, (part number like 4), section from the part "SC23."

   - Sequential number will start with the number one with each submittal group.

Project#	Contract#Spec. #Sequence#
1642-	605-01011-01

Project#	Contract#Contract Part#Sequence#
1642-	605-P4SC2301

   Note: When additional submittals are required, the Contractor shall enter the next sequential number in that submittal group (i.e. if the last submittal number in was 1642-605-01011-025, the next submittal number would be 1642-605-01011-026).

2. FDF will insert the submittal type.

   CFC (Certified for Construction)
   INF (Information)

3. FDF will insert the document family as follows:

Procurement	Construction
Health & Safety	Engineering
Medical	Quality
Training	

4. FDF will insert the document description (Health and Safety Plan, Safe Work Plan, Training Certification, Certificates of Conformance, Catalog Cuts, etc.)

6. FDF will insert the submittal due date from the list below.

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EXHIBIT 6.3

CONTRACTOR FURNISHED EQUIPMENT TURNOVER CHECKLIST

Equipment	Model No.	Serial No.	Manufacturer	Cost	Usable Yes/No
Radio's _____ _____ _____ _____ _____					
ADF's _____ _____ _____ _____ _____ _____ _____					
Wash Equip. _____ _____ _____ _____ _____ _____ _____					
Other Equip. _____ _____ _____ _____ _____ _____ _____					

EXHIBIT 6.4
FOUR WEEK SCHEDULE

SILOS 1 & 2 AWR PROJECT
CONTRACTOR _____ MONTH _____ YEAR 19____

ACTIVITY NUMBER	ACTIVITY DESCRIPTION	FOREMAN	WEEK	LAST WEEK							THIS WEEK							NEXT WEEK							SECOND WEEK							REMARKS
			DATE																													
			DAY	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	
			SCH BAR																													
			CRAFT QTY.																													
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EXHIBIT 6.5
FUGITIVE DUST CONTROL REQUIREMENTS

1.0 FUGITIVE DUST CONTROL PLAN

1.1 The Contractor shall develop a Dust Control plan based on the requirements stated in this document for controlling fugitive dust emissions and ensuring compliance with standards and site-specific limits defined in this document.

1.2 The Contractor shall submit the Dust Control Plan to FDF for compliance review. This plan shall be part of the "Safe Work Plan" (See **Part 7, ACR-002** for the outline of the "Safe Work Plan"). The Dust Control Plan shall demonstrate the Contractor's understanding of the importance of dust suppression on this project. It shall be adequate for all work areas. FDF compliance review of this plan does not relieve the Contractor of any responsibilities regarding the suppression of dust under the terms of this subcontract. This plan shall include but not be limited to the following:

- A listing of specific types and quantities of equipment to be used to suppress dust;
- A listing of proposed methods and materials that will be used to proactively suppress dust and the frequency that routine dust suppression is to take place;
- A narrative description of how the Contractor field personnel will implement the Dust Control Plan and how they will monitor for excessive or visible dust including how records will be kept and where they will be maintained; and

A description of the notification process that the Contractor intends for FDF to utilize during non-work periods to inform the Contractor of a dust alert.

EXHIBIT 6.5
(Continued)

2.0 FUGITIVE DUST CONTROL REQUIREMENTS

2.1 The Contractor shall proactively suppress dust releases from each field activity by applying Best Available Technology (BAT) dust control, such as the application of water, dust suppression agents, or other appropriate methods approved by appropriate FDF personnel and/or implementing BAT work practices at the beginning and during each field activity.

- Project field activities shall be continuously monitored by the Contractor for visible emissions;
- FDF will provide Opacity monitoring for each project and forward the information to the Contractor; and
- All dust-generating field activities in an observed area shall cease immediately if a fugitive dust limit is exceeded. An increase in BAT dust controls and/or work practices shall be implemented to bring the fugitive dust emissions below the limit during dust-generating activities (including wind erosion). Work shall not be restarted until FDF is completely satisfied that the method to suppress the fugitive dust has been executed by the Contractor.

2.2 The Contractor shall have personnel on-call as defined in the plan during non-work periods seven (7) days per week (including holidays) to respond to an off hours dust alert. The Contractor shall provide a list of his personnel that will be on-call during non-work periods. Dust suppression is to begin no more than two (2) hours after notification by FDF during non-work periods.

- The Contractor shall apply enough BAT dust control material to bring the fugitive dust emissions below the standard or site specific limit during dust-generating activities (e.g. wind erosion); and
- The Contractor shall not leave the site without FDF concurrence that sufficient controls are in place.

EXHIBIT 6.5
(Continued)

2.3 Activities May Include

Some of the activities which may require dust suppression are as follows:

- Hauling material and equipment;
- Vehicle and equipment traffic;
- Excavation;
- Trenching;
- Loading/Unloading;
- Transportation to Defined Roadway (paved or unpaved);
- Load-in/Load-out on Storage Piles;
- Materials Placement in Onsite Disposal Cell;
- Vehicle Traffic on Storage Piles; and
- Wind Erosion from Working Faces.

2.4 Definitions

Paved Roadway or Paved Parking Area: a predetermined area designed and improved specifically for vehicle traffic. Improvements to the predetermined area are the application of materials such as asphalt or concrete that forms a firm level surface for travel.

Unpaved Roadway or Unpaved Parking Area: a predetermined area designed and improved specifically for vehicle traffic. Improvements to the predetermined area include the application of gravel, shredded shingles, cinders, compaction, etc. to the delineated area.

Wind Erosion of Storage Piles: fugitive emissions from storage piles strictly created by the wind (and not by material handling equipment or vehicle traffic).

Visible Particulate (Fugitive) Emissions: visible airborne particulate that are generated from the operation of heavy equipment, equipment wheels or tracks, any tools, or vehicle wheels. Visible particulate emissions are also those generated by wind erosion. [Regulatory methods that will be used for visual determination of fugitive emissions are 40 CFR 60 Appendix A, Method 9 (used by FDF) "Visual Determination of Opacity of Emissions from Stationary Sources" and Method 22 (used by the Contractor) "Visual Determination of Fugitive Emissions from Materials Sources and Smoke Emission from Flares".]

EXHIBIT 6.5
(Continued)

Material Handling/Vehicle Traffic on Storage Piles: includes activities such as loading in and loading out of materials, excavation, and vehicle traffic on storage piles. Fugitive emissions created by the above activities on storage piles shall be subjected to the standard defined in this section. Fugitive emissions that can not be distinguished between material handling activities and wind erosion will also be subjected to the standards defined in this section.

2.5 Site-Specific Limit

The Contractor shall apply the following Site-Specific Limits:

- Visible particulate emissions from any paved roadway or paved parking area shall not exceed one minute during any sixty-minute observation period.
- Visible particulate emissions from any unpaved roadway, unpaved parking area, project field activities, or wind erosion from storage piles shall not exceed three minutes during any sixty-minute observation period.
- Compliance with this limit shall be verified using 40CFRPart 60 Appendix A, Method 22 "Visual Determination of Fugitive Emissions from Materials Sources and Smoke Emissions from Flares".

2.6 Actions:

The Contractor shall apply the following.

- At the start of each day and periodically during the day, project personnel (FDF & Contractor) shall tour paved & unpaved roads, paved & unpaved parking areas, storage piles, and project field activities taking place and proactively apply BAT fugitive dust controls and/or work practices to minimize dust generation.
- Before fugitive emissions are visible, BAT dust controls and/or work practices must be implemented or increased.
- If the limit is exceeded, all mechanical dust-generating activities such as traffic on roadway in the observed area must cease immediately. An increase of BAT dust controls and/or work practices shall be implemented to bring the fugitive emissions to, at a minimum, below the limit during dust-generating activities (including wind erosion).

EXHIBIT 6.5
(Continued)

2.7 BAT Dust Controls/Work Practices

The Contractor shall implement the following BAT Dust Control/Work Practices as applicable:

- Seal off work areas, stock piles, working piles, etc. before the end of each shift.
- In dry conditions, initiate dust control before each work shift and during lunch breaks.
- Wet sweep or otherwise remove any clods, clumps, tracks, or visible deposits of soil or mud from paved roadways or paved parking areas; applying appropriate dust control measures to suppress the generation of visible dust that may result from the sweeping or removal process.
- Remove, as practical, any clods, clumps, or visible deposits of soil or mud from unpaved roadways or unpaved parking areas, applying appropriate dust control measures to suppress the generation of visible dust that may result from the removal process.
- Repair or resurface roadways/parking areas as needed or use an alternative road surface as a last resort for unpaved roadways and parking areas.
- Maintain roadway shoulders.
- Minimize the amount of unnecessary traffic on roadways, parking areas and areas around field activities.
- Limit vehicular and equipment operating speed to 15 miles per hour.
- Reduce the speed limit as required to minimize dust generation.
- Apply appropriate dust suppression agents such as water or surfactant to the materials being transported by truck load beds to ensure the transported materials will not become airborne. Soil and soil like material shall not be visible above the vehicle body.

EXHIBIT 6.5
(Continued)

- Cover truck load beds when transported materials are still likely to become airborne.
- Change configuration of material being transported (e.g. place less in truck).
- Minimize the height of drop during loading and unloading.
- Application of dust suppression materials approved by FDF such as: water, resin, or equivalent combination of surfactant or crusting agents.
- Storage piles may be covered with a tarpaulin, plastic, etc., if practical.
- Soils in work areas and placed in stockpiles shall be rolled at the end of each work day.
- For extended periods of planned inactivity, vegetate as a last resort if protective cover or periodic application of surfactant or crusting agents proves ineffective.
- Change method of excavation/transport (e.g., from a front-end loader dumping into a truck to a self-propelled pan) when feasible.
- Wheel washing.

3.0 TRAINING

3.1 Contractor personnel shall review and understand the information contained in this document and shall be trained in the plan pertaining to an individual's responsibilities.

3.2 The Contractor shall designate individuals that will require the appropriate training.

3.3 Personnel involved in performing compliance surveillance to ensure that fugitive dust emissions from project field activities are meeting fugitive dust standards or limits, must have the following FDF provided training:

- 40CFR60 Appendix A, Method 22 - "Visual Determination of Fugitive Emissions from Material Sources and Smoke Emission from Flares."

EXHIBIT 6.5
(Continued)

4.0 RECORDS

4.1 The Contractor shall complete a "Control of Fugitive Dust Emissions- Daily Record" form Attachment "1" each time an application of dust suppression material is performed and submit the completed forms to FDF weekly.

Enter on form:

- Identification of area that was treated and/or cleaned. Record using sketch on back of the form, or by attaching similar diagram at appropriate scale.
- The date the designated area was treated and/or cleaned.
- The manner the designated area was treated and/or cleaned.
- The application rate of dust suppression material (at a minimum, the tank truck load capacity and number of truckloads applied per unit of time per area, or segment, to which applied); and
- The equipment operator (at a minimum, the name of the Contractor or subcontractor firm).

4.2 The Contractor shall document the visual determination of fugitive emission on the "Control of Fugitive Emissions Daily Record" (EXHIBIT 6.5, ATTACHMENT 1) when performing visible emission monitoring for paved and unpaved roadways, paved and unpaved parking areas, and wind erosion from storage piles and submit the completed forms to FDF daily.

EXHIBIT 6.5
ATTACHMENT 1

Control of Fugitive Emissions
Daily Record

Date:_____ ____

TIME	AREA TREATED (see sketch)	TREATMENT METHOD	APPLICATION RATE	EQUIPMENT OPERATOR

000065

EXHIBIT 6.6
LABOR UTILIZATION

1.1 Introduction

1.1.1 Fernald Atomic Trades and Labor Council (FAT&LC) and Greater Cincinnati Building Construction Trades Council (GCBCTC) will supply all labor for the Silos 1 and 2 AWR Project as described below. The Contractor will supply all management and technical support.

1.1.2 The FDF contract with DOE gives FDF responsibility for managing labor relations at the FEMP. FDF Industrial Relations (IR) negotiated a Project Labor Agreement (PLA) with the GCBCTC, including all addendums, and a Collective Bargaining Agreement (CBA) with the FAT&LC. The PLA and the CBA are provided in **Part 5**. Craft assignments for the GCBCTC crafts shall be made by the Contractor in accordance with provisions of the PLA. IR will meet with the Contractor in order to promote a better understanding of these agreements.

1.1.3 FDF IR retains primary responsibility for administering and interpreting both the PLA and CBA.

1.1.4 The FAT&LC represents FDF wage employees and affiliated Metal Trade Unions. The GCBCTC represents Building Trades employees and the twenty affiliated unions. Refer to **Part 5** for a list of affiliated unions with both Councils.

1.1.5 To promote cooperative labor relations, FDF IR has increased communication, team work, trust, and productivity between FDF management and the represented workforce and shared information in a timely manner with the respective signatory labor unions.

1.1.6 To continue cooperative labor relations for the Silos 1 and 2 AWR Project, the Contractor shall develop a Labor Relations/Work Force Utilization Plan. This plan will be reviewed by FDF prior to mobilization and shall address, at least, the following information:

- The Contractor's person who shall be responsible for labor relations, promoting cooperative labor relations and compliance with the terms and conditions of the PLA and CBA;

EXHIBIT 6.6
(Continued)

- The handling of communications to promote teamwork, partnering, and coordination within the represented workforces;
- Discussion of how the represented workforces be integrated into the project as a whole;
- Discussion of the Contractor's support of dispute resolution to minimize grievances; and
- Discussion of Contractor coordination of its labor relations efforts with FDF IR.

1.1.7 Safety and health of all FDF and Contractor personnel is the first priority of FDF. Implementation of health and safety relative to this project involves a concerted effort among DOE, FDF, the represented workforce, and the Contractor. The Contractor shall conform to FDF's commitment to safety in the workplace, which extends to all employees and contract personnel. The Contractor shall conform to FDF's guarantees to its employees, with respect to health and safety which include:

- The right to know hazards;
- The right to refuse work;
- The right to have input regarding health and safety issues;
- The right to personal protective equipment without charge to the employee; and
- The right to participate in the safety excellence program.

1.1.8 These employee and Contractor personnel rights are defined in Section 4 of the CBA.

2.1 Labor Relations/Work Force Utilization Plan

2.1.1 "Remediation Work Allocation" (EXHIBIT 6.6, ATTACHMENT 1), shows the division of work between the FAT&LC and GCBCTC and represents the work activities which FDF anticipates to be performed by FAT&LC and/or GCBCTC. Although FDF is responsible for the management and supervision of the FDF work force, the Contractor shall provide technical oversight and direction for all activities performed by the FDF work force. Exhibit 6.6, Attachment 2, Workforce Allocation Table, shall be used to designate the number of FAT&LC and/or GCBCTC needed for each operation.

EXHIBIT 6.6
(Continued)

2.1.2 The Labor Relations/Work Force Utilization Plan shall show how the Contractor plans to incorporate the FAT&LC and/or GCBCTC into the work process.

2.1.3 FAT&LC Wage Position Descriptions are included in Part 5.

3.1 FAT&LC Workforce Provisions

3.1.1 Management of the FAT&LC workforce shall be a cooperative effort between the Contractor's supervisor(s) and the FDF Team Leader(s). The Contractor supervisor shall oversee the technical direction of the FAT&LC workforce, while the FDF Operations Team Leader will serve as a subject matter expert to the Contractor supervisor. The FDF Operations Team Leader will assist the Contractor's supervisor in scheduling training and procedure implementation with respect to the FAT&LC workforce. The Operations Team Leader will coordinate, with the Contractor's supervisor, activities such as disciplinary action, the employee replacement process, absenteeism, sick time, holidays, vacations, attrition, overtime scheduling, work schedules, and other project logistic issues.

3.2 FAT&LC Workforce Staffing

3.2.1 FAT&LC personnel shall be used to perform residue retrieval, maintenance, operations support, packaging, staging, loading and shipping activities. Contractor technicians shall operate and control the AWR equipment. IR will make the final decisions on workforce staffing after contract award.

3.2.2 The Contractor shall establish required process system training for the allocated work positions that will constitute the Contractor's labor force.

3.2.3 The Contractor shall develop a work allocation table as outlined in **Exhibit 6.6, Attachment 2,** and develop a block flow diagram showing how it plans to incorporate the wage employees into its process. The Labor Relations/Work Force Utilization Plan shall reflect the entire project schedule from the time of identification of FAT&LC wage employees (i.e., prior to startup) through project completion, and outline the FAT&LC work force requirements. This Work Force Utilization Plan shall identify the number and duration of shifts, the number of wage positions required for each shift, the number of Team Leaders required by shift (or day, as appropriate), and the number of days of processing before shutdown for planned maintenance downtime. The Work Force Utilization Plan shall include allowances in the contract for absenteeism, training, vacations, holidays, and attrition using the guidance described in Paragraph 3.6.1.

EXHIBIT 6.6
(Continued)

3.2.4 The Contractor shall notify FDF of the need and number of personnel required at least 120 calendar days in advance of the need. FDF will post the positions and selection shall be made in accordance with provisions of the CBA. During the Qualifying Period (CBA, Section 17-8), the Contractor and the FDF Team Leader shall assess the capability of the employees to perform the job. If the Contractor finds an employee is incapable of performing the new job, the Contractor shall document its findings and provide them to the FDF Contract Administrator. Final determination shall be made by FDF IR based upon conformity to the CBA.

3.2.5 The Contractor shall inform the FDF Maintenance Organization of maintenance personnel needed to support the Silos 1 and 2 AWR Project, not later than six months prior to start-up of operations including:

- Number of personnel in each maintenance craft needed;
- Maintenance supervisory support needed; and
- Shift coverage needed.

3.3 Dispute Resolution

3.3.1 All disputes shall be handled in accordance with the CBA, Grievance Procedure and Arbitration, Article VIII. The Contractor shall support FDF with information, documentation and testimony as required during the process. FDF retains the sole right of dispute resolution with the FAT&LC.

3.4 Disciplinary Action

3.4.1 The Contractor shall address concerns involving violation of the rules of conduct through the FDF Team Leader in accordance with the CBA. Any concerns, not addressed by the FDF Team Leader, shall be brought to the attention of the FDF Contract Administrator.

3.5 Team Leader/Employee Replacement Process

3.5.1 FDF will maintain qualified site trained personnel for replacement of Team Leaders. FDF will establish a pool of personnel to be available to cover work of employees who terminate, are promoted, transfer, or take an assignment vacancy. Site trained personnel will be made available within 30 calendar days of occurrence of the termination.

EXHIBIT 6.6
(Continued)

3.6 Absenteeism, Sick Time, Holidays, Vacation, Attrition, and Training

3.6.1 The Contractor shall include a factor for absenteeism due to sick time, personal leave, vacation and holidays in workforce planning. Currently, FDF uses a factor of 25 percent for additional personnel due to sickness, training, holidays, vacation, attrition, and absenteeism.

3.7 Work Hours

3.7.1 Normal shifts and work hours shall be in accordance with the CBA. Changes in the normal shift and work hours shall only occur after mutual consent of FAT&LC and FDF and must be in accordance with the provisions of the CBA. Overtime shall be assigned in accordance with CBA Section 15-6. The FDF Team Leader will assure administration of these provisions.

4.1 Contractor Responsibilities

4.1.1 The Contractor shall submit, and implement, a Labor Relations/Work Force Utilization Plan for review and concurrence by FDF, including a block flow diagram and work allocation table G-1, G-2, G-3. This plan shall identify required FDF Team Leader and FDF wage positions by description and number of each required by shift.

4.2 Operational and Maintenance Procedure Training

4.2.1 The Contractor shall coordinate all project-specific operational and maintenance training required for personnel, to include FAT&LC, FDF Team Leaders, and all replacements through the duration of the contract. All training will be coordinated through FDF.

4.3 Payment of Overtime and Labor Hours in Excess of Authorized Hours

4.3.1 Overtime or other additional hours including those of additional personnel, not included in the approved Labor Relations/Workforce Utilization Plan, or in accordance with **Part 4, SC-4 & SC-27** shall be at the Contractor's cost.

5.1 Labor Issues Roadmap

5.1.1 FDF has supplied **Attachment 3** Labor Issues Roadmap, to assist the Contractor in identifying CBA and PLA articles addressing various labor issues. This roadmap does not relieve the Contractor of its responsibility to read and understand the CBA between FDF and the FAT&LC and the PLA between FDF and the GCBCTC.

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EXHIBIT 6.6
ATTACHMENT 1

Silos 1 and 2 AWR Project
Remediation Work Allocation

To ensure compliance with the PLA with the GCBCTC and the CBA with the FAT&LC, the proposed work allocation for the remedial waste treatment and disposal of the Silo 1&2 Waste Retrieval System Project will be as follows:

GCBCTC

- Construction of the Radon Control and Retrieval facility;
- Installation of process equipment and any other temporary facilities;
- Construction of a Full-Scale Mock-Up;
- Construction of the Transfer Tank Area and Retrieval System;
- Utility connections;
- Performance of Construction Acceptance Testing;
- Performance of Integrated Construction Acceptance Testing; and
- Performance of Full-Scale Mock-Up Demonstration.

FAT&LC

- Support for system operability testing activities;
- Operations of waste retrieval system (including collection of samples);
- Retrieving the waste from Silos 1 & 2;
- Container and equipment handling and movement (FDF will provide hand stackers, forktrucks, and attachments required);
- General housekeeping;
- Decontamination of equipment during facility shutdown;
- Maintenance; and
- Process operations support.

EXHIBIT 6.6
ATTACHMENT 2

Work Force Allocation Table

Construction of Waste System					
Contractor	Wage Description	Shifts			
		1	2	3	4
		No. Employees	No. Employees	No. Employees	No. Employees
Operators					
Teamsters					
Laborers					
Team Leader(s)					

Waste Retrieval/Transfer					
Contractor Job Description	Wage Description Position	Shifts			
		1	2	3	4
		No. Employees	No. Employees	No. Employees	No. Employees
Operators					
Teamsters					
Laborers					
Team Leader(s)					

Maintenance					
Contractor Job Description	Wage Description Position	Shifts			
		1	2	3	4
		No. Employees	No. Employees	No. Employees	No. Employees
Operators					
Teamsters					
Laborers					
Team Leaders(s)					

EXHIBIT 6.6
ATTACHMENT 3

Labor Issues Roadmap

ISSUES	FAT&LC-CBA	GCBCTC-PLA
Health & Safety Oversight	Article IV, Safety & Health	Article XIV, Safety & Health
Role in Staffing	Article III - Stability of Employment Section 3-2 - Assignment of Work Section 3-3 - Training	Article VI Management Rights
Employee Replacement	Article XVII - Promotions, Transfers, and Temporary Assignments Section 17-4 - Assignment Vacancies Section 17-5 - Classification Vacancies Section 17-6 - Eligibility Section 17-7 - Procedure Section 17-8 - Qualifying Period	Article III - Employment
Dispute Resolution Article IV, Safety & Health, Section 4-3, Disagreement, etc.	Article VIII - Grievance Procedure and Arbitration Article VII - Work Stoppages, Lockouts and Related Actions Section 7-1 - Dispute Resolution Procedure	Article IX - Grievance Procedure and Arbitration
Work Hours	Article XV - Hours of Work, Overtime, Shifts and Premium Pay	Article XI - Hours of Work, Overtime and Shifts
Worker's Group	FDF's Responsibility	Employer's Responsibility
Holidays/Vacation	Article XI - Paid and Unpaid Time Off	Article XII and Appendix A
Wages	Appendix A	Appendix A
Discipline	Article V - "Management Rights"	Article XIII - Working Conditions, Section 13-2, HR 145

EXHIBIT 6.7
AWR PROGRAMMATIC INTERFACES

The Contractor be subject to several programmatic interfaces involving functional areas and projects at Fluor Daniel Fernald. This exhibit will define the current programmatic interfaces. These interfaces are subject to change due to the continuous process improvement program at FDF.

1.0 Engineering Interface

The Contractor's primary engineering interface is the FDF Project Engineering.

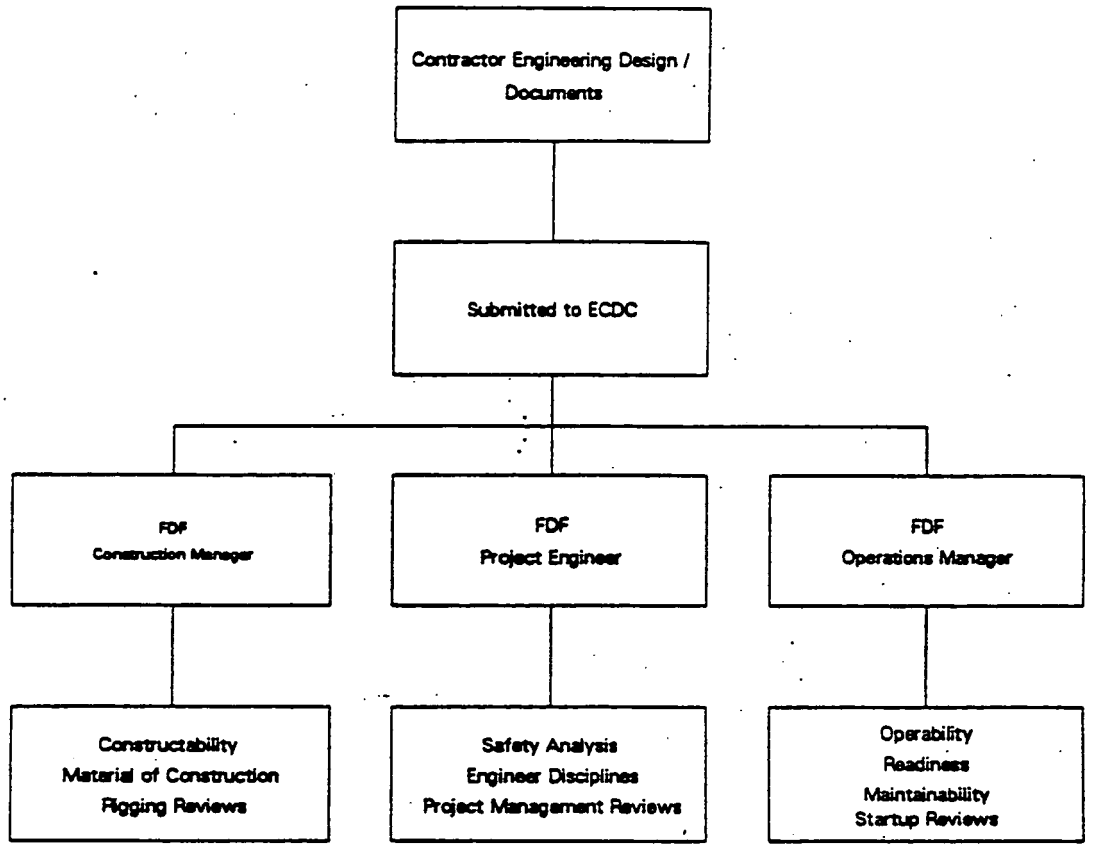
1.1 Engineering Status/Issues

The Contractor shall provide daily status and communication with FDF Project Engineering via the FDF Project Engineer located at the Contractor's engineering office.

1.2 Engineering Design and Document Review

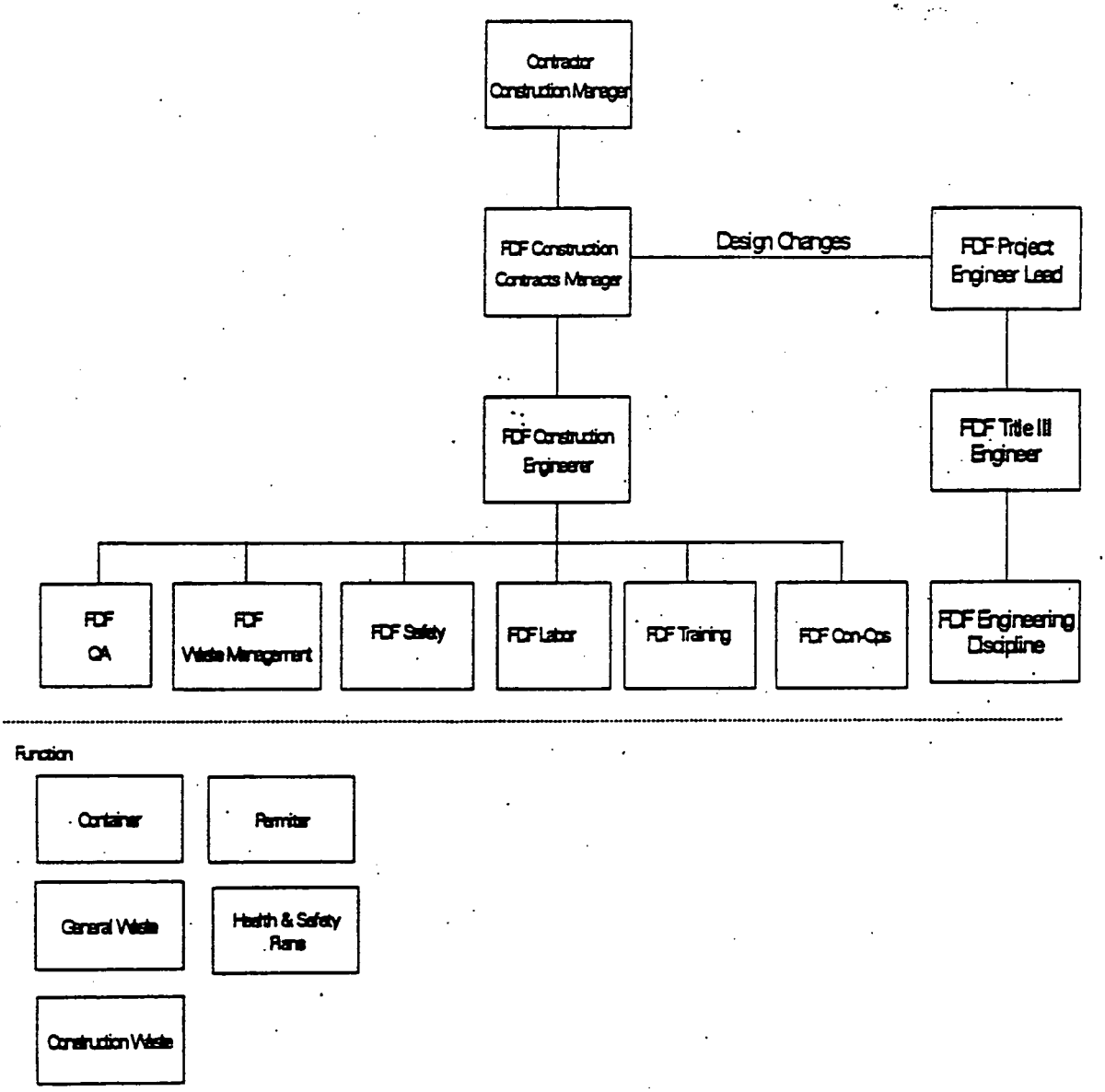
Engineering Design and documents will be submitted in accordance with ACR-001 "Contract Submittal Requirements" and reviewed in accordance with following flow diagram. The FDF Project Engineer is responsible for coordination of FDF review comments and submitting these comments in writing to the Contractor. The Contractor is responsible for comment resolution.

1.2 Engineering Design and Document Review (cont.)



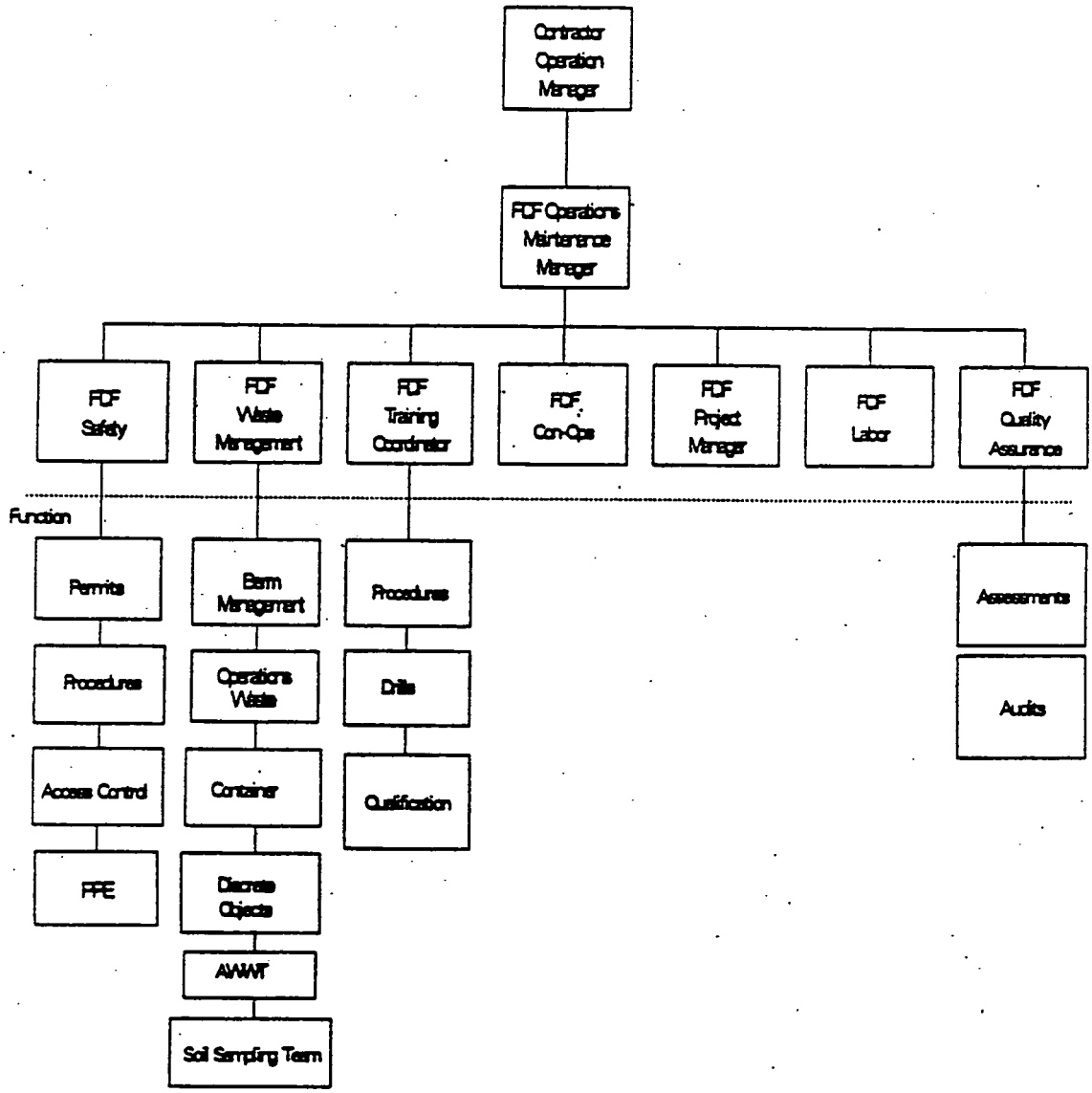
2. Construction and Field Design Issue Interface

The Contractor's primary construction interface is the Contract Construction Manager, in accordance with the following flow diagram.



3. Operation Interface

The Contractor's primary operation interface is the FDF Operation Manager or his designee.



4. Maintenance Interface

The Contractor's primary maintenance interface is the FDF Operations/Maintenance Manager or the appointed maintenance supervisor. Maintenance activities need to be accomplished utilizing FDF labor and the FDF maintenance program. The maintenance interface is as follows:

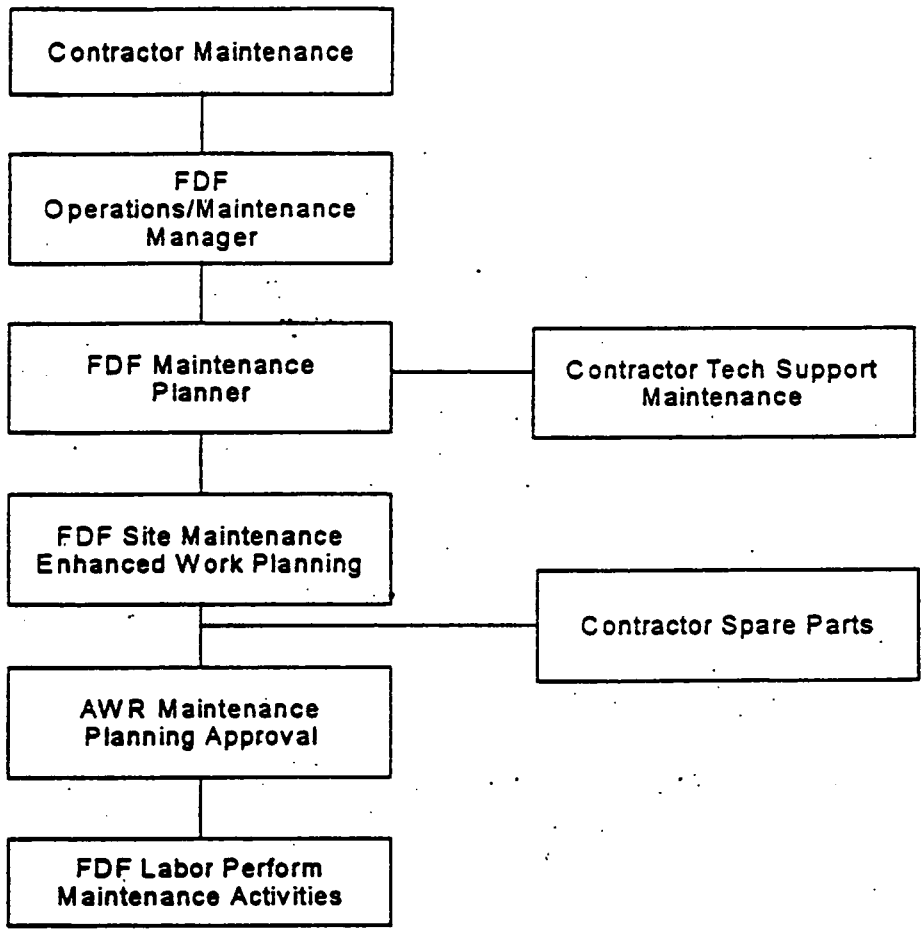


EXHIBIT 6.8

Facility Shutdown and Dismantlement

This section states the requirements for facility shutdown and dismantlement, including the decontamination of Contractor provided tools, equipment and material, waste and debris generated from the AWR Project.

1.0 Facility Shutdown

The primary purpose of facility shutdown is to isolate utilities to the designated facilities, remove gross quantities of hold-up from existing equipment, ductwork, pipes, sumps, and perform gross decontamination. Decontamination of temporary facilities and construction equipment to the unrestricted release criteria has been established in Table 6.8-1. The Contractor shall submit a Safe Work Plan as described in **Part 6, Section 4.1.1.** The Contractor shall be responsible for all temporary utility connections required during shutdown and dismantlement.

1.1 Isolation of Utilities

The Contractor shall isolate utilities including, but not limited to, electric power, water, and compressed air from the designated facilities. The Contractor shall include an Energy Isolation Plan within the Safe Work Plan for FDF approval which describes where, and how, the utilities shall be isolated.

Utilities shall be disconnected outside the facility early in the facility shutdown process, by physically cutting, air gapping, and tagging the lines. The Contractor shall remove all grounding conductors to grade level. The Contractor shall conduct a survey to verify that all utilities are capped and/or controlled and notify FDF in writing of the completion of the utilities isolation.

1.2 Removal of Hold-up Material

The interior of Silos 1 and 2, Decant Sump and all equipment, piping, ductwork, and sumps shall be assessed to determine whether they contain loose and/or visible hold-up material. Loose is defined as material that is considered releasable through a credible accident. If the item contains loose or visible material, the material shall be removed in accordance with FDF-approved Safe Work Plans and packaged in accordance with the Material Segregation and Containerization Criteria (MSCC).

EXHIBIT 6.8
(Continued)

If by visual inspection, hold-up material is found (solid or liquid), FDF shall be notified immediately. If the volume is estimated to be less than one quart, the Contractor shall remove and containerize the hold-up material in accordance with the MSCC. If the material found is estimated to be greater than one quart by volume, activities shall cease on that piece of demolition debris. In consultation with FDF, the Contractor shall remove, manage, and treat hold-up material greater than one quart by volume in accordance with the **Part 7-TRD, Section 5.0.**

1.3 Gross Decontamination

The Contractor shall perform gross decontamination of Silos 1 and 2, the Decant Sump interior, the remaining equipment and the interior of the retrieval facility. Gross decontamination is defined as general housekeeping to remove contaminated debris, vacuum loose dust, wet wipe equipment, ductwork, piping, and the interior of the structure walls, and remove loose, visible residues.

1.3.1 Materials

If stabilizer coatings are employed, they shall be Carboline D3358 or approved equal. Manufacturers may include, but are not limited to: Tnemec Series 6 - Tnemec-Cryl, Sherwin-Williams, or International Protective Coatings.

If non-strippable coatings are employed, they may include, but are not limited to: Polymeric Barrier System (Bartlett), or an approved equal.

1.4 Debris/Waste Handling Criteria

Refer to the Waste Management Plan in **Part 7-TRD, Section 5.0** for Debris/Waste Handling Criteria.

1.5 Decontamination of Contractor-Provided Tools, Equipment, and Material

This section provides preventative measures for and decontamination of Contractor-provided tools, equipment (including vehicles), and material to a level that permits removal from an enclosure/work zone, restricted reuse, or unrestricted release. This section includes, but is not limited to:

- Preventative measures/waste minimization;
- Decontamination area requirements;
- Methods of decontamination activities;
- Control of effluent and waste management activities; and
- Relocation, reuse, and release activities for tools, equipment, and material.

EXHIBIT 6.8
(Continued)

1.5.1 Project Conditions and Requirements

The Contractor shall establish a holding area to allow FDF to perform tool and equipment radiological surveying. The holding area shall be arranged such that routine access is prevented by means of fencing and/or barrier tape with appropriate posting to identify that the items contained are being held for survey and the area is off limits to individuals other than FDF/Contractor radiological survey personnel. Only those items which meet the requirements for leaving the work zone shall enter the inspection area.

1.5.2 Contractor-Provided Tools and Equipment

The Contractor shall deliver approved decontamination and contamination-controlling agent materials in original, new, and unopened containers bearing the manufacturer's label, and the following information:

- Name or title of material;
- Manufacturer's stock number and date of manufacture;
- Manufacturer's name; and
- MSDS sheets.

To meet the ALARA goal for tools, equipment, and materials, the Contractor shall control residual contamination to the extent that there is no detectable contamination on items that were free of contamination prior to use. When previously-contaminated items are no longer required for use, there shall be no increase in the level of contamination. This includes, but is not limited to, the following:

- Protective measures prior to use of items;
- Preventative measures while items are being used; and
- Decontamination upon completion of work activities.

All Contractor-furnished tools, vehicles, equipment, and material shall be inspected for radioactive contamination by FDF personnel prior to initial entry and upon removal from the radiological control area. FDF will supply all survey instrumentation used to inspect for radioactive contamination.

The Contractor shall supply all equipment required to remove and/or control contamination.

EXHIBIT 6.8
(Continued)

The Contractor shall supply all equipment required to control, filter, and move effluent produced during removal of contaminants.

1.5.3 Preventing or Minimizing Contamination

The Contractor shall plan and coordinate all work to minimize exposure of equipment, tools, and vehicles to potential radioactive contamination. Equipment shall be located in the area with the least potential for contamination. For example, locate equipment outside the facility with leads, hose lines, etc. wrapped and run to the interior of the facility (e.g., air compressors, high pressure washers, welders, generators, oxy-acetylene cylinders, and battery chargers).

Prior to use on-site, the Contractor shall evaluate materials, tools and equipment "for ease of decontamination" and disassembly that may be required for decontamination. Use of unrestricted release items shall incorporate appropriate precautions, prior to and during use, to prevent contamination. Examples of precautionary measures may include the following:

- Internal combustion equipment subject to contamination should have prefilters or a separate source of outside air on the intake;

- High volume air handling equipment such as blowers, compressors, etc. shall have a filtered inlet to minimize the potential for internal contamination due to build up of low-level radioactivity. Vents for air cooling shall be covered in a similar manner;

- The Contractor shall be prohibited from bringing electrically-driven mobile equipment to the FEMP (e.g., fork lifts) except where only electrically-driven equipment is available;

- Protective sheathing/covers, strippable coatings, or protective caps shall be used to minimize the potential for contamination (e.g., coating the buckets of man lifts or other walking/standing surfaces). In addition, all openings on equipment, tools, or vehicles that may permit contamination of inaccessible or difficult to clean areas shall be covered and protected; and

- If sealants and/or coatings are used during the project, the Contractor shall protect tools and equipment from overspray. In addition, the Contractor shall ensure that the sealant and/or coating can be readily removed during facility shutdown activities, if necessary.

EXHIBIT 6.8
(Continued)

1.5.4 Decontamination Area Requirements

Tools and equipment used inside an enclosure/building shall be decontaminated at an existing indoor debris washing location.

Options for establishing outdoor decontamination areas include:

- Using an existing pad.
- Constructing a temporary containment area where;
  - Containment must have a bermed perimeter to ensure run-off control;
  - An example of acceptable containment is Herculite with sandbag underlayment perimeters on a nonpenetrating grade; and
  - Containment used must maintain its integrity.

1.5.5 Methods of Decontamination Activities

If decontamination becomes necessary, the Contractor shall, at a minimum, use the following, if applicable:

- Dry cleaning;
- Steam cleaning;
- High pressure hot water washing (may be used in conjunction with abrasive techniques and approved decontamination agents) with a minimum of 1,000 psi and High Efficiency Particulate Air (HEPA) vacuuming; and
- When selecting a decontamination technique other than those identified above, consideration shall be given to those technologies that minimize radiological airborne emissions, secondary wastes, and tool or equipment damage.

EXHIBIT 6.8
(Continued)

1.5.6 Relocation, Reuse, and Release of Tools, Equipment, and Material

The Contractor shall perform all decontamination activities required to verify that the surface contamination limits identified in Table 6.8 are not exceeded. FDF will perform final verification surveying.

The Contractor shall provide a minimum of 24 hours prior notice to FDF of intent to remove tools and equipment from the work area.

1.5.7 Release of Tools, Equipment, and Material from Contamination Areas to the Controlled Area

If removable contamination in excess of the limits of Table 6.8 is present on the tools, equipment, or material then the items shall remain in the contamination area for decontamination or the items shall be contained such that no contaminated surfaces of the item are accessible without disassembling the equipment or breaching the containment.

Examples of acceptable containment include plastic wrapping, yellow Herculite wrapping, or a sealable hard container. However, the containment used must be adequate to maintain its integrity considering the weather, conditions of storage, and the methods or conditions of transport.

If the removable contamination limits are met, but the total (fixed plus removable) limit is exceeded, the item may be labeled or identified as radioactive material by FDF and released to the controlled area.

1.5.8 Unrestricted Release Criteria

All items are considered potentially contaminated if they have been used or stored in controlled areas that could contain unconfined radioactive material.

Prior to being released from the controlled area, all items will be surveyed by FDF to determine whether both removable and total surface contamination (including contamination on and under any coating) are in compliance with the levels given in Table 6.8-1 and that the item has been subjected to ALARA.

Upon approval from FDF, the Contractor shall remove the tools, equipment, and/or materials off-site within eight hours.

EXHIBIT 6.8
(Continued)

1.5.9 Tools and Equipment With Detectable Radioactivity

Tools and equipment with detectable radioactivity may be released with the concurrence of a FDF Material Release Evaluator (MRE). The following criteria shall be met:

- Residual radioactivity shall be at or below the unrestricted release limits identified in Table 6.8-1.

- All areas shall be readily accessible for residual radioactivity survey, including proper surface counting geometry to allow for accurate quantification. Items with inaccessible areas that are likely to be contaminated, but are of such size, construction, or location as to make them inaccessible for survey, shall be assumed to exceed the limits for release. The item shall either be disassembled to permit an adequate survey to certify that internal contamination is at or below the limits of Table 6.8-1 or a well-documented process can be applied to provide confidence that contamination in inaccessible areas is not probable. In evaluating the potential for contamination in inaccessible areas, consideration shall be given to where the item was used on-site and preventative measures taken prior to use (such as coverings, wrappings, air intake filters, etc.).

- The decontamination effort performed is such that the residual levels of radioactivity are ALARA and further significant reduction in radioactivity would require unreasonable efforts.

1.5.10 Release to an Off-site Licensed Facility

If the Contractor possesses the appropriate license to receive, possess, use, and transfer the equipment, tools, material, or vehicles with radioactive contamination, the Contractor may elect to remove such items from the site in lieu of decontamination. The Contractor shall comply with all Federal, State, and local regulations during the packaging, shipping, and receipt of the equipment. The Contractor shall submit a copy of the license and applicable procedures to FDF for compliance review prior to removal of the contaminated equipment. A copy of all Bills of Lading shall be submitted to FDF prior to shipment.

The Contractor shall provide 24 hours notice to FDF prior to shipping radioactive tools, equipment, and/or material.

EXHIBIT 6.8
(Continued)

1.5.12 Facility Shutdown and Secondary Waste

The Contractor shall be responsible for the proper management of all secondary waste generated during safe shutdown activities. Proper management includes any necessary treatment, characterization sampling, documentation, proper packaging, and interim staging prior to FDF acceptance for disposal.

Waste water should be treated to meet the AWWT acceptance criteria in **Part 7-TRD, Section 5.0.**

FDF will accept the pretreated, if required, waste water for final treatment at the FEMP AWWT.

2.0 Submittals

This section identifies and describes the required submittals for facility shutdown and dismantlement tasks. (Reference **Part 6, EXHIBIT 6.2** and **Part 7, ACR-001**, for additional submittal information.)

2.1 Facility Shutdown Submittals

The Contractor shall submit a Safe Work Plan for FDF concurrence. The work plan shall include the following information:

- Energy Isolation Plan
  - Identifies energy source of a specific process, equipment or system;
  - Identifies the methods for shutting down, isolating, blocking, and securing the specific process, equipment or system;
  - Identifies the methods of verifying isolation;
  - Shall be prepared consistent with the latest revision of RM-0021, Safety Performance Requirement No. SPR2-15;
  - Initiated, written, approved, distributed, and maintained in accordance with latest revision of FDF Lockout/Tagout procedure **Part 7, OP-0004.**

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EXHIBIT 6.8
(Continued)

1.5.11 Unsuccessful/Impractical Contractor Decontamination

If FDF determines that the Contractor has implemented the requirements of EXHIBIT 6.8-1 and the Safe Work Plan and the Contractor's decontamination efforts are unsuccessful or decontamination is not practical, then refer to Part 4, SC-10.

SURFACE CONTAMINATION LIMITS[a] TABLE 6.8-1

Nuclide[f]	Fixed Plus Removable		Removable[b,e]
	Average[b,c]	Maximum[b,d]	
U-nat, U-235, U-238, and associated decay products, alpha emitters.	5,000 dpm/100 cm^2	15,000 dpm /100 cm^2	1,000 dpm/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129.	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133.	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm /100 cm^2	15,000 dpm /100 cm^2	1,000 dpm /100 cm^2

[a] Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The limits presented for transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, and Ac-227 may be adjusted on a case-by-case basis. Consult with FDF Radiological Control when required to apply these limits for unrestricted release.

EXHIBIT 6.8
(Continued)

- Establishment of Temporary Utilities

  - Identify the type of utilities that the Contractor shall provide;
  - Identify the methods the Contractor shall tie-in to portable utilities; and
  - Identify where the utilities shall be located.

- Removal of Hold-up Material

  - Identify, characterize, locate, and quantify hold-up material;
  - Define the system to be worked;
  - Identify specific point(s) of entry;
  - Identify use of secondary containments at each point where the system is opened;
  - Identify final storage locations for containerized waste; and
  - Identify removal, management, and treatment procedures for hold-up material estimated to have a volume greater than one quart.

- Gross Decontamination Plan

  - Methods and equipment for gross decontamination;
  - Methods to control, handle, and minimize waste; and
  - Product Data - Manufacturer's technical information, including the material to be used, its intended use, and its application instructions.

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FLUOR DANIEL FERNALD

RFP NO. F98P168407

CONTRACT NO. FSC 624

Silos 1 and 2 Accelerated Waste Retrieval (AWR) Project

PART 7
TECHNICAL REQUIREMENTS

MARCH 23, 1998
DRAFT

PART 7
CONTRACT NO. FSC 624
TECHNICAL REQUIREMENTS
SILOS 1 AND 2 AWR PROJECT

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4.0 Relative FDF Waste Retrieval Information 7-13

5.0 General Relative Information 7-13

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1.0 Architectural Engineering (AE) Drawings

The following Architectural Engineering Drawings (AE) show existing conditions at Fernald. The Contractor may order these drawings from Queen City Reprographics[1] at the Contractor expense.

Drawing #	Title	Revision	Date
1.1 Site Interface Drawings			
94X-5500-E-SK-4000	Site Plan Interface Drawing Existing Electrical Utilities		
94X-5500-G-SK-1026	Facility Space Availability Plot Arrangement OU4		
94X-5500-G-SK-7034	Site Access to Accelerated Waste Retrieval Silo 1 & 2		
94X-5500-G-5000X	Space Allocation Site Plan OU4		
94X-5500-M-SK-7033	Site Plan Interface Drawing Existing Piping Utilities		
22A-5500-P-00804	Grid 31A Underground Utilities	5	
22A-5500-P-00805	Grid 31B Underground Utilities	5	
1.2 Silos and Decant Sump Tank Drawings			
34X-1450-M-00014	Decant Sump Tank by Catalytic Construction	2	
34X-1450-M-00087	Detail Two 125,000cf Slurry Storage Tank		
34X-1450-M-00089	Detail Two 125,000cf Slurry Storage Tank		
34X-1450-P-00023	General Layout K-65 Storage Area	3	

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[1]Queen City Reprographics, 1-800-966-2260.

Drawing #	Title	Revision	Date
34X-1450-P-00088	Detail Two 125,000cf Slurry Storage Tank		
34X-1450-P-00090	Detail Two 125,000cf Slurry Storage Tank		
34X-1450-S-00091	Detail Two 125,000cf Slurry Storage Tank		

1.3 Silos Dome Drawings

34X-5500-S-00108	Protective Cover System Site, Demo & Location		
34X-5500-S-00109	Protective Cover System Dome Plans & Details		
34X-5500-S-00110	Protective Cover System Sections & Details		
34X-5500-S-00111	Protective Cover Systems Structural Steel		

1.4 Waste Pit Area Drawings

4OA-4445-E-00068	Electrical - Single Line Diagram & Legend	1	12-21-90
4OA-4445-E-00069	Electrical - Site Plan	1	12-21-90
4OA-4445-E-00070	Electrical Pump Station Power & Control	1	12-21-90
4OA-4445-E-00071	Electrical Control Diagrams & Details	1	12-21-90
4OA-4445-G-00054	Key Plan	1	12-21-90
4OA-4445-G-00055	Location Plan	1	12-21-90
4OA-4445-G-00056	Site Plan	1	12-21-90
4OA-4445-G-00057	Grading Plan #1	1	12-21-90
4OA-4445-G-00058	Grading Plan #2	1	12-21-90

Drawing #	Title	Revision	Date
40A-4445-G-00059	Grading Plan #3	1	12-21-90
40A-4445-G-00063	Trench Drain Profiles	1	12-21-90
40A-4445-G-00064	Storm Sewer and Culverts - Profile & Detail	2	10-10-91
40A-4445-G-00065	Site Details	1	12-21-90
40A-4445-G-00079	East Detention Area - Plan and Sections	1	10-10-91
40A-4445-G-00080	North Detention Area - Plan and Sections	1	10-10-91
40A-4445-N-00078	Schematics and Enclosure Arrangements	0	12-21-90
40A-4445-P-00073	Legend Sheet	1	12-21-90
40A-4445-P-00074	Piping & Instrumentation Diagram - Waste Pit Perimeter Collection Pump Stations	1	12-21-90
40A-4445-P-00075	Underground Piping Plan and Profile	1	12-21-90
40A-4445-P-00076	Pumping Equipment & Piping Layout & Details	1	12-21-90
40A-4445-S-00060	Sump & Pump Station - Plan & Details	1	12-21-90
40A-4445-S-00061	Controlled Inlet Structures - Plan & Detail	2	10-10-91
40A-4445-S-00062	Miscellaneous Structural Details	2	12-21-90
40A-4445-X-00053	Cover Sheet	2	10-10-91
40A-4445-X-00066	Waste Pit Area Stormwater Control	A	10-90
40A-4445-X-00067	Waste Pit Area Stormwater Control	A	10-90

1.5 Silo 4 Drawings

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Drawing #	Title	Revision	Date
94X-5900-X-00503	Project Title Sheet		
94X-5900-X-00504	Drawing Index - Sheet 1 of 2		
94X-5900-X-00505	Drawing Index - Sheet 2 of 2		
94X-5900-X-00506	Legend Symbols		
94X-5900-G-00544	Civil - Site Plan		
94X-5900-G-00545	Civil - Grading Plan		
94X-5900-G-00546	Civil - Details		
94X-5900-A-00485	Architectural - Plan and Elevations - Pump Support Structure Enclosure		
94X-5900-A-00509	Architectural - Section and Details - Pump Support Structure Enclosure		
94X-5900-A-00510	Architectural - Schedule and Details - Pump Support Structure Enclosure		
94X-5900-S-00591	Structural - Plans - Pump Support Structure		
94X-5900-S-00592	Structural - Elevations - Pump Support Structure		
94X-5900-S-00593	Structural - Force Diagrams and Sections - Pump Support Structure		
94X-5900-S-00594	Structural - Sections and Details - Pump Support Structure		
94X-5900-S-00595	Structural - Stair Plans, Sections, and Details - Pump Support Structure		
94X-5900-S-00596	Structural - Ladder Details - Pump Support Structure		
94X-5900-S-00598	Structural - Plans, Sections, and Details - Pump Support Structure		

Drawing #	Title	Revision	Date
94X-5900-S-00599	Structural - Miscellaneous Pipe Support Details - Pump Support Structure		
94X-5900-S-00600	Structural - Dome Segment Removal - Pump Support Structure		
94X-5900-S-00601	Structural - Equipment Pad Plan, Sections, and Details - Pump Support Structure		
94X-5900-F-00491	Process - Process Flow Diagram - Symbols and Legend Sheet		
94X-5900-F-00492	Process - Process Flow Diagram - Hydraulic Surrogate Waste Removal		
94X-5900-F-00493	Process - Process Flow Diagram Silo 3 Pneumatic Waste Removal		
94X-5900-F-00494	Pocess - Process Flow Diagram -Silo Radon Treatment System		
94X-5900-M-00620	Material Handling - General Arrangement Elevation - Hydraulic Slurry Waste Removal		
94X-5900-M-00621	Material Handling - General Arrangement Plan - Hydraulic Slurry Waste Removal		
94X-5900-M-00622	Material Handling - General Arrangement Section - Hydraulic Slurry Waste Removal		
94X-5900-M-00623	Material Handling - Equipment Arrangement - Silo Insert Assembly		
94X-5900-M-00624	Material Handling - Equipment Detail - Silo Door		

Drawing #	Title	Revision	Date
94X-5900-M-00625	Material Handling - Equipment Detail - Track Frame		
94X-5900-M-00626	Material Handling - Equipment Detail - Maintenance Carriage		
94X-5900-M-00627	Material Handling - Plan Sections and Details - Equipment etail - Silo Insert		
94X-5900-M-00651	Material Handling - Plan - Silo 3 Pneumatic Waste Removal System		
94X-5900-M-00652	Material Handling - Elevations and Details - Silo 3 Pneumatic Waste Removal System		
94X-5900-P-00750 1	Piping/Plant Design - Lower Piping Plan - Silo 4 Area		
94X-5900-P-00751	Pipping/Plant Design - Upper Piping Plans and Section - Silo 4 Area		
94X-5900-P-00772	Piping/Plant Design - Piping Plan - Silo 4 Area		
94X-5900-P-00754	Piping/Plant Design - Piping and Pipe Support Details		
94X-5900-H-00498	Mechanical Utilities - Symbols Legend and General Notes - Silo 4		
94X-5900-H-00499	Mechanical Utilities - Air Flow and Control Diagram - Equipment Room and Silo 4		
94X-5900-H-00664	Mechanical Utilities - Sections - Silo 4 Ventilation Systems		
94X-5900-H-00531	Mechanical Utilities - Floor Plans and Details - Silo 4 Ventilation Systems		

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94X-5900-E-00552	Electrical - Symbols and Legend - Sheet 1 of 2		
94X-5900-E-00553	Electrical - Symbols and Legend Sheet 2 of 2		
94X-5900-E-00554	Electrical - Single Line Diagram - Silo 4 Waste Removal Area		
94X-5900-E-00555	Electrical - Cable Schedule		
94X-5900-E-00556	Electrical - Conduit Schedule		
94X-5900-E-00558	Electrical - 486V Power and Grounding Plan - Silo 4		
94X-5900-E-00560	Electrical - Interconnection Diagram		
94X-5900-E-00562	Electrical 120V Power and Lighting Plan - Silo 4		
94X-5900-E-00560	Electrical - Interconnection Diagram		
94X-5900-E-00562	Electrical 120V Power and Lighting Plan - Silo 4		
94X-5900-E-00563	Electrical - Panel Schedule		
94X-5900-E-00564	Electrical - Elementary Diagrams		
94X-5900-E-00567	Electrical - Heat Trace Riser Diagram		
94X-5900-E-00568	Electrical - Elevations and Detail - Starter Rack No. 1 and Poles		
94X-5900-E-00667	Electrical - Elevation - Starter Rack No. 2		
94X-5900-E-00565	Electrical - Elementary Diagrams - Sheet 2 of 2		
94X-5900-E-00666	Electrical - Elevation - Power Pole No.3		
94X-5900-E-00668	Electrical - 486V Overhead Power		

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94X-5900-N-00495	Mechanical Process - Piping and Instrumentation Diagram - Symbols and Legend Sheet		
94X-5900-N-00496	Mechanical Process - Piping and Instrumentation Diagram - Silo 4 Hydraulic Slurry Waste Removal System		
94X-5900-N-00497	Mechanical Process - Piping and Instrumentation Diagram - Radon Treatment System Sheet 1 of 3		
94X-5900-N-00500	Mechanical Process - Piping and Instrumentation Diagram - Radon Treatment System Sheet 2 of 3		
94X-5900-N-00501	Mechanical Utilities - Piping and Instrumentation Diagram - Radon Treatment System Sheet 3 of 3		
94X-5900-N-00486	Material Handling - Piping and Instrumentation Diagram Pneumatic Waste Removal System		

1.6 Silo Superstructure Design

94X-5900-X-00967	Project Title Sheet
94X-5900-X-00968	Drawing Index
94X-5900-X-00969	Legend and Symbols
94X-5900-G-00970	Civil - Site/Utility Plan
94X-5900-G-00971	Civil - Grading Plan
94X-5900-G-00973	Civil - Details - Sheet 1 of 2
94X-5900-G-00974	Civil - Details - Sheet 2 of 2
94X-5900-G-00975	Civil - Utility Profile

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Drawing #	Title	Revision	Date
94X-5900-A-00976	Architectural - Plans and Interior Elevation - Silo 1 and 2 Equipment Room		
94X-5900-A-00992	Architectural - Elevations - Silo 1 and 2 Equipment Room		
94X-5900-A-00977	Architectural - Sections and Details - Silo 1 and 2 Equipment Room		
94X-5900-A-00978	Architectural - Schedules and Details - Silo 1 and 2 Equipment Room		
94X-5900-S-00979	Structural - Key Plan - Silo 1 and 2 Superstructure		
94X-5900-S-00980	Structural - Enlarged Plan - Silo 1 and 2 Top Chord		
94X-5900-S-00981	Structural - Enlarged Plan - Silo 1 and 2 Bottom Chord		
94X-5900-S-00982	Structural - Enlarged Plan - Silo 1 and 2 Equipment Room		
94X-5900-S-00983	Structural - Enlarged Plan - Silo 1 and 2 Equipment Room		
94X-5900-S-00984	Structural - Plan and Details - Silo 1 and 2 Dome Segment Removal		
94X-5900-S-00985	Structural - Elevation - Silo 1 and 2 Truss		
94X-5900-S-00986	Structural - Elevations - Silo 1 and 3 Towers and Equipment Room		
94X-5900-S-00987	Structural - Sections and Details - Silo 1 and Silo 2		
94X-5900-S-00988	Structural - Sections and Details - Silo 1 and Silo 2		

Drawing #	Title	Revision	Date
94X-5900-S-01024	Structural - Sections and Details - Silo 1 and 2 Superstructure		
94X-5900-S-01025	Structural - Sections and Details - Silo 1 & 2 Superstructure		
94X-5900-S-01027	Structural - Sections and Details - Silo 1 & 2 Superstructure		
94X-5900-S-00989	Structural - Plans, Sections, and Details - Silo 1 and 2 Stairs		
94X-5900-S-00990	Structural - Elevations and Details - Silo 1 and 2 Ladders		
94X-5900-S-00991	Structural - Plans and Sections -Silo 1 and 2 Concrete Foundation		
94X-5900-S-01009	Structural - Truss Force Diagram - Silo 1 and 2		

2.0 Architectural Engineering (AE) Specifications

The following AE Specifications specify work to be performed on this Contract.

Number	Title	Revision	Date
40710-RP-0001	Silos 1 & 2 Technical Requirements Document	0	

2.1 Fluor Daniel Fernald (FDF) Engineering Specifications and Administration Contract Requirements

The following FDF Engineering Specifications and Administration Contract Requirements specify work to be performed on this Contract.

Specifications Sections

Number	Title	Revision	Date
11010	HEPA Vacuum Cleaner Requirements	0	04/09/97
15860	HEPA Air Filtration Devices Requirements	1	12/03/97

Administrative Contractor Requirements

Number	Title	Revision	Date
ACR-001	Contract Submittal Requirements	5	02/02/98
ACR-002	Contractor Safe Work Plan Format Requirements	3	01/05/98
ACR-003	Contractor Fire Extinguisher Inspection Requirements	1	03/26/97
ACR-004	Contractor Ladder Inspection Requirements	1	03/26/97
ACR-005	Contractors Disposable Anti-Contamination Clothing Requirements	1	03/26/97
ACR-006	Contractor Portable Structures	1	03/26/97
ACR-007	Waste Material Handling Criteria for Construction Projects	1	03/26/97

3.0 FDF Reference Information

The following FDF Site Procedures/Plans and reports are reference information for this Contract. The Contractor can obtain these documents from Queen City Reprographics.

Document #	Title
20100-PL-0014	Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility.
ED-12-4015	Performance Grading
ED-12-4016	Equipment and Piping Labeling
ED-12-6003	System Operability Testing and Startup and Turnover Plan
EM-0010	Event Notification and Occurrence Reporting
EM-0028	Audible Communications
EW-0002	Chain of Custody/Request for Analysis Record of Sample Control
EW-0016	FEMP Task Order System
FD-1000	Sitewide CERCLA Quality Assurance Project Plan
FEMP-OU4ROD-8 Final	Final Record of Decision for Remedial Action at Operable Unit 4

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Document #	Title
Silos Project	Hazard Analysis Report
M-134	Standing Orders for Vitrification Pilot Plant/Silos Project Operations
M-140	Facilities Closure and Demolition Projects Division Procedure System
M-143	FDF Maintenance Reference Guide
MT-0003	FEMP Work Request/Order Procedure
NS-0002	Unreviewed Safety Question Determination and Safety Evaluation System
NS-0003	FDF Safety Assessment Hazard Screening and Classification
NS-0004	Audible Safety Records
NS-0005	Safety Analysis Reports and Technical Safety Requirements
OP-0004	FERMCO Lockout/Tagout (Hazardous Energy and Material Control)
OP-1001	Operations Organization and Administration
OP-1002	Shift Routines and Operating Practices
OP-1005	Control of On-Shift Training
OP-1008	Control of Equipment and System Status
OP-1010	Independent Verification
OP-1011	Logkeeping
OP-1012	Operations Turnover
OP-1013	Operations Aspects of Facility Chemistry and Unique Processes
OP-1014	Required Reading
OP-1015	Timely Orders to Operators
OP-1016	Operations Procedure Availability and Use
OP-1017	Operator Aid Postings
PL-3049	Implementation Plan for Safety Analysis Reports and Technical Safety Requirements at FEMP

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Document #	Title
PSM-105	Silos Project Conduct of Operations Applicability Matrix
RM-0016	FDF Management Plan
RM-0020	Radiological Controls Requirements Manual
RM-0021	Safety Performance Requirements Manual
RM-0025	Pre-Operational Assessment (PA) Program
RM-0029	FDF Conduct of Operations (CONOPS) Program
RM-0034	Startup and Turnover Requirement Manual
RM-0045	Fluor Daniel Fernald Hoisting Rigging Manual
RM-2116	FDF System Safety Requirements

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4.0 Relative FDF Waste Retrieval Information

This following information is existing FDF Silos 1 and 2 waste retrieval, studies, design and evaluations. The Contractor may obtain these documents from Queen City Reprographics. If the Contractor utilizes this information, the Contractor shall validate, certify and assume all responsibility for this design.

Document #	Title
	Silo Superstructure CFC Design Package
40700-RP-0001	Waste Retrieval Evaluation Report
40150-RP-0002	Radon Treatment System Evaluation
	AIR Pre-Conceptual Design
97005-Rest-003.2	Houdini II Reconfigurable In-Tank Report
4000-RP-0004	OU4 Remediation Action Conceptual Design Report
40000-RAD-0001	OU4 Silo's Project ALARA Evaluation
40200-RP-0001	OU4 Silo Superstructure Design for the Silo Project Foundation Design

5.0 General Relative Information

The following is reference information to this Contract that is not provided. It is assumed to be available to the Contractor through the internet.

Document#	Title
11000004*ED	FEMP NPDES Permit
10 CFR 820	Procedural Rules for DOE Nuclear Activities
10 CFR 830	Nuclear Safety Management
10 CFR 835	Occupational Radiation Protection
10 CFR Part 830.120	Nuclear Safety Management - Quality Assurance Requirement.
10 CFR Part 860	Trespassing on Administration Property, issued 1/1/93

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Document#	Title
10 CFR Part 1017	Identification and Protection of Unclassified Controlled Nuclear Information, issued 1/1/93
10 CFR Part 1021.2	NEPA Implementation
10 CFR Part 1022	Compliance with Floodplain/Wetlands Environmental Review Requirements
10 CFR Part 1046	Physical Protection of Security Interests, revised 1/1/93
29 CFR Part 1904	Recording and Reporting Occupational Injuries and Illnesses
29 CFR Part 1910	Occupational Safety and Health Standards
29 CFR Part 1926	"Safety and Health Regulations for Construction," July 1, 1994, The following sections apply:
33 CFR Part 330, Appendix A	USACE nationwide Permits and Conditions
40 CFR Part 61	National Emission Standards for Hazardous Air Pollutants
40 CFR Part 261	Identification and Listing of Hazardous Waste
40 CFR Part 262	Standards Applicable to Generators of Hazardous Waste
40 CFR Part 263.20-31	Standards Applicable to Transporters of Hazardous Waste
40 CFR Part 264	Standards for Treatment, Storage, and Disposal Facilities
40 CFR Part 264, B (OAC 3745-54-13, 14, 15, and 16)	General Facility Standards
40 CFR Part 264, C (OAC 3745-54-31 through 35, and 37)	General Facility Standards
40 CFR Part 264, D (OAC 3745-54-51, 52, 55, and 56)	Contingency Plan
40 CFR Part 264, I (OAC 3745-5571 through 78)	Container Storage
40 CFR Part 264, J (OAC 3745-55-91 through 96)	Tank Systems, 40 CFR 265J
40 CFR Part 264.14	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities - Security, issued 7/1/92
40 CFR Part 264.552, S	Corrective Action Management Units; Temporary Units

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Document#	Title
40 CFR Part 264.1101 and 1101	Containment Buildings
40 CFR Part 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR Part 302	Designation, Reportable Quantities, and Notification
41 CFR Chapter 101-20, 103	Physical Protection and Building Security, issued 7/1/93
48 CFR Part 970.22	Application of Labor Policies (pre-employment Investigations), issued 1/1/93
49 CFR, Subchapter C	Hazardous Materials Regulations
Amended Consent Agreement	Administrative Docket No. V-W-90-C-057, issued 10/1/91
ANSI N.13.1 - 1969	Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities
ANSI N322-1975	Inspection and Test Specifications for Direct and Indirect Reading Quartz Fiber Pocket Dosimeters
ANSI N323-1978	Radiation Protection Instrumentation Test and Calibration
ANSI N42.18-1980	Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents
ANSI N43.2 - 1988	Radiation Safety for X-ray Diffraction and Fluorescence Analysis Equipment
ANSI N43.3-1993	General Safety Standard for Installations Using Nonmedical X-ray and Sealed Gamma-Ray Sources (formerly ANSI N543-1974, with the same title)
ANSI N45.2.11	Quality Assurance Requirements for the Design of Nuclear Power Plants
B.O.C.A.	Uniform Building Code or Local Fire and Building Codes
DOE Order 210.1	Performance Indicators and Analysis of Operations Information
DOE Order 225.1	Accident Investigations
DOE Order 231.1	Environment, Safety, and Health Reporting
DOE Order 413.1	Management Control Program
DOE Order 420.1	Facility Safety, Contractor Requirements Document (CRD)

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Document#	Title
DOE Order 425.1	Startup and Restart of Nuclear Facilities
DOE Order 430.1	Life Cycle Asset Management (LCAM)
DOE Order 440.1	Worker Protection Management for Federal and Contractor Employees
DOE Order 470.1	Safeguards and Security Program
DOE Order 471.1	Identification and Protection of Unclassified Controlled Nuclear Information, Paragraph 5 only of Contractor Requirements Document (CRD)
DOE Order 472.1	Personnel Security Activities, Contractor Requirements Document (CRD)
DOE Order 1240.2B	Unclassified Visits and Assignments by Foreign Nationals, change 001 issued 9/3/92
DOE Order 1324.5B	Records Management Program
DOE Order 1360.2B	Unclassified Computer Security Program, issued 5/18/92
DOE Order 1450.4	Consensual Listening-in to or Recording Telephone/Radio Conversations, issued 11/12/92
DOE Order 4330.4B	Maintenance Management Program
DOE Order 4700.1	DOE Project Management System
DOE Order 5480.19	Conduct of Operation
DOE Order 5480.20A	Personnel Selection, Qualifications, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities
DOE Order 5632.7A	Protective Force Program
DOE 1430.1D	Scientific and Technical Information Management
DOE 5400.5	Radiation Protection of the Public and the Environment, issued 2/8/90, change 1, 6/5/90
DOE 5480.21	Unreviewed Safety Questions
DOE 5480.22	Technical Safety Requirements
DOE 5480.23	Nuclear Safety Analysis Reports
DOE 5480.29	Employee Concerns Management System
DOE 5482.1B	Environmental, Safety, and Health Appraisal Program

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Document#	Title
DOE 5484.1	Environmental Protection, Safety and Health Protection Information Reporting Requirements
DOE 6430.1A	General Design Criteria
DOE EM-STD-5502-94	Hazard Baseline Documentation
DOE Std. 3009-94	Preparation Guide for USDOE Non-Reactor Nuclear Facility Safety Analysis Report
DOE N 441.1	Radiological Protection for DOE Activities
DOE/EH-0256T	Department of Energy Radiological Control Manual
DOE-STD-1027-92	Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23
DOE-STD-3005-YR	Evaluation Guidelines for Accident Analysis of Safety Structures Systems and Components
Federal Facility Compliance Agreement	U.S. EPA Docket No. FFCA-HW-001, issued 7/6/88
IEEE 142	Grounding Requirements
IES Standard	Lighting Requirement
National Environmental Policy Act (NEPA)	
Nevada Test Site NVO-325	Defense Waste Acceptance Criteria, Certification, and Transfer Requirements, issued 10/88, Rev. 1 issued 6/92
NFPA 780	Lightning Protection
OAC 3745-15-07, and ORC 3704.01 through .05	Prohibitions of Violations, and Air Pollution Nuisance
OAC 3745-17-07	Control of Visible Particulate Emissions from Stationary Sources
OAC 3745-17-08	Control of Fugitive Dust
OAC 3745-31	Permits to Install New Sources of Pollution
OAC 3745-31-05(A)	Permits to Install New Sources of Pollution, Criteria for Decision
OAC 3745-53-20 through 31)	Transportation Requirements
OAC 3745-95	Backflow Prevention and Cross-Connection Control
OAC 3745-95	Safe Drinking Water

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Document#	Title
ODOT Location and Design Manual	Storm Water Drainage Design
Ohio Administrative Code Chapter 4101.2	Building Code
Ohio Administrative Code Chapter 4101.8	Pressure Piping System Code
Ohio Administrative Code Chapter 4104.4	Boiler Code
SW-846 - EPA Publication	"Test Methodology for Evaluating Solid Waste, Physical/Chemical Methods"
UCRL 15673	Human Factor Design Guidelines for Maintainability of DOE Nuclear Facility
UCRL 15910	

Silos 1 and 2 Accelerated Waste Retrieval (AWR) Project

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FLUOR DANIEL FERNALD

Technical Requirements Document

No. 40710-RP-0001
March 1998
DRAFT

FERNALD
Environmental Management Project

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CONTRACT NO. FSC 624
TECHNICAL REQUIREMENTS DOCUMENT
SILOS 1 AND 2 AWR PROJECT

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CONTRACT NO. FSC 624
TECHNICAL REQUIREMENTS DOCUMENT (TRD)
SILOS 1 AND 2 AWR PROJECT

1.0 INTRODUCTION

The objective of the Accelerated Waste Retrieval (AWR) Project is to extract the materials from Silos 1 and 2, segregate appropriately (i.e., remove discrete objects), and transfer the residue to transfer tanks for staging before final remediation. Due to the residue characteristics, silos[1] condition, radon emanation and the execution of this project at a United States Department of Energy (DOE) facility, there are numerous limitations and constraints which effect this project.

The purpose of the Technical Requirements Document (TRD) is to detail the minimum requirements for the Contractor in the areas of project management, design and documentation. Due to radiological issues and DOE concerns, this project shall require Readiness Reviews in accordance with DOE Order 425.1 and the Fluor Daniel Fernald (FDF) Pre-Operational Assessment (PA) Program. To comply with readiness requirements for this project, comprehensive documentation, evaluations, planning and training shall be required. The AWR Project Block Flow Diagram, Figure 1-1, presents the project requirements for readiness.

The Silos 1 and 2 Project which includes the AWR Project will consist of four stages :

- Stage 1: maintenance of the silos and reduction of radon concentration prior to silo retrieval operations (in the scope of the AWR project);
- Stage 2: material retrieval from silos, segregate, and transfer residue to the Transfer Tank Area, or TTA (in the scope of the AWR project);
- Stage 3: staging and temporary storage of the residue material in the TTA prior to transfer to the residue remediation operation;
- Stage 4: retrieval of the residue from the TTA and transfer and processing at the Full-Scale Remediation Facility.

1.1 Elements of Section 2.0

Section 2.0 of this document defines the design functional requirements and the design criteria for this project. It also defines the areas of technical concern and provides the latest data from engineering studies.

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[1] Throughout this document, the term 'silos' will be used to refer to Silos 1 and 2, and the term 'material' will be used to refer to the contents of the silos.

Accelerated Waste Retrieval Project Block Flow Diagram

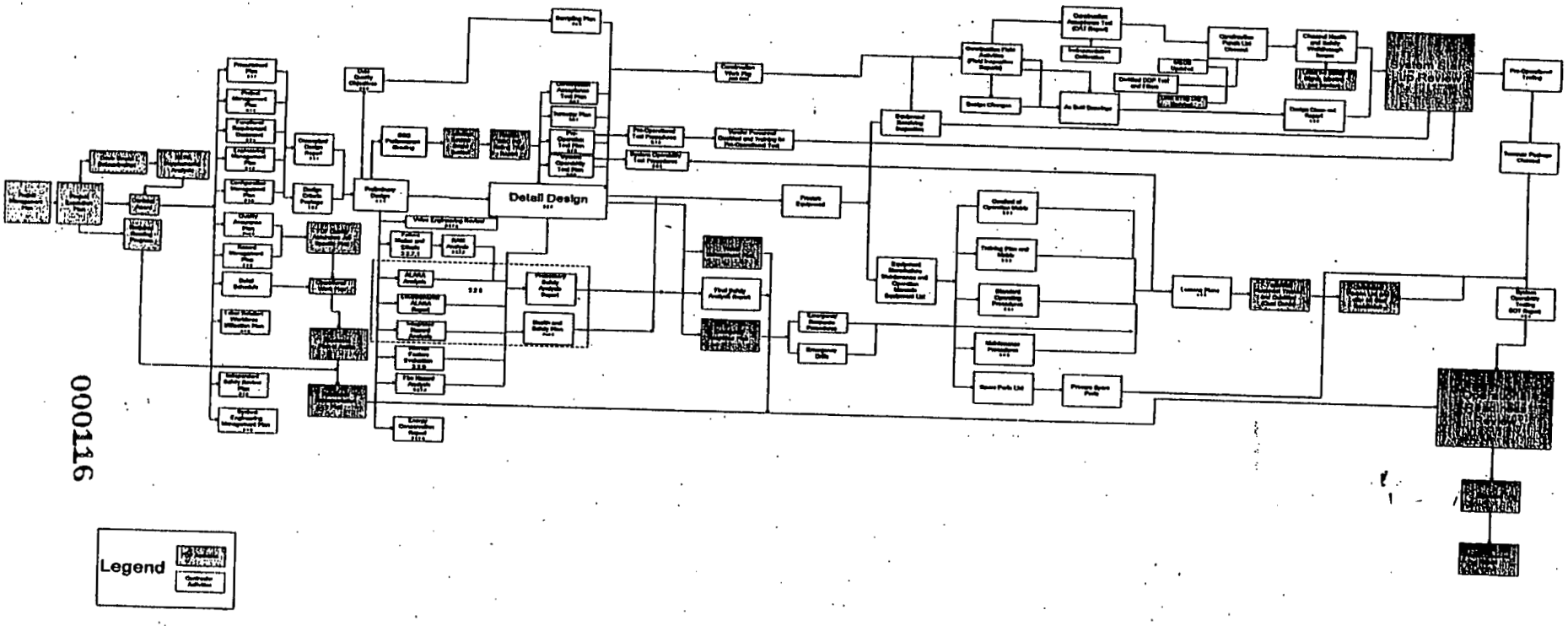

Figure 1.1

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1.2 Elements of Section 3.0

Section 3.0 of this document defines the project management and documentation minimum requirements in support of FDF readiness requirements. Each document required shall be created in Word Perfect and shall be reviewed and approved by FDF. The Contractor shall be required to submit an electronic and hardcopy of these documents. To expedite the FDF review and ORR processes, all of the Contractor's documents shall be formatted to FDF documents in accordance with ACR-008.

1.3 Elements of Section 4.0

Section 4.0 of this document defines the operating and maintenance requirements for this project. This chapter defines the requirements for any operating and maintenance activities utilizing FDF workforce.

1.4 Elements of Section 5.0

Section 5.0 of this document defines the Waste Management requirements and interfacing. This section will describe the FDF waste management procedures, drivers, forms, material disposition, containerization soil management, berm management and wastewater management.

1.5 List of Appendixes

- Appendix A: Defines the Physical and Chemical Characteristics of the Silos Residue;
- Appendix B: Project SRID Requirements and the Applicable or Relevant and Appropriate Requirements (ARARs);
- Appendix C: Physical Characteristics and Conditions of the FEMP Site;
- Appendix D: Radon Test Data;
- Appendix E: ConOps Matrix;
- Appendix F: Radon Control System, Phase I;
- Appendix G: AWR Surrogate Formula;
- Appendix H: Silos Integrity.

1.6 Available Documentation

The following FDF produced engineering documents on the issue of Silos Waste Retrieval shall be available upon request:

- Accelerated Waste Retrieval Pre-Conceptual Design;
- Silo Superstructure Design;

- Waste Retrieval System Evaluation[2] (WRE) Report;
- Houdini Waste Retrieval System;
- Radon Treatment System Evaluation; and
- OU4 Remedial Action Conceptual Design Report.

The FDF generated information is not intended to influence the Contractor's design process. If the contractor chooses to use any of the FDF design information, the Contractor shall validate, certify and assure all responsibilities for this design or any Contractor's modifications.

2.0 BASIS FOR DESIGN

The engineering design process for the AWR project shall be performed in a manner consistent with the responsibilities and authorities of FDF under its contract with the United States Department of Energy (DOE). The basis of design presented in this section serves to establish the technical baseline required for a Contractor to initiate a design. The basis of design provides the following elements to the Contractor:

- Functional Description (Sections 2.1 and 2.2) defines the scope, illustrates relationships, and defines each function. These sections provide the Contractor with an explanation of what needs to be performed in order to satisfy the objectives of the AWR project;

- System Requirements (Section 2.3). A system model is presented and each system is defined by its functional scope and requirements. This section shall be used by the Contractor in the development of a design concept;

- Design Requirements (Section 2.4). This section includes programmatic and general design requirements that govern work performed at the FEMP and shall be used by the Contractor in the development of a design concept; and

- Relevant Design Criteria (Section 2.5). This information provides reference data (e.g., residue characterization, geological, site infrastructure, radon adsorption, etc.) necessary for the design and construction activities included in the scope of this contract.

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[2] Fernald Environmental Management Project, *Silos 1 & 2 Waste Retrieval System Evaluation,* 40700-RP-0001, Revision A; April 28, 1997.

2.1 Functional Analysis

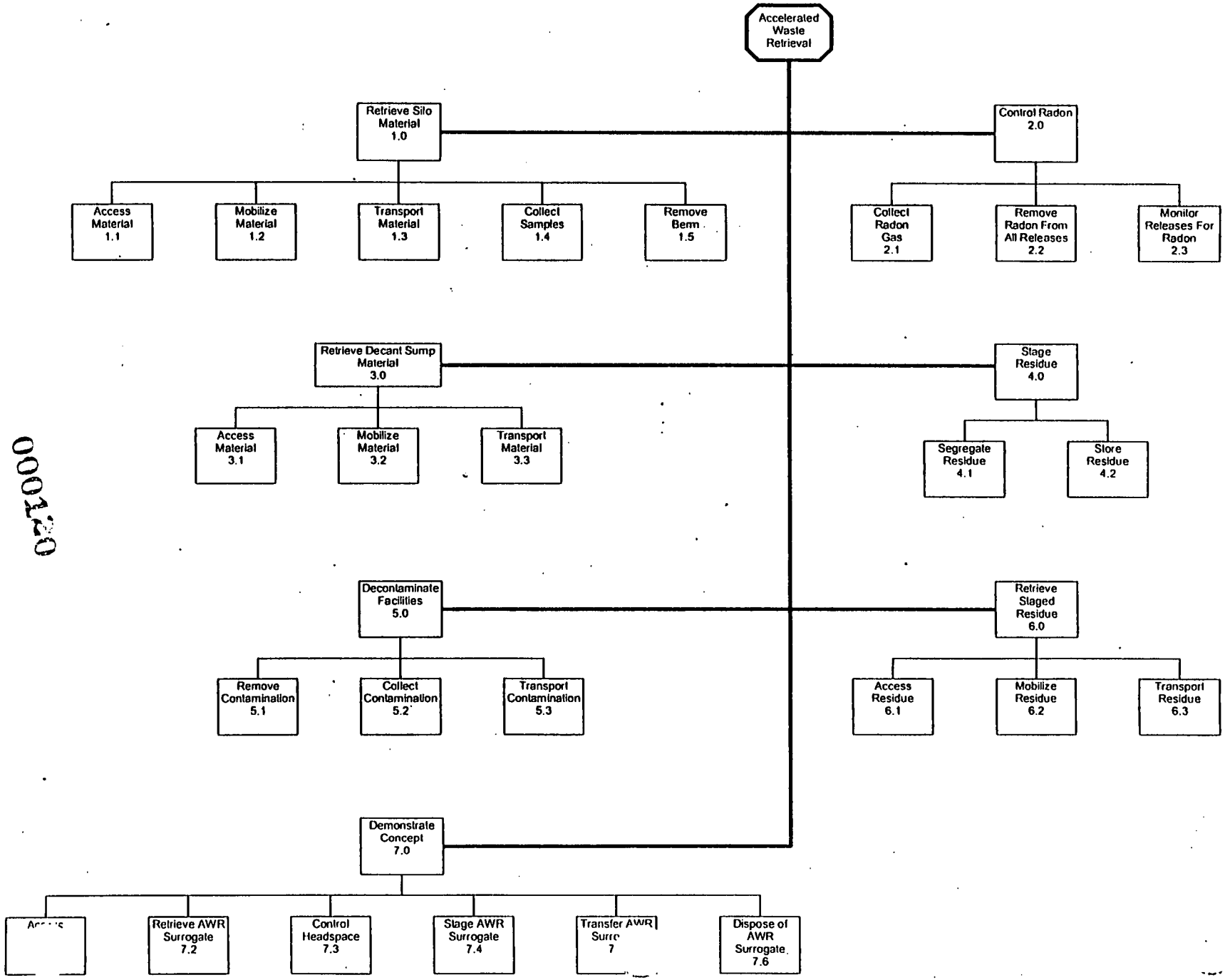
The AWR Functional Analysis Diagram is presented in Figure 2-1 and provides the Contractor with an overview of the functions required to accomplish the AWR project. The level of detail provided in Figure 2-1 is limited to avoid reference to a specific method and/or technology. This level of detail is considered adequate in defining the functional basis that characterizes the AWR project. Functions labeled in the diagram are discussed in Section 2.2 of this document.

A functional analysis is a structured methodology employed early in the engineering design process to determine the requirements that define the scope of the project. The functional analysis identifies the requirements for performing a process or mechanical function without dictating the physical design or specific technology and/or process of that function. It defines boundaries to functions, identifies the various systems or steps that shall be required to perform the identified functions, establishes logical functional relationships, and presents the information as a hierarchy of modular functions.

For the purposes of this section, a function is defined as an action required to complete a defined activity. The first function, Accelerated Waste Retrieval, is the programmatic function. This function represents the highest level management objective of the AWR project and is defined by a sequence of seven lower level functions that define how to accomplish the programmatic function. Each of the lower level functions is defined by sub-functions that further define functional scope. It is significant to note that this model does not provide a chronological sequence for the defined functions. This feature of representation is deliberate since the functional analysis model serves only to present a functional hierarchy and define the functional scope and relations.

The functional analysis model utilizes a top-to-bottom logical approach to define the functional activities that shall be performed in order to satisfy the programmatic function. (This model does not include the non-technical/ administrative elements required of this contract). Following the model in a downward direction addresses the "how to do it" component of the function, while moving in an upward direction addresses the "why do it" component. The functional analysis model does not dictate the physical design of a concept or suggest a specific process, rather it identifies and develops the functions to be performed, defines the boundaries of each function, and establishes a logical representation of the functional hierarchy required to accomplish the AWR project.

FIGURE 2.1
ACCELERATED WASTE RETRIEVAL FUNCTIONAL ANALYSIS DIAGRAM



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2.2 Functional Descriptions

Functional descriptions provide the Contractor general information of the functions illustrated in Figure 2.1. The functional description includes an overview of a function, identifies significant activities that define a function's scope, and designates the function to a system. The information presented in the functional description is essential to the Contractor in the development of a design concept. Table 2-1 identifies the appropriate sections of the TRD that address the functional descriptions for the functions defined in this section and cross references the system where the function resides.

Table 2-1 Functional Descriptions

Function	Function Title	Function Section	System Title	System Section
Programmatic	Accelerated Retrieval	2.2	N/A	2.3
1.0	Retrieve Silo Materials	2.2.1	SWRS	2.3.1.1
1.1	Access Materials	2.2.1.1	SWRS	2.3.1.1
1.2	Mobilize Materials	2.2.1.2	SWRS	2.3.1.1
1.3	Transport Materials	2.2.1.3	SWRS	2.3.1.1
1.4	Collect Samples	2.2.1.4	SWRS	2.3.1.1
1.5	Remove Berm	2.2.1.5	SWRS	2.3.1.1
2.0	Control Radon	2.2.2	RCS	2.3.1.2
2.1	Collect Radon	2.2.2.1	RCS	2.3.1.2

Table 2-1 Functional Descriptions (Continued)

Function	Function Title	Function Section	System Title	System Section
2.2	Remove Radon from Releases	2.2.2.2	RCS	2.3.1.2
2.3	Monitor Releases for Radon	2.2.2.3	RCS	2.3.1.2
3.0	Retrieve Decant Sump Materials	2.2.3	DWRS	2.3.1.3
3.1	Access Materials	2.2.3.1	DWRS	2.3.1.3
3.2	Mobilize Materials	2.2.3.2	DWRS	2.3.1.3
3.3	Transport Materials	2.2.3.3	DWRS	2.3.1.3
4.0	Stage Residue	2.2.4	TTA System	2.3.1.4
4.1	Segregate Residue	2.2.4.1	TTA System	2.3.1.4
4.2	Store Residue	2.2.4.3	TTA System	2.3.1.4
5.0	Decontaminate Facilities	2.2.5	FDS	2.3.1.6
5.1	Remove Contamination	2.2.5.1	FDS	2.3.1.6
5.2	Collect Contamination	2.2.5.2	FDS	2.3.1.6
5.3	Transport Contamination	2.2.5.3	FDS	2.3.1.6
6.0	Retrieve Staged Residue	2.2.6	TWRS	2.3.1.5

Table 2-1 Functional Descriptions (Continued)

Function	Function Title	Function Section	System Title	System Section
6.1	Access Residue	2.2.6.1	TWRS	2.3.1.5
6.2	Mobilize Residue	2.2.6.2	TWRS	2.3.1.5
6.3	Transport Residue	2.2.6.3	TWRS	2.3.1.5
7.0	Demonstrate Concept	2.2.7	FSMS	2.3.1.7
7.1	Access Silo	2.2.7.1	FSMS	2.3.1.7
7.2	Retrieve AWR Surrogate	2.2.7.2	FSMS	2.3.1.7
7.3	Control Headspace	2.2.7.3	FSMS/RCS	2.3.1.7/ 2.3.1.2
7.4	Stage AWR Surrogate	2.2.7.4	FSMS/TWRS	2.3.1.7/ 2.3.1.4
7.5	Transfer AWR Surrogate	2.2.7.5	FSMS/TWRS	2.3.1.7/ 2.3.1.5
7.6	Dispose of AWR Surrogate	2.2.7.6	TWRS	2.3.1.7

2.2.1 Function 1.0; Retrieve Silo Material

The Retrieve Silo Material function shall provide technology, methods, and facilities required to remove the material from the silos. The retrieval of silo material is functionally defined by Access Material, Mobilize Material, Transport Material. Collect Samples, and Berm Removal.

The Retrieve Silo Material function is performed by the Silos Waste Retrieval System (SWRS) (Section 2.3.1.1).

2.2.1.1 Function 1.1; Access Material

The Access Material function shall provide the systems, structures, and components (SSCs) required to gain entry to the silos material The Access material function is defined by the physical interfaces with the silo structures(including support facilities), provision of a pathway for the deployment and recovery of retrieval equipment, maintaining and monitoring the interface and pathway, management of secondary waste removed during construction of facilities, monitoring confinement of the access system and remote viewing of activities.

2.2.1.2 Function 1.2; Mobilize Material

The Mobilize Material function shall provide the SSCs required to mobilize the silo material and remove it from the silos. Mobilize material is defined by the removal of materials from the silos, maintaining and monitoring retrieval equipment, segregation of materials (e.g., residue from discrete objects) remote viewing of silo materials and retrieval activities.

2.2.1.3 Function 1.3; Transport Material

The Transport Material function shall provide the SSCs required to transfer all materials from the silos to the TTA. Transport Material is defined by the transfer and/or packaging materials from the silos, maintenance and monitoring of the transfer system.

2.2.1.4 Function 1.4; Collect Samples

The Collect Samples function shall provide the SSCs required to collect and package representative samples of residue. Collect Samples is defined by collecting residue, decanting free liquids (if required), preventing radon releases, packaging residue for storage, inventory management of samples, and physical monitoring of packaged samples.

2.2.1.5 Function 1.5; Remove Berm

The Remove Berm function shall provide the SSCs required to excavate/remove the berm from around the silos, concurrent with material retrieval. Remove Berm is defined as excavating the berm material and transporting the material to the FDF designated location.

2.2.2 Function 2.0; Control Radon

The Control Radon function shall provide the technology, method, and facilities required to mitigate radon emissions by controlling radon gases in all SSCs and activities associated with the AWR project and the Full-Scale Remediation Facility (not part of this contract). Control Radon is functionally defined by Collect Radon, Remove Radon from controlled releases, and Monitor Releases for Radon.

The Control Radon function is performed by the Radon Control System (RCS) (Section 2.3.1.2).

2.2.2.1 Function 2.1; Collect Radon

The Collect Radon function shall provide the SSCs required to collect radon gas generated during the operational activities associated with the AWR project. Collect Radon is defined by the collection of off-gases containing radon from the residue radon process, and maintenance of the collection system.

2.2.2.2 Function 2.2; Remove Radon from Releases

The Remove Radon from Releases function shall provide the SSCs required to reduce radon gas to acceptable levels prior to any controlled releases to the environment. Remove Radon from Releases is defined by the selective extraction of radon and maintenance of the removal system.

2.2.2.3 Function 2.3; Monitor Releases for Radon

The Monitor Releases for Radon function shall provide the SSCs required to monitor process emissions for radon bearing gases. Monitor Releases for Radon is defined by the monitoring system and maintenance of the monitoring system.

2.2.3 Function 3.0; Retrieve Decant Sump Materials

The Retrieve Decant Sump Material function shall provide the technology, method, and facilities required to periodically remove material from the decant sump tank during the AWR project. The Retrieve Decant Sump Material is defined by the Access, Mobilize, and Transport of decant sump material.

The Retrieve Decant Sump Material function is performed by the Decant Sump Material Retrieval System (DWRS) (Section 2.3.1.3).

2.2.3.1 Function 3.1; Access Decant Sump Material

The Access Decant Sump Material function shall provide the SSCs required to gain entry to the material in the decant sump tank. Access Decant Sump Material is defined by the physical interface with the decant sump tank, the pathway provided for the deployment and recovery of retrieval equipment, maintenance and monitoring of the interface and pathway, and management of secondary waste (removed during construction of facilities).

2.2.3.2 Function 3.2; Mobilize Decant Sump Material

The Mobilize Decant Sump Material function shall provide the SSCs required to mobilize and remove the material from the decant sump tank. Mobilize Decant Sump Material is defined by the removal of material and maintenance of retrieval equipment.

2.2.3.3 Function 3.3; Transport Decant Sump Material

The Transfer Decant Sump Material Function shall provide the SSCs required to transfer materials removed from the decant sump tank. Transport Decant Sump Material is defined by the material handling and transfer systems, segregation of materials (e.g., discrete objects from water), and maintenance and monitoring of the system.

2.2.4 Function 4.0; Stage Residue

The Stage Residue function shall provide the technology, methods, and facilities required to receive and stage the residue from the Retrieve Silos Material function (function 1.3) and the Retrieve Decant Sump Material function (functions 3.3), as required. Stage Residue is functionally defined by Segregate Residue and Store Residue.

The Stage Residue function is performed by the TTA System (Section 2.3.1.4).

2.2.4.1 Function 4.1; Segregate Material

The Segregate Material function shall provide the SSCs required to maintain segregation of the residue transferred to function 4.0. Segregate Residue is defined by the segregation of silos residue (e.g., maintaining separate inventories for each silo's residue) and maintenance of the segregation system.

2.2.4.2 Function 4. 2; Store Residue

The Store Residue function shall provide the SSCs required to store residue transferred to the Stage Residue function (function 4.0) over the duration of the AWR project in preparation for the Full-Scale Remediation Facility. Store Residue is defined by temporary storage for silos residue and maintenance of the storage system.

2.2.5 Function 5.0; Decontaminate Facilities

The Decontaminate Facilities function shall provide the technology, methods, and facilities required to decontaminate the silos, decant sump tank and process equipment after all materials have been removed. The Decontaminate Facilities function is defined by the Remove Contamination, Collect Contamination, and Transport Contamination.

The Decontaminate Facilities function is performed by the Facility Decontamination System (FDS) (Section 2.3.1.6).

2.2.5.1 Function 5.1; Remove Contamination

The Remove Contamination function shall provide the SSCs required to remove contamination from the silos decant sump tank and process equipment. Remove Contamination is defined by structure access, deployment and retrieval of decontamination (decon) equipment, contamination removal methods/systems, radiation detection systems, and maintenance of the decon system.

2.2.5.2 Function 5.2; Collect Contamination

The Collect Contamination function shall provide the SSCs required to collect and package all displaced contaminated materials (function 5.1). Collect Contamination is defined by a contamination collection system, packaging system, radiation monitoring system, and maintenance of the collection and packaging system.

2.2.5.3 Function 5.3; Transport Contamination

The Transport Contamination function shall provide the SSCs required to transfer collected/ packaged contaminated material (function 5.2). Transport Contamination is defined by the transfer/material handling equipment, radiation monitoring systems, and maintenance of the packaging and the transfer system.

2.2.6 Function 6.0; Retrieve Staged Residue

The Retrieve Staged Residue function shall provide the technology, method, and facilities required to remove the residue from the Store Residue function (function 4.2). Retrieve Staged Residue is functionally defined by accessing the residue storage facilities, mobilizing the residue, and forward transferring of the residue to the silos Full-Scale Remediation Facility (forward transfer not in scope of this contract).

The Retrieve Staged Residue function is performed by the TTA Waste Retrieval System (TWRS) (Section 2.3.1.5).

2.2.6.1 Function 6.1; Access Residue

The Access Residue function shall provide the SSCs required to gain entry to the residue stored in the Store Residue function (function 4.2). Access Residue is defined by the physical interface with the Store Residue function, provision of a pathway for the deployment and recovery of retrieval equipment, maintenance and monitoring of the interface and pathway.

2.2.6.2 Function 6.2; Mobilize Residue

The Mobilize Residue function shall provide the SSCs required to mobilize and remove the residue from the Store Residue function (function 4.2). Mobilize Residue is defined by the methods and systems to remove residue and heel material from the Store Residue function, the mobilization equipment, and maintenance of the mobilization system.

2.2.6.3 Function 6.3; Transport Residue

The Transport Residue function shall provide the SSCs required to transfer residue stored in the Store Residue function (function 4.2) to the Full-Scale Remediation Facility. Transport Residue is defined by the transfer of residue from the Store Residue function and maintenance of the transfer system.

2.2.7 Function 7.0; Demonstrate Concept, Silo 4

The Demonstrate Concept function shall provide the methods, technology, and facilities required to demonstrate successful operation of the Contractor's AWR facilities. This function requires the Contractor to provide a full-sized mock-up facility on the Silo 4 structure, utilizing and/or modifying existing facilities for operator training and proof of principle testing of the following AWR systems: SWRS, RCS, TTA Systems, TWRS, and the AWR control system. The Demonstrate Concept function is defined by accessing the Silo 4 structure, retrieving AWR surrogate material, controlling Silo 4 headspace gas, staging AWR surrogate in the TTA System, and forward transfer of the AWR surrogate using the TWRS.

The Demonstrate Concept function is performed by the Full-Scale Mock-Up System (FSMS) (Section 2.3.1.7) in conjunction with other defined systems is required (see following sections).

2.2.7.1 Function 7.1; Access Silo

The Access Silo function shall provide the SSCs required to demonstrate the Access Material function (function 1.1) on the Silo 4 structure. Access Silo is defined by the support structure/facilities required to interface with the Silo 4 structure, entry into the Silo 4 interior, pathway provision for the deployment and recovery of retrieval equipment, maintenance and monitoring of the interface and pathway.

2.2.7.2 Function 7.2; Retrieve AWR Surrogate

The Retrieve AWR Surrogate function shall provide the SSCs required to demonstrate the Mobilize and Transfer Material functions (functions 1.2 and 1.3) on the AWR surrogate in Silo 4 (AWR surrogate shall include discrete objects and heel material). Retrieve AWR Surrogate is defined by deployment of retrieval equipment, mobilization of the AWR surrogate forward transport of the AWR surrogate to the Stage AWR Surrogate function (function 7.4), handling and packaging of discrete objects, and heel removal.

2.2.7.3 Function 7.3; Control Headspace Gas

The Control Headspace Gas function shall provide the SSCs required to demonstrate proof of principle (e.g., engineering, safety basis) of the Control Radon function (function 2.0). Control Headspace Gas is defined by collecting Silo 4 headspace gas, removing Silo 4 headspace gas for controlled releases, and monitoring Silo 4 headspace gas.

The Control Radon function is performed by the FSMS (Section 2.3.1.7) and the RCS (Section 2.3.1.2).

2.2.7.4 Function 7.4; Stage AWR Surrogate

The Stage AWR Surrogate function shall provide the SSCs required to demonstrate the Stage Residue function (function 4.0) using the AWR surrogate transferred forward from the Retrieve AWR surrogate function (function 7.2). The Stage AWR Surrogate function is defined by temporary storage of AWR Surrogate, and maintenance of the storage system.

The Stage AWR Surrogate function is performed by the FSMS (Section 2.3.1.7) and the TTA System (Section 2.3.1.4).

2.2.7.5 Function 7.5; Transfer AWR Surrogate

The Transfer AWR Surrogate function shall provide the SSCs required to demonstrate the Retrieve Staged Residue function (function 6.0). The Transfer AWR Surrogate function is defined by accessing the AWR surrogate stored from function 7.4, mobilizing the AWR surrogate, transferring the AWR surrogate back to Silo 4 for reuse, or transferring it to the Dispose of AWR Surrogate function (function 7.6).

The Transfer AWR Surrogate function is performed by the FSMS (Section 2.3.1.7) and the TWRS.

2.2.7.6 Function 7.6; Dispose of AWR Surrogate

The Dispose of AWR Surrogate function shall provide the SSCs to properly dispose of the AWR surrogate offsite. The Dispose of AWR Surrogate function is defined as collecting the AWR surrogate at the end of the full-scale mock-up testing, or at the end of additional uses to be determined by the Contractor, appropriately packaging the AWR surrogate, transporting the surrogate offsite, and disposing of the AWR surrogate in a commercial landfill or other approved repository.

2.3 System Requirements

System requirements provide the Contractor general information that contribute to the development of System Design Descriptions required for the engineering design process. Section 2.5 of this document presents relevant criteria applicable to the engineering design process for the systems presented in this section. The following sections present requirements for the AWR systems.

All design of Contractor's systems must comply with applicable or relevant and appropriate requirements (ARARs) identified for the project for protection of human health and the environment. These requirements are identified in the Environmental Protection (EP) and Environmental Restoration and Waste Management (EW) Functional areas, and in more detail, in the ARAR table presented in Appendix B.

2.3.1 AWR Systems

Figure 2.2 provides a diagram of the key AWR project systems. This diagram establishes a systems convention that shall be used by the Contractor in the development of the AWR design (i.e., the Contractor shall, as a minimum, develop these systems). The use of this model serves to establish a systems convention during design development and is not intended to preclude the use of "other" systems as required by the Contractor. Figure 2-2 identifies the AWR systems and interfaces.

AWR systems, as defined within this section, include the following:

- Silos Waste Retrieval System (SWRS);
- Radon Control System (RCS);
- Decant Sump Waste Retrieval System (DWRS);
- Transfer Tank Area System (TTA);
- Transfer Tank Area Waste Retrieval System (TWRS);

- Facility Decontamination System (FDS), and
- Full-Scale Mock-Up System (FSMS).

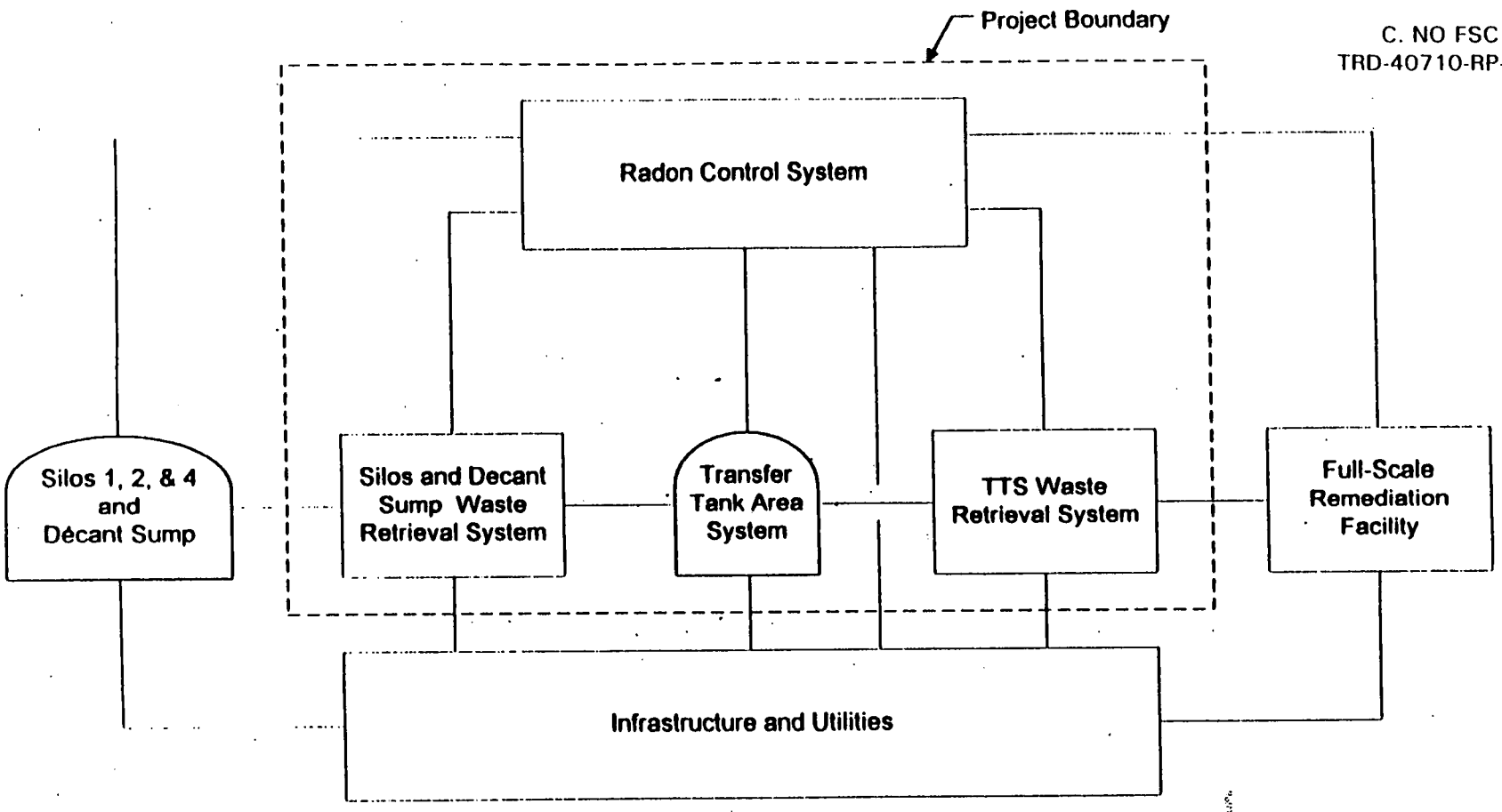

FIGURE 2-2
ACCELERATED WASTE RETRIEVAL SYSTEM INTERFACE DIAGRAM

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The following sections present requirements for the development of the AWR systems.

2.3.1.1 Silos Waste Retrieval System

The scope of the SWRS is functionally defined in Section 2.2.1 of this document. The SWRS shall access, mobilize, and remove the material from the interior of the silos and shall provide the capability of collecting samples.

The SWRS shall be capable of accessing the silos (each measures 80 feet in diameter, by 27 feet high at the side wall, and approximately 36 feet high at the geometric center) and removing approximately 8,900 cubic yards of material from both silos over the duration of the AWR project. The discrete objects contained within a silo shall be managed separately. The exact location and nature of the discrete objects within a silo will not be known until such time that they are encountered during the retrieval action. The SWRS shall be capable of removing these objects from the silos in such a way that the impact to retrieval operations is minimized, radon confinement is not compromised, and contamination is not spread.

Table 2-2 provides system requirements for the SWRS.

Table 2-2 Silos Waste Retrieval System Requirements

Requirement Number	Requirement
SWRS-001	Ensure capability of the SWRS to mobilize all material in the silos, transport it outside of the silos, and deliver it to the TTA.
SWRS-002	Ensure that material retrieval system does not impact silo integrity.
SWRS-003	Berm removal shall have minimal impact to silos integrity and shall be performed consistent with the Contractors methods noted in the Berm Excavation Plan (Section 3.1.11). Berm removal shall be performed in accordance with Waste Management requirements, Section 5.
SWRS-004	Remove and transfer all material of Silos 1 and 2 within a one year retrieval period.
SWRS-006	Ensure that construction materials do not compromise the residue, ambient conditions, and operating conditions.
SWRS-007	Minimize water accumulation in the silos.
SWRS-008	Provide Closed Circuit Television (CCTV) viewing inside the silos during retrieval operations.
SWRS-009	Prevent the uncontrolled release of headspace radon from the silos utilizing an interface with the RCS.
SWRS-014	Provide safe shutdown, secure standby, and restart capability of the SWRS.
SWRS-015	Provide sufficient shielding to limit radiation on the top of the silo dome of 1 mrem/hr or less.

Table 2-2 Silos Waste Retrieval System Requirements (Continued)

Requirement Number	Requirement
SWRS-016	Provide local control of all functions of the SWRS.
SWRS-017	Provide remote monitoring and control from the accelerated retrieval control room for SWRS process control functions.
SWRS-018	Limit total additional loading on each dome to no more than 700 pounds.
SWRS-019	Ensure that design of SWRS provides for ease of decontamination and demolition at the end of Stage 2 operation.
SWRS-020	Ensure that design life of the SWRS is 10 years.
SWRS-022	Provide local evacuation alarms activated from the site Communications Center interface.
SWRS-024	Utilize remote retrieval operations to the extent practical to limit personnel activities in accordance with ALARA principles.
SWRS-025	Provide capability to remove, decontaminate, package, inventory, and stage discrete objects during residue retrieval operations in accordance with Section 5.
SWRS-029	Ensure that the equipment placed inside the silos is retrievable from the silos for maintenance purposes
SWRS-032	Ensure that all piping systems minimize high/low points and slope accordingly.
SWRS-033	Collect 1 unit (e.g., lb., cubic feet) of residue, on a dry weight basis, for every 1000 units of residue transferred to the TTA (samples. Samples shall be collected at a uniform rate over the duration of retrieval operations.
SWRS-034	Decant any free liquids that may be present prior to packaging samples.
SWRS-035	Package samples in corrosion resistant, lined 30 gallon drums. 30 gallon drums shall be overpacked in 55 gallon drums.

2.3.1.2 Radon Control System

The scope of the RCS is functionally defined in Section 2.2.2. The RCS shall receive off-gases from the following sources; Silos 1 and 2 (including during decontamination of the silos), SWRS, decant sump tank, DWRS, residue transfer systems, the TTA System, and the Full-Scale Remediation Facility (not in scope of AWR project). The RCS shall be able to remove radon from gas streams, minimize radon releases to the atmosphere, monitor all releases to the atmosphere for radon (detection and measurement), and mitigate system upsets. The RCS shall be designed for two phases of operation:

- Phase 1: Reduction and control of radon concentration in solos headspace prior to construction activities in support of the silo waste retrieval system (corresponds with Stage 1, Section 1.0);

- Phase 2: Reduction and control of radon bearing gases during silo material retrieval activities (corresponds with Stage 2, Section 1.0).

For Phase 1 the Contractor shall design, construct, and operate a RCS according to the design information presented in Appendix F of this document. Appendix F provides the Contractor with PFDs, MFDs, a list of Government Furnished Equipment (GFE), facility sittings, and site interfaces.

For Phase 2 operation, the Contractor may modify and/or replace Phase 1 RCS facilities to meet the requirements identified in Table 2-3 below. The system requirements identified in Table 2-3 shall apply to both phases for the RCS (i.e., they shall apply to Phase 1 RCS design, construction, and operation).

Table 2-3 provides system requirements for the RCS.

Table 2-3 Radon Control System Requirements

Requirement Number	Requirement
RCS-001	Prevent the uncontrolled release of radon to the atmosphere.
RCS-002	Prevent over/under pressurization of the silos or Transfer Tanks.
RCS-003	Provide redundancy for key operating equipment such as pumps, blowers, etc. so that maintenance can be performed without requiring system shutdown.
RCS-004	Avoid direct sunlight on the carbon beds and insulate to minimize temperature fluctuations.
RCS-005	Control radon emissions in order to maintain radon concentrations below 0.03 Working Levels (WL) on a weekly average and below 0.3 WL instantaneous in the work area surrounding the Silos and Transfer Tanks during all Phases per 10 CFR 835.
RCS-006	Control radon emissions in order to maintain the contribution of radon emissions from the RCS to annual average fence line concentrations at less than 0.5 pCi/L above background at the Fernald fence line whenever there is a stack discharge from the system.
RCS-007	Maintain radiation fields on the surface of the Silo domes below 50 mrem/hr during non-construction periods of Phase 1.
RCS-008	Maintain radiation fields on the surface of the Silo domes below 10 mrem/hr during superstructure construction periods of Phase 1, and during all of Phase 2 (believed to be a radon concentration of $<1 \times 10^6$ pCi/L in the silo headspace).
RCS-009	Provide sufficient shielding and exclusion area fence to maintain the area outside of the RCS facility as a Radiation Access Zone 1 (<0.4 mrem/hr) during all phases.

Table 2-3 Radon Control System Requirements (Continued)

Requirement Number	Requirement
RCS-010	Locate all normal maintenance items with redundant backups (e.g., pumps) in areas with radiation fields less than 5 mrem/hr.
RCS-011	Locate all non-normal maintenance items without redundant backups (e.g., valves) in areas with radiation fields less than 5 mrem/hr after a 4 hour radon daughter decay period.
RCS-013	Provide a local evacuation alarm activated from the Communications Center
RCS-014	Provide HEPA filtration with pressure differential instrumentation on all stack exhaust streams to atmosphere.
RCS-015	Provide isokinetic sampling, monitoring, recording on all stack exhaust streams to atmosphere per 40 CFR Part 61 Subpart H.
RCS-016	Provide local control of all functions of the RCS.
RCS-017	Provide remote monitoring and control from the accelerated retrieval control room to verify RCS process control.
RCS-019	Design the RCS facility for ease of decontamination and demolition at the end of Stage 4 (Section 1 of TRD).
RCS-021	The RCS shall contain a connection for future tie-in from the Full-Scale Remediation Facility.
RCS-022	Design life of RCS shall be 20 years.
RCS-023	The availability of the RCS shall be 95 percent, minimum.
RCS-024	Provide continuous stack Rn monitoring. Report the data to FDF.
RCS-025	For the isokinetic monitoring for radioactive particulate, include radiation detectors with remote alarm capability to indicate buildup of radioactive particulate on the filter paper. Provide operational data from isokinetic monitoring to FDF.
RCS-026	The Contractor's design (RCS) shall permit RCS to be placed in a recirculation operational mode (forced) during Stage 3 operations (Section 1 of TRD).

2.3.1.3 Decant Sump Waste Retrieval System

The scope of the DWRS is functionally defined in Section 2.2.3 of this document. The DWRS shall access, mobilize, and remove the material in of the decant sump tank. This system shall provide the capability of segregating decant sump materials transferring decant sump materials for dispositioning and packaging discrete objects for disposal.

Table 2-4 provides system requirements for the DWRS.

Table 2-4 Decant Sump Waste Retrieval System Requirements

Requirement Number	Requirement
DWRS-001	Retrieve all material from the decant sump tank.
DWRS-002	Segregate discrete objects and package in accordance with Section 5.
DWRS-004	Ensure that construction materials do not compromise the waste characteristics, ambient conditions, and operating conditions.
DWRS-006	Provide a means to decontaminate any equipment that contacts the Decant Tank residues prior to removal of equipment from site.
DWRS-007	Provide capability for sampling characterizing the material as it is being removed from decant sump tank.
DWRS-008	Provide safe shutdown, secure standby, and restart capability of the DWRS.
DWRS-009	Provide local control of all functions of the DWRS.
DWRS-010	Provide remote monitoring and control from the accelerated retrieval control room for selected DWRS process functions.
DWRS-011	Ensure that design provides for ease of decontamination and demolition at the end of Stage 2 operations.
DWRS-012	Design life of the DWRS shall be 20 years.

2.3.1.4 Transfer Tank Area System

The scope of the TTA System is functionally defined in Section 2.2.4 of this document. The TTA System shall provide controlled, temporary storage for the residue and FSMS surrogate retrieved from the silos and decant sump tank until the Full-Scale Remediation Facility is available. During the remediation operations, the TTA System shall provide residue storage and interface with the remediation system to provide forward transfer of residue until operations are completed.

Table 2-5 provides a listing of the system requirements for the TTA System.

Table 2-5 Transfer Tank Area System Requirements

Requirement Number	Requirement
TTA-001	Receive the complete inventory of the silos residue.
TTA-002	Provide controlled storage of the residues in the storage tanks for the design life of the TTA System.
TTA-003	Truck access shall be provided to the transfer tanks (e.g., maintenance, SWRS sample transfer).
TTA-004	Ensure that construction materials are compatible with the residue characteristics, ambient conditions, and operating conditions.
TTA-005	Prevent the uncontrolled release of Transfer Tank headspace gas (radon).
TTA-006	Provide sufficient shielding and/or distance (considering space availability) to maintain the area outside of the TTA System fence line as a Radiation Access Zone 1 (<0.4 mrem/hr).
TTA-007	Locate all normal maintenance items in areas with radiation fields less than 5 mrem/hr.
TTA-008	Design life of the TTA System is 20 years.

Table 2-5 Transfer Tank Area System Requirements (Continued)

Requirement Number	Requirement
TTA-009	Ensure that the design of the TTA System provides for ease of decontamination and demolition.
TTA-010	Provide remote monitoring and control from the accelerated retrieval control room for selected TTA System process functions.
TTA-011	Provide local control of all functions of the TTA System.
TTA-013	Provide local evacuation alarms activated from the site Communications Center.
TTA-015	Provide secondary containment with leak detection is for 100% of the stored material in the largest single tank, including collected storm water from a 24 hour, 25 year design storm.
TTA-017	Provide Transfer Tanks and components with closed ventilation connected to the RCS.
TTA-018	Provide storm water segregation, collection, transfer, and control to prevent cross contamination. Provide monitoring and characterization to release to the site storm water system or the Advanced Waste Water Treatment (AWWT) facility, as appropriate.
TTA-020	Provide capability to maintain physical separation of Silo 1 and Silo 2 residue.
TTA-021	Design shall facilitate transfer of settled residue out of tanks.
TTA-022	Design of system shall prevent spillage, leakage, or other releases of the residue being transferred.
TTA-	Provide accessible shielded storage for residue samples taken by the SWRS.

2.3.1.5 Transfer Tank Area Retrieval System

The scope of the TWRS is functionally defined in Section 2.2.6 of this document. The TWRS shall access, mobilize, and transport residue staged in the TTA System.

Table 2-6 provides system requirements for the TWRS.

Table 2-6 TTA Waste Retrieval System Requirements

Requirement Number	Requirement
TWRS-002	Provide a means for decontamination of the TWRS equipment prior to removal from the site.
TWRS-003	Provide safe shutdown, secure standby, and restart capability of the TWRS.
TWRS-004	Provide local control of all functions of the TWRS.
TWRS-005	Provide remote monitoring (e.g. CCTV) and control from the accelerated retrieval control room for selected TWRS process functions.
TWRS-006	Design shall provide for ease of decontamination and demolition at the completion of the TWRS operation.
TWRS-008	Provide local evacuation alarms activated from the site Communications Center.
TWRS-09	Provide the capability to transfer residues from one TTA tank to another.
TWRS-010	Provide inspection access to TWRS equipment.
TWRS-01	Solids rate to the Full Scale Stabilization Facility shall be TBD lb/hr., on a dry weight basis.
TWRS-011	Ensure that the TWRS has an availability of 85 percent, minimum.

2.3.1.6 Facilities Decontamination System (FDS)

The scope of the FDS is functionally defined in Section 2.2.5 of this document. The FDS shall access the silos, the Decant Sump Tank, and contaminated process equipment to perform gross decontamination of the internal structures. The FDS shall remove, package, and transfer the decontamination products from these facilities in order to facilitate system closure (Part 6 of the AWR RFP, Section 3.16, here on in referenced as Part 6-AWR RFP, Section 3.16).

Table 2-7 provides system requirements for the FDS.

Table 2-7 FDS Requirements

Requirement Number	Requirement
FDS-001	Remove all lose contamination products from the silos, the decant sump tank and process equipment.
FDS-002	Retrieve and package, contaminated process equipment and decontamination products in accordance with Sections 5 and 8.
FDS-006	Provide local control of all functions of the FDS.
FDS-007	Provide remote monitoring (e.g. CCTV) and control from the accelerated retrieval control room for selected FDS process functions.
FDS-008	Ensure that design of the FDS provides for ease of decontamination and demolition at the completion of the FDS operation.
FDS-010	Provide local evacuation alarms activated from the site Communications Center.
FDS-012	Provide interim staging facilities for packaged secondary waste prior to ultimate dispositioning by FDF.

2.3.1.7 Full-Scale Mock-Up System (FSMS)

The scope of the FSMS, is functionally defined in Section 2.2.7 of this document. The Contractor shall utilize and/or modify existing facilities (to include Silo 4 and Silo 4 superstructure) for operator training and proof of principle testing of the following AWR systems: SWRS, RCS, TTA, TWRS.

Table 2-8 provides system requirements for the FSMS.

Table 2-8 Full-Scale Mock-Up System Requirements

Requirement Number	Requirement
FSMS-001	Retrieve AWR surrogate from Silo 4 at the design transfer rate of the SWRS. The quantity of AWR surrogate shall be equal to 8 hours flow of the normal SWRS retrieval rate.
FSMS-002	Ensure that retrieval method does not impact silo integrity.
FSMS-003	Provide SSCs to breach the silo, deploy and demonstrate all retrieval equipment planned for Silos 1 and 2.
FSMS-008	Provide CCTV viewing of the retrieval operations.
FSMS-009	Prevent the uncontrolled release of headspace gas in the silo utilizing a simulated interface with the RCS design.
FSMS-010	Provide a means to simulate the decontamination of equipment that comes into contact with the silo residues prior to removal of equipment from the silo.
FSMS-011	Maintain a minimum velocity of 150 ft/min air velocity across all openings between less contaminated and more contaminated areas when doors, louvers, etc. are in their normal position.
FSMS-014	Provide safe shutdown, secure standby, and restart capability of the FSMS.
FSMS-016	Provide local control of all functions of the FSMS.
FSMS-018	Limit total loading on the dome to no more than 700 pounds.
FSMS-020	Ensure that design life of the FSMS shall be 10 years. The FSMS shall remain operable for training purposes for the duration of the retrieval effort.
FSMS-021	Process control shall be demonstrated from a central control area during the FSMS demonstration as defined in Section 2.3.3.1.

2.3.2 AWR Support Systems

AWR Support Systems, as defined within this section, include the following:

- Storm Water System;
- Waste Water System; and
- Utility System.

2.3.2.1 Storm Water System

The Contractor shall provide facilities to prevent the introduction of any substances or materials into any stream, lake, aquifer, or other body of water which may pollute or degrade the water or constitute substances or materials deleterious to fish and wildlife.

The potential for generation of contaminated storm water, including any run-on and run-off, shall be minimized by process design and operation. Contaminated run-off could come from areas that are in direct contact with residue or have a high potential of coming in contact with residue, such as storage pads and stockpile areas. The quantity of contaminated storm water from the AWR Project area shall be minimized by segregating clean area run-off from potentially contaminated run-off. Clean run-off could include building roof drainage and run-off from areas of fixed contamination. "Clean" storm water shall be discharged either into the storm water collection basin, or routed to the ditch adjacent to the process area for discharge directly to Paddy's Run.

All staging and handling, including transfer, of silos residue shall preclude the release of material. At no time shall the Contractor be allowed to place residues in an open pile, container, or tank. Areas used for management of materials that could contribute to contaminated storm water shall be protected from precipitation and storm water run-on and run-off, to the extent practicable, in the design. Contaminated storm water shall not be discharged with "clean" storm water. Contaminated storm water shall be contained and sampled prior to discharge into the existing waste water management system. At a minimum, contaminated storm water shall meet the requirements identified in this document for waste water prior to discharge to the AWWT.

New storm water management systems shall be designed for the 25-year, 24-hour storm per FEMP site policy except as noted below. The Contractor shall use the five-year storm to evaluate the scour velocity regarding open channels. Storm water management basins shall be designed to safely pass the 100-year 24-hour storm see Rainfall Frequency Atlas of the U.S. Technical Paper 40, U.S. Department of Commerce, for levels for this storm event for the FEMP.

Storm drain systems not directly connected to the storm water management system (if any), with catchments less than 160 acres, may be designed by the Rational Method. Those storm drain systems directly connected to an existing storm water management system shall be designed by Soil Conservation Service (SCS) methods (e.g., TR-55, TR-20).

Storm water control design details, construction methods, and materials shall be in accordance with Ohio Department of Transportation (ODOT) standards. Storm water management, as well as erosion and sediment control during construction, shall comply with the latest version of Rainwater and Land Development: Ohio's Standards for Storm water Management, Land Development and Urban Stream Protection, Second Edition, ODNR Division of Soil and Water Conservation, Columbus, Ohio, 1996 U.S. Department of Agriculture-Soil Conservation Service, Water Management and Sediment Control in Urbanizing Areas, U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C., 1987.

Environmental releases shall be avoided to the extent possible. Any spills or other unplanned releases to the environment shall be reported immediately by the Contractor to the FDF, and cleaned up immediately to minimize the release of contaminants to the environment.

Limited storm water control facilities shall be provided to the Contractor for the collection of storm water from the Contractor's process facility location (Part 7-AWR RFP, Section 1.1). The Contractor, using assigned FDF personnel, shall maintain this system until project completion. In particular, the Contractor shall maintain the drainage ditches and other storm water appurtenances in the project area in a manner that ensures continued operation of the storm water management system pursuant to its design standards. For example, any sediment build-up that affects run-off flow below design capacities shall be removed and managed by the Contractor.

Existing storm water control facilities are shown on drawing included in Part 7 -AWR RFP, Section 1.1.

Table 2-9 provides system requirements for the SWS. Regulatory requirements for the control of storm water are listed in the ARARs in Appendix B.

Table 2-9 Storm Water System Requirements

Requirement Number	Requirement
SWS-001	Provide controlled storm water drainage, collection, and segregation of contaminated storm water from uncontaminated.
SWS-002	Ensure that drainage basins, curbs, and catch or retention basins have efficient and adequate drainage.
SWS-003	Ensure that the existing drainage pattern is maintained by providing culverts (or other controls) as needed for the SWRS, RCS, and the TTA, which are located in a potentially contaminated area.
SWS-004	Contractor shall observe AASHTO and ODOT standards for paving, surfacing methods, materials, and design.
SWS-005	Ensure that a 10-year, 24-hour storm event for Hamilton County is used to design new culverts, analyzing existing culverts and identifying drainage differences, maintenance problems, and other impacts caused by changes in the current system.
SWS-006	Contractor shall base the peak discharge on a rainfall intensity of 4.1 in/hr.
SWS-007	Ensure that velocity in the ditches is 2 fps or less for the design storm.
SWS-008	Ensure that velocities greater than 3 fps shall require check dams or riprap lining to limit erosion.
SWS-009	Contractor shall minimize the use of stone in the ditches.
SWS-010	Ensure that the road side ditches do not overtop the roads for the design storm.

Table 2-9 Storm Water System Requirements (Continued)

Requirement Number	Requirement
SWS-011	Include measures to minimize and mitigate erosion and sediment transport in the runoff controls from the distributed areas.
SWS-012	Design storm drainage in accordance with the ODOT Location and Design Manual.
SWS-013	Ensure that drainage is by open ditch systems, and make use of existing drainage structures such as culverts and catch basins when possible (the existing drainage pattern in the vicinity of each facility shall be maintained by providing culverts as needed).
SWS-014	Contractor shall minimize ditch size by flooding the road shoulder if necessary.
SWS-015	Perform side slope and ditch design in accordance with ODOT and AASHTO standards. Ditch checks may be placed where required. Ditch design shall not impact nearby underground utilities.
SWS-016	Ensure that earthwork conforms to Ohio Department of Transportation (ODOT) and OSHA standards and complies with the FDF waste management standards, discussed in Section 5.
SWS-017	Ensure that design changes and temporary modifications prevent erosion and control sediment during and subsequent to construction.
SWS-018	Use seed or mulch to stabilize areas disturbed during construction that are not surfaced or covered with riprap. Ensure that revegetation, seeding, and soil supplements conform to ODOT standards.
SWS-019	Ensure that open course storm water drainage channels have low velocities that are non-erosive and limit sediment accumulation.
SWS-020	Ensure that construction areas and exposed soil, unworked and left exposed for thirty days or more are seeded per ODOT standards and FDF waste management requirements.
SWS-021	Contaminated stormwater shall be contained and characterized. Characterization data shall be provided to FDF and approval to discharge to the AWWT obtained prior to discharge. Volume of contaminated stormwater shall also be reported.

2.3.2.2 Waste Water System

Liquid effluents may be produced within the AWR facilities as a result of residue transfer or other activities. The generation of liquid wastes produced as a result of operations shall be minimized. Where technically and economically feasible, liquid wastes shall be recycled. Material handling systems shall be provided for handling these liquid effluent streams. All liquid residues discharged from the Contractor's facility shall be staged for characterization prior to transfer to the FEMP Advanced Waste Water Treatment (AWWT) facility. The Contractor shall obtain all required samples and analytical facilities for characterization. All waste water discharges at the FEMP, including those from the AWWT, are covered by an existing National Pollutant Discharge Elimination System (NPDES) Permit. All waste water discharged from the AWR project shall be discharged via a 4 inch tie in to an existing line that feeds the headworks of the AWWT (Section 2.5.4).

Since other site users discharge variable waste water streams to the AWWT, there are no fixed pretreatment criteria for waste water discharged to the AWWT. Any water used for residue retrieval shall be treated for BentoGrout™ removal prior to release. To determine whether the process waste water would need additional pretreatment, mass balance data for rate of waste water generation, and types and concentrations of constituents in the waste water expected to be discharged during the process (including radon) shall be submitted as part of the design package. An evaluation of the mass balance data will indicate whether additional pretreatment will be needed. Intentional dilution, as a substitute to treatment, shall not be allowed. Determining the acceptability of waste water to the AWWT shall not be based on any dilution that results from combination of storm water with the waste water stream. If the data submitted during engineering design indicate the waste water discharge would exceed the site treatment capabilities of the AWWT, pretreatment of the waste water stream shall be required. Pretreatment shall most likely be required if the concentrations of dissolved RCRA heavy metals (e.g., arsenic, barium, cadmium, chromium, lead, or selenium) are excessive, due to their aquatic toxicity; also, if concentrations of dissolved radon in the discharge present a health hazard to AWWT personnel.

Current criteria and guidance for waste water discharges to the AWWT are identified in Table 2-10. Additional information concerning waste water requirements are found under the regulatory requirements presented in Appendix B.

The Contractor's activities may be affected by any change in terms and conditions of the NPDES permit. Any required process modifications, or changes in the waste water or storm water control or monitoring requirements deemed necessary shall be the subject of a directed change under the Contract.

Table 2-10 presents requirements for waste water discharges necessary in the development of the Waste Water System (WWS).

Table 2-10 WWS Requirements

Requirement Number	Requirement
WWS-001	Ensure that no listed hazardous waste as defined under RCRA, is discharged into the waste water.
WWS-002	Ensure that dissolved concentrations of heavy metals in any waste water effluents from the AWWT do not cause the discharge limits specified by the FEMP NPDES permit to be exceeded (also see note below).
WWS-003	Ensure that project discharge of Total Suspended Solids (TSS) does not exceed 1,000 ppm, including BentoGrout™.
WWS-004	Monitor and report to FDF any project waste water discharges for the following constituents: Arsenic, Barium, Cadmium, Chromium , Lead, Selenium, Radium-226, Thorium-230, Total Dissolved Uranium, Chloride, Nitrates.
WWS-005	Ensure that discharges of waste water from the AWWT do not exceed the Derived Concentration Guides (DCGs) for radionuclides identified in DOE Order 5400.5 Section III (also see note below).
WWS-006	Meter all project waste water discharged with a flow measuring and recording device (or by known batch volume). Include measurement of total flow. Report data to FDF.
WWS-007	Stage all project waste water for characterization prior to batch discharge to the AWWT.
WWS-008	Waste water characterization, including analytical facilities, shall be the responsibility of the Contractor. Characterization data shall be submitted to FDF.

NOTE: For design and evaluation of pretreatment for waste water discharge from the treatment process, the Contractor may assume that project waste water will be commingled with 40,000 gallons of water per day prior to discharge to the receiving water body. This shall be taken into account in evaluation of pretreatment needs to meet the FEMP NPDES Permit, and DCGs of DOE Order 5400.5.

2.3.2.3 Utility Systems

The Contractor shall connect all utilities from specified tie-in points provided by FDF (Section 2.5.4). The Contractor shall connect to the tie-in points and be responsible to extend the utilities to the facility and all other end use points. Communication and electricity shall be run above ground, all other utilities shall be run underground. Utilities shall be protected and have steel or concrete supports. All utilities shall be designed and specified to applicable codes and engineering standards.

The Contractor shall be given access to site utilities within the OU4 site boundaries. The quantities and characteristics of these utilities shall be limited to those available at the time of construction. Utilities not provided by FDF shall be the responsibility of the Contractor. Systems required to back-up critical systems shall be supplied by the Contractor (i.e., uninterruptable power supply, stand-by generator). The Contractor may wish to consider alternative/stand-by fuels for protection of equipment during shutdowns and/or continued operations during curtailments. Any alternative/stand-by fuel loading, storage, transfer and distribution systems shall meet all applicable engineering design codes and standards, fire protection requirements (i.e., National Fire Protection Association [NFPA]), safety categorization, hazard analysis, regulatory, environmental, and emissions requirements.

Electrical System

FDF shall provide a tie-in location to the existing electrical system for the AWR project. The Contractor shall be responsible for making the connection to the existing system, providing transformer requirements for the new AWR facilities, and routing the power to the new facilities. FDF shall review and approve the proposed overhead power routing during the design review process.

FDF shall provide a termination enclosure with overcurrent protection at the substation. The Contractor shall provide necessary conductors and raceways, and shall maintain a load factor of not less than 90 percent. The Contractor shall install all systems to meet the requirements of the current National Electric Code, NFPA-70, and the National Electrical Safety Code, ANSI C2, grounding per IEEE Standard 142, and the distribution system in accordance with IEEE Standard 141.

Telecommunications

FDF will provide telephone lines to the Contractor's office trailer during construction. This service includes telephone and telephone service communications. Telephone service shall be monitored by FDF and may be suspended if misused by the Contractor. During operations, telephone lines will be provided by FDF for operations and maintenance usage. A separate telephone connection shall be provided for the existing FEMP Site Honeywell Delta 1000, Environmental and Fire and Safety Alarm System (see Fire Detection and Annunciation below).

Domestic Water System

Domestic Water is the sites potable water distribution system. The Contractor will be provided a tie-in point, identified on drawing 94X-5500-G-5000X, to tap into this system for "process" make-up water. Since Domestic Water is potable, the Contractor shall install a site approved backflow prevention device at the tie-in point to ensure integrity of the Domestic Water system. Prior to entering a potently contaminated area, the facility process water system shall be protected from possible contamination backflow by a site approved air-gap tank backflow preventer. Access to the backflow preventers shall be provided to the designated site water purveyor for inspection.

Fire Water System

The Contractor shall provide for a fire water system within the AWR facilities. The fire water system shall provide water to all building interior fire protection systems, fire water main, and fire hydrants. The system shall meet the requirements of the NFPA (NFPA 1990). The source of the fire water shall be tie-in to the existing FEMP Fire Water System in two locations FDF (Section 2.5.4). Halon shall not be used by the Contractor in any fire suppression system. Fire suppression systems, other than water, shall be reviewed and approved by FDF prior to usage.

Fire Detection and Annunciation

The Contractor shall provide and connect an emergency alarm system that complies with NFPA 72-1996 (National Fire Protection Alarm Code) and is compatible with the existing FEMP Site Honeywell Delta 1000, Environmental and Fire and Safety Alarm System. The Contractor shall provide manual fire alarm stations, smoke detection for control room(s), and monitoring of any automatic sprinkler flow alarms. Reference Section 2.5.4 for the tie-in location to the sitewide alarm system. This tie-in shall allow all emergency alarms to report to and terminate in the FEMP Emergency Communications Center.

The Contractor shall provide emergency voice and evacuation alarm devices compatible with the FEMP Honeywell Emergency Voice Alarm and Evacuation System. The master control for the system shall be at the FEMP Emergency Operations Center.

2.3.3 General Systems

General systems, as defined within this section, include the following:

- Control System;
- Mechanical System;
- HVAC System;
- Electrical System; and
- Civil/Structural System.

The following sections present applicable requirements necessary in the development of these systems.

2.3.3.1 Control Systems

A Distributed Microprocessor-based Control System (DMCS) shall provide the necessary monitoring, analog control, recording, and archiving on-off control. The Contractor shall see redundant networking and operator interfaces to ensure system availability. The DMCS may be provided in the form of a small Distributed Control System (DCS), a Distributed Programmable Logic Controller System (PL) with operator interfaces, or a DCS/PLC hybrid.

Due to the sequencing of process systems required to support the stages of operation (Section 1.0) ongoing modifications shall be anticipated as portions of the Control System will be activated while others are deactivated. A flexible software configuration and input/output hardware system shall be required in such a dynamically changing operation (as opposed to static control panels and hardwired control logic and alarms).

Table 2-11 provides system requirements for the Control System.

Table 2-11 Control System Requirements

Requirement Number	Requirement
CS-001	A centralized control area shall be provided. The term "remote" used herein refers to monitoring and control performed by an operator from this centralized location. The term "local" refers to field mounted or intermediate between field mounted and the centralized control location.
CS-002	Worker and operator exposures shall be ALARA by performing process monitoring and control remotely.
CS-003	At the centralized control area, the DMCS redundant human machine interface (HMI) shall provide control, monitoring, alarms, trending, archiving and printing of system operations.
CS-004	The DMCS configuration software shall perform process control functions, interlock and logic routines, and sequential operations. A separate DMCS configuration software programmer station shall be provided. Activation and deactivation of HMI screens, logic, and alarms shall be easily performed.
CS-005	DMCS real-time functions (e.g., data acquisition, data storage, display, and alarms) shall be designed for 99% availability. On-line diagnostics shall be provided.
CS-006	Data handling functions (e.g., data entry, reporting, and archiving) at the HMI operator interfaces shall be designed for 96% availability.
CS-007	Down-time for lightening strikes, system maintenance and off-line diagnostics shall be included in the system availability calculations.
CS-008	No single point failure shall cause loss of the entire system.
CS-009	Data stored at local microprocessors shall be recoverable upon system restart. The microprocessors shall have execution speeds, scan rates, and transmission rates selected for proper DMCS and process operation.

Table 2-11. Control System Requirements (Continued)

Requirement Number	Requirement
CS-010	All normal operation open-close valves and dampers shall be operated remote-manually from the DMCS HMI and shall provide position feedback indication.
CS-011	The control area operator shall monitor damper line-up. Dampers shall be interlocked due to the various normal and maintenance operations, as required.
CS-012	Processes passing through various equipment shall be selectively monitored for flow, moisture content, temperature fall or rise, pressure, level, and radon removal effectiveness, as applicable.
CS-013	Contractor packaged control and monitoring systems shall provide necessary monitoring and control interfaces with the DMCS, including operation trouble alarms.
CS-014	Instrumentation systems for stack effluent monitoring shall be designed to provide remote sensing in inaccessible or high dose areas.
CS-015	Feedback to the operator shall be provided by closed circuit television (CCTV) monitoring inside each silo volume using radiation resistant cameras.
CS-016	To monitor directional air flow from work spaces to the silo or tank volumes, differential pressure shall be monitored and alarmed as necessary.
CS-017	All secondary containment transfer lines shall be provided with leak detection for alarm and pump shutdown interlocks.
CS-018	Spaces requiring access during operations shall be monitored for radiation and radon with local beacons and remote alarms.
CS-019	Process systems shall be monitored and alarmed for abnormal operations.
CS-022	Provide temperature/environmental control for instrumentation, as required.
CS-023	Avoid commingling DMCS hardware with non-related systems in the control room.

Table 2-11 Control System Requirements (Continued)

Requirement Number	Requirement
CS-024	Provide a segregated area in the control room for the DMCS with adequate work space, document laydown space, traffic patterns, and maintenance access.
CS-025	DMCS operation, process, and alarm data shall be stored long-term (archived). Large capacity storage media shall be selected that will easily permit 30 day archival data retrieval.
CS-026	The DMCS shall be interconnected to the FEMP site Local Area Network (LAN, Novell). The DMCS shall provide all work required to ensure Open Data Base Connectivity (ODBC) transmission via this LAN to the FEMP site data base system (Oracle UNIX derivative and Windows NT operating systems) for off-line analysis.
CS-027	The DMCS password and keylock security shall prevent unauthorized use.
CS-028	DMCS installed spare capacity of system hardware (input, output, memory) shall be a minimum of 25 percent.
CS-029	Selection of instruments shall depend on range, accuracy, and compatibility with safety, reliability, and maintainability. Instrument signals shall use standard voltages or currents. Electronic instruments shall be Factory Mutual approved or Underwriters Laboratories listed.
CS-030	A Uninterruptible Power Supply (UPS) shall power the DMCS.
CS-031	The Contractor shall provide emergency voice and evacuation alarm devices compatible with the FEMP Honeywell Emergency Voice Alarm and Evacuation System. The master control for the system will be located at the FEMP designated communication system.
CS-032	The Contractor shall provide an emergency alarm system that complies with NEPA 72-1996 and compatible with the existing FEMP site Honeywell Delta 1000 Safety Alarm System.

2.3.3.2 Mechanical Systems

Mechanical systems requirements shall apply during the engineering design process and operation of all AWR mechanical systems. These requirements are listed in Table 2-12.

Table 2-12 Mechanical System Requirements

Requirement Number	Requirement
Mech-001	Maximize equipment interchangeability.
Mech-002	Modularization of equipment shall be used wherever practicable.
Mech-003	Equipment material selection shall be commercially available and standardized equipment and components shall be utilized whenever practical.
Mech-004	Equipment shall be selected for practicality of design a ("fit for purpose" selection or configuration which will efficiently perform its intended function).
Mech-005	Pumps and blowers shall operate as close to their peak efficiencies as practicable.
Mech-006	Equipment shall be assessed for its reliability, availability, maintainability, and practicality.
Mech-007	Lockout capability shall be provided for mechanical and electrical systems during maintenance and repair.
Mech-008	Equipment redundancy shall be considered in achieving Contractor reliability, availability, and maintainability goals when evaluating against ALARA principles.

Table 2-12 Mechanical System Requirements (Continued)

Requirement Number	Requirement
Mech-009	Structural welding shall be performed in accordance with a welding program that meets the requirements of AWS D1.1-STRUCTURAL WELDING CODE - STEEL. Section 5, parts A, B, C, and E.
Mech-010	The fabrication and/or installation of pipe, tubing, tanks, and associated support welding under this contract shall be performed in accordance with a welding program that meets the requirements of ASME - Section IX - WELDING AND BRAZING QUALIFICATIONS according to ASME - BOILER AND PRESSURE CODE and ASME B31.3 - CODE FOR PRESSURE PIPING.
Mech-013	The Contractor performing the fabrication and/or installation of welded components shall have a weld examination program that meets the requirements of the applicable code to which the work is being performed. All weld examinations shall be documented and included in the applicable turnover package to FDF. Weld examinations shall be performed by ASNT TC-1A certified, Level 2 inspectors.

2.3.3.3 HVAC Systems

HVAC system requirements that apply during the engineering design process and operation of all AWR HVAC systems. These requirements are listed in Table 2-13.

Table 2-13 HVAC Systems Requirements

Requirement Number	Requirement
HVAC-002	Equipment material selection shall be commercially available and standardized equipment and components shall be utilized.
HVAC-003	HVAC systems shall provide for contamination confinement and functions to ensure contamination control. Sufficient redundancy and/or space capacity shall be provided as necessary to ensure adequate ventilation during operations and maintenance.
HVAC-004	Airlocks or vestibules shall be provided within the process area to protect and maintain ventilation zones.
HVAC-005	Environmental control systems (heating, ventilating, and air conditioning) shall provide appropriate temperature control for personnel, equipment, and instrumentation for local conditions.
HVAC-006	Filters shall be placed in easily accessible areas as near as practical to the source of contamination to minimize the spread of contamination.
HVAC-007	The adequacy of the filtration system (number of filtration stages required and type of filtration) shall be determined by analysis to ensure the contamination in the effluents are ALARA and do not exceed the emission limits.
HVAC-008	The design, construction, and installation of equipment to control emissions shall utilize the best available radionuclide control technology.

Table 2-13 HVAC Systems Requirements (Continued)

Requirement Number	Requirement
HVAC-009	The facility HVAC system(s) shall provide and ensure safe operation of the facility.
HVAC-010	The HVAC system shall be designed to maintain airflow from non-contaminated to progressively more contaminated areas.
HVAC-011	Consideration shall be given to providing separate supply systems for contaminated and non-contaminated areas.
HVAC-012	The HVAC system shall meet all applicable federal, state, and local regulations.
HVAC-013	The Contractor shall procure HEPA filters (refilters, and housing assemblies in accordance with the engineering technical specification, Section 15860, HEPA Air Filtration device Requirements, Rev. 1 (Part 7-AWR RFP, Section 2.1).
HVAC-014	The Contractor shall provide differential pressure monitoring across the HEPA filter system, including any prefilters.
HVAC-015	The Contractor shall ensure that all ductwork is free of dust or dirt before installing it in the ventilation system to prevent premature loading of the prefilter and HEPA filter.
HVAC-016	Maintain a minimum velocity of 150 ft/min air across all openings (e.g., doors, dampers, louvers) between less contaminated and more contaminated areas when doors are in their normal position.
HVAC-017	An HEPA filter shall be capable of in-situ DOP testing.

2.3.3.4 Electrical Systems

Electrical systems requirements shall apply during the engineering design process and operation of AWR electrical systems. These requirements are listed in Table 2-14.

Table 2-14 Electrical Systems Requirements

Requirement Number	Requirement
Elect-001	Power transmission equipment shall operate below 75 percent of the manufacturer's rating.
Elect-002	Provide a fused load break disconnect switch at the tie-in point.
Elect-003	Equipment and material selection shall be commercially available and standardized equipment and components shall be utilized whenever practical.
Elect-004	Lockout type isolation components shall be provided for electrical systems during maintenance and repair.
Elect-005	Electrical power shall be provided by FDF within limits. See Section 2.5.4 for tie-in location(s) and criteria pertaining to type and available loads.
Elect-006	Electrical design shall consider energy conservation and easily maintainable equipment.
Elect-007	Exterior lighting shall be controlled by automatic and/or manual switches.
Elect-008	Exterior lighting shall use high pressure sodium fixtures. 480 V ballasts shall be used.
Elect-009	Interior and exterior lighting levels shall meet or exceed IES and IEEE recommendations for the type of work being performed within those areas.

Table 2-14 Electrical Systems Requirements (Continued)

Requirement Number	Requirement
Elect-010	Lightening protection, personnel safety building, and equipment protection shall be in accordance with NFPA 780-1997, "Lightening Protection Code," (NFPA 1997).
Elect-011	Grounding electrodes shall be in accordance with IEEE 142-1991,"Practice for Grounding of Industrial and Commercial Power Systems," (ANSI/IEEE 1991) standards.
Elect-012	No products containing polychlorinated biphenyls (PCBs) shall be used.
Elect-013	Ground Fault Current Interrupt (GFCI) circuit breakers shall be furnished on all 15 and 20 amp, 120v circuits.
Elect-014	Adequate electrical power shall be provided for the operation of all electrical components, emissions monitoring equipment, and all items requiring electrical power.

2.3.3.5 Civil/Structural/Layout Systems

Civil/Structural/Layout (CSL) systems requirements apply during the engineering design process and operation process and operation of AWR CSL systems. These requirements are listed in Table 2-15.

Table 2-15 Civil, Structural/Layout Systems Requirements

Requirement Number	Requirement
CSL-001	Egress routes for personnel shall be identified.
CSL-002	Facility shall be designed for both men and women operators.
CSL-003	Provisions for handicapped (wheelchair) access shall not be required.
CSL-004	Similar types of equipment which require operator monitoring shall be located in close proximity.
CSL-005	Laydown and work space for equipment servicing and repairs shall be provided.
CSL-006	Complex structures, systems, or components (SSCs), including electronic devices, or SSCs having a high probability of failure, shall be located in easily accessed contact maintenance areas.
CSL-007	Equipment shall be located and layout shall be designed for ease of operation and maintenance.
CSL-008	Repair methods for major equipment shall be identified and space/ egress routes provided for such repairs.
CSL-009	Facilities shall be located to permit convenient tie-in to existing infrastructures (i.e., roadways, and utilities).
CSL-010	The facilities shall be located to minimize interference with existing underground piping and aboveground electrical.
CSL-011	The facilities shall have the capability to receive and store all chemical, consumables, and materials necessary to operate and maintain the plant.
CSL-012	The facility working areas shall be designed in keeping with ALARA goals for personnel radiation exposure, while being cost effective to operate and maintain.
CSL-013	Stairways shall be provided for primary personnel access between platforms and facility floors.

Table 2-15 Civil, Structural/Layout Systems Requirements (Continued)

Requirement Number	Requirement
CSL-014	The exterior area, outside of the facility proper, shall provide space for support services and equipment.
CSL-015	The operating areas shall be designed to achieve maximum radiation and contamination control, ease of personnel access, material handling, operations, maintenance, decontamination, and proper ventilation. The operating areas shall provide shielding as required to minimize radiation exposure to the onsite and offsite population.
CSL-016	Drains and similar piping shall have physical provisions for cleaning.
CSL-017	Floors shall be monolithic, nonporous, and sloped toward drains where needed.
CSL-018	Areas subject to contamination shall be designed to facilitate decontamination. Liners or coating may be used to provide protection from decontaminating agents.
CSL-019	Aisles shall be wide enough to facilitate operation, maintenance, and equipment movement.
CSL-020	Office/work area shall be provided in the control room for shift administration.
CSL-021	Space shall be provided for health physics monitors.
CSL-022	The facilities shall provide for both radioactive and nonradioactive equipment maintenance to support all operations and to minimize facility downtime.
CSL-023	The maintenance area(s) shall provide for appropriate decontamination equipment, eyewash stations, and safety showers to accommodate contact maintenance requirements.
CSL-024	Access and egress for emergency vehicles and Emergency Response Team (ERT) shall be provide for each facility.

Table 2-15 Civil, Structural/Layout Systems Requirements (Continued)

Requirement Number	Requirement
CSL-025	Storage areas for containers holding wastes that do not contain free liquids shall be sloped or otherwise designed and operated to drain and remove liquid from precipitation or the storage areas shall be designed to elevate or otherwise protect containers from making contact with accumulated liquid.
CSL-027	All concrete applications shall be designed according to all applicable America Concrete Institute (ACI) codes, ASTM, and Concrete Reinforcing Steel Institute (CRSI) codes.
CSL-029	All steel construction shall be designed in accordance with the applicable sections of the America Iron and Steel Institute (AISI), ASTM, AISC, ASCE, and AWS.
CSL-030	The Contractor shall identify a satellite accumulation area or an approved RCRA storage area for Hazardous waste handling, treatment, and disposal as needed.
CSL-031	Vestibules, equipment, and/or structure containment material shall be noncombustible, or fire and corrosion resistant.
CSL-032	Local containment structures shall be designed to be leak-tight and capable of maintaining a negative pressure of at least 0.1 inches water gauge or six air changes per hour.
CSL-033	Where practical, and without penetrating local containment, air equipment components not functionally required to operate directly in the presence of radioactive materials shall be located outside the local containment.
CSL-034	Space shall be provided to store failed radioactive equipment prior to removal from the facility. This space shall be sufficient to minimize adverse impact on facility operations.

2.3.3.6 General Systems

General systems includes those requirements that shall apply during the engineering design process and operation of AWR systems. These requirements are listed in Table 2-16.

Table 2-16 General Systems Requirements

Requirement Number	Requirement
Gen-001	DQOs and process control sampling plan shall be the responsibility of the Contractor (Section 3.1.12 of TRD).
Gen-002	Engineering and administrative controls shall be applied to prevent spills, releases and spread of contamination during all phases of construction, systems testing, and operation/maintenance activities.
Gen-003	Equipment material selection shall be commercially available and standardized equipment and components shall be utilized whenever practical.
Gen-004	Lag storage for process flow interruptions affected by maintenance shall be provided.
Gen-005	All systems shall be designed and operated according to ALARA principles (Part 8 -AWR RFP, Section C.2.2.2.1).
Gen-006	Overall plant availability, excluding the RCS, shall be 70 percent, minimum.
Gen-007	The Contractor shall ensure that human factors engineering is incorporated into all design of its SSCs (**Section 3.1.8**).
Gen-009	The Contractor shall furnish all SSCs necessary to support its activities.
Gen-010	All SSCs shall be designed specified, and constructed in accordance with the AWR project safety basis, performance grading, and applicable industrial standards and codes.
Gen-011	All equipment, waste transfer and handling systems containing material regulate as a hazardous waste under RCRA shall have secondary containment.
Gen-012	The Contractor shall label and color code in accordance with ED-12-4016, Equipment and Piping Labeling,(Part 7-AWR RFP, Section 3.0).

2.4 Engineering Design Requirements

Document RM-0016, Management Plan, serves as the highest level FDF management document. The Management Plan defines the scope of the FEMP's mission, describes how FDF is organized as a company to support that mission and identifies external requirements that FDF shall satisfy. The USDOE organized project work at the FEMP into 24 functional areas. A functional area is defined as a logical grouping of activities associated with the environmental, safety, health or management issues of the facility. The Management Plan characterizes each FEMP functional area by a Standards/ Requirements Identification Document (S/RID) that describes activities included in a functional area, interfaces with other functional areas, and requirements that FDF shall satisfy in its conduct of activities within that functional area.

The Engineering Design (ED) functional area encompasses the design aspects for all projects at the FEMP. The requirements applicable to this functional area apply to all Contractors who shall be responsible for design of new facilities or facility modifications, as well as to the plant engineering role of facility operators for ongoing engineering support at the FEMP. The ED functional area includes the design process from conceptual design, through start up, and on to preparation of project close out documentation. The ED functional area incorporates the programmatic and technical elements necessary for the conduct and control of Engineering Design Programs and addresses activities which shall be based on regulations, DOE Orders, nuclear industry standards, methods, and practices. It shall be the responsibility of the Contractor to understand these requirements and ensure that they are appropriately integrated into the Contractor's engineering design process.

Table 2-17 presents the 24 functional areas defined at the FEMP. Identified in this table are the 13 functional areas that have an interface with the ED functional area. The ED interface with each functional area provides the Contractor with the applicable S/RIDs that, by reference, are part of this contract.

Table 2-17 contains references to the appropriate sections of Appendix B that contain the SRIDs for each applicable functional area.

Table 2-17 FEMP Functional Area Descriptions

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
1.	(CM) Configuration Management	• change control process establishment • facility technical baseline establishment and control • establishment, maintenance, and control of technical baseline documentation	yes	B.1
2	(ED) Engineering Design	• design of demolition drawings and specifications • safety class systems identification • design and design modification of facilities • site structural characterization evaluation	yes	B.2
3.	(EM) Emergency Preparedness And Management	• emergency preparedness planning and hazards identification • emergency response • emergency reporting • performance grading • safety basis	no	N/A

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Table 2-17 FEMP Functional Area Descriptions (Continued)

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
4.	(RD) Research and Development and Experimental Activities	• technical modeling • experimental programs feasibility studies • experimental programs design, approval, control, assessment, and reporting	no	N/A
5.	(EP) Environmental Protection	• compliance assessment with environmental laws/ regulations (protecting land, water, biota, and flora)	yes	B.3
6.	(FP) Fire Protection	• fire prevention/detection • fire protection	yes	B.4
7.	(MT) Maintenance	• equipment/systems maintenance methods/practices • equipment calibrations, routine and on demand • preventative/routine equipment maintenance • standards for facility and utility support	no	N/A
8.	(MS) Management Systems	• management of procedures issues • ES&H compliance controls and occurrence reporting • operational readiness review • coordination of the identification, evaluation, and documentation of site requirements and the degree of compliance • records management • corrective action tracking and compliance assessment	yes	B.5

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Table 2-17 FEMP Functional Area Descriptions (Continued)

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
9.	(NS) Nuclear and System Safety	• safety analysis, reporting, and planning • nuclear criticality safety	yes	B. 6
10.	(SH) Occupational Safety And Health	• construction safety • occupational (worker) safety and health • employee safety and health	yes	B.7
11.	(OP) Operations	• execution and monitoring of operation activities • operating methodologies and procedures • lockout and tagout • abnormal events investigation • equipment/process labeling	yes	B.8
12.	(PT) Packaging And Transportation	• administration/monitoring onsite/offsite transportation of hazardous and radioactive materials and residue • administration/monitoring of packaging of hazardous and radioactive materials and residue	no	N/A
12.	(QA) Quality Assurance	• identification of integral elements of the QA program • corrective action and tracking of non-compliance • QA support for project, engineering, and construction and operations activities • QA support for waste programs and utilities	yes	B. 9

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Table 2-17 FEMP Functional Area Descriptions (Continued)

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
13.	(RP) Radiological Protection	• monitoring and ALARA approach to limiting radiological exposure of workers and public	yes	B.10
14.	(SE) Security	• communication and information security • program planning and management • personnel security • protection program operations • nuclear materials control and accountability • surveys and facility approval • independent inspection and evaluation	yes	B.11
15.	(TR) Training And Qualification	• training and qualification of personnel	yes	B.12

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Table 2-17 FEMP Functional Area Descriptions (Continued)

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
16.	(EW) Environmental Restoration and Waste Management	• elements and programmatic controls directly associated with Environmental Restoration program compliance • activities and requirements associated with the management and implementation of the DOE remedial action program and the decontamination and decommissioning program for surplus contaminated facilities • elements and programmatic controls necessary to manage hazardous, radioactive and solid residue compliance at active treatment, storage, and disposal (TSD) facilities • includes generation, characterization, transport, processing, storage, treatment, disposal, tracking, and reporting of radioactive, solid, and hazardous residue	yes	B.13
17.	(CT) Construction	• planning, scheduling, and managing decontamination and demolition work • planning, scheduling, managing, and closing construction of new facilities or modification to existing ones • subcontract administration for decontamination and construction projects	yes	B.14

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Table 2-17 FEMP Functional Area Descriptions (Continued)

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
18.	(AC) Acquisition	• prime contract administration • real property purchasing and acquisition • subcontractor (temporary worker) purchasing • long lead procurement	yes	B.15
19.	(HR) Human Resources and Employee Relations	• industrial relations and labor negotiations • human resource management • career development • equal employment opportunity • career retraining	no	N/A
20.	(PC) Project Control	• scheduling/cost control • project performance measure and reporting	no	N/A
21.	(PM) Property Management	• tracking of usage, inventory, and disposal of real and personal property • management of real property	no	N/A
22.	(PI) Public Involvement	• plan and implementation of programs designed to align project and stakeholder interests • media relations activities • research stakeholder concerns; address concerns through public involvement activities	no	N/A

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Table 2-17 FEMP Functional Area Descriptions (Continued)

No.	Functional Areas	Area Responsibilities/Descriptions	Interface with Engineering Design	Applicable Appendix B Section
23.	(FM) Financial Management	• maintenance of site financial accounting and reporting system • control over expenditures and assets • limitation of financial risks through investigation and planning	no	N/A

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2.5 Design Criteria

The design criteria included in this section provides the Contractor with available data applicable to the design process for the AWR project. Data from each section is discussed below and appropriately referenced. In areas where there is a general lack of data (or uncertainty associated with the data), details shall be provided regarding this concern. The Contractor shall use this data, to the extent possible, and shall be responsible for any concerns and/or outstanding data needs required during the engineering design process.

2.5.1 K-65 Characterization Data

Appendix A contains a summary of the K-65 silos residue characterization data gathered to date. The primary purpose of this data gathering effort has been to characterize the residue for vitrification process design. The following discussion provides the Contractor with an overview of the physical, chemical and radiological properties of the K-65 residue.

In November of 1991, approximately 730 metric tons of BentoGrout™ and water were mixed to produce the desired consistency of slurry and pumped into Silos 1 and 2 to cover the K-65 material (the slurry consisted of approximately 25 percent dry BentoGrout™ and 75 percent water). The purpose of this was to reduce routine emissions of radon from the K-65 silos to the maximum extent practical, and to decrease, mitigate, or otherwise control the radon gas inventory in the K-65 silos so that a failure of the dome(s) would not result in a release of significant quantities of radon gas to the environment.

The very top of the Silo 1 BentoGrout™ cap is approximately 26 feet above the silo floor. Closer to the silo perimeter, the top of the BentoGrout™ cap is about 26.5 feet above the floor (this is only a few inches below the top of the silo wall inner face). The thickness of the cap averages about 2 feet. Because of the contour of the underlying K-65 residue, the thickness of the BentoGrout™ cap averages 0.5 to 1.5 feet at the center of the silo to as much as 3.5 feet next to the walls. In Silo 2, the top of the BentoGrout™ sits about 26 feet above the silo floor in the center, and 21 to 22 feet above the floor next to the silo walls. The thickness of the Silo 2 BentoGrout™ cap is a minimum of 0.5 feet at the center of the silo and a maximum of 3 feet near the walls. Silo 1 contains approximately 3,280 cubic meters (m^3) (115,900 cubic feet [ft^3]) of residue (to include discrete objects) and approximately 360 m^3 (12,600 ft^3) of BentoGrout™ clay. Silo 2 contains approximately 2,840 m^3 (100,400 ft^3) of residue (to include discrete objects) and approximately 310 m^3 (11,100 ft^3) of BentoGrout™ clay.

The BentoGrout™ itself is a proprietary product supplied by the American Colloid Company. It contains sodium form BentoGrout™ clay and inorganic additives and, when dry, is highly hygroscopic. The BentoGrout™ was originally pumped into the silos as a aqueous, heavy slurry containing between 25 and 32 weight percent solids. BentoGrout™ slurry remains workable for about 45-60 minutes after its initial preparation and, even, sets up to form a gelatinous mass. As it dries, it becomes thicker having a consistency similar to peanut butter. The top layer (perhaps as much as six inches) of each BentoGrout™ cap is now likely to be somewhat dry, cracked and stiff, containing about 50 weight percent solids. Below that, the BentoGrout™ is likely to retain its original gelatinous consistency and contain about 25 to 35 weight percent solids. A detailed discussion regarding the challenges of retrieving BentoGrout™ from the silos is presented in Section 4.1 of the Silos 1 & 2 Waste Retrieval Evaluation[3] report.

Florida International University Hemispheric Center for Environmental Technology (FIU-HCET) is contracted to perform testing on silos material (including the BentoGrout™ clay cap material). The testing is being performed to determine the rheological properties for water-based slurries, the physical properties of these slurries, and characteristics of slurries that contain BentoGrout during pumping and resting periods. A FIU will also develop a surrogate formulation that simulates the rheological properties, hydraulic properties, and selected physical properties of the residue. Flow loop pressure drop measurements over ranges of a slurry solid's concentration, flow rate, and temperature will be used to develop empirical correlations between the residue material slurries and standard water system hydraulic data for components and friction loss calculations. Slurry physical properties to be determined include density, pH, viscosity as a function of temperature, solids settling rates, particle size distribution of solids suspended in the liquid fraction, and particle size distribution of solids in the settled fraction. FIU-HCET data will be provided to the Contractor as the data becomes available.

Corrosion testing (residue) of carbon steel and coated coupons (Plasite 4310 and Plasite 4006) is currently being performed. This testing includes:

- Complete submersion of coupons in residue;
- Coupons placed at the interface of standing water and air space above the standing water;
- Coupons placed in residue at anticipated moisture content (30 percent) found in the silos.

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[3] Ibid.

Test durations are based on 30, 90, 180, and 360 days, as well as an optimal duration following 360 days. Initial test results are anticipated in May 1998 and will be made available to the Contractor upon review by FDF.

2.5.2 Silos Structural Data and History

Silos 1 and 2 were originally designed by Preload Engineering, Inc., and were constructed by Catalytic Construction Company during 1951-1952. The silos have an approximate 80-ft inside diameter, 27-ft height at the top of the wall, and 36-ft height to the top of the dome at the center of the silo. The walls are 8 inches thick and cast in place with 4,500 pounds per square inch (psi) concrete. They are wrapped on the outside surface with prestressed steel wires and covered with 1-inch thick (gunite). The wall is tied to the floor and dome with reinforcement steel. The dome is 8 inches thick near the edge, tapering to 4 inches thick at the center, and cast in place with 4,500 psi concrete. Dome reinforcement consists primarily of welded wire mesh. The floors of the silos are constructed of 4 inches of reinforced concrete.

Beneath the floor of silos is an underdrain system. The underdrain system consists of a 2 inch slotted pipe in a 8 inch gravel layer. The gravel layer is underlain by a 2 inch thick layer of asphaltic concrete followed by a 17 inch thick layer of compacted clay. A detailed drawing showing the interconnection of the underdrain system and the silo foundation is referenced in Part 7-AWR RFP, Section 1. The underdrain system is connected to the decant sump tank to collect any potential leakage through the base of the silos.

In 1964, large areas of spalling occurred on the exterior surface coating of silos particularly Silo 2, leaving preload wires corroded and exposed to weather. The exterior surfaces were patched with a 0.75 inch thick coat of cement mortar and a waterproofing that was applied.

Also in 1964, an earthen embankment was built surrounding the silos walls to provide relief from tensile stress that had developed within the walls, weather protection, reduce radon emissions, and increase shielding from penetrating radiation. The embankment was originally constructed on a slope of 1.5:1. The slope was subsequently modified to 3:1 in 1983 to reduce soil erosion. The soils comprising the earthen berm constructed in 1964 were surface soils and underlying clays removed from an area directly south of the concrete trench and north of a small drainage ditch running parallel to the trench. The soils comprising the earthen berm constructed in 1983 originated from two on-site areas: from the location of the Biodenitrification Surge Lagoon, and from a borrow area west of Pit 5. No surveys were performed by site personnel to determine the potential presence of radiological contamination of these soils before excavation and placement in the berms.

Prior to berming the silos in 1964, the decant system was disconnected from the sump tank, but the underdrain system remained intact. The decant system collected any leakage into the underdrain system. Access was provided to this sump tank by placing an 30 inch diameter corrugated metal pipe from the tank to above the surface of the soil embankment.

This pipe extended upward 33 ft. The earthen berm was placed around this pipe as the berm was built around the silos.

Residue was originally transferred to the silos by pumping the residue in the form of a slurry. The residue eventually settled and formed two layers; consisting of settled solids covered by the slurry liquid. To remove the layer of clear liquid following settling, the silos were equipped with a series of decant ports. These ports were arranged in two vertical lines located on diametrically opposing sides of each silo. There were 25 ports in each line, making a total of 50 ports per silo. The bottom port on each silo is 1 ft from the silo bottom. The remaining 49 ports are located at 6 inch intervals.

The decant ports for the silos were, at the time of filling, each valved into a pipe that led to a 9,000-gallon carbon steel decant sump tank. The decant sump tank is located between the silos at a level below the base of the silos to allow for gravity drainage. At the base of silos at the original ground surface, are skirt drains used to contain any seepage through the walls of the silos or leakage from the decant ports. These skirt drains directed any collected water through a concrete pipe trench to an in-ground concrete-lined sump located on the Drum Handling Building, formerly located between Silos 2 and 3.

In January 1986, two load-spreading dome covers, 30 feet in diameter, were installed to span a deteriorated portion of the concrete domes of the silos. The covers are self-supporting and sit on a rolled plate-steel skirt. The covers are composed of structural steel members that support 0.75 inch thick plywood sheeting, which is covered with a weatherproof membrane. The dome cover increases the stresses in the existing concrete. The dome covers were installed so that containment of the silos residue would be maintained in the event of a center-silo dome collapse. The dome covers were not designed to be airtight, and therefore do not contain the movement of gases, such as radon. In 1987, a minimum 3 inches of rigid polyurethane foam topped by a 45-mil membrane were placed on top of the silo domes.

Part 7-AWR RFP, Section 1, provides the Contractor with relevant drawings of the silos, silo dome, decant sump system, and the silo superstructure.

2.5.3 Site Characterization Data

Appendix C, Site Characterization Data, presents information on site meteorology, topography, hydrology, seismology, and geology.

2.5.4 Site Infrastructure

The following utilities and specifications shall be provided by FDF:

- Electrical Power: overhead tie-in to existing system, 6,000 kVA @13.2 kV;
- Domestic Water: underground 4" tie-into existing system; 90 gpm at approximately 40 - 60 psig. The domestic water supply is shared with the Silo 3 stabilization Contractor. Any use of more than 50 percent of the available domestic water must be coordinated with and approved by FDF;
- Fire Water: underground 8" tie-in to existing system, two tie-in points, 100 psi at 1000 gpm;
- Waste Water System (non-radioactive): 4" tie-in to existing system;
- Storm Water: tie-in to existing on site open culvert and drainage system;
- Telephone and Fire Alarm: panel tie-in at the VITPP.

The Contractor shall extend the utilities from the tie-in locations to those locations where they are to be used in accordance with applicable codes and/or standards. All tie-in points are located on drawings 94X-5500-E-SK-4000 and 94X-5500-M-SK-7033, included in Part 7-AWR RFP, Section 1. The Contractor shall be responsible in the use of all utilities supplied to him. The Contractor shall optimize the use of all FDF supplied utilities. FDF shall monitor the Contractor's utility usage.

2.5.5 Radon

Handling of the residue presents significant issues that are unusual for a material of such a moderate level of radioactivity. These issues are the result of the constant production of Radon-222 from the decay of Radium-226 in the residue. Given that the silos have a combined inventory of approximately 4000 Ci of radium and that the concentration ranges from 300 -900 nCi/g, containment and treatment of radon involves high concentrations of radon in significant volumes of air. Therefore, in order to handle the residue, the Contractor shall have an understanding of this unique feature of the material. Appendix D presents a summary of the radon emanation characteristics of the residue and includes several outside investigations on radon control that have previously been performed.

A radon diffusion study is being conducted to determine the effectiveness of water as a diffusion barrier for ^{222}Rn emanating from residue material. Laboratory scale cylindrical PVC containers will be fabricated to simulate the conditions expected to exist during interim storage of the retrieved residue as discussed in Section 2.2.4 of this document.

Measurements of concentration of ^{226}Ra in the residue and the emanation fraction of ^{222}Rn from the residue from the residue will be performed to characterize the source term for the radon diffusion measurements. Measurements of the concentration of ^{222}Rn within and above the fluid barrier (water layer) produced in the laboratory scale containers will be performed to determine the effectiveness of the diffusion barrier under static and dynamic conditions. The data will be used as a benchmark for theoretical predictions of ^{222}Rn diffusion through a fluid barrier. Preliminary data for this study is scheduled to be available in April 1998 with final results scheduled to be available by June 1998.

2.5.6 Silo 4 Superstructure; Full-Scale Mock-Up

Certified for Construction drawings for the Silo 4 superstructure are included in Part 7-AWR RFP, Section 1.6.

3.0 DOCUMENTATION REQUIREMENTS

3.1 Project Management Documentation Requirements

The following planning documents shall be prepared and submitted individually by the Contractor.

3.1.1 Project Management Plan

A Project Management Plan (PMP) shall be prepared to describe the management approach, organizational structure (including resumes of the project management team and discipline leads), methodologies, practices, and implementing procedures for this project. The PMP shall clearly delineate and support project management interface requirements between the Contractor and FDF including progress reviews, design reviews, monthly status review meetings, and quarterly project review meetings. The PMP shall address how the Contractor shall perform the work within the schedule established in Part 6-AWR RFP. The PMP shall be based on the Contractor's Work Breakdown Structure (WBS) and shall include draft, interim, completion milestone dates, and decision hold points for all deliverables to permit the measurement of cost and schedule performance. The PMP shall be updated and maintained in accordance with the Contractor's internal procedures. The PMP shall be modeled after DOE Order 4700.1 (DOE Order 4700 is not a mandatory requirement of this contract).

3.1.2 Engineering Management Plan

An Engineering Management Plan shall be prepared to describe the engineering procedures necessary to produce, review, and issue contract documents in conformance with the functional requirements of this project. The plan shall cover training, drawings, specifications, calculations, procedures, design reviews and checking, and computer code verification and validation.

3.1.3 Configuration Management Plan

A Configuration Management Plan shall be prepared to describe the approach to establishing and maintaining the project baseline (technical, cost, and schedule). The project baseline shall be established upon acceptance of the preliminary design. Once established, all documents that define the project baseline shall be governed by the Contractor's approved change control procedures. Controlled copies of these documents shall be maintained throughout the project's life cycle, beginning with the initial baseline document and including all approved changes via controlled revisions of the originals.

Prior to becoming part of the baseline, documents shall be maintained as letter revisions. Upon becoming a controlled document, it shall be released as revision 0 (zero) and all subsequent changes shall be maintained as number revisions. The change control procedure shall use a graded approach to reviewing and approving changes, depending on the magnitude of the impact.

3.1.4 Records Management Plan

The Contractor shall prepare a Records Management Plan which identifies the program to control preparation, review, approval, issuance, use, revision and storage of documents that establish policy, prescribe work, specify requirements, and or establish design. The scope of the Records Management Plan shall include all technical, environmental, health and safety, operations and project control identified documents for the project. When requirements can not be included, these shall be addressed in the Records Management Plan and the document which provides control shall be identified. A matrix of documents shall be developed and maintained to provide title and numerical identification, status, and revision.

3.1.5 Systems Engineering Management Plan

A Systems Engineering Management Plan shall be prepared to describe how systems engineering is conducted and managed during the design phase of the project. This plan shall follow the guidelines of DOE Order 4700.1. The plan shall include a description of the proposed process, the responsibilities and methodologies for implementation, the organizational structure and interrelationships, and the relationships between configuration management and other engineering organizations in defining and managing the technical and cost/schedule baseline.

3.1.6 Independent Safety Review Plan

An Independent Safety Review Plan (ISRP) shall be prepared to describe the Contractor's approach to providing independent safety oversight of the design. The major independent safety activities shall be ensuring compliance with, and implementation of the DOE orders, regulations, and standards discussed in this contract covering environmental, safety, health, fire protection of the design, and safety analyses evaluations and documentation to support the design. The Independent Safety Manager shall have the authority to issue stop work orders.

3.1.7 Procurement Management Plan

The Contractor shall provide a Procurement Management Plan which establishes and ensures that purchased items and services meet established requirements and perform as specified. Included in the plan shall be a matrix of key procurement items. The matrix shall be maintained and identify the items/services purchased, system specification or design code requirements, Contractor name, inspection/test acceptance plan identification requirements, whether source or receipt inspection is required, date inspection shall be performed, and status of the inspection/test.

3.1.8 Human Factors Program Plan

A Human Factors Plan shall be prepared to describe the Contractor's approach to incorporating human factors engineering into the design. Human factors engineering guidelines shall be in accordance with UCRL 15673 "Human Factors Design Guidelines for Maintainability of DOE Nuclear Facilities," Biotechnology, Inc., for LLNL, June 1985, Chapter 13, "Human Factors" of DOE STD-3009-94; "Preparation Guide for USDOE Non Reactor Nuclear Facility Safety Analysis Reports," DOE Order 5480.19; "Conduct of Operations," DOE Order 5480.20A; "Personnel Selection and Qualification and Training Requirements for DOE Nuclear Facilities"; and DOE Order 5480.23, "Nuclear Safety Analysis Reports."

3.1.9 Contingency Plan and Emergency Response

Contingency plan and emergency response will be shared by FDF and the Contractor. FEMP's emergency plan will be used by the FDF Emergency Response Team (ERT) in response to any emergency situation in the project area including, but not limited to fire, personnel injury, or spills. The Contractor shall inform the Emergency Duty Officer (EDO) or the Assistant Emergency Duty Officer (AEDO) in the event of an emergency.

The Contractor shall review the FEMP's Emergency Plan and prepare a Contingency Plan for the scope of work to be performed. The requirements for the Contingency Plan are contained in DOE Order 151.1, "Comprehensive Emergency Management System." This Contingency Plan shall complement, interface with, and reference, as appropriate, the FEMP Emergency Plan. During off-normal events, FDF will take over the Contractor's work area and implement appropriate actions, with direct input from the Contractor, as directed by the EDO or AEDO and the ERT. The FDF AEDO will also be notified of unplanned nonlife-threatening events, such as a pipe or valve leak. The specific requirements for notification of the EDO or AEDO are discussed further in Part 8-AWR RFP, Section C.2.1.6.1.

3.1.10 Environmental Control Plan

The Environmental Control Plan submitted by the Contractor shall describe the methods and controls the Contractor will incorporate into the design and operation of the AWR Project to control erosion, dust, waste water, stormwater, and air emissions to minimize the impact of these activities on the environment. The plan shall describe the design and operational control strategy to ensure compliance with the EP and EW functional area requirements (Section 2.4) and ARARs identified in Appendix B. As design details are added, or operational basis is changed, the Environmental Control Plan shall be updated and resubmitted. The Contractor shall provide the following in this plan:

- Air Emissions Control
  Describe anticipated pollutant emissions and controls to be used, and any plans for stack or other air monitoring for radon and other air contaminates. Include a description of how operations will ensure that emissions from material handling and processing equipment meet ARARs and ALARA requirements.

- Dust Control
  Description of the methods and materials to be used to suppress and minimize the creation and dispersion of dust during operations.

- Wastewater Control
  Description of the design features and methods to be used to eliminate, minimize, or recycle the wastewater produced during operations. Where wastewater will be generated, a description of any pretreatment methods to be used and any methods that would be used to segregate contaminated wastewater from other wastewater streams.

- Stormwater Control
  Description of the methods, materials, and existing site features to be used to capture and control stormwater.

- Erosion Control
  Description of the methods and materials to be used to prevent erosion of soil in the project work area to reduce sediment loading in the stormwater.

- Waste Management
  Description of the design approach and methods to be used to manage secondary waste and debris generated during construction and operation.

3.1.11 Berm Excavation Plan

The Berm Excavation Plan submitted by the Contractor shall describe the methods the Contractor will employ to mitigate the impacts of the silos berms and the silos integrity throughout the Accelerated Waste Retrieval process. This plan will include:

- Methods of silo berm sampling, removal and transportation; and
- Contingency Plans for encounters with discrete objects (trench line, valve house, etc.).

This plan will be submitted to FDF for review and approval. The Berm Excavation Plan is required to support Waste Management in Section 5 of the TRD.

3.1.12 Sampling Plan

A sampling plan shall be prepared in compliance with the USEPA guidance document EPA QA/G-4, "The Data Quality Objectives Process," and shall meet the requirements set forth in Section 3.6.4 of this document. The sampling plan shall include samples required by Contractor for process control, FDF required archive samples, and waste water disposition. The Contractor shall provide FDF with all process control sample data obtained during the retrieval process. The plan shall include, but not be limited to, the following items:

- scope and purpose of sampling and analysis;
- types of analyses required;
- decisions to be made based upon results of the analyses;
- sampling frequency;
- sample size;
- chain of custody controls and sample tracking methodology;
- sample port or location; and
- sampler and sample container design.

3.2 Design Documentation Requirements

3.2.1 Conceptual Design Package

The Conceptual Design Package (CDP) shall describe the major systems: Silo Waste Retrieval System, Transfer Tank Area System, Transfer Tank Waste Retrieval System, and the Radon Control System. Interfaces to minor systems, such as cooling water systems and residue water systems, shall be included in the design package, but full system development need not be included. The fundamental objective of the conceptual design report is to develop a project scope that satisfies the project and site mission needs, operating needs, and site/regulatory requirements; validates the project feasibility and attainable technical performance levels; identifies, quantifies, and qualifies project risks; and lays the foundation for developing the project baseline. The package shall include, as a minimum, the next revision of the following documents (previously submitted with the bid package):

- process flow diagrams;
- heat and material balances;
- general arrangement drawings;
- site plot plan;
- electrical load summary;
- electrical one-line diagram;
- full-scale mock-up test plan; and
- estimate of secondary waste.

The package shall include the following new documents:

- functional analysis;
- piping and instrumentation diagrams;
- process descriptions;
- equipment list;
- data sheets and draft specifications for key equipment and long lead items;
- control system block diagrams;
- ALARA plan (See Part 8-AWR RFP, Section C);
- performance grading;
- lists of required drawings, specifications, and other documents;
- storm water drainage plan;
- design drawings of retrieval hardware and structural support;
- tie-in drawings; and
- HVAC flow and control diagram.

A conceptual design review meeting will be held at the FEMP. Contractor's representatives from the requisite engineering disciplines shall be in attendance to present the design, resolve comments, and prepare meeting minutes.

3.2.2 Functional Requirements Document

The Functional Requirements Document (FRD) shall expand upon the functional requirements contained in the TRD. The document provides the fundamental technical criteria and design requirements necessary to develop conceptual, preliminary, and final design. These criteria and requirements address design concepts such as minimum performance capabilities/margins, design basis criteria, diversity, reliability, availability, independence, redundancy, separation, environmental protection, and health and safety protection. The criteria shall incorporate organizational requirements, DOE directives, regulatory requirements, historical information, and engineering experience which provide the basis for verifying that the final project conforms to the requirements of the intended function.

3.2.3 Design Criteria Package

The Design Criteria Package (DCP) shall expand upon the design criteria contained in the TRD. The purpose of the design criteria package is to assemble the specific criteria, assumptions, and industry codes and standards applicable to this project.

3.2.4 Preliminary Design Package

The preliminary design package need not be submitted all at once. It is preferred that documents be submitted as they become available to expedite the review process and to allow comments to be incorporated into follow-on documents prior to their submittal. The package shall include, as a minimum, revision 0 or later, of the following documents:

- functional analysis;
- process flow diagrams for all systems;
- heat and material balances for all systems;
- piping and instrumentation diagrams;
- performance grading;
- control system block diagram;
- ALARA Plan (environmental and radiological);
- general arrangement drawings;
- electrical one-line diagrams;
- site plot plan; and
- tie-in drawings.

The package shall include the following documents, previously submitted with the Conceptual Design Package:

- electrical load summary;
- retrieval technology design, including structural support system;
- storm water drainage plans;
- data sheets and draft specifications for key equipment and long lead items;
- equipment list;
- full-scale mock-up test plan;
- timed estimate of secondary waste disposal requirements;
- lists of required drawings, specifications, and other documents; and
- HVAC flow and control diagrams.

The package shall also include the following new documents:

- line list;
- instrument list;
- metallurgical diagrams;
- radiation zone drawings;
- key calculations (e.g., shielding), as determined by FDF;
- underground piping drawing;
- system design descriptions;
- control room arrangement;
- cathodic protection design;
- lightening protection design;
- grounding design; and
- paving and grading plans.

A preliminary design review meeting will be held at the FEMP. Contractor's representatives from the requisite engineering disciplines shall be in attendance to present the design, resolve comments, and prepare meeting minutes.

3.2.5 Final Design Reports

The final design report for the Radon Control System (RCS) shall be submitted separately from the final design report for the remainder of the systems. In order to allow for early construction of Phase 1 operation. The RCS final design may consist only of the design details for Phase 1, or, at the Contractor's discretion, it may also contain details for the upgrade to Phase 2.

Both final design reports shall be considered and contain certified for construction (CFC) drawings and specifications. All drawings, documents, purchase specifications, construction specifications, reports, studies, analyses, calculations, etc. shall be revision 0, minimum. The final design reports shall contain written narratives that fully describe the processes, mechanics, control methodology, etc. All design drawings shall be stamped by a professional engineer. Final design reports will be submitted by FDF to the U.S. Environmental Protection Agency (USEPA) for approval.

A final design review meeting will be held at the FEMP. Contractor's representatives from the requisite engineering disciplines shall be in attendance to present the design, resolve comments, and prepare meeting minutes.

3.2.6 Design Closeout Report

The Contractor shall submit the design closeout report for the project at the end of startup testing. The package shall include, as a minimum:

- as-built copies of all drawings and specifications;
- operating and maintenance manuals for all equipment; and
- completed system design descriptions, including startup, operation, shutdown, and off-normal operational procedures

3.2.7 Engineering Evaluations

3.2.7.1 Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis (FMEA) shall be prepared to evaluate every major piece of equipment, valve, instrument, etc. to determine their potential failure modes (e.g., fail to operate, fail to close, etc.) and the effects of each failure. Results of this analysis shall be incorporated into the plant design to ensure a safe, reliable plant.

3.2.7.2 Reliability, Availability, and Maintainability Analysis

The Contractor shall prepare a Reliability, Availability, and Maintainability (RAM) Analysis in conjunction with the FMEA. The RAM analysis shall identify all major pieces of equipment, valves, instruments, etc., estimate the mean time between failure and the mean time to repair for each identified item, calculate the availability of each item, then calculate the overall plant availability during residue retrieval from the silos and during residue retrieval from the TTA. Section 2.3 specifies the required overall plant availabilities. Limited maintenance availability during inclement weather shall be factored into this analysis.

3.2.7.3 Value Engineering Review

The Contractor shall perform an independent value engineering review of the project to assess the project direction. The value engineering team shall be headed by a certified value engineer who is not currently, nor has ever been assigned to the project team. Members of the team shall include functional area managers currently assigned to the project design team.

3.2.7.4 Energy Conservation Report

If the RCS or the balance of the facilities require greater than 500 million Btu/yr or includes a building greater than 10,000 ft^2, an energy conservation report shall be prepared to meet the intent of DOE order 6430.1A, Section 0110-1213. The report(s) shall be submitted concurrent with the final design reports for the RCS and the balance of the facilities, as applicable.

3.2.7.5 Fire Hazards Analysis

A fire hazards analysis shall be prepared in accordance with DOE Order 420.1, Section 4.2, and as identified in 3.2.8.4.2.

3.2.7.6 Constructability/Operability Review

The Contractor shall perform constructability/operability reviews of the preliminary and final design packages to ensure that construction requirements have been adequately incorporated into the design . The review shall be documented and submitted along with the preliminary and final design packages.

3.2.7.7 Performance Grading

Performance Grading (PG) is the classification of an activity or function of a system structure, or component (SSC) associated with a Nuclear facility in terms of:

- Safety considerations involving the consequences of its failure to prevent or mitigate the release of radioactive materials, energy, or hazardous materials;
- Mission importance considerations involving the consequences of its failure impacting schedule delay, stakeholder reaction, or project cost;
- Life-Cycle considerations involving the design life or intended use/consequence of the SSC or project; and

- Complexity considerations involving the degree of regulatory, design, construction, process, and/or management coordination required.

NOTE: FDF and/or DOE may require an upgrade to a PG if the affect to one of the above considerations is in question.

The PG identified and approved for each SSC shall become the basis for implementation and application of the graded approach. PG is covered in the FEMP Site Procedure ED-12-4015 (Part 7-AWR RFP, Section 3).

The Preliminary Hazard Analysis performed to support the Safety Basis and the resulting Hazard Category (HC) determination are required for PG.

Using the guidance in DOE-STD-3009-94 (Part 7-AWR RFP, Section 5), Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports and the Hazard Analysis Report (HAR) for OU4 (Part 7-AWR RFP, Section 4) SSCs that are Safety significant are determined. Safety Significant SSCs shall be a PG level 3 or higher when dealing with a Hazard Category 3 or greater Nuclear facility. Silos 1 and 2 are defined as a Hazard Category 3 Nuclear facility.

The following requirements apply to SSCs determined to be PG 1, 2, or 3:

- Shall require independent design review;
- Design changes which affect PG 1, 2, or 3 that were previously approved by FDF Technical Review Board (TRB) shall be reviewed by the TRB; and
- Design changes which affect PG 1, 2, or 3 shall be evaluated using the USQ process.

3.2.8 Safety Basis Documentation

Safety Basis is the information relating to the control of hazards at a nuclear facility (including design, engineering analysis, and administrative controls), which the DOE uses to conclude whether activities at the facility can be conducted safely. While the FEMP site is considered a nonreactor nuclear facility, each project is further categorized, following the criteria set forth in DOE-EM-STD-5502-94, "Hazard Baseline Documentation (Part 7-AWR RFP, Section 5)." This hazard categorization determines the documentation required to adequately assess the hazards associated with the activities planned. This documentation can range from a full seventeen-chapter Safety Analysis Report (SAR), requiring DOE approval, to a safety assessment, which is FDF reviewed and approved. The Safety Basis is critically linked to the design of new facilities.

The Hazard Category is also used to trigger and set the level of effort for other FDF programs such as ORR, CONOPS, and PAAA Quality Assurance reporting. A Hazard Category is primarily inventory driven, although the DOE may request a higher Hazard Category designation be applied if there are extenuating circumstances, such as new technology.

The Contractor shall perform hazard categorization per the requirements of FDF document NS-0003 "Safety Assessment Hazard Screening and Classification (Part 7-AWR RFP, Section 3)," and DOE-EM-STD-5502-94 for the activities associated with this project.

3.2.8.1 Segmentation

The Contractor may address the entire operation as one segment with one safety basis document or can attempt to segment the activities. This may allow the Contractor to achieve a lower hazard category for a given segment.

An activity may be considered a segment for safety analysis purposes if the following conditions are true:

- The activities are separated by distance within a specific geographical area. **NOTE:** At a minimum this distance shall be 30 meters. This may increase based on the energy sources added by the operation.
- The activities contained within the specific geographical area are discrete. Examples include, but shall not be limited to, construction and operation of the residue retrieval facility.
- An accident or event in one segment cannot directly impact another segment (excluding natural phenomena such as earthquake and high winds).

For the Contractor to take credit for segmentation, the Contractor shall document that two out of three of these conditions for segmentation are met as part of their pre-award proposal. The Contractor shall document that all of the conditions are met as part of the post-award safety assessment as described in Section 3.2.8.6.4.

3.2.8.2 Hazard Category

The Contractor shall design, construct, test, and operate the system of the AWR Project within the criteria defined by DOE-STD-1027-92 and DOE-EM-STD-5502-94. The Contractor shall adhere to the requirements of RM-2116 and follow NS-0003 to determine the appropriate hazard category and safety documentation requirements for the facility.

The Hazard Category for this operation shall be determined based on the inventory of materials involved in the operation that are listed in DOE-STD-1027-92 and 40 CFR Part 302 and the ability of that material to become airborne. Factors that have the greatest impact on Hazard Category determination shall include:

- Size, location, and constituents of concern(both radiological and chemical) in inventory;
- Physical properties of the material, such as form, moisture content, and particle size; and
- Energy sources that could disperse the residue in inventory.

FDF has designated Silos 1 and 2 as Hazard Category 3 nuclear facilities. The current safety basis for the facility is the Basis for Interim Operations (BIOs) PL-3049, Section K (Part 7-AWR RFP, Section 3). The hazard categorization of the AWR Project systems shall be driven by the ability of the Contractor to use segmentation and define the maximum releasable inventory of residue within any segment of the process at any given time.

3.2.8.3 Methodology

The Contractor shall designate a Safety Analysis Team Leader. This person shall coordinate the development of the required safety basis documents and provide interface to FDF as to the status of these documents. This person shall complete the FDF required training for a Technically Responsible (TR) individual and a Qualified Safety Evaluator (QSE). If a SAR or a Hazard Analysis Report (HAR) is required, this person shall perform the screens required for any Unreviewed Safety Questions (USQ).

If a SAR or a HAR is required, FDF shall perform the USQ Safety Evaluation for any screen that is determined to be a possible USQ. The Contractor shall support FDF in the safety evaluation by providing calculations and analysis, as necessary.

3.2.8.4 Safety Basis Documentation Submittals

The Hazard Category/Safety Basis documentation submittals shall consist of four phases:

3.2.8.4.1 Pre-award with Proposal

The Contractor shall produce a Preliminary Hazard Analysis (PHA) for each segment of the project Along with the PHA, the Contractor shall determine the preliminary hazard category for the identified project segments using the supplied data for the silos and submit this data along with supporting hazard category calculations with the PHA for each segment.

The Contractor shall use Figure 3-1, Safety Analysis Approach for TWRS Logic Diagram, as a guide, and submit a draft Safety Basis Documentation Implementation Plan. The content and format are described in section 3.2.6.1.

3.2.8.4.2 Safety Basis Submittals With Design

The Contractor shall submit the draft safety basis documents as specified in Table 3-1 for each segment of the operation for FDF review and approval. Safety basis documentation shall be updated as indicated in Table 3-2. These updates shall be forwarded to FDF for review and approval as part of the mobilization/construction work package.

Depending on the hazard classification and the complexity of the operation, further hazard analysis (e.g., HAZOP, What-if, etc.) may be required. At a minimum, an ALARA Analysis, Human Factors Analysis, and a Fire Hazard Analysis (FHA) shall be performed in addition to the Preliminary Hazard Analysis. The Contractor shall use the guidelines of DOE-STD-1027-92 to determine the depth of hazard analysis required for the identified activities.

The team performing the hazard analysis shall contain representation from all disciplines supporting the project and consist of FDF and Contractor employees. A copy of the final documentation shall be forwarded to FDF for inclusion in the project Administrative Record. The Contractor shall include the Hazard Analysis in the overall project schedule.

Guidelines for hazard analysis techniques can be found in "Guidelines for Hazard Evaluation Procedures," Second Edition, Center for Chemical Process Safety.

The ALARA analysis shall focus on exposure points to the workers, co-located workers and the public. The Contractor shall use the OU4 ALARA Evaluation as a starting point for the analysis. The analysis shall be used to support the Occupational ALARA Plan identified in Part 8-AWR RFP, Section C.2.2.2.1, and the safety basis for the AWR project.

A Human Factors Evaluation (HFE) shall be performed. The evaluation shall focus on addressing the issues associated with the new facilities and shall include an evaluation of the existing HFE for OU4. The results of the HFE shall be incorporated into the safety basis.

A Fire Hazards Analyses (FHA) shall be performed and meet the requirements of DOE Order 420.1 and DOE Order 440.1. Examples of facilities for which an FHA shall be performed are nuclear and high-hazard facilities, buildings in which significant quantities of hazardous materials are stored or processed, and structures featuring equipment of considerable value. These examples encompass new facilities as well as significant renovations to existing facilities. Examples of facilities not generally requiring an FHA include small utility buildings, trailers, and office buildings. The FHA shall contain, at a minimum, the elements identified in the Implementation Guide for use with DOE Orders 420.1 and 440.1. The results of the FHA shall be incorporated into the Safety Basis.

The Contractor shall coordinate land use with the FDF Health and Safety representative for the silos prior to finalization of land use. Failure to do so could present an USQ, and jeopardize the safety basis for co-located facilities.

As part of the conceptual, preliminary, and final design submittals by the Contractor all design changes from reviewed and approved submittals shall be evaluated against the safety basis and the evaluation included in the safety assessment submittal.

Approval of the safety basis documents (PSAR, HAR, ASR) shall be required for authorization to mobilize and authorization to procure equipment and material for Hazard Category 3 (HC-3) facilities.

3.2.8.4.3 Approval of Safety Basis

Once the safety basis documents receive approval and authorization to mobilize has been received, all design changes shall be evaluated. For a HC-3 nuclear facility, the evaluation shall be performed using the USQ process. In addition to the design change submittals to FDF Engineering, the design change with an USQ screen as identified in NS-0003 and supporting analysis shall be submitted to FDF Safety Analysis for the USQ safety evaluation.

3.2.8.4.3.1 Incorporating Lessons Learned

Upon completion of ICAT and SOT, the Contractor shall incorporate lessons learned from the operations and USQs into the final safety basis. The final safety basis shall be reviewed and approved by FDF. DOE approval shall be required for all HC-3 and above nuclear facilities.

3.2.8.5 Submittal Schedule

Refer to Tables 3-2 through 3-7 for specific submittal requirements.

3.2.8.6 Documentation Requirements

Safety basis documentation shall be prepared using a graded approach, which keeps the rigor and depth of defense for each assessment in proportion to the hazards present. The Contractor shall provide a Safety Basis Documentation Implementation Plan which shall identify the facility segments and propose the level of safety basis documentation to be prepared for each.

3.2.8.6.1 Safety Basis Documentation Implementation Plan

As a minimum, the following information shall be provided in the Safety Basis Documentation Implementation Plan:

- Identification and basic description of the segments;
- Preliminary site plan indicating the segment locations with respect to each other and at least two FEMP landmarks;
- Preliminary process block diagram;
- Level of safety basis documentation proposed for each segment. As a minimum, preliminary hazard assessments (PHA) and hazard category calculations (Sections 3.2.8.6.4 and 3.2.8.6.3, respectively) shall be provided; and
- Schedule (incorporated into the project schedule) for each segment and completion of proposed segment documentation with review and approval times for FDF personnel, including, silos waste and safety analysis team.

3.2.8.6.2 PHA for Each Identified Segments

As a minimum, the following information shall be provided with these assessments:

- Identification of facility, process, or operation segment.
- Identification of the tasks and subtasks involved.
- PHA tables shall be prepared for each task and subtask in a format similar to the attached sample table (Table 3-1). PHA evaluation parameters are:
  - Item Number;
  - Potential Hazard/Bounding accidents;
  - Cause(s);
  - Protection/Mitigative Systems;
  - Consequences;
  - Frequency of Occurrence;
  - Ranking; and

- Action Item/Comment;
- Text executive summary of the PHA.
- Text conclusion of the PHA, which identifies items of concern or major concerns based on their ranking and how these concerns are to be resolved (e.g., project procedure, health and safety plan provisions, or recommended process redesign).

NS-0003, "Safety Assessment Hazard Screening and Classification," shall be used as a guideline for frequency of occurrence and ranking of potential hazards.

3.2.8.6.3 Hazard Category Calculations for Each Identified Segment

At a minimum, the following information shall be provided with these calculations:

- Identification of facility, process, or operational segments.
- Identification of chemical inventories and concentrations, and radiological inventory by isotope, including progeny.
- Identification of bounding accidents from PHA.
- Determination of Hazard Category 3 threshold limits.
- Identification of equations, methodology, and computer models used.
- One annotated worked example for each bounding accident. At a minimum, this annotated worked example shall include:
  - The equations used and the source of those equations;
  - Definition of the individual equation parameters [e.g., Airborne Release Fraction (ARF), which is unitless];
  - Input values to the individual equation parameters; and
  - Text describing the accident.
- Summary table listing the "potentially releasable inventory," as defined in DOE-STD-1027-92 for each segment, and accident.
- Summary chart or diagram showing the "potentially releasable inventory" for each segment, and accident with respect to Hazard Category 3 thresholds, 40 CFR Part 302 Appendix B levels, and 40 CFR Part 302, table, and 40 CFR Part 302.4 levels.
- Radiological dose estimates shall be determined for workers, co-located workers, and off-site populations. The dose estimates shall be plotted on a summary chart or diagram showing their relationship with the associated FEMP administrative limits. At a minimum, Total Effective Dose Equivalents (TEDE) shall be provided for the following:
  - Workers and co-located workers 30 m and 100 m from the analyzed accident;
  - Workers and co-located workers in the nearest regularly occupied building or work area. FDF shall provide location for these workers after the first draft equipment or facility layouts are issued by the Contractor; and
  - The maximally exposed individual (MEI); and
- Text executive summary of the Hazard Category calculation results.

3.2.8.6.4 Safety Assessment for Each Identified Segment

This document shall provide an compilation of the Safety Basis Analyses. At a minimum, this assessment shall include the following sections:

- Purpose
- Description of the facility, process, or operational segments. Suggested subsections include:
  - Identification of facility, process, or operational segments;
  - Text description of the facility, process, or operation under assessment;
  - Block flow diagram of the facility, process, or operation under assessment; and
  - General arrangement or site area plans.
- Summary and hazard classification/category. Suggested subsections include:
  - Identification of evaluation basis parameters used to determine hazard category;
  - Summary of the hazard category calculation results for the facility, process, or operation segment being assessed; and
  - Summary of the required level of new documentation required, the appropriate level of approval, and any interaction with DOE in defining the documentation requirement and/or the level of approval.
- Preliminary Hazard Assessment. Suggested content includes:
  - Summary of the PHA results for the facility, process, or operational segment being assessed.
- Radiological Hazards. Suggested content includes:
  - Identification of all radiological hazards;
  - Summary and discussion of the radiological HC calculations; and
  - Summary and discussion of estimated radiological doses to workers, co-located workers, and off-site populations determined in the hazard category calculations for the facility, process, or operational segment being assessed.
- Non radiological Hazards. Suggested content includes:
  - Identification of all non radiological (i.e., chemical or biological) hazards; and
  - Summary and discussion of the nonradiological hazard category calculations.
- Industrial Hazards. Suggested content includes:
  - Identification of all standard and nonstandard industrial hazards; and
  - Summary and discussion of the PHA conclusions for the facility, process, or operational segment being assessed.
- Conclusions. Suggested content includes:
  - Summary of hazard category calculations;
  - Summary of PHA conclusions; and
  - Additional safety basis documentation requirements based on DOE-EM-STD-5502-94, "Hazard Baseline Documentation."

- Commitments. Suggested content includes:
  - Identification of situations that could change the evaluation basis parameters;
  - Identification of actions that the Contractor shall take to ensure these situations shall be detected before the evaluation basis is impacted;
  - Identification of actions that the Contractor shall take to ensure that the existing evaluation basis is maintained.
- References

3.2.8.6.5 Additional Safety Basis Documents

In addition to the Safety Assessment the following safety basis documents may apply:

- Preliminary Safety Analysis Report (PSAR) is required for design, construction, and testing of a new HC-3 and above nuclear facility. The PSAR shall be developed using the guidelines of site procedure NS-0005, Safety Analysis Reports and Technical Safety Requirements (Part 7-AWR RFP, Section 3) and DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Non Reactor Nuclear Facility Safety Analysis Reports." The PSAR requires FDF and DOE concurrence and concurrence is required prior to purchasing equipment and materials for construction. Upon concurrence of the PSAR the USQ process shall be implemented.

- SAR is required for a HC-3 nuclear facility, which is the current hazard category for Silos 1 and 2. A SAR is developed from the PSAR, use of the guidelines of site procedure NS-0005, "Safety Analysis Reports and Technical Safety Requirements (Part 7-AWR RFP, Section 3)," and DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Non Reactor Nuclear Facility Safety Analysis Reports (Part 7-AWR RFP, Section 5)." It requires FDF, and DOE concurrence and requires implementation of the USQ process, NS-0002, "Unreviewed Safety Question (USQ) Determination and Safety Evaluation System". A HC-3 nuclear facility requires an ORR. The review is completed in two phases. The first review is performed by a team of FDF employees; approval is required prior to declaring readiness to the DOE. The second review is completed by a team of DOE employees established by the DOE Ohio field office and their approval is required prior to authorization to operate the facility.

- HAR is a graded SAR. A HAR is required for a HC-3 facility when it is determined that a graded SAR can be applied. It does not require the full seventeen chapters of a SAR. A HAR requires FDF and DOE concurrence and requires implementation of the USQ process, NS-0002.

- Auditable Safety Record (ASR) is required for facilities meeting the thresholds of a radiological facility. An ASR requires FDF approval. A radiological facility requires, as a minimum, a Standard Startup Review (SSR). The review is performed by a team of FDF employees whose approval is required prior to authorization to operate the facility.

- Safety Assessment (SA) is required for all new activities at the FEMP and is the first step for all levels of safety documentation.

3.2.8.7 References

The following documents shall be used in the development of the Safety Basis Documentation (Part 7-AWR RFP):

- DOE-EM-STD-5502-94, "Hazard Baseline Documentation";
- DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports";
- DOE-STD-3005-YR PROPOSED, "Evaluation Guidelines for Accident Analysis of Safety Structures, Systems, and Components";
- DOE-STD-3009-93, "Preparation Guide for U. S. Department of Energy Non reactor Nuclear Facility Safety Analysis Reports";
- NS-0002, "Unreviewed Safety Question (USQ) Determination and Safety Evaluation System";
- NS-0003, "Safety Assessment Hazard Screening and Classification";
- NS-0004, "Auditable Safety Record";
- NS-0005, "Safety Analysis Report and Technical Safety Requirements"; and
- "Guidelines for Hazard Evaluation Procedures"; second edition, Center for Chemical Process Safety.

Figure 3-1
Safety Analysis Approach for TWRS Logic Diagram

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Table 3-1 Preliminary Hazard Analysis

Preliminary Hazard Assessment Project Title	Hazard Category	
	Issue Date	
	Analysis	
	Project Stage	

Basis Document:

Task:

Hazard Selection Criteria	• Worker exposure to physical, chemical or radiological hazards while performing the identified task/subtask • Spread of contamination due to inadequate administrative controls • Release of toxic or radiological materials to the atmosphere, ground, or groundwater due to catastrophic failure of a system, structure, or component

Subtask:

Item	Potential Hazard	Cause(s)	Protection and Mitigative Systems	Consequences	Frequency of Occurrence	Significant Hazard	Action Item / Comment

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Table 3-2 Safety Basis Documentation Submittal Matrix

Document	Attachment	Submittals		Timing	Update	Document Control
		Type [1]	Minimum FDF Review Cycle, Working Days per Submittal			
1 Safety Basis Documentation Implementation Plan	3.2.8.6.1	• Final	10	Final approval prior to initiation of Preliminary Hazard Category Calculations and Safety Assessment	None	Yes
2 Preliminary Hazard Assessment	3.2.8.6.2	• Conceptual Design • Preliminary Design • Final Design	10	Final approval prior to Safety Assessment Final Submittal	As needed due to change in evaluation basis	Yes
3 Hazard Category Calculations	3.2.8.6.3	• Conceptual Design • Preliminary Design • Final	10	Final approval prior to Safety Assessment Final Submittal	As needed due to change in evaluation basis	Yes
4 Safety Assessment	3.2.8.6.4	• Conceptual Design • Preliminary Design • Final Design	10	Final approval required for authorization to mobilize	Annual (DOE 5480.23)	Yes
5 Safety Basis Document	3.2.8.6.5	• Conceptual Design • Preliminary Design • Final	20	- Final due at final design - Final approval required for authorization to mobilize	Annual (DOE 5480.23)	Yes
6 Hazard Analysis	3.2.8.6.2	• Report w/Analysis	10	Prior to Authorization to Operate	As needed due to change in evaluation basis	Yes

Note (1): DOE shall get equal review and approval time as FDF for all Safety Basis documents requiring DOE approval.
Note (2): FDF and ISRC review and approval will be concurrent.

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Table 3-3 Safety Basis Documentation Implementation Plan Submittal Matrix

	Key:	o Partial or Draft ● Complete	
	Item	**With Proposal**	**Final Submittal**
1	Identification and basis description of the segments including initial calculations.	●	
2	Preliminary site plan indicating the segment locations with respect to each other and at least two FEMP landmarks.	o	●
3	Preliminary block diagram.	●	
4	Level of documentation proposed for each segment.	●	
5	Schedule for each segment and level of documentation.	o	●

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Table 3-4 Hazard Category Calculation Submittal Matrix

Key:	o Partial or Draft • Complete			
Item	With Proposal	Conceptual Submittal	Preliminary Submittal	Final Submittal
1 Submittal section titles.	•			
2 Submittal section abstract in 25 words or less.	•			
3 Submittal subsection titles.	•			
4 List of open items for which the Contractor would like clarification.	o	o		
5 Contractor recommendations for further investigation or inclusion to the scope of work.	o	o		
6 Identification of facility, process, or operation segments.	o	•		
7 Identification of material inventories.	o	o	•	
8 Identification of the radiological and chemical constituents of concern and their concentrations.		o	•	
9 Identification of evaluation basis parameters.	o	•		
10 Identification of accidents.	o	•		
11 Identification of equations, methodology, and computer models used.	o	•		
12 One annotated worked example for each accident.		o		•
13 Summary table listing the "potentially releasable inventory" for each segment, and accident.			o	•
14 Summary chart or diagram showing the "potentially releasable inventory" for each segment and accident with respect to hazard classification thresholds, 40 CFR 302 Appendix B levels, 29 CFR 1910.119 or 40 CFR 355 thresholds, and 40 CFR 302 Table 40 CFR 302.4 levels.			o	•
15 Radiological dose estimates for workers, co-located workers, and off-site populations.			o	•
16 Summary chart or diagram of radiological dose estimates with respect to the associated FEMP administrative limits.			o	•
17 Text executive summary of the hazard category calculations results.			o	•
18 Hard and electronic copies of spreadsheets and/or computer printouts generated as part of each segment Hazard Category calculation.				•

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Table 3-5 Preliminary Hazard Assessment (PHA) Submittal Matrix

Key:	o Partial or Draft • Complete			
Item	With Proposal	Conceptual Submittal	Preliminary Submittal	Final Submittal
1 Submittal section titles.	•			
2 Submittal section abstract in 25 words or less.	•			
3 Submittal subsection titles.	•			
4 List of open items for which the Contractor would like clarification.	o	o	•	
5 Contractor recommendations for further investigation or inclusion to the scope of work.	o	o	•	
6 Identification of facility, process, or operational segments.	o	•		
7 Identification of tasks and subtasks involved.	o	o	•	
8 PHA tables with the column entries for the item number and potential hazard.	o	o	•	
9 PHA tables with the following column entries: cause(s), protection/mitigative systems, consequences, and action item/comment.	o	o	•	
10 PHA tables with column entries for the frequency of occurrence and ranking.		o		•
11 Text executive summary.		o		•
12 Text conclusion which identifies the items are items of concern or major concern based on their ranking.		o		•
13 Text conclusion which identifies how the items of concern or major concern are to be resolved.		o		•

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Table 3-6 Safety Assessment Submittal Matrix

Key:	o Partial or Draft • Complete		
Item	**Conceptual Submittal**	**Preliminary Submittal**	**Final Submittal**
1 Submittal section titles	•		
2 Submittal section abstract in 25 words or less, unless otherwise noted on this matrix.	•		
3 Submittal subsection titles.	•		
4 List of open items for which the Contractor would like clarification.	o	•	
5 Contractor recommendations for further investigation or inclusion to the scope of work.	o	•	
6 Purpose		•	
7 Description of the facility, process, or operational segments	o	•	
8 Summary and hazard classification/category	o	•	
9 Preliminary hazard assessment	o	•	
10 Radiological hazards		o	•
11 Non-radiological hazards		o	•
12 Industrial hazards		o	•
13 Conclusions		o	•
14 Commitments		o	•
15 Design Changes from Previously Approved Submittal.		•	•
16 References		o	•

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Table 3-7 Safety Basis Submittal Matrix (SAR, HAR, ASR, or SA)

Key:	o Partial or Draft • Complete		
Item	Conceptual Submittal	Preliminary Submittal	Final Submittal
1 Submittal section titles (PSAR, SAR shall use the format in DOE-STD-3009-94).	•		
2 Submittal section abstract in 25 words or less, unless otherwise noted on this matrix.	•		
3 Submittal subsection titles.	•		
4 List of open items for which the Contractor would like clarification.	o	•	
5 Contractor recommendations for further investigation or inclusion to the scope of work.	o	•	
6 Purpose		•	
7 Description of the facility, process, or operational segments	o	•	
8 Summary and hazard classification/category	o	•	
9 Preliminary hazard assessment	o	•	
10 Radiological hazards.		o	•
11 Non-radiological hazards		o	•
12 Industrial hazards		o	•
13 Conclusions		o	•
14 Commitments		o	•
15 References		o	•

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3.3 Definition of Deliverables

This sections defines the minimum requirements of the deliverables specified in Section 3.2. Letter revisions of documents shall be considered preliminary and need not be configuration controlled. Number revisions of documents, starting with 0, shall be considered part of the project baseline and subject to configuration control.

Documents submitted to FDF for the first time shall contain sufficient information to describe the main systems, structure, or components (SSC) and identify primary interfaces. Documents submitted a second or third time to FDF, but not released as revision 0 shall include increasingly more detail. All SSCs shall be described in an appropriate level of detail and all interfaces shall be identified. Documents submitted as revision 0 shall be considered final and include complete detail on all SSCs and all interfaces.

3.3.1 Lists

3.3.1.1 Electrical Load Summary

This is a list of electrical loads. It shall include the equipment name and number, voltage, phase, and horsepower or kilowatts.

3.3.1.2 Equipment List

This is a list of equipment. It shall contain the equipment name, number, location, functional capacity, physical size, electrical capacity, weight, materials of construction, manufacturer, model number, purchase requisition number, quality level, performance grade, and any special notes. The equipment number shall contain the system number, equipment designator, and trainer designator.

3.3.1.3 Instrument List

This is a list of all process sensors and field measurement devices. It shall contain the instrument name, number, location, function, loop number, manufacturer, model number, wetted materials construction, purchase requisition number, setpoints, and any special notes. Instrument designators shall be in accordance with ANSI/ISA-S5.1.

3.3.1.4 Line List

This is a list of fluid lines on the project. It shall contain line numbers, the process system, the fluid being transported, service temperature and pressure, material of construction, line size, insulation and heat tracing, origin, and terminus, and other technical data used in design stress analysis, fabrication, installation, and testing. Line numbers shall indicate the process system, line size, material classification, hot or cold insulation, and heat tracing.

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3.2 Diagrams

3.3.2.1 Control System Block Diagrams

This is a schematic diagram depicting the basic control system components and clearly defines major hardware and operator interfaces. Hardware interconnections illustrate the relationship between major hardware, communication networks, human machine interfaces, peripherals and any external system.

3.3.2.2 Electrical One-Line Diagram

This is a schematic diagram of the electrical distribution system. It shall include all electrical loads, transformers, disconnects, and circuit breakers. It shall include line numbers and wire sizes.

3.3.2.3 Heat and Material Balance

This is a list of flows, temperatures, pressures, residue, and concentrations, for key flow streams, identified on the process flow diagram by stream number. It may be placed directly on the process flow diagram or in an attached table.

3.3.2.4 HVAC Flow and Control Diagram

This is a schematic diagram that depicts the system design necessary to fulfill the functional requirements of the heating, ventilating, and air conditioning system. It is similar to a process flow diagram. It shall include all equipment, systems, components, air flows and directions, air temperatures, duct sizes, materials of construction, and performance grade.

3.3.2.5 Metallurgical Diagram

This is a diagram, based on the process flow diagram, that depicts the metallurgy requirements for all equipment, instrumentation, piping, and valves. This information shall be incorporated into the equipment list, instrument list, line list, and valve list.

3.3.2.6 Piping and Instrumentation Diagram

The Piping and Instrumentation Diagram is a schematic diagram that depicts the system design and control logic. It shows all equipment, instrumentation, controls, valves, and interconnecting piping (with their respective numbers). The P&ID shows interfaces to other systems, tie-in points to existing utilities, and performance grade breaks.

3.3.2.7 Process Flow Diagram

This is a schematic diagram that shows all major equipment with name and equipment number, and interconnecting main piping with stream numbers corresponding to the heat and material balances. Utility services are shown to the extent required to clarify their function in the process.

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3.3.3 Drawings

3.3.3.1 General Arrangement Drawing

This is a scale drawing that shows the location of all equipment and facilities. It shall include all major equipment, power panels, motor control centers, transformers, instrument panels, etc., with equipment numbers.

The location control plan shall show the locations of hard and soft items that require space. Hard items are structures, equipment, or physical obstructions that are permanent. Soft items are items such as clearances, passageways, maintenance removal/lay down and repair spaces.

3.3.3.2 Paving and Grading Plans

This is a scale drawing that depicts all road details and grading plans.

3.3.3.3 Radiation Zone Drawing

This is a scale drawing that shows the expected radiation zones in all facilities. The radiation zone drawing depicts the application of the ALARA philosophy (see reference in Part 7-AWR RFP, Section 3, "OU4 Silos Project ALARA Evaluation"). The drawing divides the facility into radiological areas based upon the radiological requirements in accordance with the ALARA philosophy. It segments the facility into radiological areas and provides guidelines for operations and maintenance maximum allowable durations in those areas.

3.3.3.4 Site Plot Plan

This is a scale drawing that depicts the location of all facilities and major equipment on the site. It includes existing site features.

3.3.3.5 Storm Water Drainage Plan

Storm water drainage is a topographical representation of the site design. It shall depicts the SSCs and grading used to direct or remove storm water from the site around the new facility. It shows the direction of drainage, the method used and tie-in points to the existing system.

3.3.3.6 Tie-In Drawings

This drawing shows the locations, superimposed on a plot plan, and details of all connections to site utilities. This shall include, but not be limited to domestic water, fire water, and electrical.

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3.3.4 Descriptions

3.3.4.1 Data Sheets

This is a one to two page summary of the physical and functional parameters for a piece of equipment. It is primarily used is as an attachment to a specification.

3.3.4.2 Functional Analysis

A functional analysis is a structured methodology employed early in the engineering design process to determine the requirements that define the scope of the project. This procedure is a logical step-by-step analysis used to identify and develop the functions required to be performed in order to meet the project objectives. The functional analysis identifies the requirements for performing a process or mechanical function without dictating the physical design or specific technology and/or process of that function. It defines boundaries to functions, identifies the various systems or steps that shall be required to perform the identified functions, establishes logical functional relationships, and presents the information as a hierarchy of modular functions. A functional analysis consists of two components: the Functional Analysis Diagram, and the Functional Analysis Document.

The Functional Analysis Diagram is developed to present a hierarchy of functions (including technical, safety, and environmental functional requirements) that shall be required in order to satisfy project objectives. This diagram provides a basis that is developed into the Functional Analysis Document. The Functional Analysis Document defines each function in terms of its scope, relations, and interfaces, and is used to transition from analyzing a function to identifying component elements, substantive requirements, and associated functions. This document also identifies preliminary system requirements and begins to produce specific technical requirements.

3.3.4.3 Process Description

This is a general written description of the system process. It shall discuss such things as flows, major equipment, processing steps, control philosophy, temperatures, pressures, etc..

3.3.4.4 System Design Description

This is a complete, detailed description of the system. It shall include information from the process description plus a complete description of all equipment and instrumentation in the system and all applicable codes and standards for the SSCs used in the system.

3.4 Construction Documentation Definitions

3.4.1 Construction Acceptance Testing

3.4.1.1 Construction Acceptance Test Plan

The Contractor shall be responsible for the preparation and implementation of the AWR Construction Acceptance Testing (CAT) Plan. FDF shall review and approve the CAT Plan.

The CAT Plan shall identify the systems and equipment requiring CAT. CAT is defined as testing performed to verify that components, systems, structures have been constructed and installed correctly, and operate as intended.

The CAT Plan shall describe:

- Test Planning;
- Testing Execution;
- Documentation of Activities and Testing to Ensure:
  - Construction is in Accordance with:
    - Design Requirements;
    - Regulations;
    - Codes;
    - Standards; and
  - Components, systems, and structures are installed and constructed correctly, and operate as intended.

The AWR CAT Plan shall specify:

- The designated responsibilities of FDF and Contractor personnel for construction and testing activities;
- Contractor / FDF Interfaces;
- Prerequisites to performance of construction testing activities;
- Personnel training and qualification requirements; and
- The program for preparation of testing and verification documentation in accordance with ACR-002-Silo's.

3.4.1.2 Safe Work Plan Requirements

The safe work plan will be utilized to develop the project construction turnover package. The safe work plan/turnover package shall include all CAT, Integrated Construction Acceptance Testing, and full-scale mock-up demonstration documentation. These safe work plan/turnover packages shall be controlled in accordance with the Contractors document control program. The CAT requirements define the specific testing to be performed. ACR-002-Silo's provides examples of this testing and the associated documentation. A Safe Work Plan shall be used to control and document these CAT activities. A Safe Work Plan is defined as a controlled package of instructions for performing special work processes, instructions for performing the verification of the construction work through inspection and examinations, and forms for documenting the performance and/or verification of construction work. The scope of the Safe Work Plan instructions and documentation is a function of the Performance Grade/Quality Level of the work.

Safe Work Plans shall include the following:

- Safe Work Plan Cover/Approval Sheet;
- Safe Work Plan Revision Record (not required for Revision 0, initial issue of the documentation/record);
- Manufacturer's Instructions;
- Specifications;
- Safe Work Plan Documentation Index;
- Certified for Construction Installation Drawings and any approved Design Change Notices issued against the drawings; and
- Construction Verification Checklist (This form would be added to the documentation/record by the Construction Engineer (CE) when a surveillance verification has been performed on the work identified in the documentation/record).

The following is a list of typical forms, records, and documents which support this testing and may be included as part of the Safe Work, Records Plan (ACR-002-Silos):

- Safe Work Plan Record/Forms

  The following is a list of records that may be required for documentation of work activities within various construction disciplines and the forms that may be included in the Safe Work Plans if required by the specific work scope:

  - Civil Documentation/Records:
    - Building Inspection Record;
    - Coatings Inspection Record;
    - Compaction Test Card;
    - Concrete Pour Card;
    - Grout/Drypack Placement Form;
    - Grout Inspection Record; and
    - Site Survey Data Record.

  - Electrical Documentation/Records:
    - Cable Pull Verification Record;
    - Cable Splice Inspection Record;
    - Cable Termination Verification Record;
    - Circuit Breaker Verification Record;
    - Conduit Sealing Inspection Record;
    - Electrical Heat Tracing Inspection Record;
    - Electrical Heat Tracing Test Record;
    - Grounding System Verification Record;
    - Hi Pot Test Record;
    - Insulation Resistance Test Record;
    - Large Electrical Motor Verification Record;
    - Switch Gear Inspection Record; and
    - Transformer Inspection Record.

- Instrumentation Documentation/Records:
  - Instruction Sheet - Instrument Installation; and
  - Instrument Calibration Record.

- Mechanical Equipment Documentation/Records:
  - Equipment Inspection Record;
  - Final Vessel Closure/Acceptance Record;
  - Instruction Sheet - Equipment Installation;
  - Insulation Inspection Record;
  - Maintenance Records; and
  - Rotating Equipment Alignment Record.

- Piping Documentation/Records:
  - Construction Piping Weld Instructions/Examinations;
  - Flange Control Record;
  - Flange Torque Sequence Sheet;
  - In-Service Leak Test Record;
  - Instruction Sheet - Piping Installation;
  - Hanger Verification Record;
  - Hydrostatic/Pneumatic Test Record;
  - Valve Removal Record; and
  - Visual Weld Examination Checklist.

3.4.2 Integrated Construction Acceptance Test

3.4.2.1 Integrated Construction Acceptance Test Plan

The Contractor shall be responsible for the preparation and implementation of the AWR Integrated Construction Acceptance Test (ICAT) Plan. FDF shall review and approve the ICAT Plan. ICAT is considered a construction activity and shall be completed following the completion of CAT and before construction turnover to startup.

- The AWR ICAT Plan shall define the following:
  - Organization;
  - Responsibilities;
  - Contractor / FDF Interfaces
  - Methodologies;
  - Standards;
  - ICAT Specification;
  - Material requirements in support of ICAT activities;
  - Temporary utility requirements in support of ICAT activities;
  - Disposal plan for any material that was used to support ICAT (in accordance with waste management program, TRD, section 5.0);
  - Process Control Parameter, Setpoint, and Instrument and Controls (I&C) Calibration Tolerance Document;
  - Acceptance Criteria;
  - Activities Associated with the ICAT Process; and

- Testing Schedule.

- The ICAT Plan shall address development of the following:
  - ICAT Procedures;
  - ICAT Training Plan for:
    - Personnel Qualification Requirements; and
    - Training of FDF personnel for ICAT.

The ICAT Plan shall be written by applying the same general guidance that is provided for development of the FDF System Operability Test (SOT) Plan. To aid in the development of an ICAT Plan that is compatible with FDF guidelines, the Contractor shall refer to the following documents that describe and provide comparable examples of the FDF SOT Plan:

- RM-0034, Startup and Turnover Requirements Manual; and
- ED-12-6003, System Operability Testing and Startup and Turnover Plan.

The Contractor shall develop a process control parameter, setpoint, and I&C calibration tolerance document. This document shall identify all process operating parameters to include acceptable ranges and optimum operational values. This shall identify all alarm and control logic setpoints. Alarm setpoints shall include appropriate limiting conditions for operation and appropriate responses to alarm actuations during operations. All control logic shall be identified by logic diagrams and include all input functions, logic types, and resulting output functions. All I&C devices (alarm modules, transmitters, signal conditioners, output devices, controllers, positioners, process monitoring devices, valves, dampers, etc.) shall have calibration points and tolerances identified in such a manner that they consider desired process control operating parameters and manufacturers accuracy and tolerances. This I&C information shall be organized to support the development of calibration data/record sheets. This document shall be kept current and shall support ICAT, SOT, and Operations.

- ICAT is the testing that is imposed on a facility or system to:
  - Verify that the performance of a system meets or exceeds design specifications;
  - Optimize operating parameters;
  - Identify problems that shall be corrected prior to AWR Startup activities;
  - Ensure that all of the AWR systems and components have been tested (to include process monitoring equipment, data acquisition, data archiving, data hard copy recording, and data trending); and
  - Prepare the AWR for Construction turnover and startup testing of all of the components, equipment, and structures of the AWR systems in preparation for turnover of the systems to startup.

3.4.2.2 ICAT Requirements

ICAT includes testing of all of the components, equipment, and structures of the AWR systems in preparation for turnover of the systems to startup.

- ICAT shall test and validate:
  - SWRS Design;
  - RCS Design;
  - DWRS Design;
  - TTA System Design;
  - TWRS Design;
  - Silo 4 Mock-Up System (FSMS) Design; and
  - All interconnections and support systems.

Depending upon the applicability to full-scale mock-up related systems, schedule, and construction completion evolutions, ICAT activities may be in progress before, during, and after the full-scale mock-up demonstration.

3.4.2.3 ICAT Procedure Development

Procedures shall be developed to support the AWR ICAT activities. The Contractor shall be responsible for the development of the procedures.

The purpose of the AWR ICAT procedures is to provide specific, step-by-step guidance, methods, and documentation for testing of the AWR systems and equipment that require testing prior to Construction turnover to startup.

The ICAT procedures shall include the applicable performance sequence and specific acceptance criteria required to ensure that each system and piece of equipment is thoroughly tested relative to its operation functions. The test procedure shall verify that the performance of a system meets or exceeds design specifications, optimizes the operating parameters, and identify any problems that must be corrected before construction turnover to startup.

The Contractor shall develop the ICAT procedures using DOE-STD-1029-92 and AWR operational system requirements as guidelines (refer to TRD, Section 2.3). The procedures shall provide for performance verification and shall address independent verification as applicable. The procedures shall provide for collection of data and for the verification of completed testing activities. The Contractor shall consider and incorporate the elements of RM-0020, Radiological Controls Requirements Manual and RM-0021, Safety Performance Requirements Manual into the ICAT procedures. The ICAT procedures shall be developed in such a manner that the Contractor may easily convert them into System Operability Test (SOT) procedure format, as applicable. ICAT procedure development is the first stage in the procedure development and validation in support of the SOT process. This process is completed by Construction and coordinated with the startup organization. The Contractor shall refer to the following for general guidance when developing the ICAT procedures(Part7-AWR RFP, Section 3):

- RM-0034, Startup and Turnover Requirements Manual; and
- ED-12-6003, System Operability Testing and Startup and Turnover Plan.

The procedural format may include sections that provide:

- Cover Sheet with Approval Signatures;
- Table of Residue;
- Purpose/Scope;
- Test Requirements;
- References/Drivers;
- Prerequisites;
- Test Equipment;
- Special Conditions or Setup;
- Precautions and Limitations;
- Detailed Test Procedure;
- Data Required and Acceptance Criteria;
- Data Record Sheets;
- Pretest Briefing Record;
- Performance Signature Record Log;
- Procedure Completion Verification Signature Sheet; and
- Other Supporting Attachments.

3.4.2.4 Final ICAT Report

A Final ICAT Report shall be written upon completion of the ICAT activities. This report shall identify any lessons learned during the testing performance and shall be reviewed and approved by FDF. The Final ICAT Report shall include:

- Comparison of test data to acceptance criteria;
- Compilation of test records (charts, graphs, tables, sign-off sheets, etc.);
- Identification of discrepancies and relative resolutions;
- Identification of procedural changes as a result of testing;
- Identification of test exceptions and dispositions; and
- Recommendations for any changes to operating procedures and drawings.

The Final ICAT Report shall document:

- Jumpers removed and systems restored;
- Outstanding Work Requests;
- Engineering Design Drawing changes issued as a result of testing;
- Test Data documenting successful test completion;
- Directions regarding the disposition of test equipment used; and
- Preliminary engineering review of test performance data.

3.4.3 Full-Scale Mock-Up Demonstration

3.4.3.1 Full-Scale Mock-Up Demonstration Plan

Contractor shall be responsible for preparation and implementation of the Full-Scale Mock-Up Demonstration Plan. FDF shall review and approve the Full-Scale Mock-Up Demonstration Plan.

The Full-Scale Mock-Up Demonstration Plan shall identify the purpose, scope, and objectives of the full-scale mock-up demonstration as identified in Section 2.3.1.7, Full-Scale Mock-Up System. The Full-Scale Mock-Up Demonstration Plan shall define the following:

- Organization;
- Responsibilities;
- Methodologies;
- Standards;
- Demonstration Scope;
- Demonstration Specifications;
- Demonstration Requirements;
- Calibration, Grooming, and Alignment activities for full-scale mock-up demonstration;
- Demonstration Acceptance Criteria;
- Identification of activities associated with Full-Scale Mock-Up Demonstration;
- Full-scale mock-up demonstration schedule;
- Material requirements in support of full-scale mock-up demonstration activities;
- Temporary utility requirements in support of full-scale mock-up demonstration activities; and
- Disposal Plan for any material that was used to support Full-Scale Mock-Up Demonstration (in accordance with Section 5.0).

3.4.3.2 Full-Scale Mock-Up Requirements

Full-Scale Mock-Up is the demonstration of retrieval activities utilizing FSMS and support equipment for AWR surrogate retrieval and transfer to the TTA (AWR Surrogate formulation is as listed in Appendix G). Full-Scale Mock-Up Demonstration shall be consistent with the system requirements as stated in Section 2.3.1.7, and shall minimally test and validate:

- FSMS Design for:
  - Successful removal of AWR surrogate from Silo 4 using typical SSCs specified in SWRS design;
  - Performance of AWR equipment which shall be used during operations;
  - Retrieval from areas within the silo that may pose a challenge for the specific removal process;
  - Removal from the heel area;
  - Removal of discrete objects and separation of discrete objects from the AWR surrogate stream;
  - Washdown of silos 1 and 2 interior walls;
  - Gross decontamination of interior walls;
  - Sampling capabilities for collection of FDF required archive samples during

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FDMS transfer to the TTA; and
- Transfer of removed AWR surrogate to the TTA.

- TTA Design for:
  - Successful containment and management of AWR surrogate;
  - Dewatering of AWR surrogate stored in the TTA;
  - Handling of the water/BentoGrout™ mixture removed from the TTA;
  - Sampling capabilities at the TTA to support surrogate settling and decanting; and
  - Waste water treatment demonstration to meet AWWT Acceptance Criteria.

- TWRS Design for:
  - Removal of the AWR surrogate from the TTA at the design transfer rate of the TWRS (refer to Table 2-6); and
  - Transfer of the AWR surrogate from the TTA to the Full-Scale Remediation Facility.
- RCS Design for:
  - Silo 4 headspace gas negative pressure control;
  - Simulation of radon control; and
  - Equipment ingress and egress.

The Contractor shall present FDF with a comprehensive Full-Scale Mock-Up Demonstration Plan for review and approval.

3.4.3.3 Discrete Objects for Full-Scale Mock-Up Retrieval Demonstration

The Contractor shall demonstrate successful removal of discrete objects during the of Full-Scale Mock-Up Demonstration. Specific discrete objects have been identified as existing in the silos. The following list of objects shall be included as items to be removed during full-scale mock-up demonstration. The Contractor shall configure the full-scale mock-up demonstration to conform with the FSMS functional analysis.

<u>Demonstration Objects for Removal</u>

<u>Sample Containers - Size</u>

Glass	-	1 pint
	-	1 gallon
Plastic	-	1 pint
	-	1 gallon
Hard Hat	-	plastic
Piping	-	6 foot length 2 inch PVC
	-	6 foot length 2 inch carbon steel
Tools	-	Pipe wrench - 10"
Gaskets	-	neoprene - 2 foot diameter
Angle iron	-	6 foot length 2" x 2"
Glove Bag	-	3 foot diameter, 4 foot length

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Permanently installed AWR system equipment shall be used to the extent possible to support full-scale mock-up testing. The transfer of AWR surrogate from the TTA to the Full-Scale Remediation Facility shall be simulated to represent actual proposed transfer piping length, size, and flow dynamics/rates.

3.4.3.4 Full-Scale Mock-Up Demonstration Procedures

The Contractor shall be responsible for the preparation of the full-scale mock-up demonstration procedures in accordance with RM-0029. FDF shall review and approve the documents prior to implementation. The full-scale mock-up demonstration procedures shall be developed such that a qualified operator can perform operations activities having verified that there will be no harm to the personnel, public, property, or environment. Full-scale mock-up demonstration procedures shall be developed for all anticipated operations, evolutions, tests, alarm response, and abnormal or emergency situations. The Contractor shall consider and incorporate the elements of RM-0020, Radiological Controls Requirements Manual and RM-0021, Safety Performance Requirements Manual into the full-scale mock-up demonstration procedures.

3.4.3.4.1 Elements of Full-Scale Mock-Up Demonstration Procedures

The following elements of full-scale mock-up demonstration procedures shall be required:

- Cover Page;
- Table of Contents;
- Revision Table;
- Purpose;
- Scope;
- References;
- Responsibilities;
- Contractor / FDF Interfaces;
- General Provisions;
- Prerequisites;
- Procedures for tasks;
- Drivers; and
- Definitions.

Each element shall be clearly developed for the specific scope of the procedure and sufficiently detailed to perform the required functions without direct supervision.

3.4.3.4.2 Requirements of the Full-Scale Mock-Up Demonstration Procedures

A full-scale mock-up demonstration procedure shall be developed for each demonstration activity performed for the full-scale mock-up demonstration. Each procedural step shall be presented as a separate item. In each step, each operational unit, valve, system component, switch, etc. shall be identified by its identification number. "Warnings," "Cautions," and "Notes" shall precede the steps to which they apply.

3.4.3.4.3 Reviews of the Full-Scale Mock-Up Demonstration Procedures

Each revision of the procedures shall be reviewed by all parties identified in the "responsibilities" section.

3.4.3.5 Final Full-Scale Mock-up Demonstration Report

The Contractor shall prepare and issue a final full-scale mock-up demonstration report upon completion of the demonstration activities. This report shall be reviewed and approved by FDF. This report shall address all the demonstration performance activities.

- The Final Full-Scale Mock-Up Demonstration report shall include:
  - Comparison of performance results to acceptance criteria;
  - Compilation of performance records;
  - Identification of discrepancies and relative issues;
  - Identification of procedure changes as a result of demonstration performance;
  - Identification of exceptions and relative dispositions; and
  - Recommendations for any changes to design documents and demonstration procedures.
- The Final Full-Scale Mock-Up Demonstration report shall document:
  - Jumpers removed and systems restored;
  - Outstanding work requests identified;
  - Engineering design drawing changes issued as a result of the demonstration identified;
  - Demonstration data documenting successful completion is identified;
  - Directions regarding the disposition of test equipment used is provided; and
  - Preliminary engineering review of demonstration performance data is completed.

3.5 Startup Documentation Requirements

3.5.1 Startup and Turnover Plan

The Contractor shall be responsible for the preparation and implementation of the AWR Startup and Turnover Plan. FDF shall review and approve the Startup and Turnover Plan prior to implementation.

The AWR Startup and Turnover Plan shall document the formalized process by which the AWR facility can be turned over to operations having verified that each AWR system can be started in a manner that is safe to personnel, equipment, and environment. The Startup jurisdiction for the AWR Project shall begin with acceptance of the Construction turnover to startup and end with the startup turnover to operations. The startup process and related activities shall be considered during the design process, construction activities, startup activities, and through turnover to operations. The Startup and Turnover Plan shall define acceptance criteria and activities that shall be accomplished to establish a state of operational readiness at the AWR facility.

- The AWR Startup and Turnover Plan shall define the following:
  - Organization;
  - Responsibilities;
  - Methodologies;
  - Standards;
  - Testing Scope;
  - Test Specifications;
  - Testing Requirements;
  - Calibration, Grooming, and Alignment Activities for ICAT;
  - Startup and Turnover Acceptance Criteria;
  - Identification of Activities Associated with the Startup Process; and
  - Startup Schedule with Dates.

- The Startup and Turnover Plan shall address the development of the following:
  - Procedures ;
  - Training Plans;
    - Personnel Qualification Requirements; and
    - Training of FDF personnel for Startup Activities.

To ensure the development of a Startup and Turnover Plan that complies with FDF guidelines, the Contractor shall refer to the following documents that describe and provide examples for the FDF Startup and Turnover Plan.

- RM-0034, Startup and Turnover Requirements Manual; and
- ED-12-6003, System Operability Testing and Startup and Turnover Plan.

3.5.2 System Operability Test Plan

The Contractor shall be responsible for the preparation and implementation of the AWR SOT Plan. FDF shall review and approve the SOT Plan.

- The SOT Plan shall ensure that the SOT activities are planned and completed during the period following the turnover from construction to startup and before the turnover to operations. The SOT is the testing that is imposed on a facility or system to:
  - Verify that the performance of a system meets or exceeds design specifications;
  - Optimize operating parameters;
  - Identify problems that must be corrected prior to AWR startup activities;
  - Ensure that all of the AWR systems and components have been tested (to include process monitoring equipment, data acquisition, data archiving , data hard copy recording, and data trending);
  - Provide/develop solutions for off-normal operating conditions that may occur during AWR operations (e.g., excess water inventory in the silos, excess water inventory in the TTA, material transfer rate reductions, etc.); and
  - Prepare the AWR for turnover from startup to operations.

- The AWR SOT Plan shall define the following:
  - Organization;
  - Responsibilities;
  - Methodologies;
  - Standards;
  - Material requirements in support of SOT activities;
  - Temporary utility requirements in support of SOT activities;
  - Disposal plan for any material that was used to support SOT (in accordance with waste management program, Section 5.0);
  - Acceptance Criteria;
  - Activities Associated with the SOT Process; and
  - Schedule.

- The SOT Plan shall address the development of:
  - SOT Procedures;
  - SOT Training Plan:
    - Personnel Qualification Requirements; and
    - Training of FDF personnel for SOT.

- The AWR SOT Plan shall ensure that the SOTs test and validate the AWR design of:
  - SWRS for:
    - Removal of actual silos residue;
    - Removal of discrete objects; and
    - Transfer of removed residue to the TTA.

  - TTA for:
    - Containing and handling the AWR surrogate;
    - Dewatering of the residue stored in the TTA; and
    - Handling of the water removed from the TTA.

  - TWRS for:
    - Residue removal from the TTA; and
    - Transfer of residue from the TTA to the Full-Scale Remediation Facility.

  - RCS for:
    - Silos headspace gas negative pressure control;
    - Control of radon in the silos;
    - SWRS equipment silo ingress and egress;
    - Control of radon during transfer of residue from the silos;
    - Control of radon in the TTA; and
    - Control of radon in the Full-Scale Remediation Facility.

  - DWRS for:
    - Monitoring of decant sump liquids; and
    - Transfer of decant sump liquids.

- FSMS for:
  - Removal of AWR surrogate from Silo 4 as follows:
  - The use of AWR equipment as it would be used during operations;
  - Retrieval from various strategic areas within the silo;
  - Removal from the heel area;
  - Removal of discrete objects and separations of discrete objects from the residue stream;
  - Silo interior wall washdown;
  - Gross decontamination of interior walls; and
  - Transfer of removed AWR surrogate to the TTA.

To aid in the development of a System Operability Test Plan that is compatible with FDF guidelines the Contractor shall refer to the following documents that describe and provide examples for the FDF System Operability Test Plan:

- RM-0034, Startup and Turnover Requirements Manual; and
- ED-12-6003, System Operability Testing and Startup and Turnover Plan.

3.5.3 System Operability Test Procedures

Procedures shall be developed to support the AWR System Operability Testing (SOT) activities. The Contractor shall be responsible for the development of the procedures. FDF shall review and approve the procedures.

The purpose of the AWR SOT procedures is to provide specific, step-by-step guidance, methods, and documentation for testing of the AWR systems and equipment that require testing prior to Startup turnover to Operations.

The SOT procedures shall include the applicable performance sequence and specific acceptance criteria required to ensure that each system and piece of equipment is thoroughly tested relative to its operational functions. The SOT procedure performance shall: (1) verify that the performance of a system meets or exceeds design specifications, (2) optimize the operating parameters, and (3) identify any problems that must be corrected prior to Startup turnover to Operations.

The Contractor shall develop the SOT procedures using industry standards and operational functional requirements as guidelines. The procedures shall provide for performance verification and shall address independent verification as applicable. The procedures shall provide for collection of data and for the verification of completed testing activities. The Contractor shall refer to RM-0034, Startup and Turnover Requirements Manual, for general developmental guidance. The Contractor shall consider and incorporate the elements of RM-0020, Radiological Controls Requirements Manual and RM-0021, Safety Performance Requirements Manual into SOT procedures.

The procedural format may include sections that provide:

- Cover Sheet with Approval Signatures;
- Table of Contents;
- Purpose/Scope;
- Test Requirements;
- References/Drivers;
- Prerequisites;
- Test Equipment;
- Special Conditions or Setup;
- Precautions and Limitations
- Detailed Test Procedure
- Data Required and Acceptance Criteria;
- Data Record Sheets;
- Pretest Briefing Record;
- Performance Signature Record Log; and
- Procedure Completion Verification Signature Sheet.

3.5.4 Final SOT Report

The Contractor shall prepare and issue a Final SOT Report upon completion of the SOT activities. This report shall be reviewed and approved by FDF. This report shall address the testing performance for all SOT activities. This report shall identify any lessons learned during the testing performance.

The Final SOT Report shall include:

- Comparison of test data to acceptance criteria;
- Compilation of test records (charts, graphs, tables, sign-off sheets, etc.);
- Identification of discrepancies and relative resolutions;
- Identification of procedure changes as a result of testing;
- Identification of test exceptions and dispositions; and
- Recommendations for any changes to operating procedures and drawings.

The Final SOT Report shall document that:

- Jumpers are removed and systems restored;
- Outstanding Work Requests identified;
- Engineering Design Drawing changes issued as a result of testing are identified;
- Testing data documenting successful completion is identified;
- Directions regarding the disposition of test equipment used is provided; and
- Preliminary engineering review of test performance data is completed.

3.6 Operations and Maintenance Documentation Requirements

3.6.1 Standard Operating Procedures

The Contractor shall be responsible for the preparation of the AWR Standard Operating Procedures (SOP) in accordance with RM-0029. FDF shall review and approve the documents prior to implementation. The AWR SOPs shall be developed such that a qualified operator can perform operations activities having verified that there will be no harm to the personnel, public, property, or environment. SOPs shall be developed for all anticipated operations, evolutions, tests, alarm response, and abnormal or emergency situations. The Contractor shall consider and incorporate the elements of RM-0020, Radiological Controls Requirements Manual and RM-0021, Safety Performance Requirements Manual into the standard operating procedures (Part 7-AWR RFP, Section 3).

3.6.1.1 Elements of the Standard Operating Procedures

The following elements of SOPs shall be required:

- Cover Page;
- Table of Contents;
- Revision Table;
- Purpose;
- Scope;
- References;
- Responsibilities;
- Contractor/FDF Interfaces;
- General Provisions;
- Prerequisites;
- Procedures for tasks;
- Drivers; and
- Definitions.

Each element shall be clearly developed for the specific scope of the procedure and sufficiently detailed to perform the required functions without direct supervision.

3.6.1.2 Requirements of the Standard Operating Procedures

An SOP shall be developed for each normal activity performed at the AWR (this shall include process monitoring equipment, data acquisitions, data hard copy recording, and data trending processes). Each procedural step shall be presented as a separate item. In each step, each operational unit, valve, system component, switch, etc. shall be identified by its identification number. "Warnings," "Cautions," and "Notes" shall precede the steps to which they apply.

3.6.1.3 Reviews of the Standard Operating Procedures

Each revision of a SOP shall be reviewed by all parties identified in the "responsibilities" section.

3.6.1.4 Posting of Standard Operating Procedures

Controlled copies of SOPs shall be posted at SOP Stations such that operations personnel can readily access the SOPs in the work area. The SOPs shall be maintained in three ring binders at SOP Stations that are protected from the elements. An index with SOP titles, numbers, and effective dates shall be included in the front of each three-ring binder and shall be updated each time an SOP is revised. The SOPs shall be segregated by labeled and tabbed dividers. Each three-ring binder shall be clearly labeled. Emergency SOPs shall be maintained at the same SOP Stations, but in separate three-ring binders.

3.6.2 Project-Specific Training Program/Matrix

The Contractor shall be responsible for developing a project-specific training program for operations and maintenance management and personnel. A training matrix shall be utilized to track and document the progress each person makes through the project-specific, Contractor-developed training program.

3.6.2.1 Project-Specific Training Program Elements

The Contractor shall be responsible for the following elements of the project-specific training program:

- Training Program;
- Training Documentation;
- Lesson Plans to Include Instructor Briefings;
- Lesson-Specific Tests/Quizzes;
- Post-Training Qualifications;
- On-the-Job Training (OJT) Lesson Plans/Tests:
- Update of Training Matrices;
- Interface with the FEMP Site Training Program; and
- Maintenance and Update of Training Requirements.

The Contractor shall provide a training coordinator to interface with the FDF Training Department for construction, start-up operations, need maintenance, personnel training issues. The Contractor shall provide Subject Matter Experts for each of the training areas. FDF will provide training classrooms space as required. The Contractor shall provide all specific individual trainee information to FDF to be entered into the Training Department data base.

The Contractor shall be responsible for providing sufficient training to field personnel to ensure the safety of the personnel, property, public, and environment.

3.6.3 Maintenance Procedures

The Contractor shall be responsible for the preparation of the AWR maintenance procedures in accordance with DOE Order 4330.4B (Note: Refer to Site Procedure MT-0003 for additional information). FDF shall review and approve the documents prior to implementation. The AWR maintenance procedures shall be developed such that a qualified crafts person shall be able to perform maintenance activities that ensure there will be no harm to the personnel, public, property, or environment. Maintenance procedures shall be developed for all anticipated operations, evolutions, tests, and abnormal or emergency situations. The Contractor shall consider and incorporate the elements of RM-0020, Radiological Controls Requirements Manual and RM-0021, Safety Performance Requirements Manual into the maintenance procedures (Part 7-AWR RFP, Section 3).

3.6.3.1 Elements of Maintenance Procedures

The following elements of Maintenance Procedures shall be required:

- Cover Page;
- Table of Contents;
- Revision Table;
- Purpose;
- Scope;
- References;
- Responsibilities;
- General Provisions;
- Prerequisites;
- Procedures for Tasks;
- Drivers; and
- Definitions.

Each element shall be clearly developed for the specific scope of the procedure and sufficiently detailed to perform the required functions without direct supervision.

3.6.3.2 Requirements of the Maintenance Procedures

A Maintenance Procedure shall be developed for each maintenance task performed for the AWR project. Each procedural step shall be presented as a separate item. In each step, each operational unit, valve, system component, switch, etc. shall be identified by its identification number (Part 7-AWR RFP, Section 3, ED-12-4016). "Warnings," "Cautions," and "Notes" shall precede the steps to which they apply.

3.6.3.3 Reviews of the Maintenance Procedures

Each revision of a maintenance procedure shall be reviewed by all parties identified in the "responsibilities" section.

3.6.3.4 Posting of Maintenance Procedures

Controlled copies of Maintenance Procedures shall be posted at Maintenance Procedure Stations such that Maintenance personnel can readily access them in the work area. The Maintenance Procedures shall be maintained in three ring binders. An index with Maintenance Procedure titles, numbers, and effective dates shall be included in the front of each three-ring binder and shall be updated each time a Maintenance Procedure is revised. The Maintenance Procedures shall be segregated by labeled and tabbed dividers. Each three-ring binder shall be clearly labeled.

3.6.4 Sampling Requirements

The Contractor shall prepare a sample plan and sample procedures that conform to the guidelines in FD-1000, Sitewide CERCLA Quality Assurance Project Plan (Part 7-AWR RFP, Section 3) and meets the requirements set forth in Section 3.1.12 of this document.

The Contractor will be responsible for developing, maintaining, and executing a sample identification and tracking system. The sample identification and tracking system shall:

- identify each sample uniquely;
- correlate each sample of residue with the Silo from which the residue came and the tank into which it is transferred;
- track the sample through analysis or to storage location;
- correlate the sample with the testing or analytical data with which it is associated;
- identify the time and day the sample is collected;
- identify the relationship the time of sample collection has with the duration of the residue transfer; and
- identify the preservation of the samples and the initial purpose of the samples.

The Contractor shall direct the collection of samples in accordance with AWR Sample Plan. This shall include a collection of samples, if required by the Contractor, for AWR Process Control and the collection of achieve samples required by FDF.

FDF FAT&LC personnel will perform the sample collection activities in accordance with the sampling procedures. FDF FAT&LC personnel will collect, prepare, and maintain custody of the samples until final disposition of the samples or transfer of sample custody. FDF FAT&LC personnel shall control the sampling process and maintain a sample logbook in accordance with EW-0002, Chain of Custody/Request for Analysis Record for Sample Control (Part 7-AWR RFP, Section 3).

3.6.5 Conduct of Operations Matrix

The Contractor shall comply with DOE Order 5480.19 "Conduct of Operations" and RM-0029 "FERMCO Conduct of Operation Program." The FDF Conduct of Operation Program (CONOPS) requires a CONOPs Applicability Matrix to define how DOE Order 5480.19 applies to the project. The Contractor shall comply with the Silos Project Conduct of Operations Applicability Matrix (Attachment E). If the Contractor deviates from the Silos Project Conduct of Operation Applicability Matrix, the Contractor's modifications shall be justified and approved by FDF.

4.0 OPERATION AND MAINTENANCE REQUIREMENTS

All Contractor activities involving operation or maintenance must comply with the environmental ARARs identified in the EP and EW functional areas (Section 2.4), and with the ARAR tables included in Appendix B.

4.1 Accelerated Waste Retrieval Operation Requirements

In support of the Accelerated Waste Retrieval operation, the Contractor shall utilize FDF wage personnel as defined in the FDF labor agreements. The Contractor shall comply with DOE Order 5480.19, Conduct of Operations for DOE Facilities. The Contractor shall develop operating procedures as defined in 3.6.1 and shall train the FDF operators per the Contractor lesson plans defined in 3.6.2. The Contractor shall perform periodic drills to maintain and refresh the personnel training per DOE Order 5480.19. The Contractor operation activities include all sampling activities defined by the Sampling Plan.

4.2 Accelerated Waste Retrieval Maintenance Requirements

In support of the Accelerated Waste Retrieval project, the Contractor shall utilize the FDF maintenance program that complies with DOE Order 4330.4B; "Maintenance Management Program," MT-0003 "FEMP Work Request/Order Procedure," and FDF Plan "M-143 Maintenance Reference Guide" (Part 7-AWR RFP, Section 3). The maintenance activities shall be performed by FDF wage personnel in accordance with the FDF labor agreements. The Contractor shall provide and maintain a spare parts inventory at his expense, and provide spare part information for the FDF CMMS system. The Contractor shall provide all maintenance tooling required for this project. The Contractor shall develop preventative maintenance and standard repair maintenance procedures, these procedures shall be incorporated into the CMMS.

The Contractor shall provide all of the technical guidance for maintenance activities and shall interface with a FDF Maintenance Planner assigned to this project to input the maintenance work orders into the FDF maintenance program. As part of the FDF Maintenance Program all maintenance work orders are reviewed and approved by Safety, Facility Owner, Quality, Engineering, Project Manager and Operations prior to initiation of maintenance activities.

The Contractor shall provide the FDF Maintenance Planner with all AWR requirement identification information required to support maintenance and preventative maintenance activities.

The FDF maintenance shall provide this information for input into the CMMS. The maintenance engineer will provide identification tags for each piece of equipment that is entered into CMMS.

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5.0 SILOS 1 AND 2 AWRS RFP WASTE MANAGEMENT

Management of all above-grade, at-grade and below-grade debris associated with the scope of work as detailed in this contract must be conducted per FEMP site procedures and applicable regulatory drivers. Prior to Contractor mobilization, FDF Waste Planning and Integration (WP&I) will provide the Contractor with a Waste Management Plan (WMP) which will include a Project Waste Identification and Disposition Report (PWID) and Material Segregation and Containerization Criteria (MSCC) Report. The PWID will identify anticipated waste streams, characterization information, and volumes based upon the Contractor's design and identify disposition locations. The PWID is a living document and will be revised throughout the duration of the project to track with actual volumes and waste types generated. The MSCC will identify potential waste streams based on the Contractor's design and the containers that will be required for each waste stream. The Contractor is responsible for reporting volumes of waste generated (residue, containerized water, secondary wastes, soil, etc.) to FDF immediately upon containerization. The Contractor is further responsible for segregation of the waste/residue in accordance with the MSCC.

The Silo Waste Retrieval System shall be designed and operated in such a manner that minimizes secondary waste generation. Waste management shall be based on a philosophy of waste minimization, recycling, and environmental ALARA. The methods used to manage waste and debris generated during construction and operations shall be consistent with the ARARs and TBCs identified in the OU4 ROD and site procedures. Secondary waste management includes waste characterization, staging, segregation, containment, and disposal. Classification and packaging of secondary wastes generated by the Contractor shall be based on radiological monitoring, analytical data, and process knowledge provided by the Contractor to FDF personnel.

The Contractor is responsible for segregating waste and placing waste in containers previously identified by FDF in the WMP. FDF will provide oversight of these activities. Waste shall be packaged in containers appropriate for the materials' U.S. DOT hazard classification as defined in 49 CFR, Subchapter C, Hazardous Material Regulations and the NTS WAC. The Contractor is also responsible for weighing containers to ensure that their weight and volume capacities are not exceeded. FDF labor, under Contractor supervision, must initiate a 65-card which will identify material type by container inventory number. The 65-card will also include weight, container integrity, generation date, and characterization information provided by FDF. Once the waste is placed in the approved containers and moved by the Contractor to an approved, Contractor-designed queing area, FDF is responsible for all handling, transportation and associated documentation. If the material is not appropriately segregated, the Contractor is responsible for repacking the waste with FDF guidance. This waste management interface applies to all waste generated from this project.

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5.1 Free-Releasable Debris

All debris generated as a result of construction and operations activities, whether in a radiologically controlled area, a contamination area or a clean area, must be evaluated by FDF Radiological Control Technicians (RCTs) prior to disposition. If FDF RCTs determine that the debris is free-releasable to an off-site commercial disposal facility (CDF), the Contractor is responsible for disposal. The Contractor must report material types and volumes to FDF. FDF will provide guidance to the Contractor regarding segregation of free-releasable debris. FDF Radiological Control must document survey results in accordance with RP-0009 for inclusion with the final PWID at project completion. The Contractor shall manage construction debris in accordance with this section and ACR-007 (Part 7-AWR RFP, Section 2.1).

5.2 Contaminated Debris

If FDF RCTs determine that construction or operations debris is radiologically contaminated (i.e., not free-releasable to a CDF), the contractor must manage the waste stream(s) in accordance with the WMP (i.e., package per the MSCC), report volumes, and deliver containers to a queing area, as previously identified. Some construction debris destined for disposal at the On-Site Disposal Facility (OSDF) must be size-reduced in accordance with "Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility," 20100-PL-0014. When a waste stream (contaminated debris) is generated and is not identified in the WMP, the Contractor must notify WP&I so that characterization and disposition determinations can be made and the WMP can be revised. WP&I will give the Contractor containerization and segregation information after characterization is determined. FDF personnel will manage containers once they are filled.

5.3 Discrete Objects

Items which will likely not be free-releasable are the discrete objects which have been identified as existing in the silos. The following types of objects are suspect of being inside the silos: glass and plastic sample bottles ranging in size from pint to gallon, hard hats, pipe (material type, diameter and length unknown), PVC tubing (diameter and length unknown), glovebags (poly), wrenches, manway gaskets, and angle iron (material type and dimensions unknown). These items are contaminated with Silo material and need to be retrieved, segregated and containerized by the Contractor. FDF will ship the containerized items to a D&D facility on or off-site for decontamination and disposal in accordance with the waste characterization requirements specified by FDF. The WMP will identify segregation and containerization requirements.

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5.4 Silo 4 AWR Surrogate Material Disposition

It is not anticipated that the AWR surrogate used for FSMS demonstration will become radiologically contaminated since Silo 4 has never contained contaminated materials. If the AWR surrogate is deemed free-releasable (i.e., not contaminated following FSMS operations), absorbent material (added to slurried AWR surrogate) or dewatering may be required so that it (AWR surrogate) passes the Paint Filter Liquids Test (PFLT), Method 9095, as defined in SW-846 (Part 7-AWR RFP, Section 5). The local CDF will not accept the AWR surrogate without documentation that it is not contaminated and has passed the PFLT. The Contractor shall be responsible for removing and transferring the AWR surrogate into containers/vehicles pre-approved by FDF for transport. Addition of absorbent and sampling and analysis to ensure that the material passes the PFLT is the Contractor's responsibility. Sampling by the Contractor will be conducted using FDF labor. FDF RCTs will survey the material and document that it is not contaminated before it is released from site for disposal in a CDF. Non-contaminated AWR surrogate will be managed and disposed of by the Contractor in the same manner as non-contaminated construction debris.

If the AWR surrogate becomes contaminated, and depending upon its moisture content, it shall containerized with an absorbent by the Contractor. Following determination of contamination and containerization, the Contractor shall direct the sampling of the material, using FDF labor, and the FDF analysis for characterization purposes. Characterization will dictate treatment/disposition. The containers will be transported from the Silos Project queing area by FDF. WP&I will coordinate FDF characterization and movement of containers.

5.5 Containerization Requirements

WP&I will facilitate all containerization activities. Based upon the anticipated waste streams identified in the PWID, the container requirements identified in the MSCC, and the anticipated levels of contamination, FDF will ensure delivery of containers that meet the Department of Transportation (DOT) requirements for the radionuclides and levels of contamination identified from characterization of the material and real-time readings. WP&I will identify container Inventory Numbers, Lot Code Numbers, Material Evaluation Forms (MEFs) based on characterization data, DOT labeling requirements, and dunnage requirements. The Contractor shall provide WP&I with any and all analytical data to facilitate FDF characterization of material prior to packaging. WP&I will facilitate task orders for movement of all containerized debris to the FDF shipping department. Hold points will be identified in the WMP. All operators performing containerization must be trained to applicable site packaging procedures.

FDF RCTs must conduct and document real-time surveys after containerization and report results to FDF Traffic. This information will be used to ensure appropriate labeling for DOT purposes. FDF Traffic will maintain all shipping papers.

5.6 Decon Water, Wastewater, Groundwater

All decon water, wastewater and groundwater shall be managed in accordance with Section 2.3. If any of these waste streams are containerized, they must be managed by the Contractor in the same manner as other contaminated waste streams. FDF will assume responsibility for management after the waste has been containerized per FDF direction, and transferred to a queing area. The Contractor, using FDF labor, shall be responsible for the direction of sampling as required.

5.7 Sample Management

All samples sent off-site by the Contractor shall be logged and reported to FDF. If the Contractor uses an on-site laboratory for sampling, and does not reintroduce the samples into the AWR system, the Contractor shall segregate and containerize the residue/waste per the WMP and MSCC, reporting volumes as with all other contaminated residue/waste to FDF. Management, documentation, and handling activities and responsibilities shall be consistent with all other contaminated waste.

5.8 Soil Management

All excavations and management of excess soil shall be conducted in accordance with EW-0016, "Management of At and Below-Grade Debris" (Part 7-AWR RFP, Section 3). Excavation of the silo berm is addressed in the following section. If the design identifies that soil must be excavated, the Contractor shall notify FDF WP&I in order to have analytical data on the locations of excavation pulled from the Sitewide Environmental Database (SED). This data will be pulled and krieged by the FDF Soils Characterization and Excavation Project (SCEP). SCEP will establish, based upon the COCs identified from the SED, Material Tracking Locations (MTLs). Separate MTLs will be established based upon any variability in COCs by area. If more than one MTL is identified, the Contractor shall be responsible for ensuring that soil excavated from one MTL is not cross-contaminated with soil from any other MTL(s). If excess soil from the excavations is anticipated and identified in the design, WP&I will identify in the WMP, in conjunction with real-time radiological readings, the existing site soil pile to receive the excess soil. No soil piles can be staged as a "new" soil pile without prior agency approval. Excess soil should be moved by FDF immediately to a pre-approved existing site soil pile. If any excess soil is left in the area of excavation for more than one week in anticipation of using the soil for backfill, geotextile, silt fence and any other run-off controls deemed necessary by SCEP it shall be put into place by the Contractor. The Contractor shall place the backfill within the MTL from which it was excavated.

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If during excavation activities, real-time readings indicated contamination levels in excess of 1030 ppm Total Uranium, the Contractor shall stop excavation work until FDF WP&I is notified. FDF WP&I, with the direction of SCEP, will identify which pile the soil shall be delivered to by FDF personnel. If during excavation miscellaneous debris or radioactive material is unearthed, the Contractor shall stop the work until WP&I can coordinate container delivery. The Contractor shall segregate the material and place the material in an FDF-approved container. FDF will complete characterization and movement of packaged material. The PWID will be revised by FDF with Contractor input to include disposition of any unanticipated soil or debris generated as a result of this project. Any perched water encountered during excavation shall be containerized if it exceeds 1030 ppm Total Uranium. Following sampling and analysis by FDF labor, FDF Environmental Compliance will determine if the water can be discharged at the AWWT. FDF WP&I will facilitate container deliver, and perform characterization and movement/disposition of water and samples.

5.9 Berm Excavation

Approximately 11,000 yd^3 of berm soil will be excavated throughout the duration of this project. FDF will provide the Contractor with an excavation plan prior to Contractor mobilization. Prior to excavation, FDF SCEP will initiate a Project Specific Plan (PSP), which will be submitted to the US and Ohio EPAs with the excavation plan. The PSP will identify sampling and analysis efforts to be conducted by FDF. Based upon the comments submitted by the agencies and the final approved PSP and excavation plan, the Contractor shall anticipate a lead time of ten days, prior to excavation. A SCEP team will use an High-Purity Germanium Detector (HPGE), possibly in conjunction with physical sampling, to determine the level of Total Uranium in the soil.

Preliminary data indicates that the level of Total Uranium in the berm soil is within the parameters of the OSDF WAC. If HPGE and physical sampling and analysis confirm this preliminary finding, the Contractor shall supervise the placement of excavated soil into a dump truck and the transport to a pre-approved site soil pile by FDF for final disposition at the OSDF. If activities conducted per the PSP identify that the berm soil exceeds the OSDF WAC, it may be loaded in a truck under Contractor supervision and transported by FDF to a pre-approved soil pile destined for off-site disposal. WP&I in conjunction with SCEP will provide guidance to the Contractor prior to excavation. Any elevated real-time readings obtained during excavation, i.e., equal to or greater than 1030 ppm Total Uranium, may alter disposition location and therefore shall be reported to WP&I immediately. If any unanticipated material is unearthed, the Contractor shall report this immediately to WP&I. WP&I will provide guidance to the contractor regarding segregation and containerization. FDF will manage the waste once it has been placed in the approved containers.

APPENDIX A
Silos Residue Characterization

A.1 Purpose
A.2 Summary Conclusions
A.3 Sampling
A.4 Characteristics
A.5 Chemical Characteristics
A.6 Radiological

ATTACHMENTS

Silo 1 and 2 - Summary of Chemical Analyses of K-65 Residue pp 1-3
Silo 1 and 2 - Radiological pp 4-5
Distribution of Predominant Constituents pp 6-7
Sample Data - Particle Size/Moisture Density Relationship pp 8-19
One Dimensional Consolidation Results pp 20-35

A.1 Purpose

The purpose of this appendix is to present what is known about the characterization of K-65 material. This includes a delineation between data which is technically sound and data which may be considered spurious in nature. This also includes an understanding of that data which is sufficient in a general sense and that data which given the material and the requirements of our specified treatment method, need be specific. The ultimate purpose is to define our knowledge of characterization in terms of physical characteristics primarily for transfer of the material and chemical characterization primarily for treatment purposes.

Questions regarding the adequacy of our knowledge of characterization of the K-65 material are the result of incomplete sampling and of a relatively small amount of data on elemental analysis and chemical specification. Given these limitations, however, it is important that recognize that the data is sufficiently consistent (in most primary constituents) to provide an understanding of treatment needs of the material. In order to define this consistency, an explanation of sampling and analytical methods is necessary.

A.2 Summary Conclusions

- There is a limited amount of data from sampling, but it is adequate to characterize the primary constituents of K-65 material.
- Process knowledge supports the range of constituents found.
- There are locality differences in constituents in the two silos.
- Sulfate content is higher than previously understood, identification of compounds of sulfate is important.
- Particle size data, although incomplete due to sampling difficulties, provides significant information on particle size distribution.

A.3 Sampling

There have been several types of sampling done on silo material. Essentially, there were core bores (such as RI sampling), sampling of the slurry prior to deposition in the silos and sporadic incomplete sampling (such as removal of surface material with a bucket on a rope). If we ignore the latter type of sampling, we know that on three occasions the silos have been core sampled: in 1972, 1989 and 1991. The 1972 sampling was done in anticipation of sale of the material and was the most complete in a cross-sectional context since a mostly unbroken column of material was obtained from the silo profile. The 1989 sampling effort was unsuccessful in terms of recovery, and the 1991 sampling was unable to achieve 100% recovery (a complete core); however, the degree of recovery was adequate to meet the sampling plan requirements.

Process sampling was done by National Lead of Ohio (NLO) as Silo 2 was being filled (for the purpose of tracking radium). With the exception of this sampling and the three core sampling events mentioned above, all other sampling which resulted in elemental analysis is known to be unrepresentative or limited in its characterization of the material.

The result of this is that we have elemental analysis from perhaps half of the depth of the silo from our primary source of information, the 1991 sampling. This limitation on sample retrieval is offset, however, by a consistency between this and other sampling events. Among primary constituents there is sufficient data agreement from these other sampling events to establish an identity for the material and to describe a predictable variation of specific constituents over the course of processing history. This can be clearly seen from Attachments 1-3, whether the silos are depicted in an individual or collective sense. The NLO analysis was taken from the 1972 sampling.

The primary elemental constituents from Silo 1 and 2 are listed collectively (expressed on a wt% oxide basis from Appendix A, attachment p.3).

Element	Mean	Std Dev
Si	50.62	4.00
Pb	8.92	2.96
Fe	4.08	2.25
Ba	4.36	2.06
Al	3.13	0.82
Ca	3.11	1.60
Mg	1.58	0.74
S	2.54	0.97
C	5.22	1.03
Na	1.33	0.58

To summarize, the level of information we possess regarding the location of constituents within the silo (with the exception of radium) is limited by the continuity of sample material. We have enough data to draw general conclusions on constituent variation within a silo but no sound technical basis for a more elaborate and detailed depiction of the location of specific constituents within the silo material. This is not only the result of incomplete sample withdrawal but also due to repeated sampling in a specific location, which has altered and disturbed the areas beneath manways. This produces a lack of certainty regarding the identity on zone material as being solely from that zone. Therefore, there is no technical basis for the development of a model placing constituents at specific locations within the silo.

4.4 Physical Characteristics

The material in Silos 1 and 2 is currently covered by a layer of BentoGrout™ clay to retard radon release and to protect the K-65 material in case of dome collapse. Prior to the installation of the BentoGrout™, the surface of the K-65 material was a dry powder. The material below the dry powder was more moist with isolated pockets of wet material toward the bottom of the silo. Moisture levels in both silos are approximately 30 wt. %. This silo material is divided into three zones, of equal depth, from zone A at the top of the material, and zone C at the bottom of the silo.

Table 4.1 General Description of the Waste from Silos 1 and 2

Sample	Description
Silo 1 Zone A	The material was grayish brown when wet, pale brown when dry. No rocks of noticeable size were observed. The material was in many clumps which broke apart easily. Material does not appear excessively wet. When dry, the clumps break into a fine, ash-like powder. The dry material wets readily.
Silo 1 Zone B	The material is similar in color and texture to Zone A. No rocks of noticeable size were observed. Material was in bigger clumps than Zone A, perhaps a little wetter. The dry material wets readily.
Silo 1 Zone C	The material is similar in color and texture to Zone A. No rocks of noticeable size were observed. The material was in very big clumps, almost one big ball, and was noticeably wetter than Zones A and B. The dry material wets readily.
Silo 2 Zone A	The material is dark brown, much darker than Silo 1. No rocks of noticeable size were observed. Material was clumpy and not excessively wet. Some reddish material was observed in distinct pieces spread throughout the sample. The dry material is more powdery than Silo 1 and is much more difficult to wet.
Silo 2 Zone B	The material is light brown, not as dark as Silo 2A and not as light as Silo 1. No rocks of noticeable size were observed. The material is much wetter than Silo 2A, very large clumps. The dry material is fine and powdery and is more difficult to wet than Silo 1.
Silo 2 Zone C	The material is a dark greenish-gray. Very wet, almost like clay. Material readily clumps together. Much coarser than Silo 2A and 2B, more gritty or sandy. Pressure causes the material to flow like a fluid.

A.4.1 Particle Size

The material in Silos 1 and 2 has been characterized in regard to particle size. Although the limitations of incomplete sampling relate to the completeness of particle size data just as it does to chemical characterization, a significant body of data is available to better understand particle size. This data is included below and is expressed graphically along with other physical characteristics in Attachment 8. The data is from both the 1989 (less complete) and the 1991 sampling events, (8 from 1989, 5 from 1991).

LO NO: 1

MANWAY NO: NE-1
VERTICAL SECTION: A - 1989

WATER CONTENT: 50.7%
SPECIFIC GRAVITY: 3.19 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: 55.2
PLASTIC LIMIT: 50.0
PLASTICITY INDEX: 5.2
USCS: MH

GRAIN SIZE:

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	95.1
NO. 20	0.850	93.2
NO. 40	0.425	92.6
NO. 60	0.250	91.6
NO. 140	0.106	80.1
NO. 200	0.075	72.7
HYDROMETER ANALYSIS:		
1 min	0.047	49.3
2 min	0.034	46.3
5 min	0.022	40.1
15 min	0.013	33.9
30 min	0.008	27.8
60 min	0.007	24.7
240 min	0.003	21.6
1440 min	0.001	15.4

SILO NO: 1

MANWAY NO: SE-2
VERTICAL SECTION: B -1989

WATER CONTENT: 31.9%
SPECIFIC GRAVITY: 3.37 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: NP
PLASTIC LIMIT: NP
CONSISTENCY BREAK POINT (WATER CONTENT): 38.0%

PLASTICITY INDEX:NP
USCS: NA

GRAIN SIZE:

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	96.7
NO. 20	0.850	95.1
NO. 40	0.425	92.4
NO. 60	0.250	83.6
NO. 140	0.106	49.3
NO. 200	0.075	43.9
HYDROMETER ANALYSIS:		
1 min	0.051	28.5
2 min	0.036	23.7
5 min	0.023	19.0
15 min	0.014	17.4
30 min	0.010	15.8
60 min	0.007	15.8
240 min	0.003	14.2
1440 min	0.001	12.7

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ILO NO: 1 MANWAY NO: NE-1
VERTICAL SECTION: C - 1989

WATER CONTENT: 71.5%
SPECIFIC GRAVITY: 2.74 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: 70.3
PLASTIC LIMIT: 66.6

PLASTICITY INDEX: 3.7
USCS: NA

GRAIN SIZE:

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	97.3
NO. 20	0.850	91.6
NO. 40	0.425	86.7
NO. 60	0.250	81.2
NO. 140	0.106	72.2
NO. 200	0.075	71.5
HYDROMETER ANALYSIS:		
1 min	0.042	62.1
2 min	0.031	58.5
5 min	0.019	56.0
15 min	0.011	53.6
30 min	0.008	48.7
60 min	0.006	46.3
240 min	0.003	41.4
1440 min	0.001	26.8

SILO NO: 1 MANWAY NO: SW-1/SE-1/NW-1
VERTICAL SECTION: COMPOSITE - 1989

WATER CONTENT: 22.8%
SPECIFIC GRAVITY: 2.58 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: NP
PLASTIC LIMIT: NP
CONSISTENCY BREAK POINT (WATER CONTENT): 35.7%

PLASTICITY INDEX: NP
USCS: NA

GRAIN SIZE:

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	97.2
NO. 20	0.850	95.5
NO. 40	0.425	92.0
NO. 60	0.250	81.1
NO. 140	0.106	58.7
NO. 200	0.075	54.5
HYDROMETER ANALYSIS:		
1 min	0.049	40.7
2 min	0.035	37.6
5 min	0.022	34.5
15 min	0.013	31.3
30 min	0.009	28.2
60 min	0.007	26.6
240 min	0.003	25.1
1440 min	0.001	21.9

LO NO: 2 MANWAY NO: SW-2/NW-2/NE-1
VERTICAL SECTION: COMPOSITE - 1989

WATER CONTENT: 34.2%
SPECIFIC GRAVITY: 2.78 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: NP
PLASTIC LIMIT: NP

PLASTICITY INDEX: NP
USCS: NA

CONSISTENCY BREAK POINT (WATER CONTENT): 46.4%
GRAIN SIZE:

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	96.4
NO. 20	0.850	88.9
NO. 40	0.425	67.2
NO. 60	0.250	57.1
NO. 140	0.106	39.7
NO. 200	0.075	38.1
HYDROMETER ANALYSIS:		
1 min	0.050	32.0
2 min	0.036	30.5
5 min	0.023	28.9
15 min	0.013	25.9
30 min	0.009	22.9
60 min	0.007	19.8
240 min	0.003	18.3
1440 min	0.001	10.7

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SILO NO: 2 MANWAY NO: SW-1
VERTICAL SECTION: A - 1989

WATER CONTENT: 73.5%
SPECIFIC GRAVITY: 3.11 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: NP
PLASTIC LIMIT: NP

PLASTICITY INDEX: NP
USCS: NA

CONSISTENCY BREAK POINT (WATER CONTENT): 79.4%

GRAIN SIZE:

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	96.5
NO. 20	0.850	89.4
NO. 40	0.425	80.4
NO. 60	0.250	73.1
NO. 140	0.106	63.7
NO. 200	0.075	63.3
HYDROMETER ANALYSIS:		
1 min	0.042	48.2
2 min	0.030	47.2
5 min	0.019	45.3
15 min	0.011	42.5
30 min	0.008	39.7
60 min	0.006	36.8
240 min	0.003	34.0
1440 min	0.001	20.8

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LO NO: 2 MANWAY NO: NW-1
VERTICAL SECTION: A - 1989

WATER CONTENT: 25.9%
SPECIFIC GRAVITY: 2.87 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: NP
PLASTIC LIMIT: NP

PLASTICITY INDEX: NP
USCS:NA

CONSISTENCY BREAK POINT (WATER CONTENT): 47.6%

GRAIN SIZE

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	93.2
NO. 20	0.850	88.1
NO. 40	0.425	83.0
NO. 60	0.250	74.9
NO. 140	0.106	45.7
NO. 200	0.075	39.8
HYDROMETER ANALYSIS:		
1 min	0.050	31.0
2 min	0.036	28.0
5 min	0.023	25.1
15 min	0.013	19.2
30 min	0.010	16.2
60 min	0.007	14.8
240 min	0.003	11.8
1440 min	0.001	8.9

Date: March 23, 1998

Draft

SILO NO: 2 MANWAY NO: NE-2
VERTICAL SECTION: B

WATER CONTENT: 21.8%
SPECIFIC GRAVITY: 2.59 G/CC

ATTERBERG LIMITS:
LIQUID LIMIT: NP
PLASTIC LIMIT: NP

PLASTICITY INDEX: NP
USCS: NA

CONSISTENCY BREAK POINT (WATER CONTENT): 40.9%

GRAIN SIZE

SIEVE SIZE/TIME	DIAMETER (mm)	PERCENT FINER
SIEVE ANALYSIS:		
3.000 in	75.000	100.0
1.500 in	37.500	100.0
0.750 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	100.0
NO. 10	2.000	86.3
NO. 20	0.850	80.5
NO. 40	0.425	69.6
NO. 60	0.250	62.2
NO. 140	0.106	53.1
NO. 200	0.075	51.9
HYDROMETER ANALYSIS:		
1 min	0.050	36.1
2 min	0.036	32.8
5 min	0.023	26.3
15 min	0.013	18.1
30 min	0.010	11.5
60 min	0.007	9.8
240 min	0.003	8.2
1440 min	0.001	4.9

O 1 ZONE A

SAMPLE ANALYSIS RESULTS

PROJECT NAME	FERNALD K-65	USCS SYMBOL:	ML
PROJECT NO.:	313327.40.03.03	WATER CONTENT, %:	37.1
CUST. SAMPLES NO.:	100053	LIQUID LIMIT:	37.0
SPECIFIC GRAVITY:	3.0300 (MEASURED)	PLASTICITY INDEX:	6.0
MAXIMUM DRY DENSITY:	96.pcf	OPTIMUM MOISTURE:	28.7%

SIEVE ANALYSIS

SIEVE NO.	DIAMETER (mm)	PERCENT FINER (%)
3.0 in	75.000	100.0
1.5 in	37.500	100.0
0.75 in	19.000	100.0
0.375 in	9.500	99.8
NO.4	4.750	99.4
NO. 10	2.000	97.5
NO. 20	0.850	94.2
NO. 40	0.425	87.9
NO. 60	0.250	78.3
NO. 140	0.106	62.7
NO. 200	0.075	56.9

HYDROMETER ANALYSIS

DIAMETER (mm)	PERCENT FINER (%)
0.0327	54.7
0.0241	51.3
0.0157	46.6
0.0094	42.0
0.0068	33.4
0.0050	26.6
0.0036	24.9
0.0025	20.4
0.0011	11.9

Date: March 23, 1998

Draft

SILO 1 ZONE C

SAMPLE ANALYSIS RESULTS

PROJECT NAME	FERNALD K-65	USCS SYMBOL:	ML
PROJECT NO.:	313327.40.03.03	WATER CONTENT, %:	59.08
CUST. SAMPLES NO.:	100055	LIQUID LIMIT:	51.0
SPECIFIC GRAVITY:	2.9786 (MEASURED)	PLASTICITY INDEX:	NONPLASTIC
MAXIMUM DRY DENSITY:	77.1 pcf	OPTIMUM MOISTURE:	45.7%

SIEVE ANALYSIS

SIEVE NO.	DIAMETER (mm)	PERCENT FINER (%)
3.0 in	75.000	100.0
1.5 in	37.500	100.0
0.75 in	19.000	100.0
0.375 in	9.500	100.0
NO.4	4.750	100.0
NO. 10	2.000	99.3
NO. 20	0.850	94.1
NO. 40	0.425	83.2
NO. 60	0.250	72.5
NO. 140	0.106	62.1
NO. 200	0.075	58.9

HYDROMETER ANALYSIS

DIAMETER (mm)	PERCENT FINER (%)
0.0228	54.7
0.0149	51.3
0.0089	46.6
0.0065	42.0
0.0048	36.9
0.0035	31.7
0.0026	25.9
0.0011	15.5

Date: March 23, 1998

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LO 2 ZONE A

SAMPLE ANALYSIS RESULTS

PROJECT NAME	FERNALD K-65	USCS SYMBOL:	NONPLASTIC
PROJECT NO.:	313327.40.03.03	WATER CONTENT, %:	30.5
CUST. SAMPLES NO.:	100068	LIQUID LIMIT:	NONPLASTIC
SPECIFIC GRAVITY:	3.0301 (MEASURED)	PLASTICITY INDEX:	NONPLASTIC
MAXIMUM DRY DENSITY:	100.6 pcf	OPTIMUM MOISTURE:	23.8 %

SIEVE ANALYSIS

SIEVE NO.	DIAMETER (mm)	PERCENT FINER (%)
3.0 in	75.000	100.0
1.5 in	37.500	100.0
0.75 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	99.8
NO. 10	2.000	98.5
NO. 20	0.850	92.7
NO. 40	0.425	84.0
NO. 60	0.250	72.3
NO. 140	0.106	45.1
NO. 200	0.075	35.2

HYDROMETER ANALYSIS

DIAMETER (mm)	PERCENT FINER (%)
0.0360	26.1
0.0266	22.2
0.0173	19.1
0.0103	16.0
0.0074	14.0
0.0053	11.3
0.0038	9.0
0.0028	7.4
0.0011	3.5

SILO 2 ZONE B

SAMPLE ANALYSIS RESULTS

PROJECT NAME	FERNALD K-65	USCS SYMBOL:	MH
PROJECT NO.:	313327.40.03.03	WATER CONTENT, %:	55.5
CUST. SAMPLES NO.:	100069	LIQUID LIMIT:	58.0
SPECIFIC GRAVITY:	2.9890 (MEASURED)	PLASTICITY INDEX:	9.0
MAXIMUM DRY DENSITY:	79.0 pcf	OPTIMUM MOISTURE:	41.4 %

SIEVE ANALYSIS

SIEVE NO.	DIAMETER (mm)	PERCENT FINER (%)
3.0 in	75.000	100.0
1.5 in	37.500	100.0
0.75 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	98.8
NO. 10	2.000	96.0
NO. 20	0.850	85.9
NO. 40	0.425	74.0
NO. 60	0.250	66.3
NO. 140	0.106	57.6
NO. 200	0.075	55.0

HYDROMETER ANALYSIS

DIAMETER (mm)	PERCENT FINER (%)
0.0332	50.2
0.0236	49.7
0.0153	46.9
0.0091	43.5
0.0066	40.1
0.0048	35.6
0.0035	29.9
0.0026	25.4
0.0011	13.0

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LO 2 ZONE C

SAMPLE ANALYSIS RESULTS

PROJECT NAME	FERNALD K-65	USCS SYMBOL:	ML
PROJECT NO.:	313327.40.03.03	WATER CONTENT, %:	38.5
CUST. SAMPLES NO.:	100070	LIQUID LIMIT:	34.0
SPECIFIC GRAVITY:	2.9894 (MEASURED)	PLASTICITY INDEX:	4.0
MAXIMUM DRY DENSITY:	92.7 pcf	OPTIMUM MOISTURE:	30.1 %

SIEVE ANALYSIS

SIEVE NO.	DIAMETER (mm)	PERCENT FINER (%)
3.0 in	75.000	100.0
1.5 in	37.500	100.0
0.75 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	99.4
NO. 10	2.000	98.1
NO. 20	0.850	93.8
NO. 40	0.425	87.5
NO. 60	0.250	79.9
NO. 140	0.106	56.8
NO. 200	0.075	48.2

HYDROMETER ANALYSIS

DIAMETER (mm)	PERCENT FINER (%)
0.0358	41.2
0.0263	36.0
0.0170	32.6
0.0100	29.2
0.0059	24.6
0.0050	22.3
0.0038	19.4
0.0027	15.4
0.0011	8.6

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A.4.2 Settling

Settling studies of pure K-65 material and K-65 mixed with 4% BentoGrout™ were done at FDF. Pure material settles quickly with little or no suspended and dissolved solids. K-65 with BentoGrout™ settles to 40% greater volume and produces a settled material with density of approximately 1.5 g/cc. Supernatant contains 2 wt. % typical suspended solids which polymers have as yet not been able to reduce. Rad and RCRA elements are very low in the supernatant. Viscosity of 30% solids is less than 10 cp. Water retention of the K-65 is high, with no free liquids seen until 35 % water added. Material dries easily though, with complete loss of water at 60-70°C.

Description of material as claylike is deceiving. There is little clay in the material.

A.5 Chemical Characteristics

A.5.1 Analytical Method

Of equal importance to sampling variation for chemical characterizations the need for comparable analytical techniques. For this reason, only those analyses (with exception of NLO) which are based on dissolution by fusion technique are compared. This delineation is important for K-65 material in particular as it is essentially the insoluble portion of the ore; therefore, a simple acid dissolution will bring into solution some of the constituents but not others. During the Remedial Investigation (RI), an acid dissolution step in accordance with EPA protocol was used and resulting lead levels were near that of other analysis (although with significant variability). More difficult to dissolve constituents such as silicon or sulfate were very significantly under-reported. This is important to us since of all constituents, silica at the levels generally found (50 wt. % range), is the primary elemental reason for using vitrification as a treatment technology. An example of the two types of dissolution may be seen in FDF data generated in 1996. The acid dissolution for silica was 96.9 mg/Kg, the fusion dissolution was 250072 mg/Kg, for the same sample. If silicon existed at the level reported in the RI (about 1 wt. %), vitrification would require massive additions of silicon. This is also important for sulfate since if the sulfate level was as low as indicated by RI data, there would be much greater confidence as to the outcome of vitrification as a treatment method. It is for this reason that in general RI data should not be used where elemental analysis is desired.

It is also for this reason that caution should be the rule in the use of statistical method to extend the value of our data. There is limited data which is of sufficient quality to command respect as decision points in a pivotal role for a project of this magnitude and importance. It would be prudent to recognize the value of the data and its limitations. The value of data which is limited by analytical technique or sampling bias cannot be expanded.

The various chemical analyses have indicated that less than 100% of the material has been dissolved and analyzed. The percentage of constituents is generally in the 80-90% range, with the oldest analysis yielding 61.02 (NLO). The amount less than 100% analyzed indicates material which did not dissolve, such as some silicates, some carbonates, and sulfates, and possibly some hydrated species. The lower recovery of the NLO sample seems to be from a different dissolution procedure and a different analytical method.

The NLO data mentioned above was retained for comparison despite analytical method since it is known to have come from a well extracted core boring sample (composite). Despite the lower percentage measurement of constituents, it follows the same pattern of percentage of constituents seen in the other analyses. It is the contention of this comparison that the degree of variability (with two notable exceptions) is well within the limits of toleration of vitrification technology. The exception are sulfate and lead. In order to understand the role of these constituents we should consider the process history of the material.

A.5.2 Process History - Sulfate

The analytical data reported (except for ANL Silo 2) is quite consistent with process knowledge for the K-65 material. The primary changes in Silo 1 and 2 constituents are a result of the changing nature of the ore stream over time (the richest ore was mined and processed first). This may be seen today in the change in radium content (radium and uranium content would be interrelated) between the Silos. Silo 1 having been filled with the earliest processed material has about twice the radium content as does Silo 2.

Although radium is not of chemical concern in vitrification, its role in process history of the K-65 material is very important in understanding the material in the silos. Since the Atomic Energy Commission (AEC) was committed to return to Afrimet (the owners of the residue at that time) essentially all the radium which arrived as part of the ore, great care was given to tracking radium and maintaining the integrity of the material in the silos. This meant sampling all material as ore prior to processing and then as residue to verify that the radium had not been lost. Beyond any doubt, this resulted in the most extensive characterization of the silos for any constituent. We have records of the radium (and gold) sampled in this manner, during the years of processing here. In order to verify the accuracy of NLO sampling, the samples were split and sent to two other highly regarded laboratories for analysis. The results were required to agree within a very small limit of variation. We also have some of the data on Mallinckrodt Chemical Works (MCW) generated material to clearly establish the general downward trend in radium from Silo 1 to Silo 2 (see attachments 5, 6, 7 & 8). The end result was that there was more control over what went into the silos than usual residue. Variation in constituents was therefore only a result of variation in the ore stream and the effect of process on this material.

The Attachment 4 describes the process of extracting the uranium from the ore. It should be points out that a part of the uniqueness of the K-65 material as a residue is that it came almost entirely from one mine. This mine, at Shinkolobwe, Katanga, in the former Belgion Congo has aspects important to us now in our evaluation of silo characterization data. A description of the ore deposit is included to better understand Q-11 ore, which was the source of K-65 material (taken from The Chemistry of Uranium, Katz and Rabinowitch 1951).

The deposit is in isolated silicified breccia 15 miles south of Kamove on the divide between the drainage basins of the Mura and Panda rivers. The rocks form a ridge 40 to 45 ft high and 250 ft long. The uranium is in some cases very close to the surface; solid masses of pitchblende have been found under only a few centimeters of topsoil. Presumably the fresh-vein material is covered by thin transported soil.

Since the entire region is heavily mineralized, a magmatic source for the solutions from which the deposits formed cannot be doubted. The host rock containing the ore deposits resembles that observed in numerous copper deposits in Katanga. It consists of altered carbonate rocks of the "Série des Mines," which is surrounded by comparatively undisturbed argillaceous and talcose schists (Kundelungu formation). In addition to uranium there are found at Shinkolobwe copper, cobalt, nickel, vanadium, iron, and precious metals. Molybdenum (as MoS_2 and wulfenite) has also been observed. None of these elements is found in the Kundelungu formation itself. The Série des Mines in which the uranium is found is about 200 meters (656 ft) thick and consists mainly of dolomitic limestone. The pitchblende-bearing veins tend to parallel the main faults that cut the dolomite although they are not in the faults. The veins are capricious and swell in short distances from a few centimeters in width to a meter and yield masses of compact pitchblende weighing several tons. The uranium minerals are free of visible gangue materials. To minimize losses, the entire mass of rock is mined, and the ore is hand-sorted. The veins are so irregular that it is difficult to estimate the reserves.

Besides the veins, uranium also occurs disseminated in the wall rocks adjacent to them. In the wall rock it is present in various minerals derived from the complete alteration of pitchblende. Other disseminations made up principally of torbernite have no apparent relation to the veins. More than half the oxidized uranium is in the form of torbernite, but numerous other oxidation products of pitchblende also have been observed here (Buttgenback, 1935). Kasolite and sklodowskite occur as disseminated minerals, with the sklodowskite lining cavities in the rock similarly to the torbernite. Uraninite is also present (Hitchen, 1934). Small quantities of copper, cobalt and nickel sulfides, which are present in considerable quantities in other parts of the Séries des Mines, also are found in the uranium veins.

The mineralization sequence is complex. According to Thoreau and de Terdonck (in Hess, 1934), the ores were formed by siliceous solutions entering carbonate rocks and producing a series of silicate minerals; pitchblende was deposited next, and this was followed by a succession of sulfide minerals. Later processes altered the ores and yielded many secondary minerals. The deposition of pitchblende is thus considered an early high-temperature phase of the copper mineralization. This mineralization sequence appears to be common in this region.

The two important compositional issues to understand from this description are 1) the variation of our K-65 material (other than process induced) is confined to variations found within this relatively small uranium ore body and 2) the "succession of sulfide minerals" may explain the degree of variation seen in sulfate content, especially in Silo 2. This would be the result of the highest value ore being removed from the mine first and the lower value ore being discarded initially, only to be retrieved in later years as a source equal to the quality of material mined at that time. It is known that this sequence of utilizing ore did occur. The suggestion is that the increase in sulfide in the ore and the change in process from a dual cycle ether (sulfate intolerant) to a kerosene-TBP (sulfate tolerant) process were not unrelated. This would indicate that insoluble sulfate remained in NLO generated material as a result of the initial sulfide content of the ore. The sulfate content of MCW generated material was the result of added H_2SO_4 as well as sulfide in the ore. The addition of $BaCO_2$ following the H_2SO_4 addition was intended to remove all sulfate possible. This is reflected in higher barium content in Silo 1.

In the NLO process (where barium was added to remove radium, not residual sulfate) a lower level of barium remains in the residue. The significance of this is that total sulfate may be higher in NLO generated material but that $BaSO_4$ may not be the dominant sulfate species. Data available from recent Argonne National Lab analysis and PNL data on Silo 2 suggest a degree of variation in the sulfate level of this silo which needs clarification.

Considering the profound potential impact of high sulfate levels or variation in levels on vitrification, further analysis should be done to expand our knowledge base on the sulfate content of material we currently have as archived. In contrast then to a body of data on other constituents which despite its limitations has the consistency of content to justify proceeding with vitrification planning, the sulfate content of the material is significant enough to justify additional analysis and sampling.

Recent analysis FDF (1996) on K-65 material indicated a range of sulfate levels similar to that found at ANL: FDF 4.05 - 4.3 wt. %, ANL 2.88 - 7.05 wt. %. This data should be contrasted with previous information on sulfate content, i.e., that measured by PNL in 1992. Silo 1 concentration was 1.6 - 1.9 wt. % and Silo 2 was measured from 0.87 - 2.7 wt. %. Since the amount of sulfate is known to have a limited solubility in silicate melts (typically less than 1 wt%), any amount above this level can contribute to processing difficulties.

Other data which would also suggest a need to define sulfate content can be taken from the Vitro report which was written in 1951. (dry wt.% was added for comparison to our other data).

1951 VITRO ANALYSIS OF K-65 RESIDUE

	Dry Wt.% Basis	% Sulfate
SiO_2	53.4	
$BaSO_4$	11.3	4.66
$PbSO_4$	2.0	.63
Na_2SO_4	0.19	.13
$PbCO_3$	16.1	
Na_2CO_3	1.3	TOTAL- 5.42

This data would also suggest that we need a more definitive understanding of the cations of sulfate compounds since the sulfate data indicates that a significant portion of this sulfate is in a relatively stable form. This means that such a form, such as barium or lead sulfate, poses a processing difficulty for vitrification since its dissociation temperature exceeds our proposed melting temperature (unless we enter the region of in situ melting temperatures). This same stable form, specifically in regard to lead sulfate but also applicable to barium sulfate, is an advantage in cement remediation. In this method of treatment the insoluble sulfate form is desired since it prevents teaching from the residue in.

A.5.3 Lead

Pb content is also equally important to define due to its processing importance. Since we know that the general trend in concentration is for Silo 1 material to have at least twice as much Pb as Silo 2 (attachments 1 & 2); our process shall be tolerant of the levels found in Silo 1 (about 10 wt.% average, with 13 wt.% not atypical). Since the concentration in Silo 2 is in general about half of this level, the assumption has been that high Pb levels will not be an issue in Silo 2. The exception to this is the 29.9 wt. % elemental Pb found in an RI sample. Previously it was stated that the reason for excluding RI data was explained as well as why RI Pb data may be compared to our other data. As a result, by including the RI data we raise the issue of the importance of the single extremely high Pb data point. The Pb data is listed below, first as RI alone and then as added to all data from Attachment 3. The purpose is to indicate the effect the single high data point has on the data set.

	Silo 1 Pb wt. %	Silo 2 Pb wt. %	Silo 2 Pb wt. %
Remedial Investigation Data from 1991 Sampling	5.7	4.3	4.3
	13.3	2.8	2.8
	9.9	3.5	3.5
	11.4	29.9	
	4.4	7.5	7.5
	10.9	3.4	3.4
	11.7	1.3	1.3
	11.2	3.2	3.2
	10.7		
	12.1		
	10.2		
	1.7		
	Mean: 9.43 Std. Dev. 3.53	Mean: 6.98 Std. Dev. 9.42	
	8.85	4.9	4.9
	1.9.57	7.2	7.2
	9.01	6.4	6.4
	10.0	6.6	6.6
	13.0	7.5	7.5
	13.0	3.25	3.25
	13.0	2.18	2.18
	12.6	3.24	3.24
	13.04		
	12.93		
	13.15		
	Mean: 9.91 Std. Dev. 3.22	Mean: 6.81 Std. Dev. 7.22	Without 29.9%: Mean 4.8

Although the 29.9% sample may be considered an outlier, there is an equal likelihood that it is the accurate measurement of that particular sample. If this is assumed, the remaining question is how often would this level of Pb would be encountered.

Beyond the other Pb data, which would indicate it would not be encountered, our only source of information is in regard to ore. There was an ore mined at Shinkolobwe, dumontite ($2\ PbO \cdot 3\ UO_3 \cdot P_2O_5 \cdot 5\ H_2O$), which was 29% elemental Pb.

As this ore was closely associated with torbernite at Shinkolobwe (The Chemistry of Uranium Katz and Rabinowitch 1951) and we know that more than half the oxidized uranium at Shinkolobwe was in the form of torbernite, it is likely that some dumontite was processed as Q-11. Since information on the ore body is not as specific as analytical data on the material, the value of this information would be to indicate that high Pb levels might be encountered, but not to attempt to define at what frequency or to what degree. (See Attachments 7 & 8 to see variation in lead content.)

A.6 Radiological

Table 2-18 Summary of Radionuclide Analyses for Silos 1 and 2 Residue

Analyte[a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (pCi/g)[d]	Upper 95% CI on Mean[c] (pCi/g)	Range of Detects[c] (pCi/g)
SILO 1					
Actinium-227	13/20	0	5960	7670	4320-17390
Lead-210	20/20	0	165000	202000	48980-381400
Polonium-210	13/13	0	242000	281000	144000-434000
Radium-226	20/20	0	391000	477000	89280-890700
Thorium-228	2/20	0	422	2280	835-2280
Thorium-230	24/24	0	60000	68900	10569-105372
Thorium-232	8/20	0	424	1110	661-1106
Uranium-234	21/21	0	800	932	326-1548
Uranium-235/236	14/20	0	38	54	19.1-105
Uranium-238	20/20	0	642	693	387-920

Analyte[a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (pCi/g)[d]	Upper 95% CI on Mean[c] (pCi/g)	Range of Detects[c] (pCi/g)
SILO 2					
Actinium-227	11/14	0	5100	6640	2905-10450
Protactinium-231	1/14	0	2350	4040	4041-4041
Lead-210	14/14	0	145000	190000	58160-399200
Polonium-210	8/8	0	139000	231000	55300-241000
Radium-226	14/14	0	195000	263000	657-481000
Thorium-228	5/14	0	645	7360	411-7360
Thorium-230	15/15	0	48400	76200	8365-132800
Thorium-232	3/14	0	402	985	851-985
Uranium-234	13/13	0	961	1160	121-1465
Uranium-235/236	11/13	0	73	94	35.6-172
Uranium-238	14/14	0	912	1120	46-1925

[a]Sample numbers used in this data set include:
(Silo 1) 99728, 99743, 99870, 99885, 99909, 99930, 99939, 99948, 99966, 99975, 100004, 100025, 100039, 100108, through 100114; and (Silo 2) 99359, 99710, 99774, 99802, 99811, 99831, 99846, 99861, and 100115 through 100120.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R are excluded. The mean and upper 95% Confidence Interval (CI) on mean have been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.
[d]Values expressed in picoCuries per gram (pCi/g)

Radon

The most important characteristic of the K-65 material is the constant release of radon. The rate of radon emanations is very high and because of the difficulty of containing radon poses a significant challenge for any handling of the material. The rate of radon generation is related to the significant concentrations or radium in the material. The measure values for radionuclides are contained in Table 2-19. In using this data it is important to remember that the actual radionuclides content is but represented by their upper 95% C1 data, as less representative 1989 sampling data is included in this table. Radon emanation is therefore understand to be approximately 250,000 pCi/m^2/sec.

A.6.1 Organic Carbon

The PNL Treatability Report[4] identified organic carbon in K-65 material in the range of 0.3 to 1.2%. These numbers are similar to those reported in the RI, where total organic carbon and oil and grease are both reported. These values are listed below.

From process knowledge there is no known explanation for the presence of oil or grease at the level found in Silo 1. Silo 2, in contrast, has a known source of organic carbon, kerosene. Kerosene is assumed to be a significant source of organic carbon in Silo 2.

[4] Battelle Pacific Northwest Laboratories, *Operable Unit 4 Treatability Study Work Plan for the Vitirfication of Residues from Silos 1, 2, and 3*; April, 1992. (This report was revised and issued again by the U.S. Department of Energy; Fernald Field Office, Fernald, Ohio, *Operable Unit 4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3*; May, 1993.

Silo 1

SUMMARY OF CHEMICAL ANALYSES OF K-65 RESIDUE: NOT NORMALIZED (expressed in wt% as oxides)

Element	CEP-90 average	PNL-90 average	PNL-92 Zone A	PNL-92 Zone B	PNL-92 Zone C	PNL-92 Silo 1 ABC	ANL Analysis Silo 1-A	Silo 1-B	Silo 1-C	Mean	Std. Dev.
Si	52.75	55.4	52	48	48	49	62.9	66.54	66.11	55.63	7.613
Pb	9.57	9.01	10	13	13	13	13.04	12.93	13.15	11.86	1.765
Fe	9.01	4.86	2.7	2.3	2.4	2.6	1.46	1.5	1.52	3.15	2.431
Ba	7.57	2.63	6	6.1	6.8	6.8	5.25	4.95	5.05	5.68	1.448
Al	6.46	3.45	2.6	2.7	2.6	2.6	4.02	3.7	3.82	3.55	1.236
Ca	1.23	2.57	0.62	0.28	0.22	0.45	0.24	0.29	0.25	0.68	0.777
Mg	2.24	3.47	1.2	1.2	1.1	1.2	2.08	1.87	1.96	1.81	0.762
S	N/A	N/A	1.9	1.8	1.6	N/A	2.95	2.88	3.05	2.36	0.663
C	N/A	N/A	1.4	3.5	4.6	N/A	3.04	3.22	3.11	3.15	1.030
Na	1.48	1.08	1	2.2	2.2	1.8	1.24	1.2	1.2	1.49	0.467
P	0	4.6	0.93	0.46	0.48	0.65	1.1	1.06	1.06	1.15	1.345
Ti	0.43	1.34	0.35	0.24	0.25	0.28	0.65	0.62	0.63	0.53	0.346
K	0.47	0.51	0.72	0.72	0.6	0.6	0.6	0.54	0.55	0.59	0.086
Ni	0.64	0.62	0.29	0.51	0.45	0.41	0.33	0.29	0.31	0.43	0.137
Co	0.25	0.37	0.17	0.22	0.19	0.18	0.13	0.11	0.11	0.19	0.082
Mo	0.24	0.32	0.69	0.27	0.34	0.47	1.59	1.53	1.55	0.78	0.599
Cr	0.49	0	0.029	0.015	0.015	0.022	0.01	0.01	0.01	0.07	0.159
N	N/A	N/A	0.23	0.42	0.21	0.24				0.28	0.097
Cl	N/A	N/A	0.082	0.1	0.076	0.072				0.08	0.016
Cu	0.08	0.11	0.053	0.063	0.055	0.052	0.05	0.05	0.05	0.06	0.019
Ce	0	0	0.64	0.32	0.27	0.35	0.99	0.97	0.99	0.50	0.407
V	0.12	0	0.083	0.057	0.057	0.06	0.09	0.07	0.07	0.07	0.032
La	0	0	0.65	0.31	0.29	0.41	0.9	0.88	0.91	0.48	0.368
Mn	0.06	0.04	0.016	0.012	0.014	0.014	0.01	0.01	0.01	0.02	0.017
Zr	0	0	0.059	0.036	0.058	0.047	0.03	0.04	0.03	0.03	0.022
Nd	0	0	0.3	0.15	0.13	0.2	0.43	0.43	0.44	0.23	0.178
Sr	0	0	0.075	0.069	0.084	0.081	0.06	0.06	0.06	0.06	0.034
Be	0.02	0	0.0056	0.0069	0.0056	0.0056	ND	ND	ND	0.01	0.007
Se	0	0.04	0.035	0.056	0.049	0.042	ND	ND	ND	0.04	0.020
TOTAL	93.1	90.4	84.8	85.1	86.1	81.6					

0002262

8103

SUMMARY OF CHEMICAL ANALYSES OF K-65 RESIDUE: NOT NORMALIZED (expressed in wt% as oxides)

Element	PNL-89 average	PNL-92 Zone A	PNL-92 Zone B	PNL-92 Zone C	PNL-92 Silo 2 ABC	ANL Analysis Silo2-A	Silo2-B	Silo2-C	Mean	Std. Dev.
Si	53.75	49	57	46	58	39.54	26.74	26.1	44 52	12.678
Pb	8.85	4.9	7.2	6.4	6.6	3.25	2.18	3.24	5 33	2.313
Fe	3.75	8.4	3.4	6.4	5.8	7.26	7.58	4.27	5 86	1.878
Ba	5.39	1.5	3.7	3.8	3.1	2.1	1.25	1.76	2 83	1.428
Al	3.11	3.7	3.2	3.2	3.4	4.48	4.35	2.65	3 51	0.631
Ca	2.82	3.1	2.2	2.2	2.7	12.7	25.47	26.02	9 65	10.532
Mg	1.28	2.3	1.1	1.6	1.7	4.89	4.03	3.32	2.53	1.397
S	N/A	1.4	0.87	2.7	N/A	7.05	4.65	3.7	3.40	2.274
C	N/A	3.3	3.3	3.3	N/A	11.54	23.85	22.34	11.27	9.710
Na	1.6	0.61	0.98	1	0.93	2.09	1.58	1.47	1.28	0 482
P	0.64	0.7	0.73	0.61	0.68	2.84	1.88	1.31	1.17	0 807
Ti	0.31	0.36	0.3	0.32	0.36	0.23	0.23	0.2	0 29	0 062
K	0.86	0.72	0.6	0.72	0.84	0.54	0.49	0.31	0.64	0 187
Ni	0.44	0.31	0.46	0.33	0.38	0.37	0.24	0.22	0.34	0.086
Co	0.27	0.18	0.25	0.2	0.22	0.23	0.15	0.13	0.20	0.048
Mo	0.2	0.04	0.12	0.079	0.077	0.17	0.09	0.24	0.13	0.069
Cr	0.06	0.12	0.037	0.1	0.08	0.06	0.06	0.04	0 07	0.029
N	N/A	0.66	0.63	0.57	0.67				0 63	0 045
Cl	N/A	0.008	0.003	0.003	0.004				0 00	0.002
Cu	0.1	0.068	0.084	0.1	0.083	0.24	0.16	0.11	0.12	0 056
Ce	0.3	0.31	0.4	0.29	0.35	0.18	0.15	0.23	0 28	0 085
V	0.13	0.078	0.077	0.088	0.022	0.39	0.27	0.18	0 15	0 122
La	0.26	0.27	0.36	0.23	0.3	0.15	0.13	0.21	0 24	0.076
Mn	0.03	0.031	0.03	0.036	0.035	0.28	0.19	0.14	0 10	0 096
Zr	0.15	0.12	0.12	0.18	0.28	0.03	0.01	0.01	0 11	0 094
Nd	0.12	0.16	0.19	0.13	0.23	0.08	0.06	0.1	0 13	0.057
Sr	0.11	0.035	0.078	0.072	0.084	0.06	0.06	0.06	0 07	0 021
Be	0.09	ND	ND	ND	ND	0.01	ND	ND	0 05	0 057
Se	0	0.042	0 042	0.042	0.042	ND	ND	ND	0 03	0 019
TOTAL	84.6	82.4	87.5	80.7	86.9					

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8103

SUMMARY OF CHEMICAL ANALYSES OF K-65 RESIDUE: NOT NORMALIZED (expressed in wt% as oxides)

Element	NLO Average	PNL-80 Average	CEP-80 Average	PNL-80 Average	PNL-82 S1-ZA	PNL-82 S1-ZB	PNL-82 S1-ZC	PNL-82 S1-ABC	PNL-82 S2-ZA	PNL-82 S2-ZB	PNL-82 S2-ZC	PNL-82 S2-ABC	Silo 1 FDF-86	Silo 2 FDF-86	ANL Silo 1-A	ANL Silo 1-B	ANL Silo 1-C	ANL Silo 2-A	ANL Silo 2-B	ANL Silo 2-C
Si	43.59	53.76	52.75	55.40	52.0	48.0	48.0	49.0	49.0	57.0	48.0	58.0	53.4	51.5	62.9	60.54	60.11	39.54	26.74	28.1
Pb	5.49	8.85	9.57	9.01	10.0	13.0	13.0	13.0	4.9	7.2	6.4	6.6	12.6	7.5	13.04	12.93	13.15	3.25	2.18	3.24
Fe	1.72	3.75	9.01	4.88	2.7	2.3	2.4	2.6	8.4	3.4	6.4	5.8	2.1	4.8	1.48	1.5	1.52	7.26	7.58	4.27
Ba	0.08	5.38	7.57	2.63	6.0	6.1	6.8	6.8	1.5	3.7	3.8	3.1	5.6	4.47	5.25	4.95	5.05	2.1	1.25	1.76
Al	1.65	3.11	6.46	3.45	2.6	2.7	2.6	2.6	3.7	3.2	3.2	3.4	2.6	3.01	4.02	3.7	3.82	4.46	4.35	2.65
Ca	5.44	2.82	1.23	2.57	0.82	0.28	0.22	0.45	3.1	2.2	2.2	2.7	0.25	2.8	0.24	0.28	0.25	12.7	25.47	20.02
Mg	1.40	1.28	2.24	3.47	1.2	1.2	1.1	1.2	2.3	1.1	1.6	1.7	0.29	0.39	2.06	1.87	1.86	4.69	4.03	3.32
S	N/A	N/A	N/A	N/A	1.9	1.9	1.9	N/A	1.4	0.87	2.7	N/A	3.4	3.59	2.96	2.88	3.05	7.05	4.65	3.7
C	N/A	N/A	N/A	N/A	1.4	3.5	4.6	N/A	3.3	3.3	3.3	N/A			3.04	3.22	3.11	11.54	23.85	22.34
Na	0.84	1.60	1.48	1.08	1.0	2.2	2.2	1.8	0.61	0.88	1.0	0.83	1.7	0.74	1.24	1.2	1.2	2.09	1.58	1.47
P	0.00	0.84	0.00	4.80	0.83	0.48	0.48	0.65	0.70	0.73	0.61	0.68			1.1	1.06	1.06	2.84	1.88	1.31
Ti	0.11	0.31	0.43	1.34	0.35	0.24	0.25	0.28	0.36	0.30	0.32	0.36			0.65	0.62	0.63	0.23	0.23	0.2
K	0.19	0.89	0.47	0.51	0.72	0.72	0.60	0.60	0.72	0.60	0.72	0.64	0.12	0.25	0.8	0.54	0.55	0.54	0.49	0.31
Ni	0.00	0.44	0.64	0.62	0.29	0.51	0.45	0.41	0.31	0.48	0.33	0.38	0.44	0.38	0.33	0.29	0.31	0.27	0.24	0.22
Co	0.22	0.27	0.25	0.37	0.17	0.22	0.19	0.18	0.16	0.25	0.20	0.22			0.13	0.11	0.11	0.23	0.15	0.13
Mo	0.03	0.20	0.24	0.32	0.69	0.27	0.34	0.47	0.04	0.12	0.078	0.077			1.59	1.53	1.55	0.17	0.09	0.24
Cr	0.02	0.09	0.49	0.00	0.028	0.015	0.015	0.022	0.120	0.037	0.10	0.060			0.01	0.01	0.01	0.06	0.06	0.04
N	N/A	N/A	N/A	N/A	0.23	0.42	0.21	0.24	0.68	0.63	0.67	0.67								
Cl	N/A	N/A	N/A	N/A	0.062	0.10	0.076	0.072	0.0060	0.0030	0.0030	0.0040								
Cu	0.06	0.10	0.08	0.11	0.063	0.083	0.065	0.062	0.088	0.084	0.10	0.083			0.05	0.06	0.05	0.24	0.16	0.11
Ce	0.00	0.30	0.00	0.00	0.84	0.32	0.27	0.35	0.31	0.40	0.29	0.35			0.99	0.97	0.99	0.18	0.15	0.23
V	0.04	0.13	0.12	0.00	0.083	0.067	0.067	0.060	0.078	0.077	0.068	0.022			0.09	0.07	0.07	0.39	0.27	0.18
La	0.00	0.28	0.00	0.00	0.66	0.31	0.29	0.41	0.27	0.38	0.23	0.30	0.05	0.01	0.9	0.88	0.91	0.15	0.13	0.21
Mn	0.03	0.03	0.08	0.04	0.018	0.012	0.014	0.014	0.031	0.030	0.038	0.035	0.01		0.01	0.01	0.01	0.26	0.19	0.14
Zr	0.00	0.15	0.00	0.00	0.069	0.038	0.068	0.047	0.12	0.12	0.18	0.28			0.03	0.04	0.03	0.03	0.01	0.01
Nd	0.00	0.12	0.00	0.00	0.30	0.15	0.13	0.20	0.19	0.19	0.13	0.23			0.43	0.43	0.44	0.08	0.06	0.1
S[a]	0.00	0.11	0.00	0.00	0.075	0.089	0.084	0.081	0.035	0.078	0.072	0.064			0.06	0.06	0.06	0.06	0.06	0.06
Be	0.00	0.09	0.02	0.00	0.0068	0.0069	0.0066	0.0059	ND	ND	ND	ND			ND	ND	ND	0.01	ND	ND
Se	0.00	0.00	0.00	0.04	0.035	0.068	0.049	0.042	0.042	0.042	0.042	0.042			ND	ND	ND	ND	ND	ND
TOTAL	61.02	84.48	93.11	90.40	84.89	85.89	85.89	80.99	82.85	87.85	80.93	86.84								

Note: a) Determined from the difference between total carbon and total organic carbon, expressed as carbonate.
b) Sulfate was determined as total sulfur using ICP and expressed as sulfate.

0002364

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Silo 1 - Radiological

nCi/g	PNL-90 S1-ZA	PNL-92 S1-ZA	PNL-92 S1-ZB	PNL-92 S1-ZC	PNL-92 S1-Composite	RI
Bi-214	280	368	414	441	439	
Pb-214	297	368	414	438	437	
Ra-226	479	368	414	441	439	477
Pb-210	338	212	327	316	292	202
Th-230	284	45	69	ND	54	69
Pb-211	65	18	14	19	19	
Ra-223	22	15	16	16	14	
Rn-219	20	14	12	15	15	
Ac-227						6
Po-210						281
Th-228						2
Th-232						1
U-234						0.9
U-235/236						0.05
U-238						0.6

000265

8103

Site 2 Radiological

nCi/g	PML-02 S2-2A	PML-02 S2-2B	PML-02 S2-2C	PML-02 S2-Composite	RI
Bi-214	170	250	242	230	
Pb-214	178	253	246	228	
Ra-226	176	250	246	228	
Pb-210	182	236	247	233	
Th-230	184	26	35	32	
Pb-211	unresolved	8	8	7	
Ra-223	7	10	8	8	
Rn-219	5	9	8	7	
Ac-227					6
Po-210					231
Th-228					7
Th-232					0.9
U-234					1
U-235/236					0.09
U-238					1

0002266

8103

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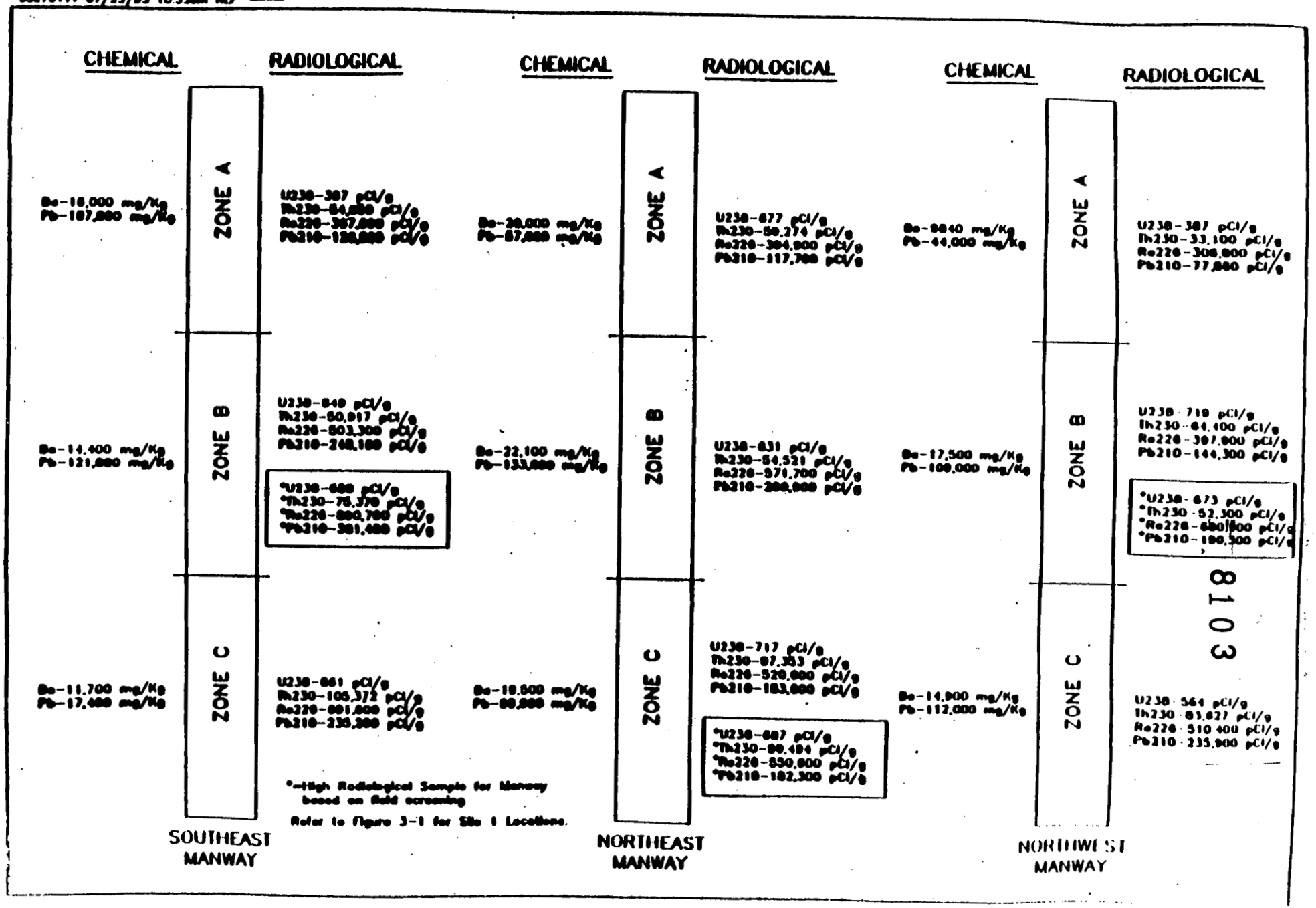

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002262

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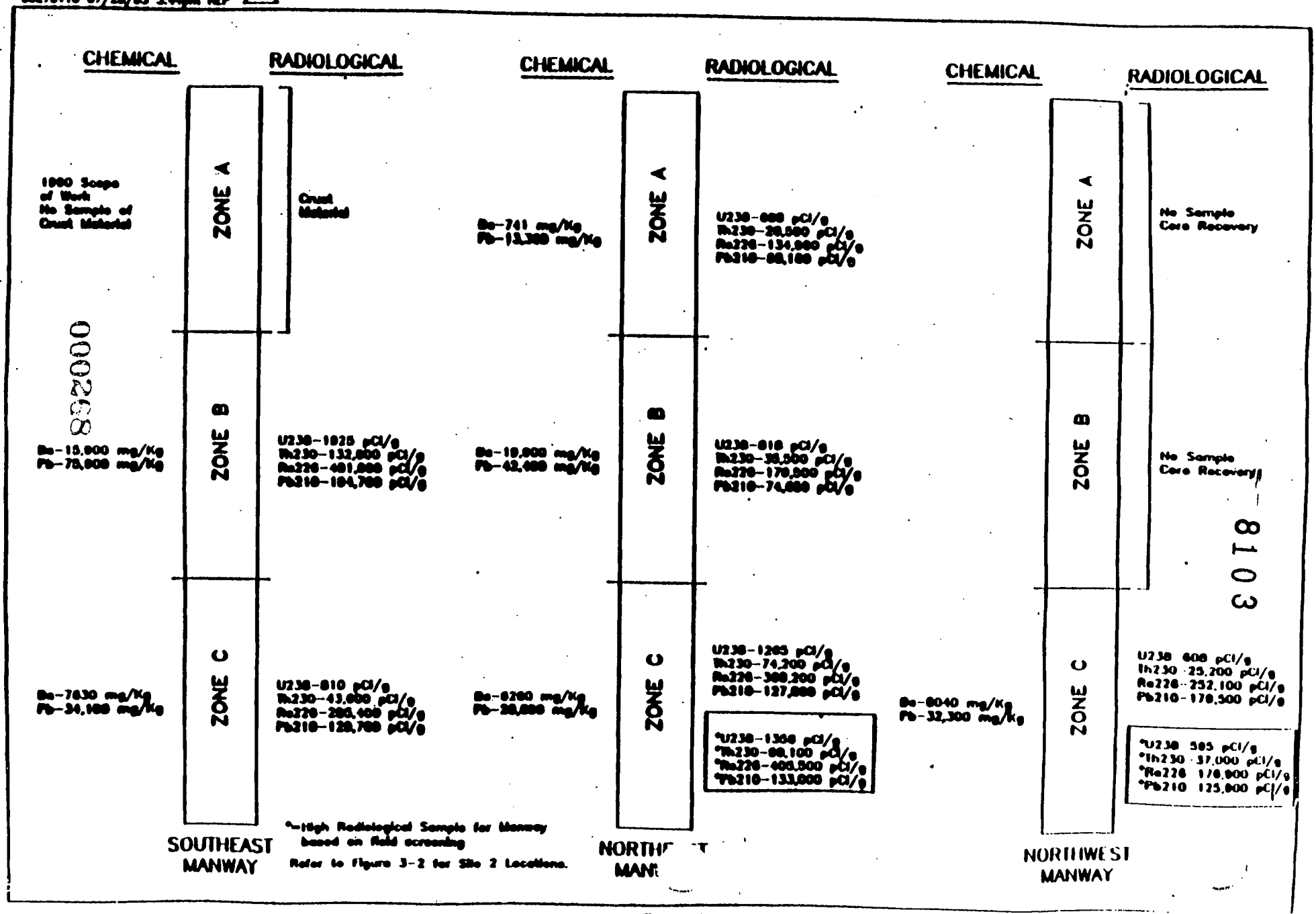

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8103

Ju e 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1, Zone A
Particle Size

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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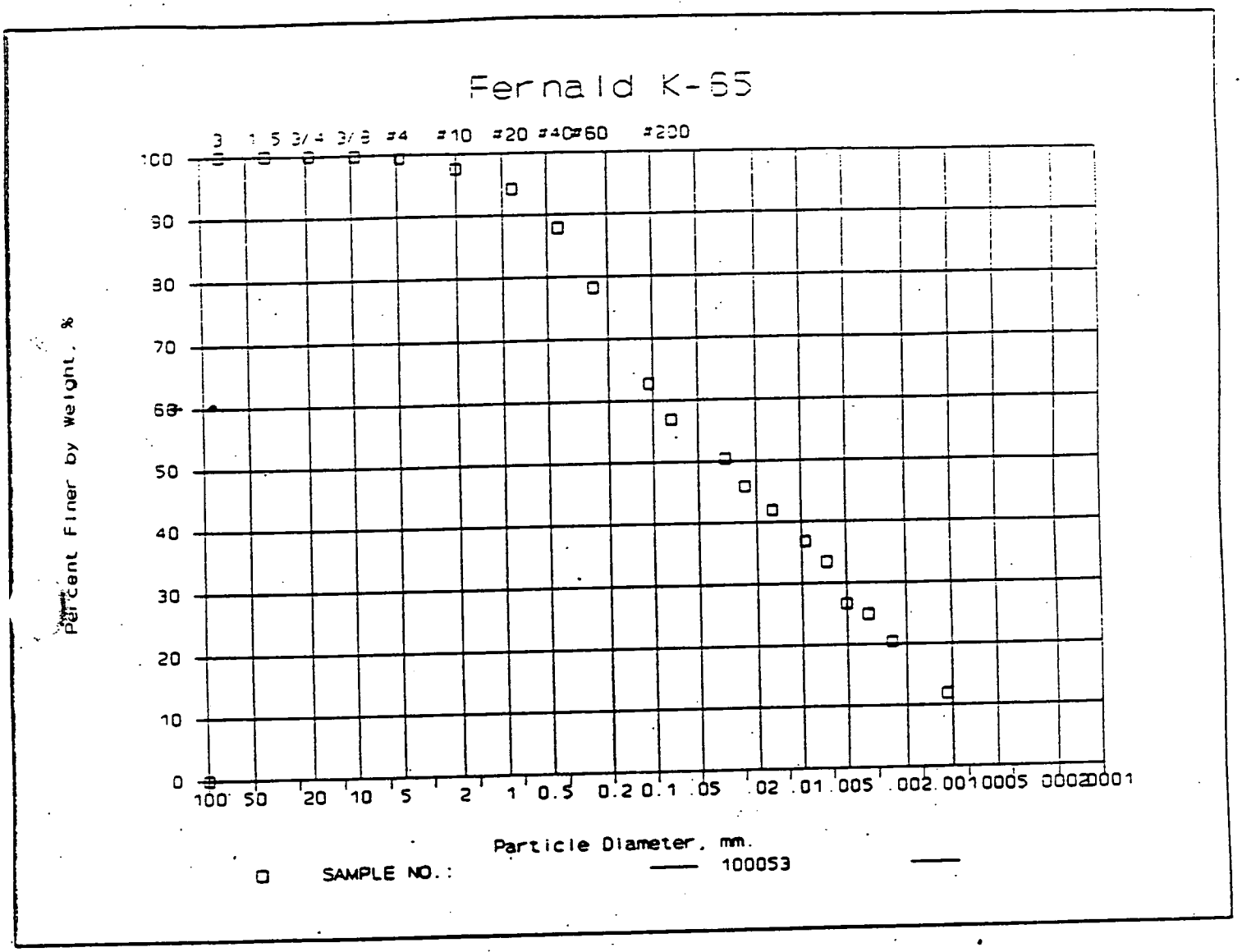

000269

582-1-69

J ne 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4 8103
IT Project No.: 313327.40.03.03

Silo 1
Zone A

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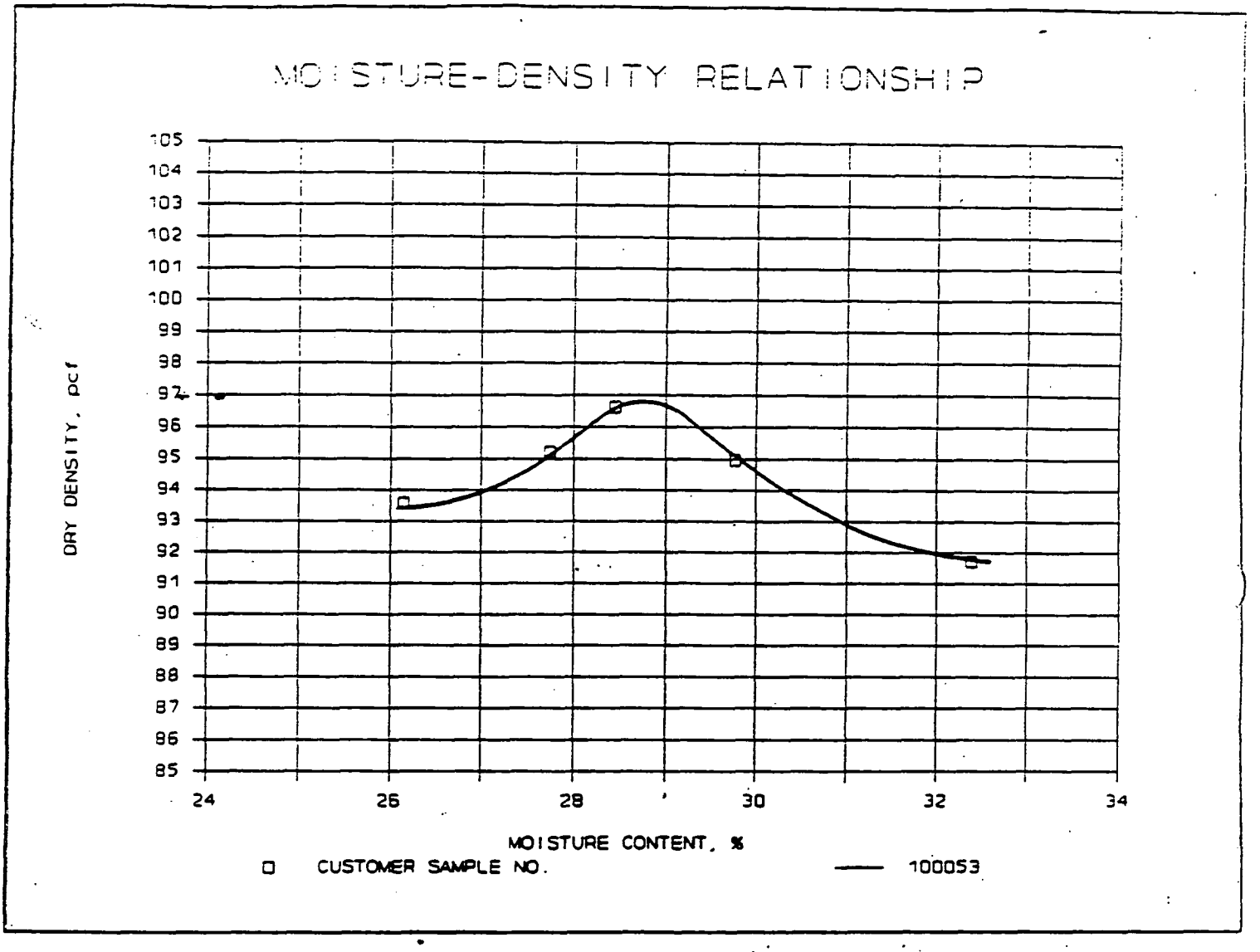

MAXIMUM DRY DENSITY: 96.8 pcf **OPTIMUM MOISTURE: 28.7 %**

INDIVIDUAL PROCTOR POINTS:

MOISTURE CONTENT	26.2 %	27.8 %	28.5 %	29.8 %	32.4 %
DRY DENSITY	93.6 pcf	95.2 pcf	96.6 pcf	95.0 pcf	91.7 pcf

000270

582-1-69

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone B

8103

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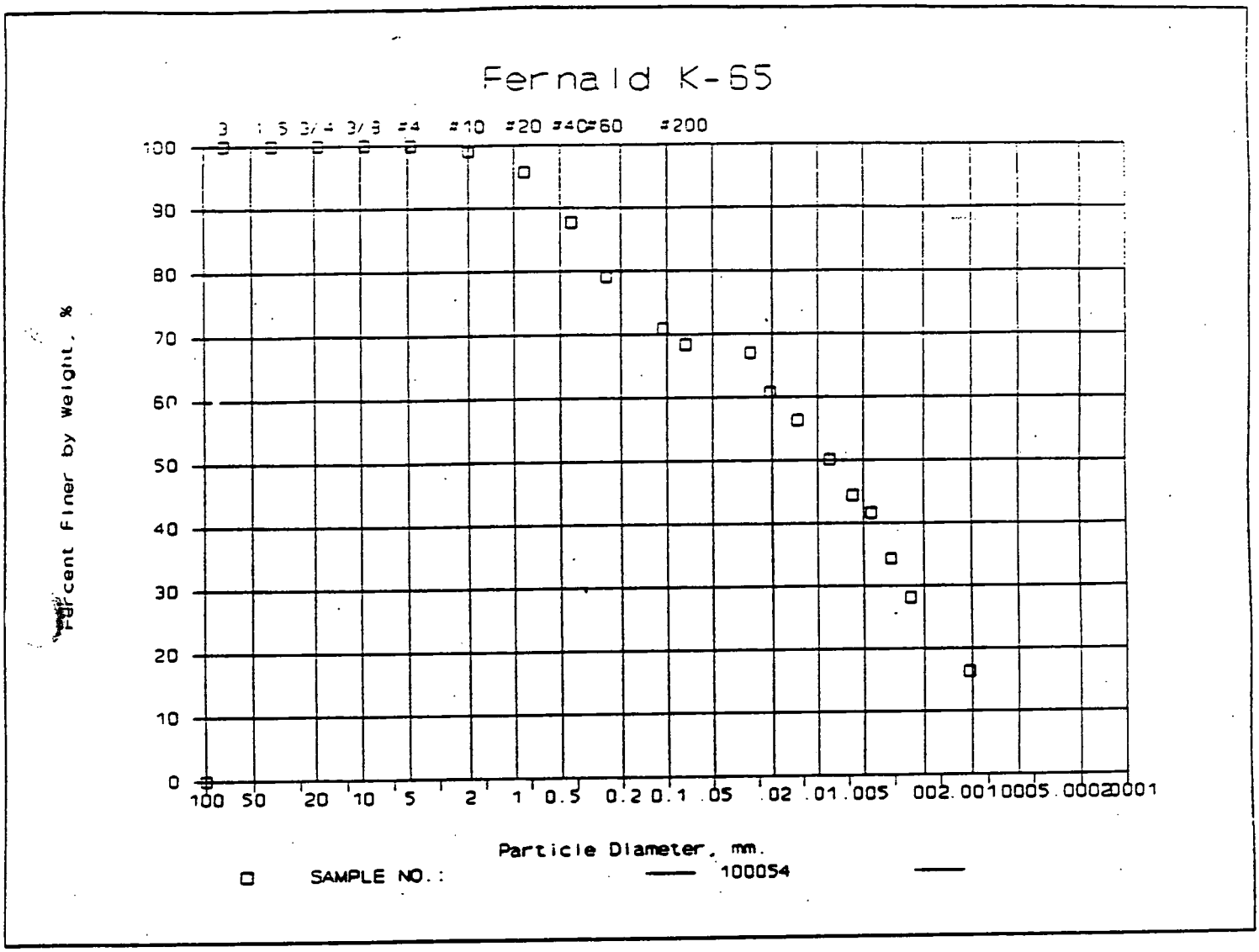

682-1-89

J ne 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone B

8103

IT ANALYTICAL SERVICES
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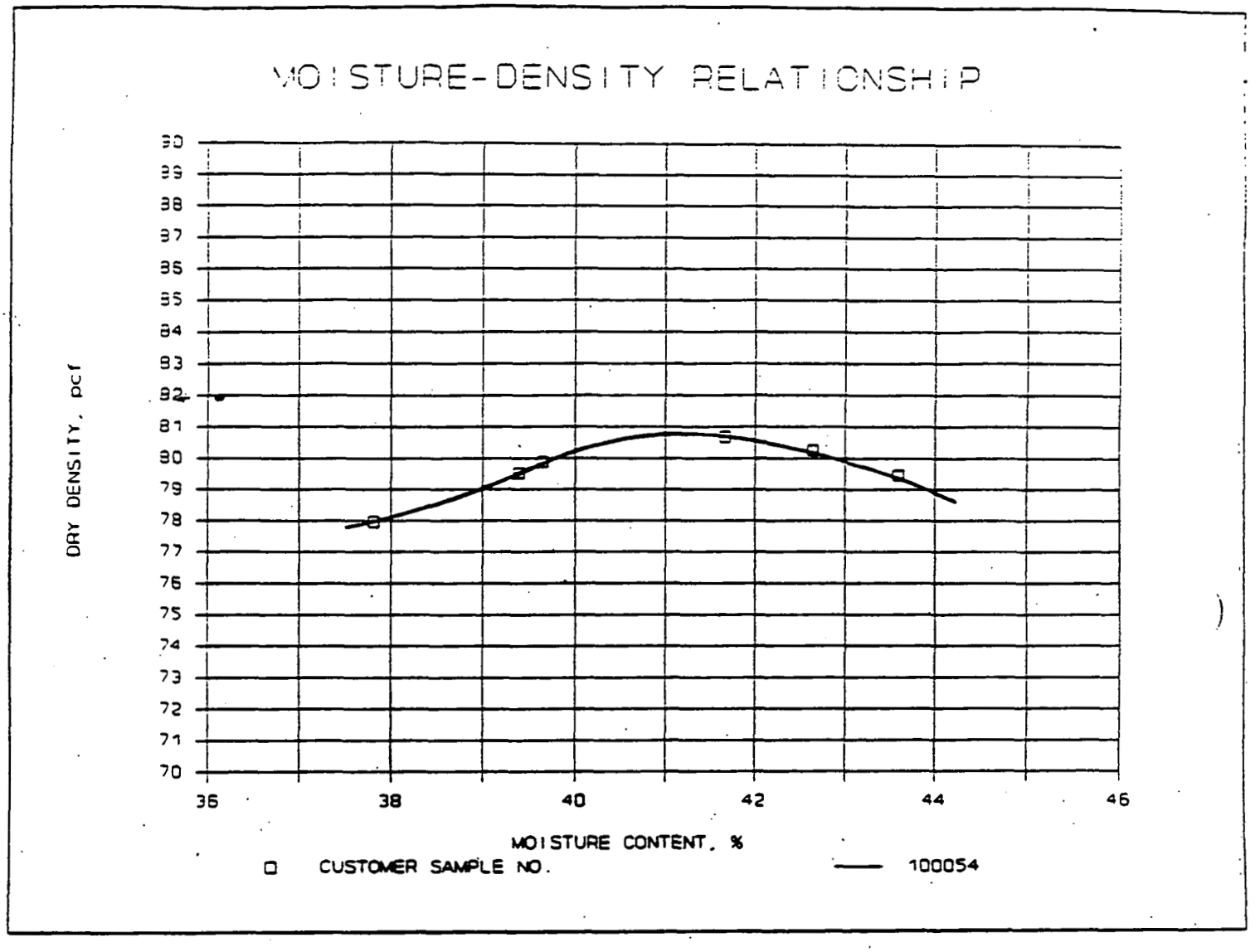

MAXIMUM DRY DENSITY: 80.8 pcf **OPTIMUM MOISTURE: 41.2 %**

INDIVIDUAL PROCTOR POINTS:

MOISTURE CONTENT	37.8 %	39.4 %	39.7 %	41.7 %	42.6 %	43.6 %
DRY DENSITY	78.0 pcf	79.5 pcf	79.9 pcf	80.7 pcf	80.2 pcf	79.5 pcf

000272

682-1-89

une 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone C

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
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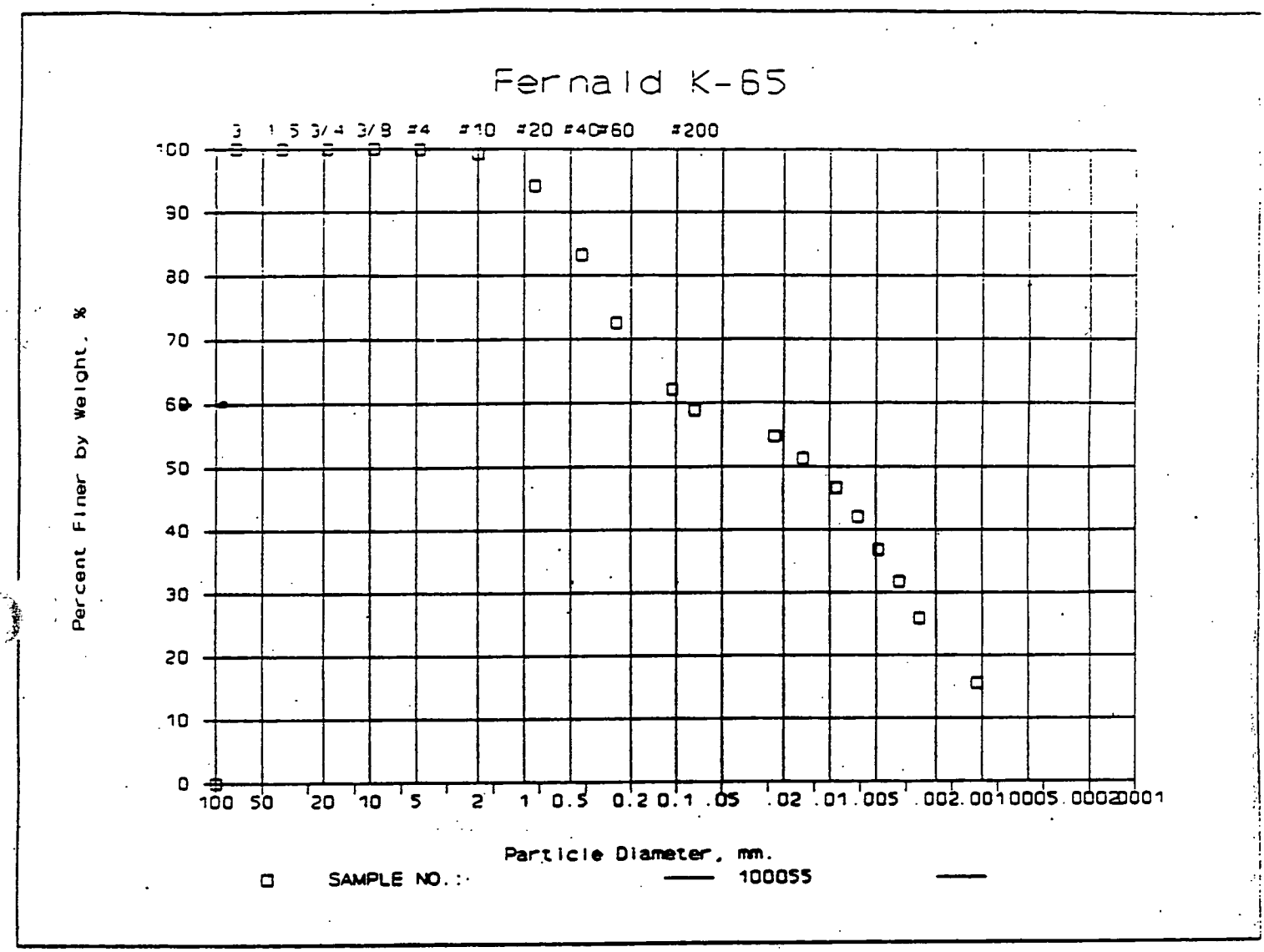

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682-1-89

J ne 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone C

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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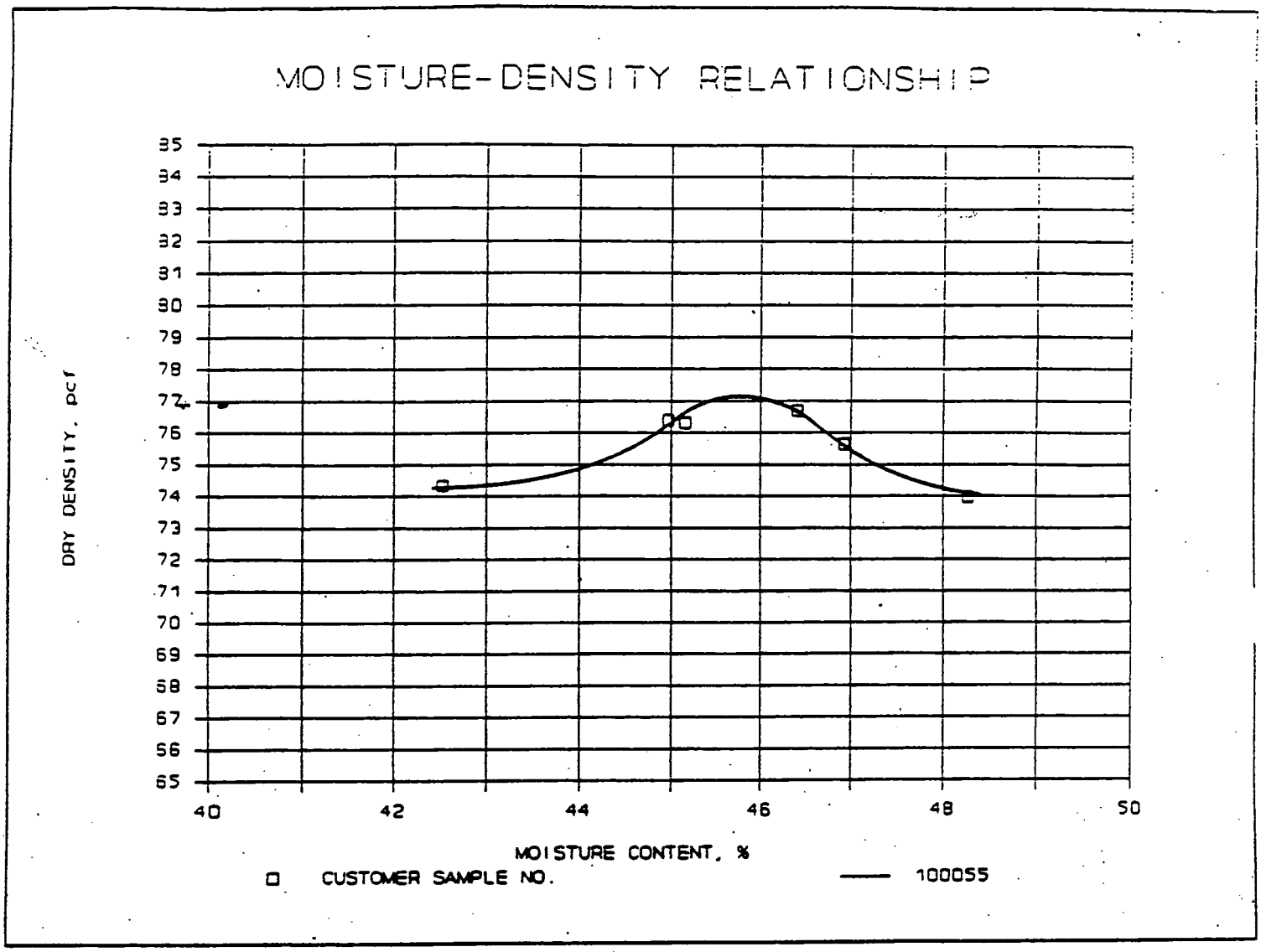


MAXIMUM DRY DENSITY: 77.1 pcf **OPTIMUM MOISTURE: 45.7 %**

INDIVIDUAL PROCTOR POINTS:

MOISTURE CONTENT	42.5 %	45.0 %	45.2 %	46.4 %	46.9 %	48.3 %
DRY DENSITY	74.3 pcf	76.4 pcf	76.3 pcf	76.7 pcf	75.7 pcf	74.0 pcf

000274

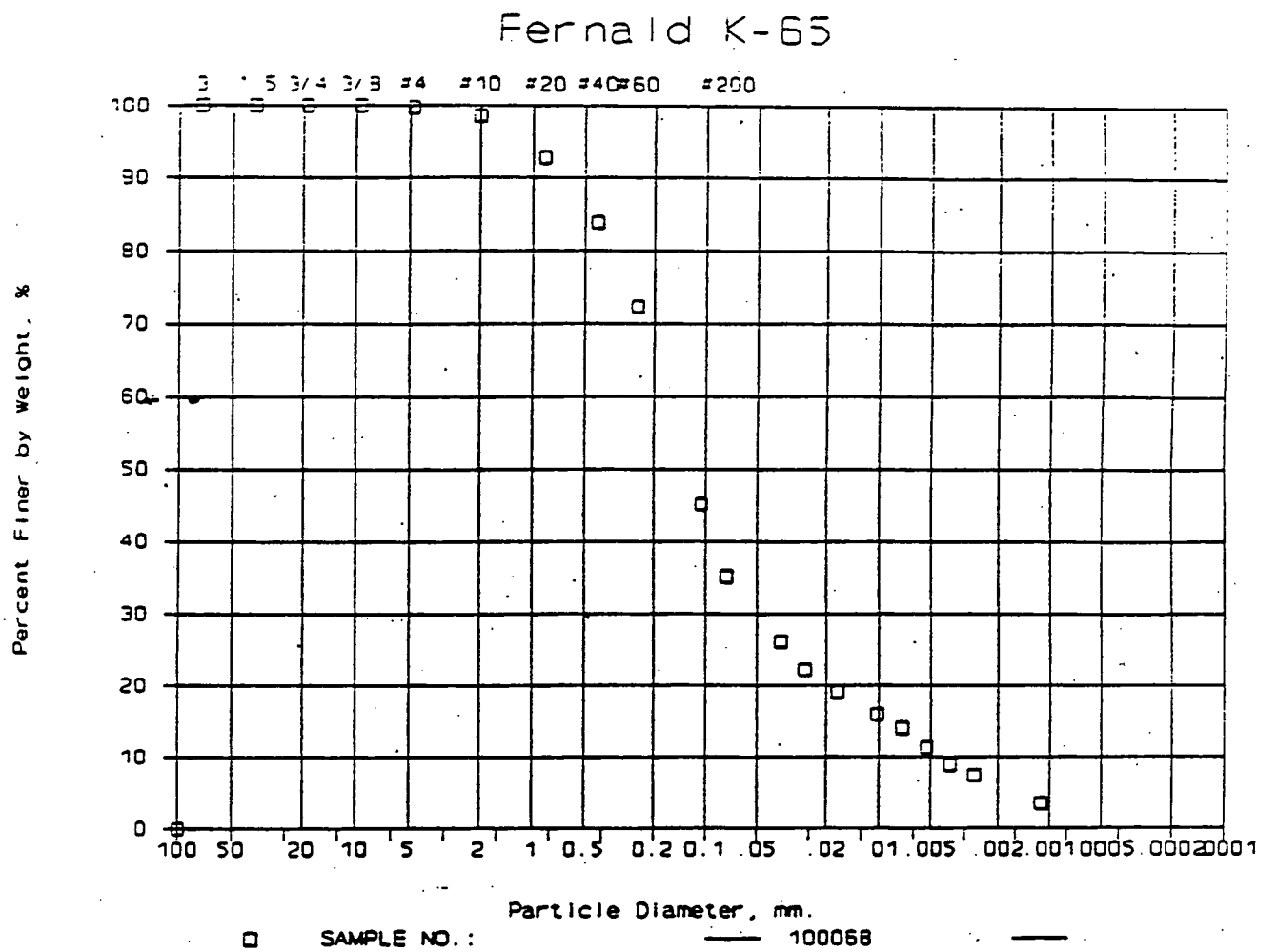
562-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone A

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
(615) 690-3211

8103



000275

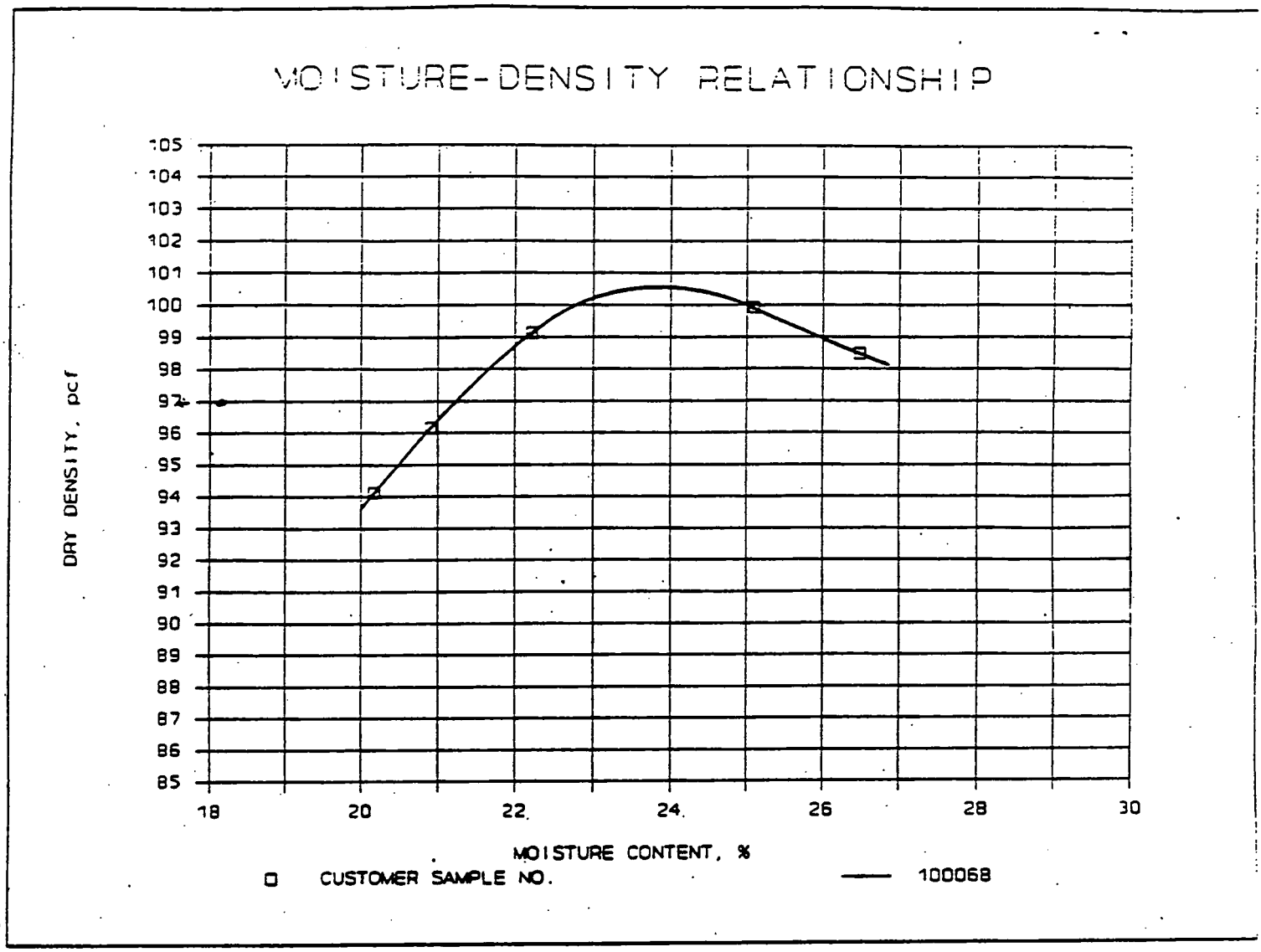
582-1-89

une 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone A

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
(615) 690-3211



MAXIMUM DRY DENSITY: 100.6 pcf **OPTIMUM MOISTURE: 23.8 %**

INDIVIDUAL PROCTOR POINTS:

MOISTURE CONTENT	20.2 %	20.9 %	22.2 %	25.1 %	26.5 %
DRY DENSITY	94.1 pcf	96.2 pcf	99.1 pcf	99.9 pcf	98.5 pcf

000276

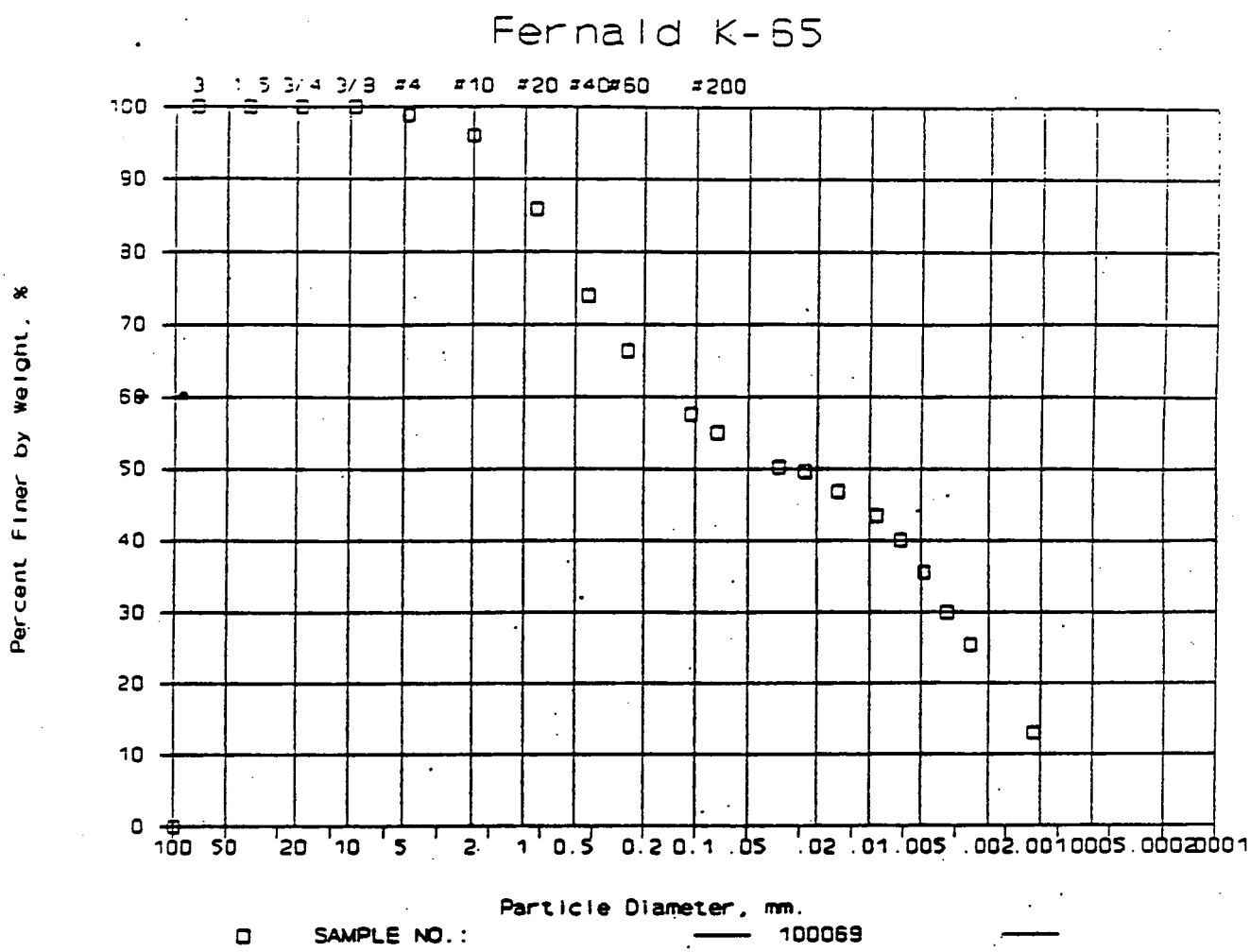
582-1-89

. une 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone B

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
(615) 690-3211



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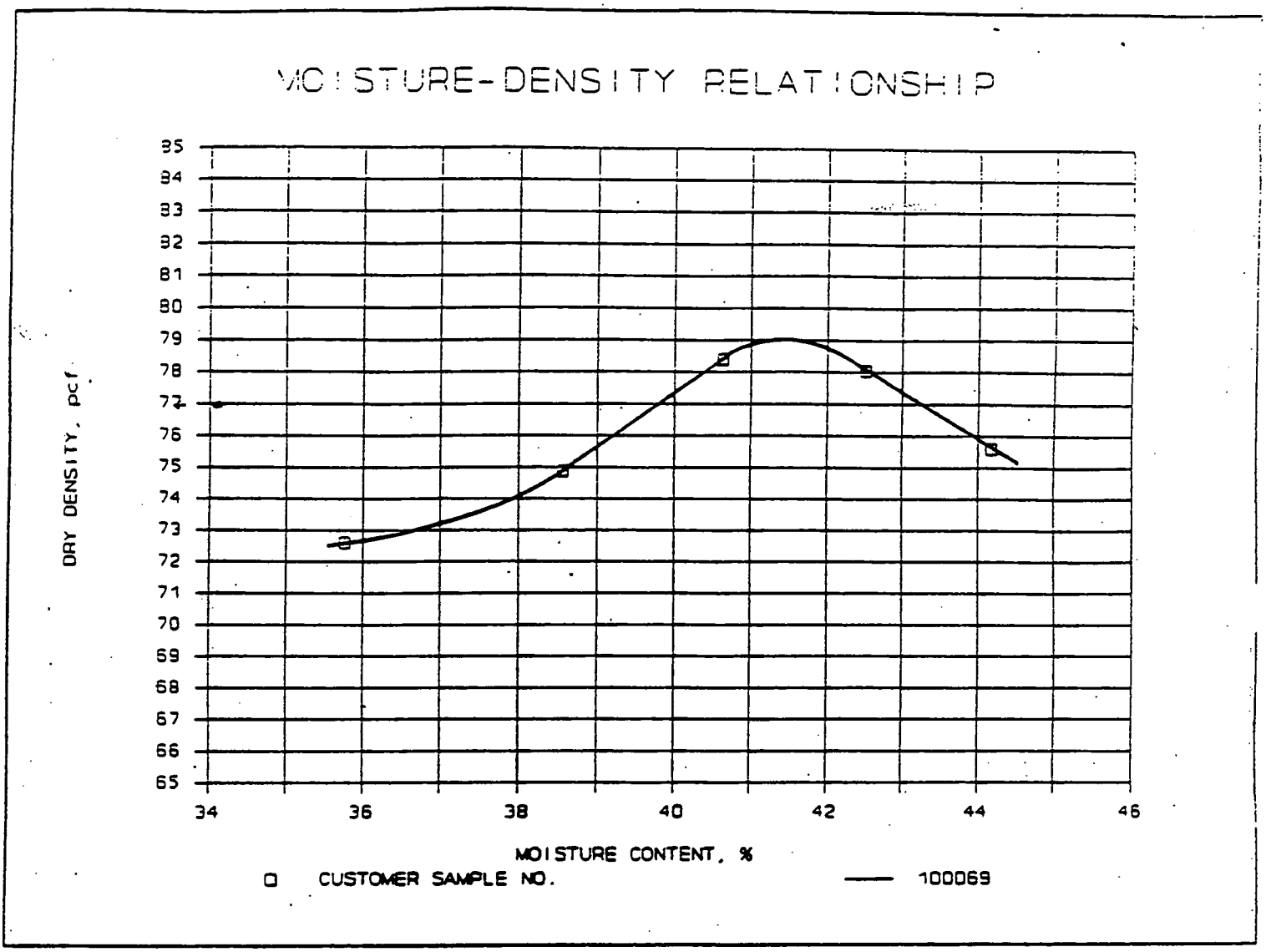
682-1-89

une 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone B

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
(615) 690-3211

8103



MAXIMUM DRY DENSITY: 79.0 pcf **OPTIMUM MOISTURE: 41.4 %**

INDIVIDUAL PROCTOR POINTS:

MOISTURE CONTENT	35.8 %	38.6 %	40.6 %	42.5 %	44.2 %
DRY DENSITY	72.6 pcf	74.9 pcf	78.4 pcf	78.0 pcf	75.6 pcf

000278

682-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone C

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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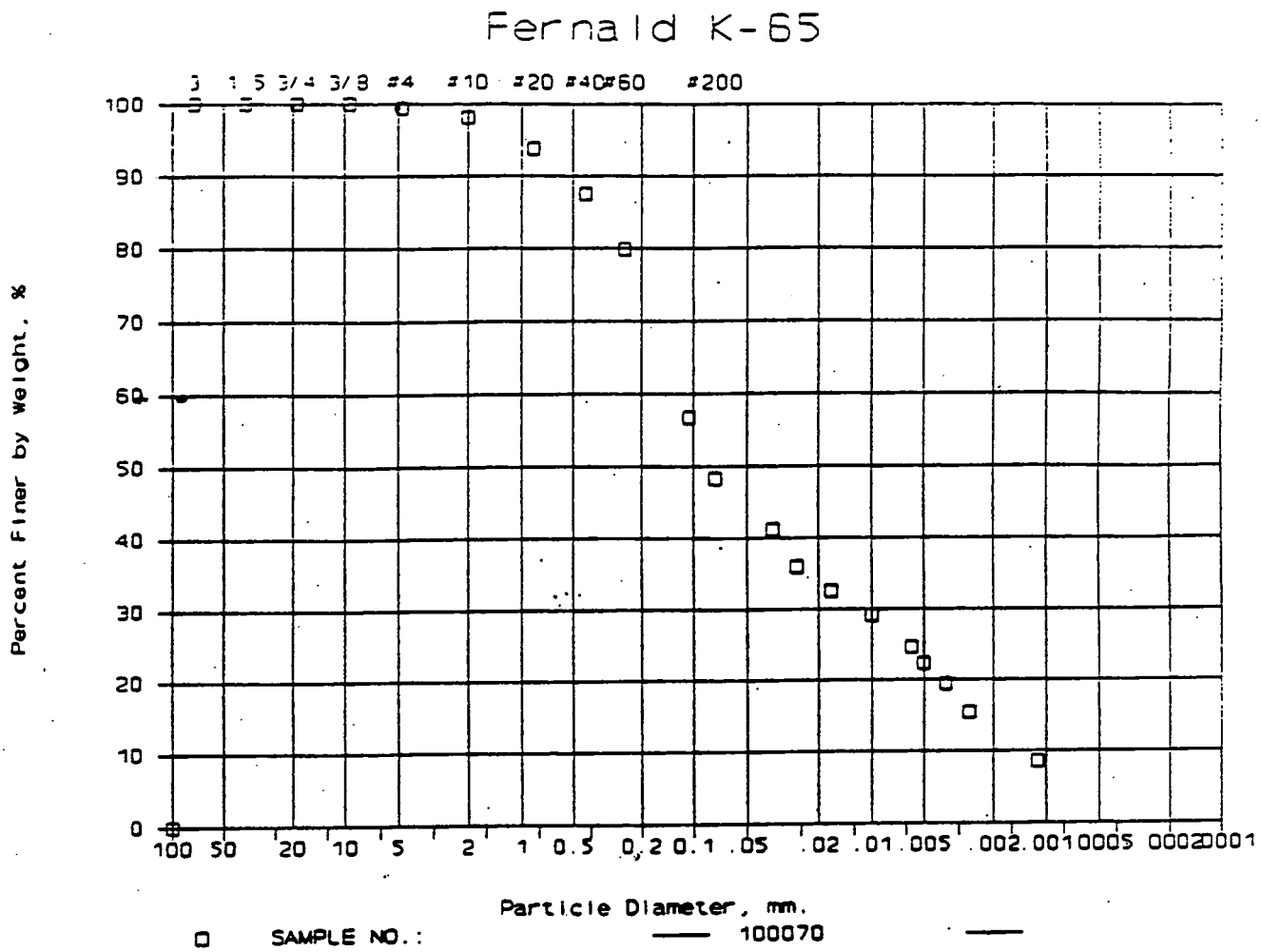

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582-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone C

8103

IT ANALYTICAL SERVICES
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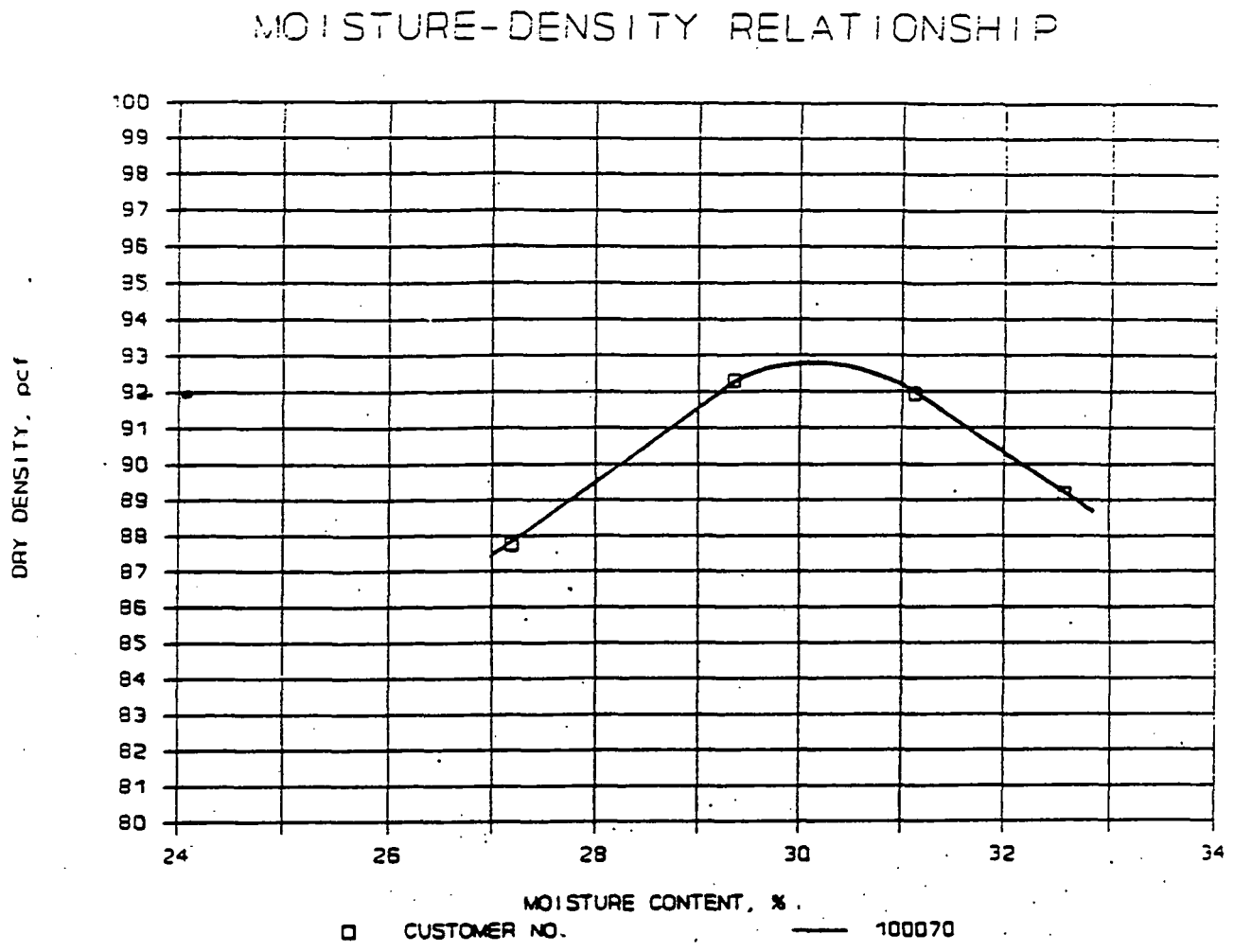

MAXIMUM DRY DENSITY: 92.7 pcf **OPTIMUM MOISTURE: 30.1 %**

INDIVIDUAL PROCTOR POINTS:

MOISTURE CONTENT	27.2 %	29.4 %	31.1 %	32.6 %
DRY DENSITY	87.8 pcf	92.3 pcf	91.9 pcf	89.2 pcf

000280

682-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone A

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	56.6
CUST. SAMPLE NO.:	100090	LIQUID LIMIT:	NOT REQUESTED
SPECIFIC GRAVITY:	3.0688 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	1.82
0.25	1.80
0.50	1.78
1.00	1.74
2.00	1.69
4.00	1.60
8.00	1.49
16.00	1.32
8.00	1.33
4.00	1.34
2.00	1.35
1.00	1.36
0.50	1.36
0.25	1.38
0.13	1.38

000281

682-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone A

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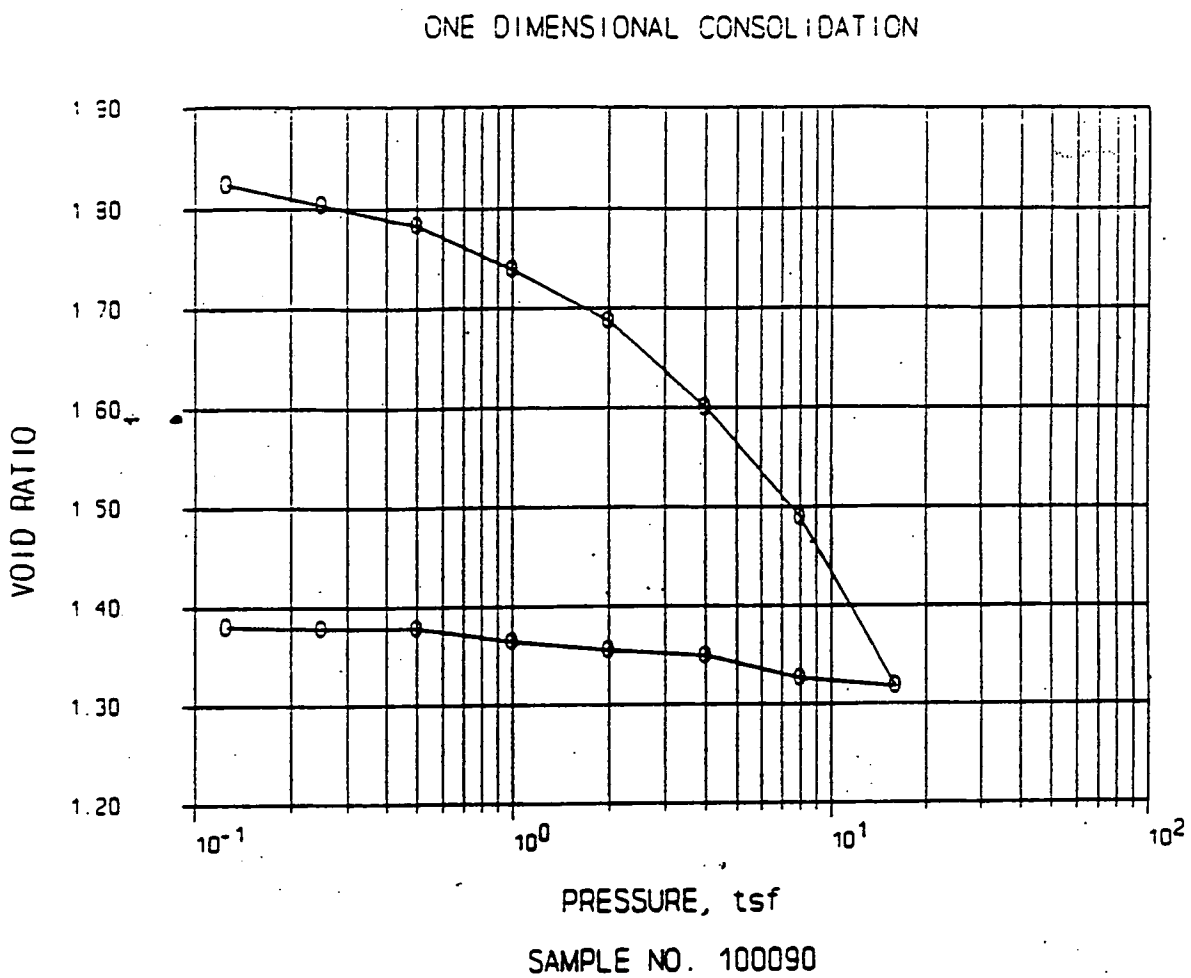

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682-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone A

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	74.7
CUST. SAMPLE NO.:	100091	LIQUID LIMIT:	NOT REQUESTED
SPECIFIC GRAVITY:	2.7864 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	2.16
0.25	2.14
0.50	2.10
1.00	2.05
2.00	1.96
4.00	1.85
8.00	1.70
16.00	1.50
8.00	1.51
4.00	1.52
2.00	1.54
1.00	1.55
0.50	1.56
0.25	1.57
0.13	1.58

000283

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone A

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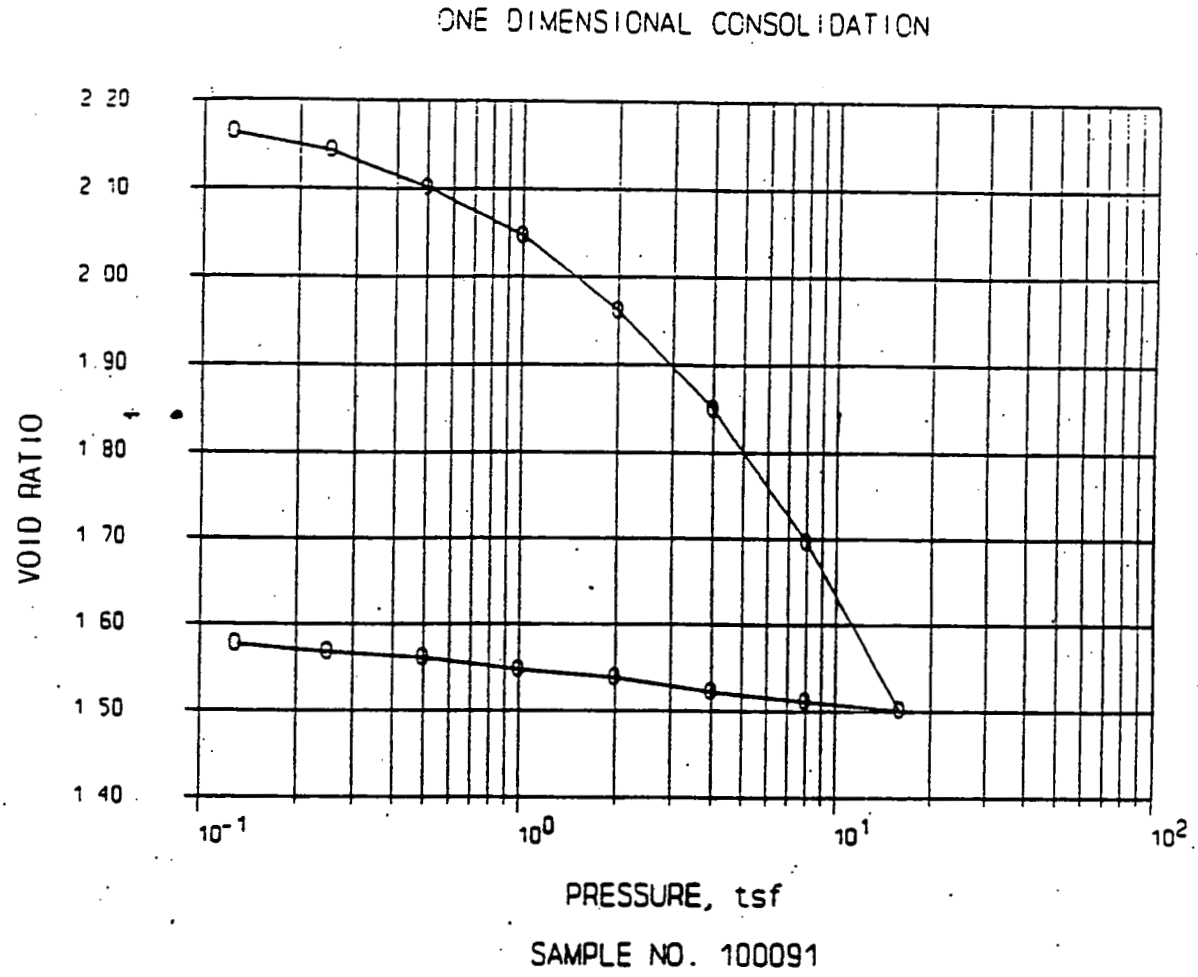

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June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone B

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
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SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	59.8
CUST. SAMPLE NO.:	100092	LIQUID LIMIT:	NOT REQUESTED
SPECIFIC GRAVITY:	3.0206 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	1.90
0.25	1.87
0.50	1.85
1.00	1.80
2.00	1.74
4.00	1.69
8.00	1.53
16.00	1.37
8.00	1.38
4.00	1.39
2.00	1.40
1.00	1.41
0.50	1.41
0.25	1.43
0.13	1.43

000285

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone B

8103

IT ANALYTICAL SERVICES
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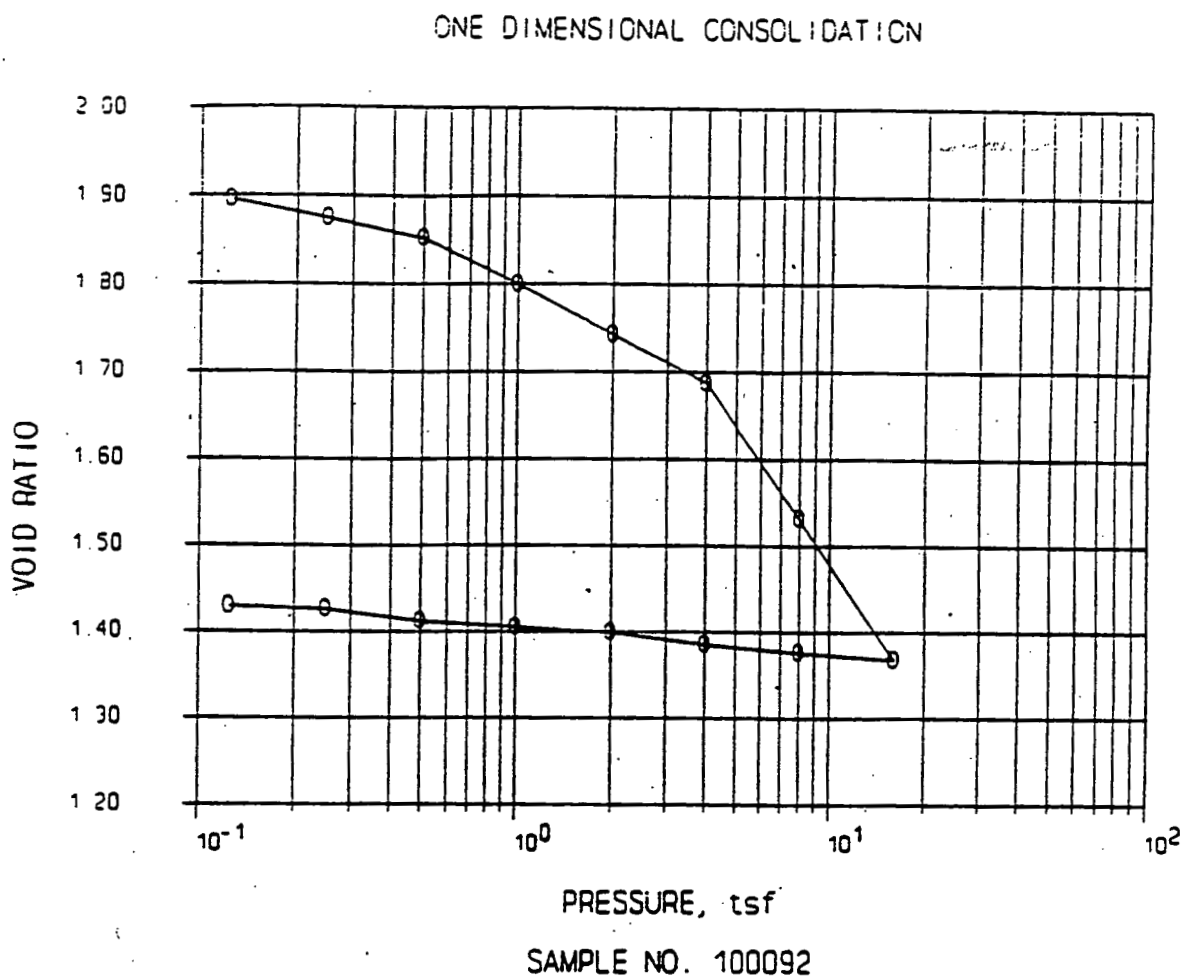

000286

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone A/B

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
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SAMPLE ANALYSIS RESULTS

ROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
ROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	65.2
UST. SAMPLE NO.:	100093	LIQUID LIMIT:	NOT REQUESTED
PECIFIC GRAVITY:	2.9027 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	2.06
0.25	2.05
0.50	2.02
1.00	1.99
2.00	1.94
4.00	1.88
8.00	1.69
16.00	1.50
8.00	1.51
4.00	1.52
2.00	1.54
1.00	1.55
0.50	1.56
0.25	1.56
0.13	1.57

000287

582-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zones A/B

8103

IT ANALYTICAL SERVICES
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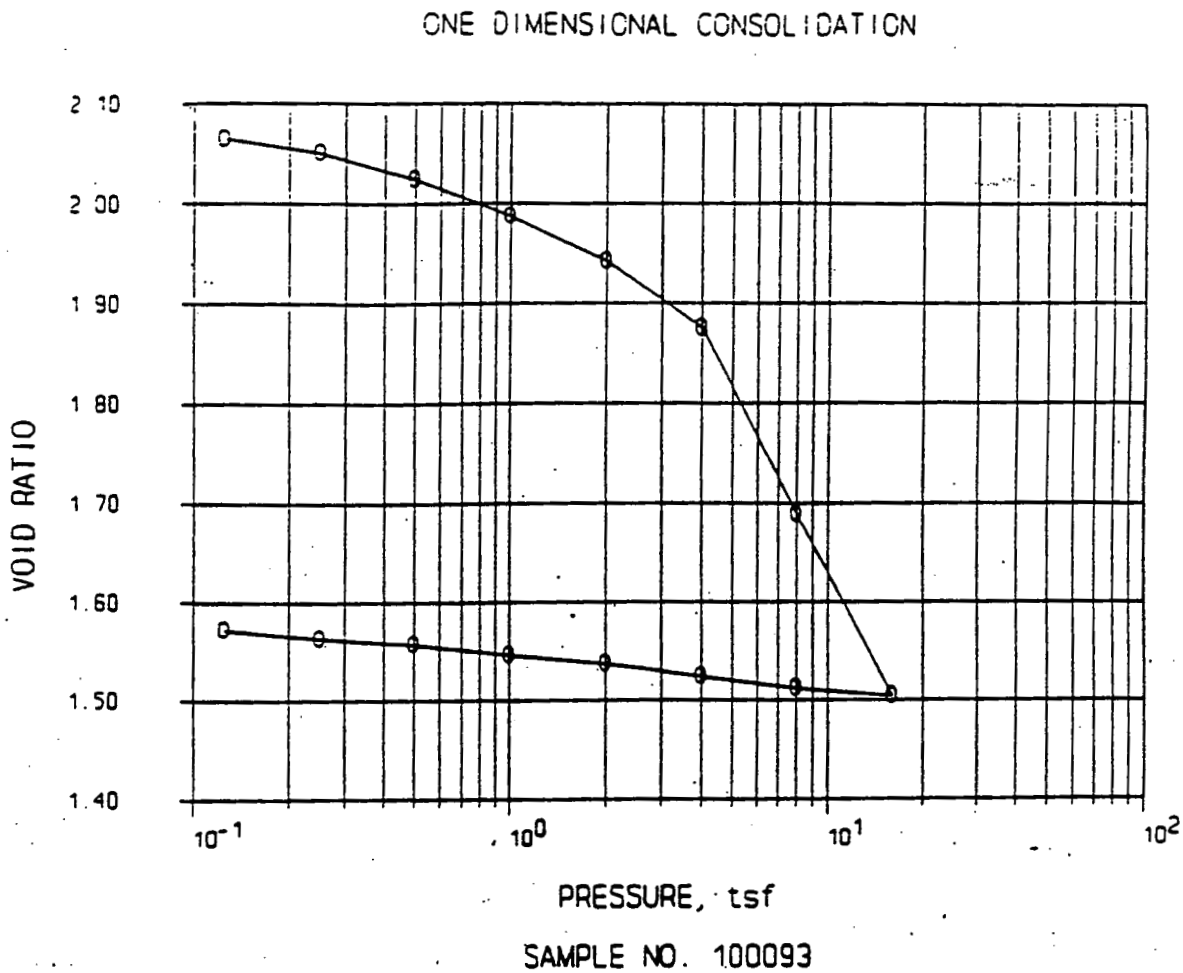

000288

582-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone B

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
(615) 690-3211

SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	57.0
CUST. SAMPLE NO.:	100094	LIQUID LIMIT:	NOT REQUESTED
SPECIFIC GRAVITY:	3.0837 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	2.04
0.25	2.02
0.50	1.97
1.00	1.93
2.00	1.84
4.00	1.73
8.00	1.60
16.00	1.45
8.00	1.46
4.00	1.47
2.00	1.48
1.00	1.50
0.50	1.50
0.25	1.52
0.13	1.52

000289

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 2
Zone B

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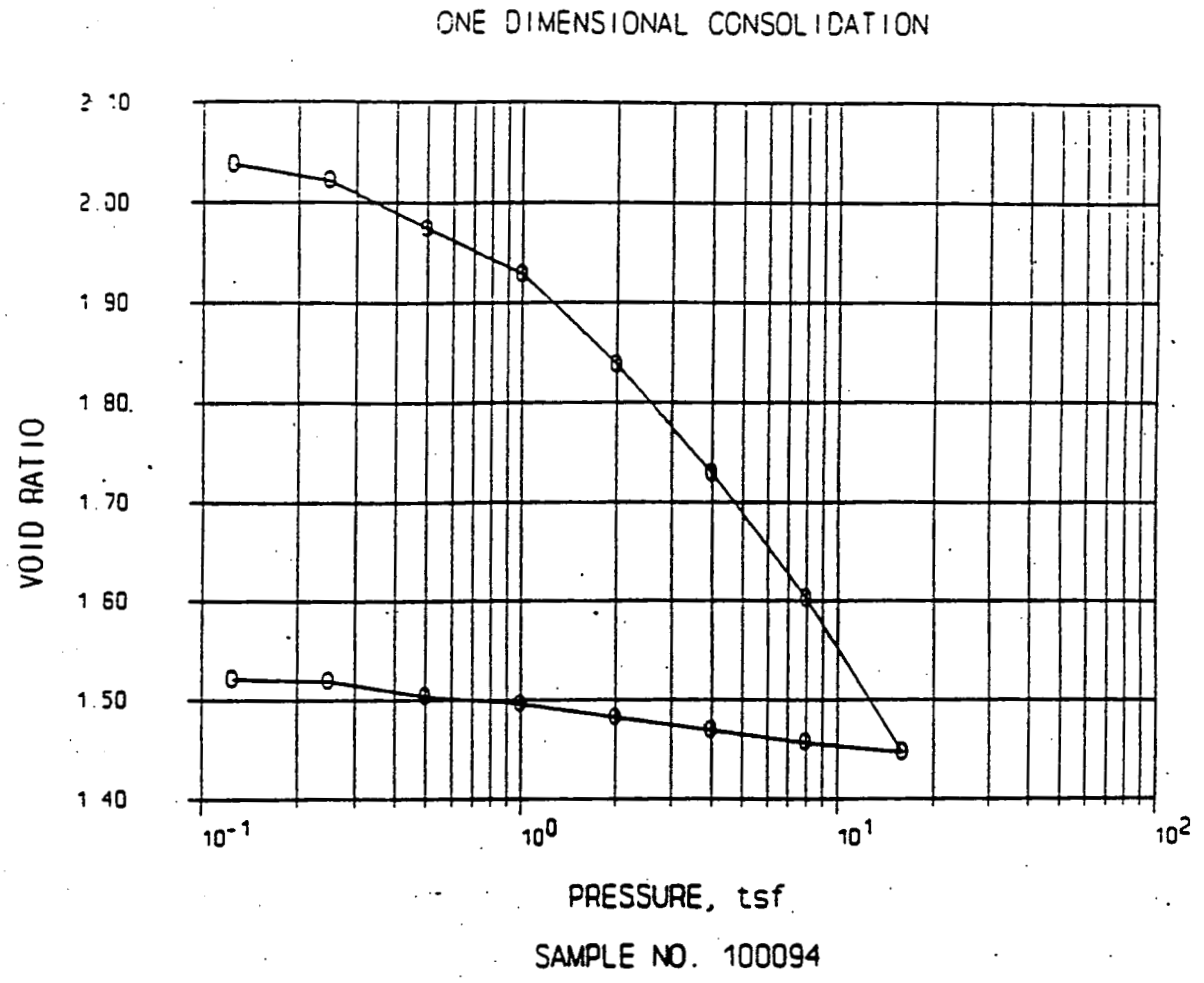

000290

582-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone C

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
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SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	82.2
CUST. SAMPLE NO.:	100095	LIQUID LIMIT:	NOT REQUESTED
SPECIFIC GRAVITY:	3.2556 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	2.76
0.25	2.73
0.50	2.68
1.00	2.63
2.00	2.52
4.00	2.38
8.00	2.18
16.00	1.93
8.00	1.94
4.00	1.96
2.00	1.97
1.00	1.99
0.50	2.00
0.25	2.02
0.13	2.03

000291

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone C

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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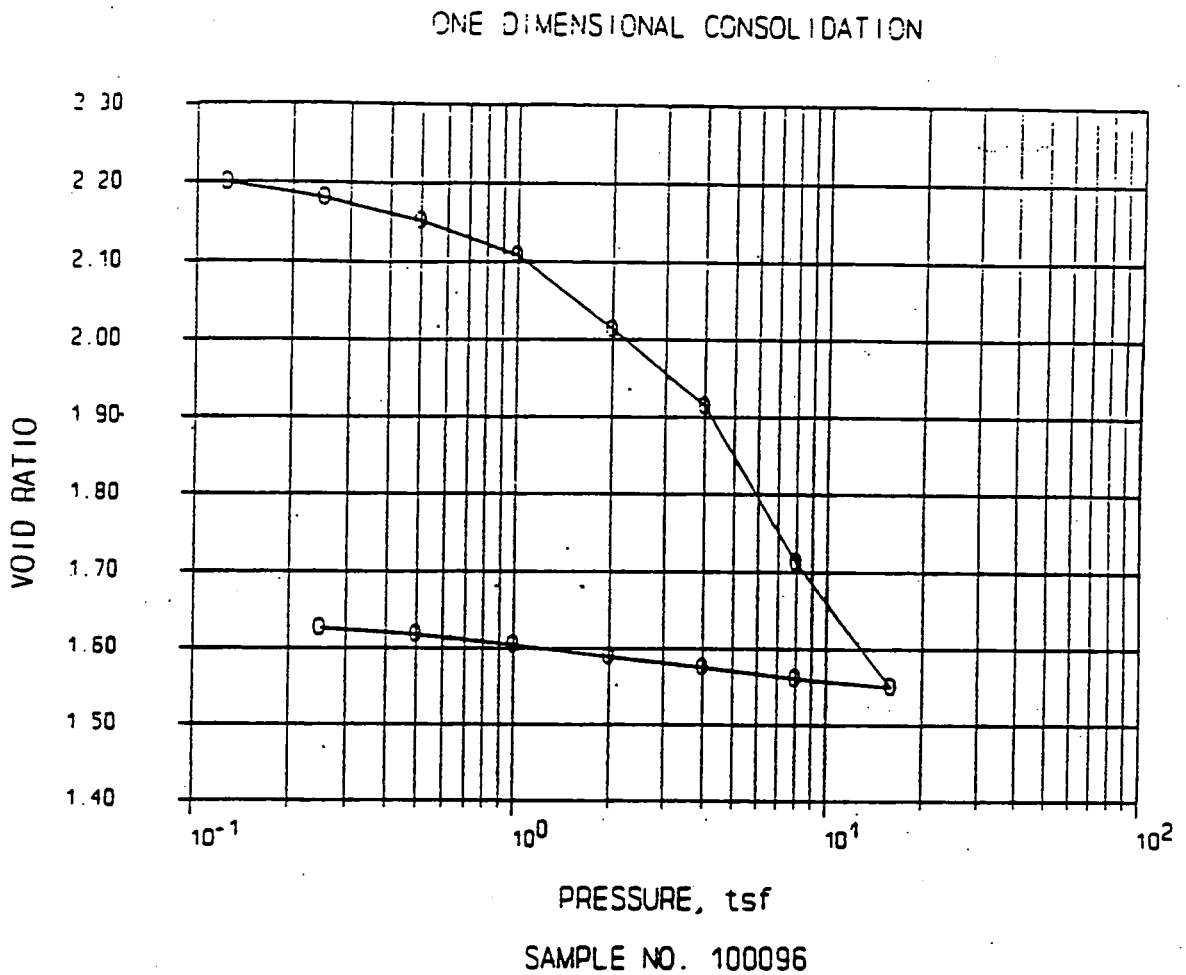

000292

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone C

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
KNOXVILLE, TN
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SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NOT REQUESTED
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	64.6
CUST. SAMPLE NO.:	100096	LIQUID LIMIT:	NOT REQUESTED
SPECIFIC GRAVITY:	3.1562 (MEASURED)	PLASTICITY INDEX:	NOT REQUESTED

ONE DIMENSIONAL CONSOLIDATION RESULTS

PRESSURE, tsf	VOID RATIO
0.13	2.20
0.25	2.18
0.50	2.15
1.00	2.11
2.00	2.01
4.00	1.91
8.00	1.71
16.00	1.55
8.00	1.56
4.00	1.58
2.00	1.59
1.00	1.60
0.50	1.62
0.25	1.63
0.13	1.64

000293

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zone C

8103

IT ANALYTICAL SERVICES
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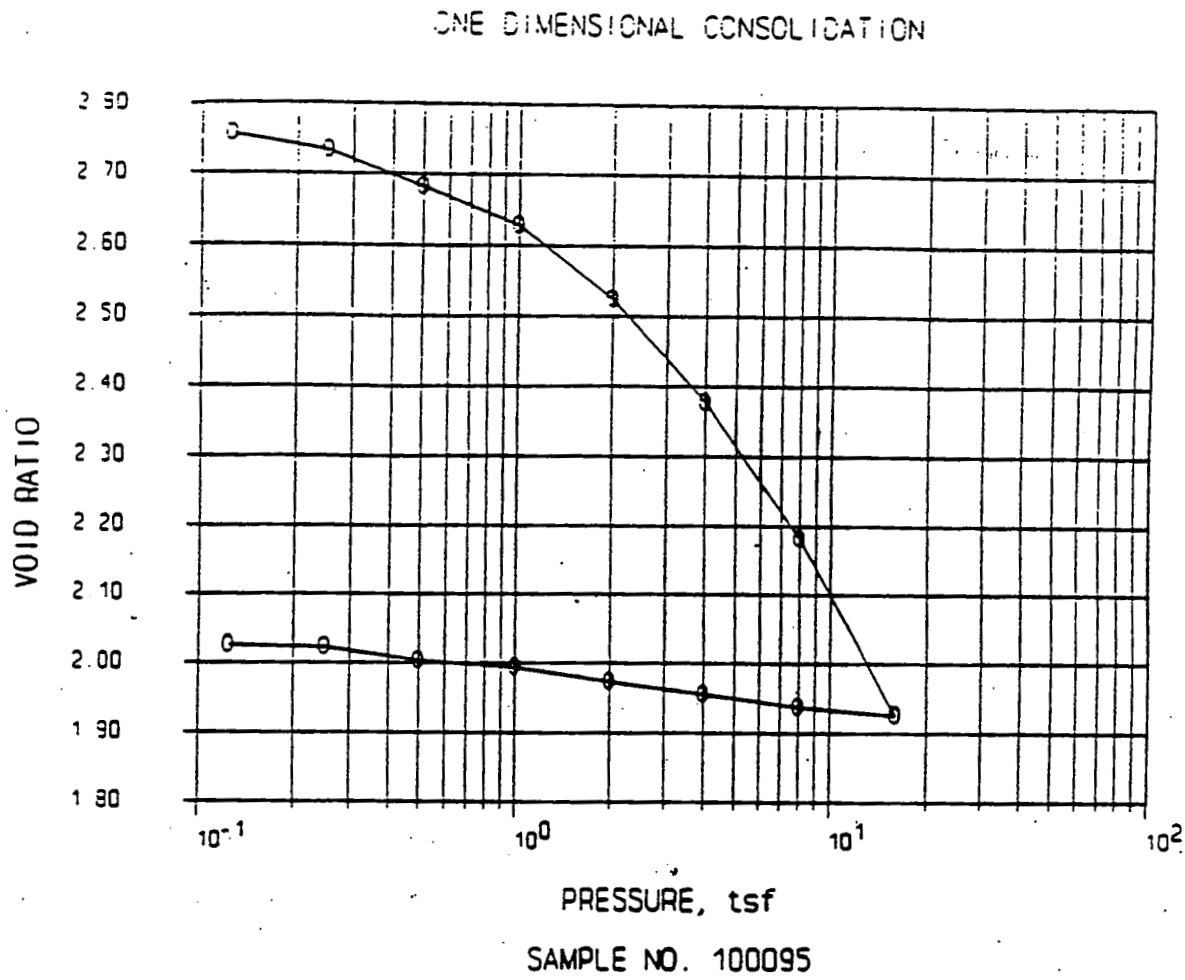

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June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zones A/B/C

8103

IT ANALYTICAL SERVICES
304 DIRECTORS DRIVE
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SAMPLE ANALYSIS RESULTS

PROJECT NAME:	FERNALD K-65	USCS SYMBOL:	NONPLASTIC
PROJECT NO.:	3133278.40.03.03	WATER CONTENT, %:	48.9
CUST. SAMPLE NO.:	100097	LIQUID LIMIT:	46.0
SPECIFIC GRAVITY:	3.0351 (MEASURED)	PLASTICITY INDEX:	NONPLASTIC

SIEVE ANALYSIS

SIEVE NO.	DIAMETER (mm)	PERCENT FINER (%)
3.0 in	75.000	100.0
1.5 in	37.500	100.0
0.75 in	19.000	100.0
0.375 in	9.500	100.0
NO. 4	4.750	99.7
NO. 10	2.000	98.6
NO. 20	0.850	94.9
NO. 40	0.425	86.6
NO. 60	0.250	77.7
NO. 140	0.106	67.4
NO. 200	0.075	63.7

HYDROMETER ANALYSIS

DIAMETER (mm)	PERCENT FINER (%)
0.0298	59.9
0.0220	55.4
0.0145	51.0
0.0087	47.0
0.0064	41.4
0.0047	35.8
0.0034	30.8
0.0026	24.6
0.0011	14.0

000295

582-1-89

June 29, 1992
Susan Rhyne
IT Corporation
Client Project ID: Fernald RI/FS, OU4
IT Project No.: 313327.40.03.03

Silo 1
Zones A/B/C

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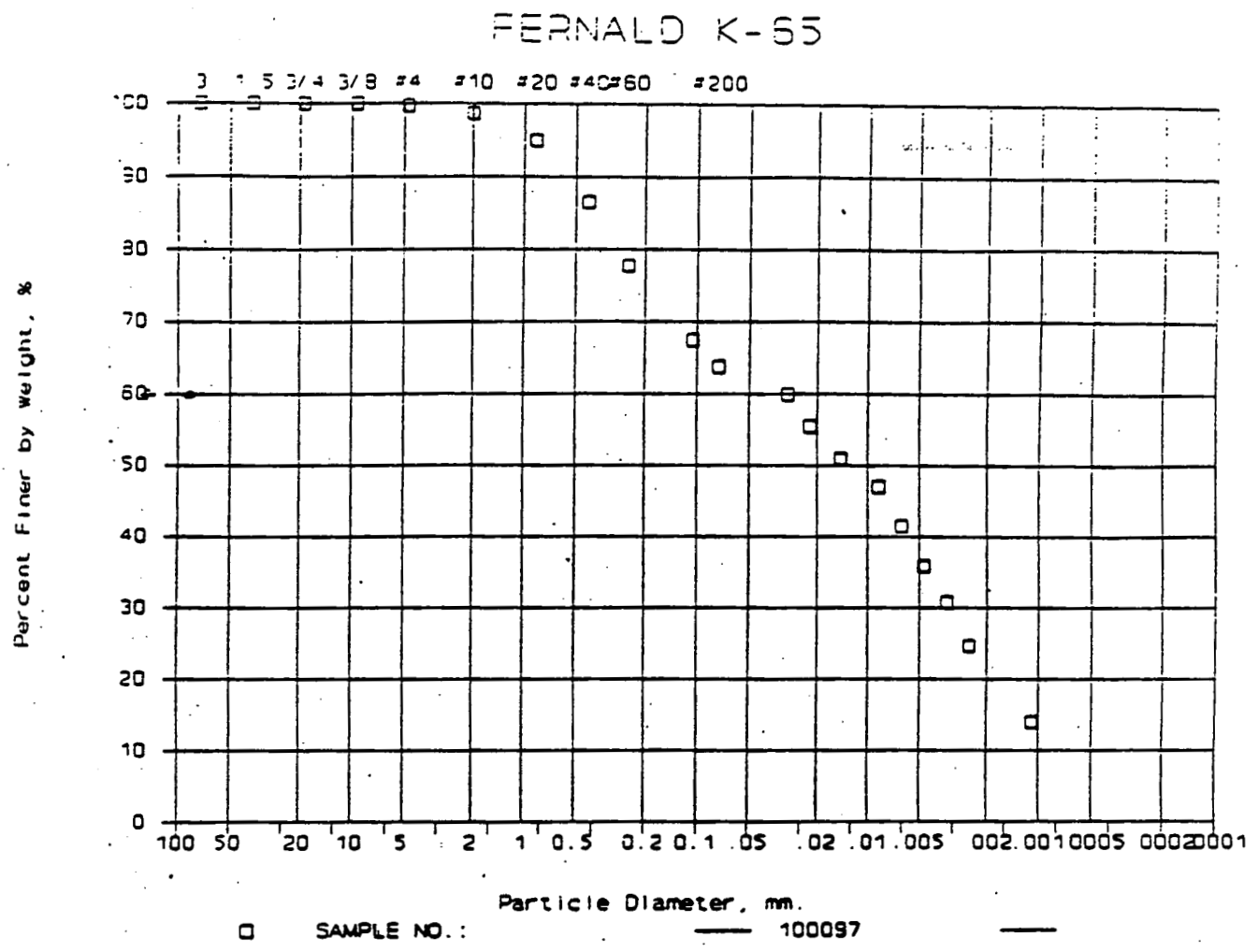

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APPENDIX B

Standards / Requirements Identification Documents
(SRIDs) and Applicable or Relevant and Appropriate Requirements (ARARs)

B.1 Configuration Management (CM) Functional Area Requirements
B.2 Engineering Design (ED) Functional Area Requirements
B.3 Environmental Protection Functional Area (EP)
B.4 Fire Protection Functional Area (FP)
B.5 Management Systems Functional Area (MS)
B.6 Nuclear And System Safety Functional Area (NS)
B.7 Occupational Safety and Health Functional Area
B.8 Operations
B. 9 Quality Assurance Functional Area (QA)
B.10 Radiological Protection Functional Area (RP)
B.11 Security Functional Area (SE)
B.12 Training and Qualification Functional Area (TR)
B.13 Environmental Restoration/Waste Management Functional Area (EW)
Construction Functional Area (CT)
Acquisition Functional Area (AC)

The following Standards/Requirements Identification Documents (S/RID) are a part of FDF's prime contract with DOE. By reference herein, they are part of this contract. The following S/RIDs are presented by functional area:

B.1 Configuration Management (CM) Functional Area Requirements

DOE Order 430.1, Life-Cycle Asset Management (LCAM) has replaced DOE (4700.1) DOE Order 430.1 has no specific Contractor requirements listed Rather, DOE Order 430.1 is implemented through the establishment, of site-specific performance criteria and performance measurement system.

In keeping with this objective, configuration management requirements have been defined in Section 3.1.3, Configuration Management Plan to include relevant portions of DOE 4700.1 as a model.

B.2 Engineering Design (ED) Functional Area Requirements

The following requirements apply in their entirety, unless otherwise specified:

B.2.1 Federal, State and Local Laws, Regulations, and Guidance

Ohio Administrative Code

- Chapter 4101.2, Building Code;
- Chapter 4014.4, Boiler Code;
- Chapter 4101.8, Pressure Piping System Code.

B.2.2 Industry Standards

ANSI N45.2.11 "Quality Assurance Requirements for the Design of Nuclear Power Plants," issued 1974. The following sections are applicable:

- 6.3, Methods (Design Verification);
- 9.0, Corrective Action.

B.2.3 DOE Orders

Environmental Protection Functional Area (EP)

Environmental Protection Functional Area 5 requirements defined in the RM-0016, Management Plan, are FEMP site high level requirements (primarily statutory regulatory programs) that govern environmental protection during site remedial projects. Operable Units (OUs) are logical subdivisions of FEMP site remediation; the AWR project activities are included in the Silo Projects (formerly OU4) remediation. The Silo Projects has a signed Record of Decision (OU4 ROD) that establishes the subset of environmental regulatory requirements for remediation of OU4. These requirements are known as Applicable or Relevant and Appropriate Requirements (ARARs), and "To Be Considered" (TBC) criteria. Activities conducted under specific projects in OU4, such as the AWR project, shall comply with the ARARs and TBCs identified in the OU4 ROD and included in Tables B-1 through B-3.

The requirements in this Section identify the governing environmental programs as well as the specific regulatory ARARs and TBCs that pertain to this project. Note that the specific requirements pertain to the current project scope, as described; any subsequent changes of scope or circumstance that affect the project may require reconsideration of the requirements necessary to ensure adequate protection of public health and the environment.

On-site project activities shall also be required, through the subcontracting process, to comply with existing DOE Orders and site procedures for conduct of specific activities. With certain exceptions, these Orders and procedures are not exclusively identified in this Section Alternatives to literal compliance with site procedures may exist for subcontractors to develop equivalent procedural approaches to work activities through approval of project specific work plans and other project documents.

The following environmental protection requirements apply in their entirety, unless otherwise specified:

B.3.1 Federal, State and Local Laws, Regulations, and Guidance

While some requirements are directly applied to the FEMP through U.S. EPA federal regulations contained in Part 40 of the Code of Federal Regulations (40 CFR), many of the federal requirements under the various Acts are implemented by Ohio EPA through Ohio regulations (Ohio Administrative Code, OAC) promulgated pursuant to the Ohio Revised Code (ORC). Only the statutes or regulations which supply substantive requirements for the project are cited below.

National Environmental Policy Act (NEPA)
In April, 1994, DOE revised its policy on NEPA to streamline compliance requirements especially as it applies to CERCLA actions. Although there is an approved sitewide Environmental Impact Statement (EIS) under NEPA that covers site remediation, specific projects may have changed scope significantly from the activities described in the signed OU4 ROD, reflected in the approved EIS. The project shall include documentation of compliance with NEPA. Project-specific NEPA requirements are found in the following:

- 10 CFR Part 1022, Compliance with Floodplain/Wetlands Environmental Review;
- 10 CFR §1021.2, NEPA Implementation

Federal Water Pollution Control Act (FWPCA) and Clean Water Act (CWA)
33 USC §§ 1251-1376, Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977, is the statute which establishes the national program for regulation of surface water pollution control. OAC requirements are promulgated pursuant to ORC Chapter 6111, Ohio Water Pollution Control Act, or in the case of wetland or dredge and fill requirements, by the U. S. Army Corps of Engineers (USACE) regulations at Part 33 of the Code of Federal Regulations (33 CFR). The following requirements pertain to project-specific activities:

- 40 CFR Part 302, Designation, Reportable Quantities, and Notification;
- 40 CFR Part 122.26 (OAC 3745-38), Discharge of Storm Water Runoff
- 40 CFR Part 125.100 and §125.104, Best Management Practices
- 33 CFR Part 330, Appendix A, USACE Nationwide Permits and Conditions;
- OAC 3745-31, Permits to Install New Sources of Pollution.
- OAC 3745-1-04, Protection of Surface Waters

Safe Drinking Water Act (SDWA)
42 USC Sections 300(f) et seq., Safe Drinking Water Act of 1974, as amended, is the statute which establishes the national program for regulation of drinking water. Ohio regulations (OAC) are promulgated under ORC Chapter 6109, Safe Drinking Water. As of February 17, 1996, the FEMP made connection to the City of Cincinnati Water Works (CCWW). CCWW now provides all potable water to the FEMP site; hence, the FEMP is no longer a public drinking water system subject to ORC 6109. Therefore, backflow prevention is needed to protect the CCWW from process water entering via our distribution system. The following requirement is applicable to project-specific activities:

- OAC 3745-95, Backflow Prevention and Cross-Connection Control.
- OAC 3745-9-10, Ohio Water Well Standards

Clean Air Act (CAA)
42 USC Sections 7401 et seq., Clean Air Act, as amended, is the statute which establishes the national program for regulation of air pollution control. Ohio promulgates regulations pursuant to ORC Chapter 3704, Ohio Air Pollution Control Act. Only the regulation that actually applies a requirement is listed below. The following requirements pertain to project-specific activities:

- 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants - Following portions only:
  - I. Subpart H, National Emission Standards for Emission of Radionuclides Other than Radon from Department of Energy facilities;
  - ii. Subpart Q, National Emission Standards for Radon Emissions from Department of Energy facilities;
- OAC 3745-15-07, and ORC 3704.01 through .05, Prohibitions of Violations, and Air Pollution Nuisance;
- OAC 3745-17-07, Control of Visible Particulate Emissions from Stationary Sources;
- OAC 3745-17-08, Control of Fugitive Dust;
- OAC 3745-31-05(A), Permits to Install New Sources of Pollution, criteria for decision, and;
- OAC 3745-31-35-02(C), Criteria for Air Permits to Operate.

DOE Orders

The project-specific DOE Orders identified below for the project are TBC during remediation.

DOE Order 5400.5, Radiation Protection of the Public and the Environment
TBC requirements are found in the following portions only:

- Chapter II.1.a, Requirements for Radiation Protection of the Public and the Environment (Radiation Dose Limit, All Pathways);
- Chapter III, Derived Concentration Guides for Radionuclides in Air and Water.

B.4 Fire Protection Functional Area (FP)
The following fire protection requirements apply in their entirety, unless otherwise specified:

B.4.1 Federal, State and Local Laws, Regulations, and Guidance

29 CFR 1910, "Occupational Health Standards," July 1, 1992. The following sections apply:

- Subpart E, Means of Egress;
- Subpart L, Fire Protection;
- 1910.252(a), Cutting and Welding Fire Prevention and Protection.

29 CFR 1926, "Safety and Health Regulations for Construction," July 1, 1994. The following sections

- 1926.24, Training in Fire Protection and Prevention;
- Subpart F, Fire Protection and Prevention;
- 1926.352, Cutting and Welding Fire Prevention.

B.O.C.A, Uniform Building Code or Local Fire and Building Codes

B.4.2 DOE Orders

DOE Order 420.1, Facility Safety - following portion only:

- Section 4.2, Fire Protection (except 4.2.2; item 4, Redundant Fire Protection Systems).

DOE Order 440.1, Worker Protection Management for Federal and Contractor Employees - following portion:

- Attachment 2, Paragraph (item) 14, Fire Protection;
- Exceptions: NFPA standards not applicable to the site:

  10R, 11C, 12A, 13D, 13R, 30A, 30B, 34, 35, 36, 40, 40E, 43B, 43D, 50, 50A, 50B, 51A, 53, 59, 59A, 61, 65, 73, 86C, 86D, 88A, 96, 99, 99B, 115. 120, 121, 122, 123, 130, 150, 231D, 231E, 231F, 260, 261, 302, 303, 306, 307, 312, 318, 395, 402, 403, 407, 408, 409, 410, 412, 414, 415, 416, 417, 418, 423, 424, 481, 482, 485, 490, 496, 497A, 497B, 497M, 498, 501A, 501C, 501D, 502, 513, 560, 600, 650, 651, 654, 655, 664, 802, 803, 804, 850, 851, 910, 911, 912, 914, 1122, 1123, 1124, 1125, 1126, 1127, 1141, 1405, 1452, 8503, 8504, 8506.

B.5 Management Systems Functional Area (MS)

The following management systems requirements apply in their entirety, unless otherwise specified:

B.5.1 Federal, State, and Local Laws, Regulations and Guidance

10 CFR 820, "Procedural Rules for DOE Nuclear Activities. The following sections are applicable:

- Subpart A, § 820.1 (a); § 820.2; § 820.8 (b); § 820.8 (d); § 820.8 (g); § 820.8 (h); § 820.8 (l); § 820.11;
- Subpart B, § 820.20 (b); § 820.23 (b); § 820.24 (b), (c), (d); § 820.25 (b)(2), (c); § 820.27; § 820.32 (c); § 820.33 (a);
- Subpart C, § 820.42; § 820.43;
- Subpart F, § 820.71;
- Appendix A to Part 820 — General Statement of Enforcement , to include sections I-III, IV-X.

10 CFR 830,"Nuclear Safety Management." The following sections are applicable:

- § 830.1; § 830.3; § 830.4; § 830.5; § 830.6.

29 CFR Part 1904, "Recording and Reporting Occupational Injuries and Illnesses." The following sections apply:

- § 1904.1-4;§ 1904.5 (a, b, d); § 1904.6-7 (a), (b.2-3); § 1904.8 (d); 1904.9-10; § 1904.13 (a), (b), (c.1-5); § 1904.21.

B.5.2 DOE Orders

O 210.1, "Performance Indicators and Analysis of Operations Information," issued 9/27/95. The following sections apply:

- § 1, 2, 3.a., 3.b, 4, and 5;
- Attachment 1, "Contractor Requirements Document"

DOE Order 225.1, "Accident Investigations," issued 9/29/95. The following sections are applicable:

- § 1, 2, 3.a, 3.b, and 3.c
- Attachment I, "Contractor Requirements Document";
- Attachment II, "Accident Investigation Categorization Algorithm".

DOE Order 231.1, "Environment, Safety, and Health Reporting." The following sections apply:

- § 1,2.f, 2.h, 3.a, 3.b, 4, 5.a, and 6.a;
- Attachment 1, "Contractor Requirements Document," 1-11.

DOE Order 413.1, "Management Control Program." The following sections apply:

- § 1.a, b, c, 2, 3.b;
- Attachment 1, "Contractor Requirements Document," with the following exception: Significant problems which meet any of the applicable criteria (1-9 and 11) listed in DOE O 413.1, "Contractor Requirements Document," shall be reported to the appropriate Departmental Element on a timely basis using existing reporting mechanisms. This exception is intended to supersede the annual reporting requirement with timely reporting.

DOE Order 425.1,"Startup and Restart of Nuclear Facilities," issued 9/29/95. The following sections are applicable:

- § 1, 2, 3.a and 3.b;
- Attachment I, "Contractor Requirements Document."

DOE 1324.5B, "Records Management Program," issued 1/12/95, is applicable as follows:

- § 1, 2, 3.a, 3.b, 5, 6, and 7.a;
- Attachment 1 - 1.b, c, e, j, k, m, p, q, t, u, and z;
- Attachment 2, "Contractor Requirements Document."

DOE 1430.1D, "Scientific and Technical Information Management." The following sections apply:

- § 1, 2, 3.a, 3.b, 5.a, and 5.b;
- "Contractor Requirements Document," Sections 4 and 8.

DOE 5480.29, "Employee Concerns Management System," issued 1/15/93. The following sections are applicable:

- § 1, 2, 3, 5.a, 5.b, 5.e, 5.f, 6, 7.a, 7.b, 7.c, 7.h, 7.j, 8.f(8), and 8.h(9);
- Chapters 1 and 2.

DOE 5482.1B, "Environmental, Safety, and Health Appraisal Program," change 001, issued 11/18/91. The following sections are applicable:

- § 1, 2, 3, 4, 5, 6, 7, 8.f, 9 (1st paragraph), 9.d, 9.f, and 10.

B.6 Nuclear And System Safety Functional Area (NS)

The following requirements apply in their entirety, unless otherwise specified:

DOE 5480.21, Unreviewed Safety Questions;

DOE 5480.22, Technical Safety Requirements;

DOE 5480.23, Nuclear Safety Analysis Reports;

DOE Order 420.1, Facility Safety, Contractor Requirements Document (CRD) - following portions only:

- 4.1, Nuclear and Explosives Safety Design Criteria;
- 4.3, Nuclear Criticality Safety;
- The requirements listed in Section 5.3 (Seismic Tolerance) of ANSI/ANS 8.3-1986 are not applicable to the FEMP. This is based on the FEMP's mission for the safe, least cost, earliest, and final cleanup of the Fernald site; the application of the graded approach; and the implementation of administrative controls during a seismic event. The RDA System currently used is adequate for detecting and annunciating a criticality event. The lack of seismic tolerance requirements do not adversely affect programmatic or operational safety at the Fernald site [DOE-FEMP concurred by memorandum DOE-0699-96, dated 04/01/96].

Occupational Safety and Health Functional Area

The following requirements apply in their entirety unless otherwise noted.

B.7.1 Federal, State, and Local Laws, Regulations, and Guidelines

10 CFR 1008.7 Privacy Act
29 CFR 1910 Occupational Safety and Health Standards

- All sections except the following:

1910.13 Ship Repairing
1910.14 Ship Building
1910.15 Ship Breaking
1910.16 Long Shoring and Marine Terminal
1910.68 Manlifts
1910.216 Mills and Calendars in the Plastics Industries
1910.261 Pulp, Paper, and Paperboard Mills
1910.262 Textiles
1910.263 Bakery Equipment
1910.265 Sawmills
1910.266 Pulpwood Logging
1910.267 Agricultural Operations
[illegible].272 Grain Handling Facilities
[illegible]0.1029 Coke Oven Emissions

29 CFR 1926 Safety and Health Regulations for Construction

- A sections except the following which have been superseded by Section B.4 and by DOE Order 420.1:
- 1926.24, subpart F, training for Fire Protection and Prevention
- 1926.252, Cutting and Welding Fire Prevention

B.8 Operations

The following requirements apply in their entirety unless otherwise specified:

B.8.1 Federal, State, and Local Laws, Regulations, and Guidance

29 CFR 1910.147 The Control of Hazardous Energy

B.8.2 DOE Orders

DOE Order 5480.19 Conduct of Operations Requirements for DOE Facilities

B. 9 Quality Assurance Functional Area (QA)

Consensus Standards

The following requirements apply in their entirety, unless otherwise specified:

Federal Facility Compliance Agreement, U.S. EPA Docket No. FFCA-HW-001, issued 7/6/88:

- Task 2, Work Plan Requirements, d. Quality Assurance Project Plan, Sections 1 and 2.

Amended Consent Agreement, Administrative Docket No. V-W-90-C-057, issued 10/1/91, following portions only:

- Sections XXVI, "Sampling and Data/Document Availability";
- Sections XXVII, "Retention of Records."

Nevada Test Site NVO-325, "Defense Waste Acceptance Criteria, Certification, and Transfer Requirements," issued 10/88, Rev.1 issued 6/92.

- Appendix C, "Quality Assurance Requirements for Waste Certification Program," items 1 through 19.

B.9.2 Federal Regulations

10 CFR Part 830.120, "Nuclear Safety Management - Quality Assurance Requirements," effective 5/5/94.

B.10 Radiological Protection Functional Area (RP)

B.10.1 Environmental Radiological Protection Requirements

B.10.1.1 Industry Standards

ANSI N 13.1 - 1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities."

B.10.1.1 DOE Orders

DOE 5400.5, "Radiation Protection of the Public and the Environment"; issued 2/8/90; change 1, 6/5/90. The following section is specifically *excluded* from this functional area:

- Paragraph IV.6, Control of Residual Radioactive Material (identified in the EW functional area).

5484.1, "Environmental Protection, Safety and Health Protection Information Reporting Requirements"; issued 2/24/81; change 7, 10/17/90; only Attachment 12, Radioactive Effluent/Onsite Discharges/Unplanned Releases.

B.10.2 Occupational Radiological Protection Requirements

B.10.2.1 Federal, State and Local Laws, Regulations, and Guidance

10 CFR 835, "Occupational Radiation Protection," effective 1/13/94 (with the exception of those provisions for which DOE has granted requests for exemption pursuant to 10 CFR 820).

B.10.2.2 Industry Standards

ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration."

ANSI N42.18-1980, "Specifications and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents."

ANSI N322-1975, "Inspection and Test Specifications for Direct and Indirect Reading Quartz Fiber Pocket Dosimeters".

ANSI N43.2-1988, "Radiation Safety for X-ray Diffraction and Fluorescence Analysis Equipment".

N43.3-1993, "General Safety Standard for Installations Using Nonmedical X-ray and Sealed Gamma-Ray Sources" (formerly ANSI N543-1974, with the same title).

B.10.2.3 DOE Guidance Documents

DOE N 441.1, Radiological Protection for DOE Activities.

DOE/EH-0256T, Department of Energy Radiological Control Manual (those provisions listed in Appendix A only).

B.11 Security Functional Area (SE)

B.11.1 Federal, State, and Local Laws, Regulations, and Guidance Documents

10 CFR Part 860, "Trespassing on Administration Property," issued 01/01/93;

10 CFR Part 1017, "Identification and Protection of Unclassified Controlled Nuclear Information," issued 01/01/93;

10 CFR Part 1046, "Physical Protection of Security Interests," revised 01/01/93. The following references apply:

- Section 1046.11, Protective Force Personnel, paragraph (a);
- Section 1046.13, Medical Certification;
- Section 1046.13, Appendix A, Medical and Physical Fitness Qualifications and Standards.. Those qualifications and standards applicable to unarmed guards are contained in paragraphs A, B(1), B(5), B(6), B(7), B(8), B(10), C, H, I, and J.

40 CFR Part 264.14, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities - Security," issued 07/01/92;

41 CFR CHAPTER 101-20.103, "Physical Protection and Building Security," issued 07/01/93;

48 CFR Part 970.22, "Application of Labor Polices (Pre-employment Investigations)," issued 01/01/93.

B.11.2 DOE Orders

DOE 1240.2B, "Unclassified Visits and Assignments by Foreign Nationals," change 001 issued 09/03/92 The following references are applicable:

- Paragraph 7, Policies and Standards;
- Paragraph 9, Procedures and Requirements;
- Attachments 1 through 7.

DOE 1360.2B, "Unclassified Computer Security Program," issued 05/18/92. The following references are applicable:

- Paragraph 9, Policy;
- Paragraph 11, Requirements;
- Attachment 3, Procedures for Reporting Significant Unclassified Computer Security Incidents.

DOE 1450.4, "Consensual Listening-in to or Recording Telephone/Radio Conversations," issued 11/12/92. The following references are applicable:

- Paragraph 5, Definition;
- Paragraph 6, Policy;
- Paragraph 8.a, and f, Procedures.

DOE Order 470.1, "Safeguards and Security Program," Paragraph 5 only of Contractor Requirements Document (CRD);

DOE Order 471.1, "Identification and Protection of Unclassified Controlled Nuclear Information," Paragraph 5 only of Contractor Requirements Document (CRD);

der 472.1, "Personnel Security Activities," Contractor Requirements Document (CRD) only - shall app., beginning October 1996.

DOE 5632.7A, "Protective Force Program." The following references are applicable:

- Chapter I, Management of Protective Forces:
(1) Paragraph 1, Plans and Orders
(2) Paragraph 2.c, Qualification for Guards
(3) Paragraphs 3.a, and c, Allocation of Personnel Resources
(4) Paragraph 4, Personnel Management;

- Chapter II, Protective Force Duties:
(1) Paragraph 1, Guards;
(2) Paragraph 5, Supervisory Responsibilities;

- Chapter III, Protective Force Training:
(1) Paragraph 1, Purpose;
(2) Paragraph 2, Program Requirements;
(3) Paragraph 6, Guards;
(4) Paragraph 7, Supervisors;
(5) Paragraphs 8.a, c, and d., Exercises;

- Chapter IV, Protective Force Equipment and Facilities:
(1) Paragraphs 1, 1.a(1), Equipment/Uniforms;
(2) Paragraph 1.c, Protective Force Vehicles;
(3) Paragraph 1.d, Communications Equipment.

B.12 Training and Qualification Functional Area (TR)

B.12.1 DOE Orders

DOE 5480.20A, "Personnel Selection, Qualification, Training, and Staffing Requirements at DOE Reactor and Non-Reactor Nuclear Facilities," change 1, issued 11/15/94. The following sections are applicable:

- Chapter I, Sections 1-3, 5-12, 14, and 15;
- Chapter IV, Section 4; "Specific Training Requirements";
- Chapter IV, Section 5; "Operator, Fissionable Materials Handler, and Supervisor Proficiency Requirements".

B.13 Environmental Restoration/Waste Management Functional Area (EW)

The following environmental restoration and waste management requirements apply in their entirety, unless otherwise specified (refer also to Tables B-1 through B-3 for more information on ARARs).

B.13.1 Federal, State and Local Laws, Regulations, and Guidance

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
CERCLA, originally enacted in 1980, was amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The implementing regulations for this statute are found in 40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan (NCP). While CERCLA itself offers no specific ARARs for this project, it is the statutory driver for remediation at the FEMP, and requires the establishment of project-specific ARARs for all portions of the remediation.

Resource Conservation and Recovery Act (RCRA)
RCRA governs the management of solid and hazardous residue for the project. The State of Ohio has been delegated authorization for implementation of certain parts of the RCRA Hazardous Waste Program; hence, state regulations that are counterpart to (or more stringent than) the federal citations identified above are project specific ARARs.
Sections of the federal regulations implementing this statute in project specific ARARs are found in the following sections:

- 40 CFR Part 261, Identification and Listing of Hazardous Waste
  §261.7 Empty Containers

- 40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste
  §262.11 (OAC 3745-52-11), Hazardous Waste Determinations
  §262.20 through 262.33 (OAC 3745-52-20 through 33), Generator Shipping of Hazardous Waste

- 40 CFR §263.20-31 (OAC 3745-53-20 through 31), Transportation Requirements

- 40 CFR Part 264, Standards for Treatment, Storage, and Disposal Facilities
  40 CFR Part 264, B (OAC 3745-54-13, 14, 15, and 16), General Facility Standards
  40 CFR Part 264, C (OAC 3745-54-31 through 35, and 37), General Facility Standards
  40 CFR Part 264, D (OAC 3745-54-51, 52, 55, and 56), Contingency Plan
  40 CFR Part 264, I (OAC 3745-55-71 through 78), Container Storage
  40 CFR Part 264, J (OAC 3745-55-91 through 96), Tank Systems
  40 CFR Part 264, S, Corrective Action Management Units; Temporary Units
  40 CFR §264.1101 and 1101, Containment Buildings

B.13.2 DOE Orders

The project-specific DOE Orders identified below for the project are "to be considered" (TBC) during remediation.

DOE 5400.5, Radiation Protection of the Public and the Environment
TBC requirements are found in the following portions only:

- Chapter IV.6.b, Control of Residual Radioactive Material (Radon) during Interim Storage.

Agreements/Other Requirements

The following are applicable in their entirety:

- Amended Consent Agreement, September 20, 1991 (as modified by Dispute Resolution 1997) - establishes milestones, schedules, and major deliverables that impact project activities.

B.14 Construction Functional Area (CT)

B.14.1 Industry Standards

ASME B31.3 "Chemical Piping"

B.14.2 DOE Guidance Documents

DOE Order 420.1 Implementation Guide

This guide requires the use of industrial codes and standards for all aspects of design and construction.

B.15 Acquisition Functional Area (AC)

The Acquisition Functional Area includes all activities necessary for compliance with the terms and conditions of prime contract DE-AC24-920R21972 and directions issued by the DOE Contracting Officer ant to the prime contract.

Consistent with the above requirements, Acquisition Functional Area shall:(1) procure the required supplies and services in the manner which is most advantageous to Fluor Daniel Fernald and the Government - price, quality, and other factors considered;. (2) provide well defined and consistently applied procurement methods and procedures which fully comply with the prime contract and allow the flexibility to satisfy program requirements through the use of best commercial practices; (3) support socio-economic subcontracting programs; and (4) award procurements to suppliers/subcontractors who shall meet program requirements for safety, quality, performance, and schedule.

All functional areas exist in support of the terms and conditions of the prime contract; therefore, there is a contractual interface between Acquisition Functional Area and all other functional areas.

The following Tables B-1 through B-3 contain the applicable or relevant and appropriate requirements (ARARs) referenced in the text to the RFP and environmental functional area S/RIDs. The two blank columns on the right in each table are for the Contractor to complete as part of the documentation of compliance with environmental requirements. The Contractor should include adequate detail to demonstrate design and operations will result in compliance, and support environmental ALARA. The column to the far right should be used to cross reference the specific document submitted, and specific section/page numbers where the ARAR is satisfied through design, operation, or other action by the Contractor.

Table B-1 Chemical Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Radionuclide Emissions (Except Airborne Radon-222)	40 CFR § 61 Subpart H Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that might cause any member of the public to receive in any year an EDE of 10 mrem per year. Monitoring is required at release points having potential to discharge radionuclides which could cause an EDE in excess of 1% of the standard (0.1 mrem/yr) to any member of the public.	Radioactive air emissions from AWR activities might contribute to the dose to members of the public from the air pathway during implementation of remedial actions.		
Radon-222 Emissions	40 CFR § 61 Subpart Q No source at a DOE facility shall emit more than 20 pCi/m^2•s of radon-222 as an average for the entire source during periods of storage and disposal.	This requirement is applicable only to storage and disposal of radium-bearing byproduct material, such as Silo 1 & 2 residues. Interim storage of Silo 1 & 2 residues, including the TTA facilities, qualify as sources.		

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Table B-1 Chemical Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Protection of Air from Residual Radioactive Material	DOE Order 5400.5 Chap. IV, 6.b (proposed 10 CFR § 834) Interim Storage: The above-background concentration of radon-222 in air above an interim storage facility must not exceed 100 pCi/L at any point, an annual average of 30 pCi/L over the facility, or an annual average of 3 pCi/L at or above any location outside the site.	DOE Orders are identified as TBCs only when no promulgated ARARs exist, to ensure the adequate protection of human health and the environment. Portions of DOE Order 5400.5 were selected as TBCs to ensure adequate protection of the public during and following remediation. Management of radium and thorium bearing wastes might result in the release of radon gas to the environment.		
Ohio Water Quality Standards Use Designation and Criteria	OAC 3745-1-07 All pollutants or combinations of pollutants shall not exceed, outside the mixing zone, the Numerical and Narrative Criteria for Aquatic Life Habitat and Water Supply Use Designation listed in Tables 7-1 through 7-15 of this rule.	This requirement is met by compliance with the FEMP NPDES permit.		
Ohio Water Quality Standards "Five Freedoms" for surface water	OAC 3745-1-04 All surface waters of the state shall be free from: • objectionable suspended solids • floating debris, oil, and scum • materials that create a nuisance • toxic, harmful or lethal substances • nutrients that create nuisance growth	Requires compliance with the FEMP NPDES permit.		

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Table B-1 Chemical Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
OEPA NPDES Permit No. 1I000004ED (used in conjunction with Ohio Water Quality Standards (OAC 3745-1-04)	Waste water associated with the AWR Project wastes must be treated if necessary to ensure compliance with the terms and conditions of the FEMP NPDES permit. DOE is required to notify OEPA of any activities or changes at the site which have the potential to significantly alter the character of the waste water streams being discharged under its existing NPDES permit. A NPDES permit modification is required if the discharge is deemed significant enough to cause a change in the character of the waste water stream. The existing NPDES permit must also be modified to reflect the addition of any new point source discharges of process waste waters and storm waters.	Waste water must be eliminated, recycled, or minimized during the AWR Project to the extent practicable. Waste water discharges associated with the AWR Project wastes must be pretreated, if required, to ensure compliance with NPDES permit requirements.		

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Table B-2 Location-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Ref. Index
Endangered Species Protection	50 CFR § 402 ORC 1518, 1513.25 OAC 1501-18-1-01 Federal agencies must not jeopardize the continued existence of any endangered or threatened species, or destroy or adversely modify critical habitat of such species.	Although the FEMP is located within the range of the Indiana bat, a federally listed endangered species, no sighting has occurred on the FEMP. Therefore, this requirement is relevant and appropriate. Any potential impacts of the remedial actions on this species must be evaluated and appropriate actions taken.		
Compliance with Floodplain/Wetlands Environmental Review Requirements	10 CFR § 1022 Executive Order 11990 DOE actions in a wetland must first evaluate the potential adverse effects those actions might have on the wetland and consider the natural and beneficial values served by the wetlands.	This requirement is applicable because the FEMP is a DOE facility. Several alternatives might result in destruction or modification of wetland areas.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
NEPA Evaluations	10 CFR § 1021.2 DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality (CEQ) regulations in 40 CFR § 1500-1508.	A NEPA Supplemental Analysis has been prepared and approved addressing NEPA requirements for the AWR Project.		
Nationwide Permit Program	33 CFR § 330 The U.S. Corps of Engineers can issue a Nationwide Permit (NWP) as a general permit for certain classes of actions that involve dredge or fill activities in wetlands or navigable waters. Discharges of dredged or fill material into wetlands may require a wetland delineation.	This requirement is applicable to remediation activities that may require construction of access roads and utility lines resulting in minor wetland disturbances. All dredge and fill activities related to construction of these access roads and utility lines will be conducted in accordance with the substantive terms and conditions of NWP 14 (Road Crossing) and NWP 12 (Utility Line Backfill and Bedding). OEPA has been granted Section 401 State Water Quality Certification for NWPs 12 and 14.		
Discharge of Storm Water Runoff	40 CFR § 122.26 OAC 3745-38 Storm water runoff from landfills, construction sites, and industrial activities must be monitored and controlled. A Stormwater Pollution Prevention Plan (SWPPP) is required for construction activities which result in a total land disturbance of 5 or more acres.	This requirement is applicable to industrial waste sites and construction sites of greater than 5 acres that discharge storm water runoff to the waters of the United States. This requirement is applied through the FEMP NPDES Permit.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Discharge of Treatment System Effluent	40 CFR § 125.100 & 40 CFR § 125.104 Best Management Practices Develop and implement a BMP program to prevent the release of toxic or hazardous pollutants to waters of the U.S. Development and implementation of a sitewide BMP Program is also required as a condition of the FEMP NPDES Permit. The BMP program must: • Establish specific objectives for the control of toxic and hazardous pollutants • Include a prediction of direction, rate of flow, and total quantity of toxic and hazardous pollutants where experience indicates a reasonable potential for equipment failure.	The requirement is not applicable because BMP under the NPDES permit program applies only to ancillary facilities of manufacturing units that might have releases of toxic or hazardous pollutants. The purpose of the BMP program is relevant and appropriate to prevent releases from spills or runoff during implementation of remedial actions. The current FEMP NPDES permit does not contain a BMP Plan requirement. BMP requirements have been superseded by the SWPPP.		
Ohio Water Well Standards	OAC 3745-9-10 Abandonment of Test Holes and Wells Upon completion of testing, a test hole or well shall be either completely filled with grout or such material as will prevent contaminants from entering groundwater.	This requirement is applicable to any test borings and wells that might be installed and/or closed as part of these remedial alternatives.		
Implementation of Health and Environmental Protection Standards for Uranium Mill Tailings	40 CFR § 192 Subpart C This subpart contains guidance, criteria, and supplemental standards for compliance with Subparts A and B of 40 CFR 192.	This requirement is relevant and appropriate to remediation activities involving Silo 1 and 2 material. Radioactive materials in this operable unit are primarily byproduct residues from uranium processing. Requirements for design of controls should be consistent with design of controls for other residual radioactive materials such as mill tailings.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Hazardous Waste Determinations	40 CFR § 262.11 OAC 3745-52-11 Any generator of waste must determine whether or not the waste is hazardous. The procedures to be followed include: • To identify whether a particular material of concern is a "solid waste" • To identify whether a particular exclusion applies to the material eliminating it from definition as a "solid waste" • To identify whether a particular solid waste might be classified as a hazardous waste • To determine if a material otherwise classified as a "hazardous waste" might be excluded from RCRA regulation	These procedures are established to determine whether wastes are subject to the requirements of RCRA. The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate to determine whether OU4 wastes, whether excluded or not, exhibit the characteristics of hazardous waste. The wastes stored in the silos are sufficiently similar to hazardous wastes based on the TCLP results. Silo 1 & 2 contains material which must be treated, stored, and disposed in accordance with RCRA. Other wastes such as debris generated during decontamination (e.g., concrete scabbling), will also require a hazardous waste determination to be made.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Empty Containers	40 CFR § 261.7 OAC 3745-51-7 Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if one or more of the of the following are met: • No more than 2.5 cm (1 inch) of residue remains on bottom of inner liner. • Less than 3% by weight of total capacity remains (less than or equal to 110 gallon container, • Less than 0.3% by weight of total capacity remains (greater than 110 gallon container) Containers that have held acutely hazardous ("P" listed) wastes are "empty" and exempt from further RCRA regulation if: • They or their inner liners have been triple rinsed with an adequate solvent or the inner liner has been removed from the container.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Containers used to treat or store the contents of Silo 1 & 2 might contain residues which exhibit hazardous waste characteristics which may be removed before the containers might be reused or disposed.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Generators Who Transport Hazardous Waste for Off-site Treatment, Storage, or Disposal	40 CFR § 262.20 - 262.33 and 263.20 - 263.31 OAC 3745-52-20 through 33 and OAC 3745-53-20 through 31 Any generator who transports hazardous waste for off-site treatment, storage or disposal must originate and follow-up the manifest for off-site shipments.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Any wastes determined to be RCRA hazardous waste removed from this operable unit for off-site treatment, storage, or disposal are subject to the manifest requirement.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Treatment, Storage, or Disposal Facility Standards	40 CFR § 264 Subpart B OAC 3745-54-13 through 16 General Standards • Waste Analysis - OAC 3745-54-13 Operators of a facility must obtain a detailed chemical and physical analysis of a representative sample of each hazardous waste to be treated, stored, or disposed of at the facility prior to treatment, storage, or disposal. • Security - OAC 3745-54-14 Operators of a facility must prevent the unknowing or unauthorized entry of persons or livestock into the active portions of the facility, maintain a 24-hour surveillance system, or surround the facility with a controlled access barrier and maintain appropriate warning signs at facility approaches. • Inspections - OAC 3745-54-15 Operators of a facility must develop a schedule and regularly inspect monitoring equipment, safety and emergency equipment, security devices and operating and structural equipment that are important to preventing, detecting or responding to environmental or human health hazards, promptly or immediately remedy defects, and maintain an inspection log. • Training - OAC 3745-54-16 Operators must train personnel within 6 months of their assumption of duties at a facility in hazardous waste management procedures relevant to their positions including emergency response training.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Wastes, which exhibit a characteristic similar to RCRA hazardous waste, removed from this operable unit must be treated, stored, and disposed in accordance with TSD facility standards.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Treatment, Storage, or Disposal Facility Preparedness and Prevention	40 CFR § 264 Subpart C OAC 3745-54-31 through 35 and OAC 3745-54-17 OAC 3745-54-31 - TSD operators must design, construct, maintain, and operate facilities to minimize the possibility of a fire, explosion, or any unplanned sudden or nonsudden release of hazardous waste to air, soil, or surface water which might threaten human health or the environment. OAC 3745-54-32 - All facilities must be equipped with an internal communication or alarm system, a telephone, or a two-way radio for calling outside emergency assistance, fire control, spill control, and decontamination equipment and water at an adequate volume and pressure to supply water hose streams, foam producing equipment, automatic sprinklers, or water spray systems. OAC 3745-54-33 - All fire protection and spill control and decontamination equipment and communication and alarm systems must be tested and maintained as necessary to assure proper emergency operation. OAC 3745-54-34 - All personnel must have immediate access to emergency communication or alarm systems whenever hazardous waste is being handled at the facility. OAC 3745-54-35 - Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment. OAC 3745-54-37 - Operators must attempt to make arrangements, appropriate to the waste handled, for emergency response by local and state fire, police and medical personnel.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Wastes removed from this operable unit which exhibits a hazardous characteristics must be treated, stored, or disposed in accordance with TSD facility standards.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Treatment, Storage, or Disposal Facility Contingency Plan and Emergency Procedures	40 CFR § 264 Subpart D OAC 3745-54-51 through 52 and OAC 3745-54-55 through 56 OAC 3745-54-51 - Each facility operator must have a contingency plan designed to minimize hazards to human health or the environment due to fires, explosions, or any unplanned releases of hazardous waste constituents to the air, soil, or surface/groundwater. OAC 3745-54-52 - Contingency plans should address procedures to implement a response to incidents involving hazardous waste, and provide for internal and external communications, arrangements with local emergency authorities, and emergency coordinator list, a facility emergency equipment list indicating equipment descriptions and locations, and a facility personnel evacuation plan. OAC 3745-54-55 through 56 - Each facility must have an emergency coordinator who has responsibility for coordinating all emergency response measures, is on the premises or on call at all times, is thoroughly familiar with all aspects of the contingency plan, facility operations, location and characteristics of waste handled, location of pertinent records, and facility layout, and who has the authority to commit the resources necessary to implement the contingency plan in the event of an emergency.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the wastes stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Wastes removed from this operable unit which exhibit a hazardous characteristic must be treated, stored, or disposed in accordance with TSD facility standards.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Closure	40 CFR § 264 Subpart G OAC 3745-55-11, 3745-55-14, and 3745-55-16 Operators must close the facility in a manner that: • Minimizes the need for further maintenance • Minimizes post-closure escape of hazardous constituents • Complies with specific unit type closure requirements All contaminated equipment, structures and soils must be properly disposed or decontaminated. Following closure, a survey plot showing the location of hazardous waste disposal units with respect to surveyed benchmarks must be filed with the legal total zoning authority.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the wastes stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. The Contractor's facility must be clean closed, else media remediation to meet closure performance standard. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.)		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Container Storage	40 CFR § 264 Subpart I OAC 3745-55-71 through 78 Containers of RCRA hazardous waste must be: • Maintained in good condition • Compatible with hazardous waste to be stored • Closed during storage (except to add or remove waste) • Managed in a manner that will not cause the container to rupture or leak Storage areas must be inspected weekly for leaking and deteriorated containers and containment systems. Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide a containment system with a capacity of 10 percent of the volume of the largest container of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all containers, liners, bases, and soils.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) These requirements are relevant and appropriate for alternatives utilizing containers for temporary storage or storage before disposal.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Tank Systems	40 CFR § Subpart J OAC 3745-55-91 through 96 Design, operating standards, and inspection requirements for tank units within which hazardous waste is stored or treated. • Tank design must be compatible with the material being stored. • Tank must be designed and have sufficient strength to store or treat waste to ensure it will not rupture or collapse. • Tank must have secondary containment that is capable of detecting and collecting releases to prevent migration of wastes or accumulated liquids to the environment.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Design criteria, operating standards, and inspections for tank treatment units will be relevant and appropriate for alternatives utilizing treatment or storage in a tank prior to disposal.		
Closure Requirements for Tanks	40 CFR § 264.197 OAC 3745-55-97 At closure, the facility owner must do the following: • Remove all waste residues • Remove or decontaminate all tank system components • Remove or decontaminate all contaminated soils and structures • Manage all of the above as hazardous wastes • If all contaminated soils cannot be removed, the landfill requirements of 40 CFR § 264.310 apply.	These standards pertain to closure of any tanks and appurtances used to store or treat Silo 1 & 2 material during remediation. These requirements are relevant and appropriate because the circumstances and wastes subject to potential release are similar to those RCRA is designed to address.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Miscellaneous Units	40 CFR § 264 Subpart X OAC 3745-57-91 through 92 Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined in 40 CFR § 260.10.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) Miscellaneous units might be utilized under various alternatives to remediate waste that is sufficiently similar to hazardous waste.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Corrective Action for SWMUs	40 CFR Subpart S 40 CFR § 264.552, . 553 Corrective Action Management Units might be designated at the site as areas where remediation wastes (solid, hazardous, or contaminated media and debris) might be placed during the process of remediation. Temporary units consisting of tanks and container storage units might be used to store and treat hazardous waste during the process of corrective action.	The material in Silo 1 & 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) During the process of remediation, waste materials might require temporary management for the purpose of staging or treating the material. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Containment Buildings	40 CFR § 264 Subpart DD Hazardous waste and debris might be placed in units known as containment buildings for the purpose of interim storage or treatment. Containment buildings must be fully enclosed to prevent exposure to the elements and ensure containment of managed wastes. Floor and containment walls must be designed and constructed of materials of sufficient strength and thickness to support themselves, the waste contents, and any personnel and heavy equipment that operate within the operable unit. All surfaces coming in contact with hazardous waste must be chemically compatible with the waste. Primary barriers must be constructed to prevent migration of hazardous constituents into the barrier. Secondary containment systems including secondary barrier and leak detection systems must also be constructed for containment buildings used to manage wastes containing free liquids. Controls must be implemented to ensure: the primary barrier is free of significant cracks, corrosion, or other deterioration that may allow release of hazardous waste; the level of hazardous waste does not exceed height of containment walls and is otherwise maintained within containment walls; tracking of waste out of unit by personnel or equipment used in handling waste is prevented, and fugitive dust emissions are controlled at level of no visible emissions.	The material in Silos 1 and 2 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate since the material stored in Silo 1 & 2 are sufficiently similar to hazardous wastes based on TCLP results. (This requirement will be applicable to non-excluded solid waste that exhibit a hazardous characteristic.) During the process of remediation, waste materials might require temporary management for the purpose of staging or treating the material. Some of the waste material might exhibit a RCRA characteristic, or otherwise be sufficiently similar to hazardous waste to make this requirement relevant and appropriate.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Radiation Dose Limit (All Pathways)	DOE Order 5400.5, Chapter II, Section 1.a (proposed 10 CFR §834) The exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways.	DOE Orders are identified as TBCs only when no promulgated ARARs exist, to ensure adequate protection of human health and the environment. Portions of DOE Order 5400.5 were selected as TBCs to ensure adequate protection of the public during and following remediation. Radiation sources within this operable unit might contribute to the total dose to members of the public from this DOE facility.		
Control of Fugitive Dust	OAC 3745-17-08 Requires the minimization or elimination of visible emissions of fugitive dust generated during grading, loading, or construction operations and other practices which emit fugitive dust.	The implementation of remedial action alternatives may require the movement of dirt and other material likely to result in fugitive dust emissions. This requirement is relevant and appropriate because the FEMP is not located in an area subject to this regulation.		
Prevention of Air Pollution Nuisance	ORC 3704.01 - .05 OAC 3745-15-07 Measures shall be taken to adopt and maintain a program for the prevention, control, and abatement of air pollution in order to protect and enhance the quality of the state's air resource so as to promote the public health, welfare, and economic vitality of the people of the state. The emission or escape into open air from any source whatsoever of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors, and combinations of the above in such a manner or in such amounts as to endanger the health, safety, or welfare of the public or to cause unreasonable injury or damage to property shall be declared a public nuisance and is prohibited.	This requirement is applicable to AWR Project activities. Some potential exists for emissions of radionuclides and toxic chemicals to the air, which might endanger individuals or damage property.		

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Table B-3 Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Requirements

Category	ARAR	Requirement Assessment	Compliance Strategy	Cross Reference Index
Control of Visible Particulate Emissions from Stationary Sources	OAC 3745-17-07 Discharge of particulate emissions into ambient air from any stack of a shade or density greater than 20 percent opacity is prohibited. Transient exceedence limits are included in this regulation.	This requirement is applicable to AWR Project activities.		
Permit to Install	OAC 3745-31-05(A)(3) The director shall issue a permit to install if he determines that the installation or modification and operation of the air contaminant source will employ the best available technology, not prevent or interfere with the attainment or maintenance of ambient air quality standards, and not result in a violation of any applicable air pollution control laws.	An administrative Permit to Install is not required for the AWR Project. However, the substantive requirements of this section must be met by employing Best Available Technology for treating particulate and off-gas emissions during treatment operations. OEPA may also require stack performance testing to evaluate controls.		
Ohio EPA Air Toxics Policy [used in conjunction with OAC 3745-31-05(A) (3)]	The current PTI regulations provide the Director of OEPA with a mechanism to require the evaluation of toxic air contaminants from new sources. The OEPA Air Toxics Policy provides a mechanism for calculating the Maximum Acceptable Ground-Level Concentration for a toxic substance. This value at the site boundary will be modeled to the stack to determine a stack limit. All toxic compounds that will exceed the stack limit shall be controlled administratively or by BAT to lower emissions to below the calculated stack limit.	For toxic compound emissions that are calculated to exceed the established stack limit, administrative controls shall be implemented or emissions shall be controlled by implementing BAT for toxic emissions. Performance of these control measures may be verified through performance testing during operation.		

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APPENDIX C
Physical Characterization of FEMP Site

C.1 Meteorology
C.2 Topography
C.3 Surface Water Hydrology
C.4 Soils, Seismology and Earthquake Design
C.5 Physiography and Geology
C.6 Groundwater Hydrology
C.7 Geotechnical

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This Appendix includes detailed information on physical site characteristics in the vicinity of the project work area. Additional detail may be found in the Operable Unit 4 Remedial Investigation (RI) Report[5].

C.1 Meteorology

Information on the local climate was gathered from two primary sources: an on-property meteorological system installed at the FEMP in 1986 and the National Weather Service Office at the Cincinnati/Northern Kentucky International Airport. Note that inclement weather, such as high winds, high or low temperatures, and icy conditions can affect operations and maintenance productivity.

Winds

The FEMP meteorological system was used by the National Oceanic and Atmospheric Administration (NOAA) to examine the complexity of the local wind field at the FEMP site. The study showed that two major features, the Great Miami River Valley and the ridges surrounding the site, affect the local wind patterns. Wind data from the Cincinnati airport were found to be representative of local conditions and would serve as sufficient database for the years prior to the installation of the on-property meteorological system.

Figure C-1 shows the yearly wind patterns (wind rose) and frequency of atmospheric stability class at the site, recorded from a 10-m tower for the year 1992 Prevailing winds are generally from the southwest and west-southwest. The annual frequency distribution is noted on the scale of the figure as is the stability class distribution, a parameter that is used in air dispersion modeling. Atmospheric stability is a measure of the potential for vertical mixing, both mechanical and thermal. It is classified from A through F based on the wind speed, net solar radiation, and atmospheric turbulence. A classification of A is the most stable and F the most unstable.

Precipitation

The average annual precipitation for the Cincinnati area for the period of 1967 through 1996 was 42.04 inches and ranged from 30.29 inches in 1976 to 57.58 inches in 1990. The highest precipitation occurs during the spring and early summer. The maximum 24-hour rainfall event of record occurred in March 1964 when 5.21 inches fell. Precipitation is typically lowest in late summer and fall.

The average annual snowfall for the 1967 to 1996 period was 23.5 inches, with the heaviest snowfall usually occurring in January. The maximum monthly snowfall of 31.5 inches occurred in January 1978. The maximum 24-hour snowfall event of record occurred in when over 18 inches was recorded at the Cincinnati/Northern Kentucky International Airport.

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[5] IT Corporation for the U.S. Department of Energy, *Remedial Investigation Report for OU4*, U.S. Department of Energy (Fernald Field Office, Fernald, Ohio; November, 1993).

Temperature

The regional climate is defined as continental, with temperatures ranging from a monthly average of 29.5°F in January to 75.6°F in July. The highest temperature recorded over 35 years of record was 103°F in July 1988, and the lowest was -25°F in January 1977. The average number of days per year with a minimum temperature of 32°F or less is 108 days; the average number of days per year with a maximum temperature of 90°F or greater is 20 days. Frost depth can reach 36 inches.

Climatic data for temperature and precipitation for the project area are included in Tables C-1 through C-3, with Figure C-2 and Tables C-5 and C-6 presenting similar data for the greater Cincinnati area.

C.2 Topography

The FEMP site rests on a relatively level plain at about 580 ft above Mean Sea Level (MSL). The plain slopes from 600 feet above MSL along the eastern boundary of the FEMP to 570 feet above MSL at the K-65 silos. The elevation drops off toward the west, to a minimum elevation of around 540 feet above MSL at the bed of Paddys Run. Manmade earthen berms surround the K-65 silos. Maximum elevation at the project site is around 602 feet above MSL at the top of the berm. South of the silos, the elevation drops to around 555 feet MSL at the bottom of the east-west ditch south of the K-65 silos.

A topographic map of the area is included as Figure E-4.

C.3 Surface Water Hydrology

The FEMP site is located within the Great Miami River Basin drainage but above the river's present day floodplain. The Great Miami River is the main surface water feature in the vicinity of the FEMP site, and receives water from a NPDES-permitted discharge from the FEMP site. The Great Miami River flows roughly southwest within 0.75 mile of the facility's eastern boundary and discharges into the Ohio River approximately 24 river miles from the FEMP effluent line. Paddys Run, which flows south along the project area at the FEMP's western boundary, enters the Great Miami River approximately 1.5 miles south of the southwest corner of the FEMP property.

All natural drainage for surface water on the FEMP site is generally from east to west toward Paddys Run, with the exception of the extreme northeast corner, which drains east toward the Great Miami River. Prior to 1958, surface water flow within the project area flowed either directly or indirectly to Paddys Run through drainage swales located to the north and south of Operable Unit 4. In 1958, a portion of the storm water falling in the northeast corner of the Operable Unit 4 area was redirected to flow to the Clearwell in the residue pit area instead of the north drainage swale. In 1992, the residue pit area Runoff Control Removal Action was completed, which resulted in the installation of a series of trench drains, concrete curbs, and gutters around the perimeter of the Operable Unit 4 area to redirect all storm water flows falling on Operable Unit 4 surfaces to storm water controls in the residue pit area.

Paddys Run is approximately 8.8 miles long and drains an area of approximately 15.8 square miles. Paddys Run is a steep-sided stream, and its banks erode severely during high flow periods. Due to the highly permeable channel bottom in the project area, the stream loses water to the underlying Great Miami Aquifer. This characteristic contributes to the intermittent nature of the stream, which usually flows throughout its entire length only between January and May.

In 1970, a portion of the stream south of the K-65 silos was straightened to prevent erosion of Paddys Run Road. The stream is ungauged, but typical flows for the January through May period range from 0.2 to 4.0 cubic ft/second (ft^3/s). Channel overflow resulting from 25-year, 100-year, and 24-hour storm events is possible, but peak flows occurring during storm events have not been measured.

C.4 Soils, Seismology and Earthquake Design

Soils

Soils in the region of the FEMP site were formed from materials deposited by the Wisconsin and Illinoisan glaciers. These parent materials consist mainly of till, but include sand, gravel, glacial-lake clays, and silt clays. The predominant grain size is in the silt fraction (0.05 to 0.002 mm). Grain size determinations run on two surface samples (0 to 4.5 ft) indicate that greater than 85 wt. % of all particles were within the silt and clay size fractions.

Three major soil associations, or groups of soils related by certain physical characteristics, are found in the vicinity of the FEMP site: Russell-Xenia-Wynn, Fincastle-Xenia-Wynn, and Fox-Genesee. These soils are usually light-colored, acidic, and well-drained. Many of them have developed on wind-blown material (loess), or along river channels where the Fox-Genesee soils are of till origin. The major series on site are Fincastle and Xenia silt loams. These soils are light colored with a medium acidity, with a moderate moisture-supplying capacity and organic content. The Fincastle series consists of deep, nearly level, somewhat poorly drained soils on broad flats. Permeability is low and the available water capacity is high. The seasonal high perched water table in this series is commonly found between 1 and 3 feet below the ground surface from January to April. The Xenia soil series is a deep, nearly level, moderately well-drained soil located on till plains. Permeability is moderately low, available water capacity is high, and the runoff potential is low. The seasonal high water table in the Xenia is usually within 2 to 6 feet of the surface from March to April.

The soils of the Operable Unit 4 area were mapped by the Soil Conservation Service (SCS) in 1982 as Fincastle Urban Land Complex and Henshaw series soils that have been slightly modified by man's activities. The Fincastle Urban Complex soils are Fincastle series soils that have been disturbed by human activities. The Henshaw series are deep, somewhat poorly drained, moderately low permeability soils that are found on low stream terraces and in lacustrine (lake sediment) valleys.

Seismology

A seismic risk zone of two (on a scale of less-than-one to four), a measurement of earthquake intensity, has been assigned to the region of the FEMP site. Local geologic structures and historical seismicity are used to analyze the potential for seismic events and structural damage. While there is no recent direct evidence of area faulting, the presence of minor faults in the region cannot be completely dismissed. This is because Paleozoic rocks in the FEMP area are largely covered by Pleistocene sediment, and fault traces older than Pleistocene could be obscured. The historical record of seismicity, and the absence of post-Wisconsin age faults show that significant damage from local earthquakes at the FEMP site is highly unlikely. Throughout the 19th and 20th centuries, no damaging earthquakes have been recorded within 71 miles of the FEMP: nine earthquakes caused minor damage between 71 and 199 miles from the FEMP site, and one earthquake caused localized moderate damage at Anna, Ohio, approximately 81 miles north of the FEMP site.

Earthquake Design

The seismic design provisions presented in this section are based on the Uniform Building Code (UBC) and general guidelines of UCRL 15910 for low hazard facilities including special provisions for existing facilities which are applicable to the existing K-65 Silos.

The UBC provisions for evaluating the lateral force requirements due to earthquake loads using modified parameters per UCRL 15910 are:

1) The seismic zone factor Z is taken as equivalent to PGA of 0.13g for FMPC using a Hazard Annual Probability of Exceedance (HAPE) value of 1×10^{-3} for a low-hazard facility.

2) Based on the provisions of Section 2.3 of UCRL 15910, for existing facilities, the HAPE is doubled to 2×10^{-3} or a return period of 500 years for a low-hazard facility. This corresponds to a PGA of 0.1g.

3) The spectral amplification factor C is taken from the 5 percent median damped response spectra in UCRL 53582 and shown in Figure 4-3.

4) The Importance Factor, I taken from UCRL 15910 is 1.25.

Earthquake loads are based on the general procedures outlined in UCRL 15910 and UBC.

C.5 Physiography and Geology

Physiography

The FEMP site lies in the Till Plains section of the Central Lowland physiographic province, characterized by structural and sedimentary basins and domes. Among these features, the Cincinnati Geoanticline is structurally significant in this region. The underlying bedrock is shale and fossiliferous limestone of Middle and Late Ordovician age, which crops out on steep valley walls. In some areas, it is overlain by glacial deposits that reach as much as 400 feet in thickness.

The main physiographic features in the area are gently rolling uplands, steep hillsides along the major streams, and the Great Miami River Valley. This valley is a relatively broad, flat-bottomed river valley flanked on either side by bluffs that rise to a maximum height of 300 feet above the valley floor.

Geological History

In Late Ordovician time (approximately 450 million years ago), sediment that later formed the predominantly flat-lying shale with thin interbedded limestone in the area was deposited. This shale appears as the relatively impermeable bedrock that underlies the project area and forms the adjacent highlands. During the Illinoisan Glaciation (300,000 to 400,000 years ago), river valleys cut deeply into the shale bedrock to depths up to 200 feet below current land elevations. The 2-mile-wide valley where the FEMP site is located is termed the New Haven Trough. As the ice retreated, the area of the New Haven Trough was filled with well-sorted sand and gravel outwash deposits. This formed the Great Miami Aquifer, which is a widely distributed buried valley aquifer in the southwestern Ohio area. During the Wisconsin glaciation (approximately 20,000 years ago), the advancing glacier deposited the surface sediment that lies above the sand and gravel of the Great Miami Aquifer. This glacial overburden consists of till (unsorted clays) deposited by the ice sheet, and glaciofluvial sediments consisting of stream deposits from the glacier. Following the retreat of the glacier, a blanket of wind-blown silt, called loess, was deposited across the area.

Since the last retreat of the glaciers, the streams in the area have removed much of the glacial overburden left by the ice sheets. The FEMP site is located on a remnant dissected glacial overburden plain left by the Wisconsin glaciation. The Great Miami River has eroded through the glacial overburden and is now in direct contact with the glaciofluvial outwash deposits that comprise the Great Miami Aquifer. Paddys Run is also in contact with these deposits in its lower reaches.

Figure C-4 presents a generalized map of surface geology in the project area.

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Geology of the Project Area Glacial Overburden

In the project area, sand and gravel outwash deposits of the buried valley aquifer are overlain by 5 to 10 feet of till, that is in turn overlain by 15 to 20 feet of lacustrine sediments. The till is an unsorted mixture of clay, silt, sand, and pebble to cobble size material, with 70 to 80 percent of the material falling in the clay and silt size range. The till contains sparse, thin, and discontinuous lenses of sand and gravel.

Lying above the till, the lacustrine strata consists of a 5 to 10 feet thick coarse-grain base stratum that is overlain by finer clays and silt. The coarse-grain stratum was deposited by streams and residue flows, and is comprised of predominantly clayey silt, along with silt and sands with appreciable fine fractions. Above this coarse-grain unit are deposits of finer grained lacustrine sediments, consisting of predominantly silty clay, as well as clay, clayey silt, silt, and fine sand. A loess cap probably overlies the lacustrine strata; however, it cannot be readily distinguished from the lacustrine deposits. Elsewhere on the site, where the loess cap can be distinguished, the loess is a clayey silt approximately 3 feet thick.

Adjacent to the silos, Paddys Run has eroded approximately 35 feet of the glacial overburden such that the stream presently resides at an elevation of around 540 feet MSL. The coarse grain outwash unit is exposed in outcrop on the steep bank west of the silos; however, on the majority of the bank the outcrop is obscured by a thin veneer of alluvium, sloughed soil, and fill that covers the bank. The elevation of the base of the glacial overburden is approximately 555 ft MSL. West of the silos, Paddys Run lies directly on the sand and gravel outwash deposits of the buried valley aquifer.

Geologic cross sections of the project area were constructed using area boring logs. A map showing the locations of geologic cross sections is included in Figure C-5. The cross sections are shown individually in Figures C-6, C-7, and C-8 and portray the subsurface geology of the silos area.

C.6 Groundwater Hydrology

Great Miami Aquifer

The Great Miami Aquifer is the principal aquifer in the vicinity of the FEMP, and has been designated a sole source aquifer under the provisions of the Safe Drinking Water Act. The buried valley in which it occurs varies in width from about 0.5 mile to more than 2 miles, having a U-shaped cross section with a broad, relatively flat bottom, and steep valley walls. This valley is filled with extensive deposits of sand and gravel that range in thickness from 120 to 200 ft in the valley to only several feet along the valley walls. In addition, the aquifer contains scattered silt and clay deposits. The hydraulic conductivity of the Great Miami Aquifer ranges from 120 to 775 ft per day (ft/day) with most of the values in the 270 to 335 ft/day (0.95 to 0.12 cm/s) range. Based on the natural gradients in the aquifer, groundwater in the project area is believed to flow generally toward the southeast to the Great Miami River. The estimated groundwater velocity is on the order of several hundred feet/year.

The principal sources of aquifer recharge in the FEMP area are direct precipitation and stream infiltration. Infiltration of rainfall and snow melt is the dominant regional source of groundwater recharge, providing approximately 12 inches per year to the water table of the aquifer. Much of the surface runoff enters Paddys Run, which in the project area is subject to leakage directly to the aquifer on an intermittent basis.

Large groundwater supplies occur in the sand and gravel deposits, allowing the aquifer to yield a considerable amount of water. In areas where the aquifer is 150 to 200 ft thick or more, and induced stream infiltration is available, water supply wells in the Great Miami Aquifer can yield 3000 gpm or more. The bedrock outside the buried valleys has a low hydraulic conductivity; wells generally yield less than 10 gpm in these areas.

Glacial Overburden

The thickness of the glacial overburden in the project area averages between 20 and 30 feet. In the reaches of Paddys Run west of the silos, the glacial overburden is eroded away, allowing surface water leakage directly to the Great Miami aquifer.

Each of the subunits of the glacial overburden have distinct hydrogeologic characteristics that determine the presence and movement of water in the subsurface. Directly above the Great Miami Aquifer is a sequence of till: a dense, silty clay that contains minor lenses of poorly sorted fine- to medium-grained sand and gravel, silty sand, and silt with layers of silty clay. This dense silty clay material acts as an aquitard (barrier to water movement), with intergranular hydraulic conductivities in the 10^{-7} to 10^{-5} ft/day range (10^{-11} to 10^{-9} cm/s). A series of slug tests of the coarser, perched water bearing zones within the till found hydraulic conductivities ranging from 1.6 ft/day (0.0006 cm/s) to 7.1×10^{-3} ft/day (2.5×10^{-5} cm/s).

Above the till, the lacustrine deposits found beneath the project area grade upward from coarse to fine. The coarse grain stratum at the base of the lacustrine deposits is predominantly silty and clayey sands and varies from 5 to 20 feet thick. The sands appear to have substantial primary permeability. Overlying the sands are clays, silty clays, clayey silts, and silts. These fine-grain sediments exhibit a substantial secondary permeability. The entire lacustrine unit has good, but slow lateral and vertical hydraulic communication. Due to the presence of the till aquitard, the lateral flow rate is significantly greater than its vertical downward rate.

The glacial overburden exposed at the surface has relatively low permeability, so much of the precipitation is lost to evaporation and surface water runoff. Infiltration is primarily limited to the weathered till, and in isolated areas where more permeable deposits of silt, sand, and gravel are the primary overburden constituents. In the zone of weathering (the upper 20 feet), deposits of clayey or silty till and glaciolacustrine clay exhibit networks of predominantly vertical joints or fractures. These fractures can locally enhance infiltration, and bulk hydraulic conductivity. In general, the hydraulic conductivity of fractured till and clay decreases with depth.

Erratically distributed pockets of more permeable sediments within the glacial overburden contain zones of perched groundwater. Perched groundwater is separated from the underlying aquifer by the low-permeability units which behave as an aquitard. These units can store groundwater, but transmit it slowly downward from one more porous saturated zone to another. Depth to perched groundwater at the FEMP site ranges from 1 to 15 feet below ground surface. This depth can fluctuate seasonally by up to 10 feet at a single location, with the highest water levels occurring during the early spring and the lowest during the late fall.

Although precipitation may enter the upper zone of the glacial overburden, it does not act as a significant source of recharge to deeper aquifer zones (e.g., the Great Miami Aquifer) because the majority of the water lost from till deposits is from evapo-transpiration. Perched groundwater underlying the FEMP site generally flows laterally toward surface drains and potentially at a lower rate vertically downward. In the project area, perched groundwater is likely discharging westward to the bank of Paddys Run, and southward in the east-west drainage ditch south of Silo 1. The westward flow is implied using water levels in 1000 series wells in the area, which are screened into the coarse grain stratum that is present at the base of the lacustrine unit. However, no visible seeps have been noted along the banks of Paddys Run adjacent to the silos. It is likely that the fill zone located between the silos and Paddys Run would intercept any seasonal seeps, preventing the seeps from having a visible surface expression. Seeps have been identified in the drainage ditch located south of Silo 1. There is uncertainty, however, regarding actual horizontal movement of perched groundwater, because the perched zones may not be laterally interconnected, and the overburden varies considerably in its ability to confine or transport water. Other influences on flow patterns within perched zones may include seasonal variations in rainfall and recharge, and the presence of leaky storm sewers and agricultural drain tiles. Consequently, groundwater flow within the glacial overburden should be considered discontinuous and nonuniform across the project area.

C.7 Geotechnical

Limited geotechnical information was presented in the Remedial Investigation Report for Operable Unit 4[6]. Four vertical borings (1620, 1621, 1622, and 1623) were advanced through the silo berms between 2 and 3 feet from the exterior of the silo walls. Boring locations are provided in Figure C-9. A continuous core of berm material was collected from each boring to a maximum depth of 30 ft, for characterization of the berm material down to the base of the silos. Results of geotechnical analyses are summarized in Table C-6. The boring logs and geotechnical results indicate that these materials are a silty clay, with greater than 60 weight percent passing the 200-mesh sieve. Water content ranged from 12.1 to 26.8 percent and all samples showed the property of plasticity.

[6] Ibid.

Slant (angle) borings were also done to characterize the subsurface beneath Silos 1 and 2. Slant boring locations are provided in Figure C-10. Table C-7 provides a summary of the results of the geotechnical analyses of subsurface soil samples collected. Depths reported are not true depths but the distance at which the sample was taken along the boring. Water content in these fine-grained soils ranged from 10.9 to 28.3 percent. In most cases, the weight percent of material passing the 200-mesh sieve ranges between approximately 70 and 99 percent. All soils showed varying degrees of plasticity, with the plasticity index ranging from 5 to 29.

A summary of previous geotechnical data and studies conducted in the project area is found in the *Geotechnical Evaluation of Soils Surrounding Silos 1-4, Pilot Plant Vitrification Facility*[7]. The ring wall foundation for the silos was constructed using an allowable design soil bearing pressure of 4,000 psf. Compaction on the berm soils during construction of the berm was at 90% of standard proctor. An allowable shallow foundation bearing capacity of 1,000 psf is recommended for construction using berm soils. Based on stiff natural clayey soils in the vicinity of Silos 3 and 4, an allowable soil bearing capacity of 3,500 psf is indicated. Based on a soil unit weight of 125 lb/ft^3, a lateral earth pressure coefficient of 2.4 is recommended. Cut and fill slopes should be no steeper than 3H:1V.

The Operable Unit 4 Geotechnical Design Investigation Summary Report for Silo Superstructure, May 1996, by Parsons summarizes geotechnical data from field investigations conducted for a silo superstructure foundation design. Eight test borings were advanced in the project area, four at Silos 1 and 2, and four at Silo 3. Based on the geotechnical data, an allowable soil bearing capacity of 2,900 psf is calculated for the fill area at the toe of the berms at Silos 1 and 2. Bearings on natural soils east of Silos 1 and 2 can be as high as 3,700 psf.

More detailed information on the geotechnical characterization of the project area, including the slant boring around the silos, can be found in the referenced reports.

[7] H.C. Nutting Company, *Geotechnical Evaluation of Soils Surrounding Silos 1-4, Pilot Plant Vitrification Facility*, Fernald, Ohio; June 11, 1993.

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APPENDIX D
Radon Test Data

ATTACHMENTS

Adsorption Coefficient Report	D-1
Temperature and Flow Rate Report	D-2
Competition for Radon Adsorption Sites Report	D-3

Handling and treatment of K-65 material involves issues which are unusual for material of such a moderate level of radioactivity (about 500 -600 mR/hr surface dose on a drum of material). These issues are the result of the constant production of Radon-222 from the decay of Radium-226 in the material. Given that the silos have a combined inventory of approximately 4000 Ci of radium and that the concentration ranges from 300 -900 nCi/g; containment and treatment of radon from this material involves high concentrations of radon in significant volumes of air. Therefore, the plan to handle and treat the K-65 material must involve an understanding of this unique aspect of the material.

In order to compare these unique handling and treatment needs to typical radon handling and treatment needs, it is beneficial to consider the high radon emanation rate from this material (approximately 250,000 pCi/m^2/sec) compared to the most common source of radon in domestic dwellings from the soil beneath them (an average emanation rate of .45 pCi/m^2/sec). To approach the emanation rate from K-65 material, one must think in terms of a radium source. Then to complete the concept, the volume of air involved in handling and treating such a large volume of material must be included. Finally, there is the issue of release of radon in relation to onsite and offsite radon limits. On site, worker exposure cannot exceed 3 pCi/l average concentration; offsite concentration above background is limited to .5 pCi/l on an annual average.

In order to achieve treatment which would allow us to reach these limits, a series of tests have been performed to determine the adsorption coefficient for activated carbon and to provide data on competition to radon adsorption from other substances. The two most important competing substances are moisture and O_x. There are also important issues regarding rate of flow and the temperature at which the treatment system is maintained. Attachment D-1 is our initial testing on adsorption coefficient. Attachment D-2 describes temperature and flow rate data. Attachment D-3 explains competition for radon adsorption sites.

Attachment D-1
Absorption Coefficient

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Controlling Radon Emissions With Activated Carbon Columns: Preliminary Investigations

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INTRODUCTION

The purpose of this report is to communicate to FEMP, CRU-4 the results of preliminary investigations that the GJPO Radon Laboratory has conducted concerning adsorption of radon on activated carbon. These investigations were designed to further the understanding of how a flow-through activated carbon radon treatment system would behave under steady state conditions.

Because radon is a noble gas, it is chemically inert and hence difficult to control and measure. There are two properties of radon gas that have traditionally been exploited in order to control the movement of radon gas. One of these properties is its relatively high boiling temperature that allows radon to be collected and transferred using relatively mild cryogenic procedures. The other property is its ability to be collected on activated carbon. The latter property has been particularly useful for making radon flux and indoor atmospheric radon concentration measurements. Activated carbon has also been proposed as a means to control radon concentrations in mine environments (Strong and Levins 1978).

All of these applications of activated carbon to controlling radon behavior are similar in that they are all batch type techniques. In each one of these applications radon is first collected on the activated carbon. Following the collection interval, the radon is removed from the carbon and transferred to some other medium which effectively regenerates the carbon and allows it to be used again to collect more radon. This is the traditional way of using activated carbon to control chemicals.

Because radon is radioactive, it does not need to be actively removed from the activated carbon for the carbon to be relieved of its load of radon so that it can be reused. All that is necessary is to wait several times the 3.8 day half life of radon for most of the radon to decay into its progeny. Rather than waiting for the radon on a small batch of carbon to decay away, the mass of carbon can be made large enough, relative to the flow rate of the radon laden air passing through it, so that

enough of the radon decays before it is swept out the column to reduce the outlet concentration to the desired level (Scheibel et al. 1980).

MATHEMATICAL ANALYSIS

It is possible to develop a relatively simple equation for the steady state behavior of radon in air passing through a column filled with activated carbon. This equation can be used to predict the behavior of a wide range of such columns and to optimize various design parameters. In the following sections we outline the derivation of this equation and present some experimental evidence that confirms its accuracy.

When activated carbon is mixed with an atmosphere of radon in air, radon atoms will be adsorbed by the carbon until the rate of adsorption equals the rate of desorption. The higher the atmospheric radon concentration, the higher will be the concentration of radon on the carbon. For most adsorption processes, the increase of concentration on the carbon is less than linear with the increase in atmospheric concentration. However, Scheibel et al. (1980) have shown that radon adsorption on activated carbon can be characterized as linear at very low partial pressures. For radon at normally encountered concentrations, its partial pressure is minute relative to the partial pressures of the other gases of the atmosphere such as nitrogen and oxygen. For example, a mole of an ideal gas at standard temperature and pressure occupying 22.4 liters consists of 6×10^{23} molecules. On the other hand, an equal volume of air containing radon gas at concentrations as high as 10^6 pCi/L will only contain about 4×10^{11} atoms of radon. Under such dilute conditions, the adsorption of radon on activated carbon will be essentially linear. That is, the equilibrium concentration of radon on the carbon relative to the concentration of radon in the adjacent air will be a constant regardless of the concentration.

Consider a small mass of activated carbon dM that has an adsorption coefficient of K pCi/g per pCi/L with air flowing through it at a rate of f L/min. If the radon in air concentration and its change in passing through the carbon are respectively C and dC, then the steady state mass balance relationship for this small mass of carbon is

$$f\frac{dC}{dM} + \lambda KC = 0 \qquad (1)$$

where λ is the decay constant for radon.

Solving equation 1 for the concentration of radon (C_o) leaving a column of mass M for a given inlet concentration (C_i) gives

$$C_o = C_i e^{\frac{-1.0K}{t}}. \qquad (2)$$

If the radon source parameter is a fixed radon source strength (S) instead of a fixed concentration, then equation 2 can be rewritten as

$$C_o = \frac{S}{t} e^{\frac{-1.0K}{t}}. \qquad (3)$$

The adsorption coefficient (K) is a function of temperature, humidity and pressure. Small changes in temperature (Strong and Levins 1978) can make large changes in K with K decreasing as the temperature increases. Increasing humidity also causes K to decrease although the effect is not nearly as pronounced as with temperature.

The effect of pressure on the effective value of K is somewhat less straight forward to assess. Air molecules, which are in much greater concentrations than the radon, are in competition with radon for the active sites on the carbon. If the partial pressure (i.e. the concentration) of radon is increased without increasing the pressure of the air containing it, the radon adsorbed on the carbon increases proportionately. However, if the pressures of all gases are increased in the same proportion (as would occur if the column were operated under pressure), the outcome is not quite so easy to predict. If the carbon has a greater affinity for radon than for air, then the result will be an increase in the concentration of radon on the carbon. However, if the carbon has a greater affinity for air than for radon, the concentration of radon on the carbon will decrease.

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EXPERIMENTAL METHODS AND RESULTS

Activated Carbon Column at Atmospheric Pressure

A series of experimental tests of some of these properties of activated carbon was performed. The first experiment was to test the validity of equation 2. An experimental activated carbon column was set up that was intended to simulate some of the parameters of the column that has been designed for the Fernald vitrification pilot plant furnace. The experimental column, consisting of an assembly of six smaller columns in series, was constructed using nominal 3 inch PVC pipe and fittings as shown in Figure 1. The total column length filled with charcoal was 36.4 ft. (11.1 m). The charcoal column and the heat exchanger were situated inside the GJPO Radon/Radon Daughter Environmental Chamber (E-Chamber). This was done because the E-Chamber was a convenient means of maintaining the columns at a relatively constant temperature for the duration of the experiment. The remainder of the plumbing apparatus was located outside the chamber so that it could be easily manipulated.

A total of 27.4 Kg of activated carbon was required to fill the 36.4 ft. of column length. This resulted in a bulk density for the carbon filled segments of the column of 0.47 g/cm^3. An activated carbon manufactured by Barnebey-Cheney was used for this, and all other experiments. The carbon is nominally 4 mesh and less in size. No attempt was made to reduce the fraction of fines during the loading of the column, thus the carbon is distributed over a wide range of grain sizes.

The air supplied to the system was treated with a heatless dryer to remove most of the moisture in the air. This predried air was then passed through columns filled with Drierite ($CaSO_4$) to complete the drying process. Except for one incidence of breakthrough of undried room air (RH ~ 30%) in one of the drierite columns near the beginning of the experiment, the average relative humidity of the air supplied to the charcoal column was below 15%.

The average temperature in the E-Chamber during this experiment was 24.0 °C, with a minimum of 23.0°C and a maximum of 25.1 °C. The temperature in the carbon beds was slightly cooler at approximately 23.5°C.

A steady inlet radon concentration of 590 pCi/ L (21.8 kBq/ m^3) was maintained by flowing dried air through a 58.4 μCi (2,159 kBq) Pylon flow-through radon source. The flow rate through the activated carbon column was 11.3 L/min (0.400 ft^3 /min), giving rise to a superficial velocity of 3.62 cm/s (7.1 ft/min).

Three continuous radon monitors (CRMs) were used to monitor the radon concentration of the inlet air stream, the exhaust from the first third of the column length, and the entire column length. Figure 1 shows the location of these radon monitors with respect to the plumbing system. Figure 2 shows a time plot of the resulting radon concentrations for these three locations in the column.

The experiment was run for a total of 27 days, from 10-12-94 to 11-7-94. From 10-12-94 (Julian day 285) through 10-26-94 (Julian day 299) the inlet air stream was laden with 590 pCi/L of radon. By 10-26-94 it was apparent that the charcoal system had achieved steady state, i.e. the exhaust radon concentration was no longer climbing. At 1700 on 10-26-94 the radon source was removed from the system, and dried room air was pumped through the column at the same flow rate (11.3 L/min). As can be seen from Figure 2, the radon concentration of the column exhaust does not start to drop for approximately 8.5 days. Interestingly, the column required approximately 8.5 days for the initial breakthrough to occur. Thus, it is apparent that the loading and unloading of the column are symmetrical in time, so long as the flow rate remains unchanged.

The following radon concentrations for steady state conditions were observed for this column experiment:

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Inlet	590 pCi/L
1/3 Column Length	323 pCi/L
Entire Column Length	94.5 pCi/L

Using these data, a least squares regression fit to equation 2 was performed. The results of this regression are shown graphically in Figure 3. The adsorption coefficient predicted from this fit is 6.0 (pCi/g)/(pCi/L), or in simpler units 6.0 L/g.

Activated Carbon Column at Elevated Pressure

To test the effect of increasing the pressure at which an activated carbon column is operated, a single six foot long column was assembled from three-inch PVC pipe and fittings. The column was loaded with 3884 grams of activated carbon, and was run at a pressure of 2585 mm of mercury. This pressure is four times the normal Grand Junction atmospheric pressure of 640 mm of mercury. The flow rate of air through the column measured at atmospheric pressure was 10.86 L/min.

For an inlet concentration of 614 pCi/L, the steady state outlet radon concentration was found to be 361 pCi/L. If the same column had been run at normal atmospheric pressure, equation 2 predicts that the outlet concentration would have been 469 pCi/L. Thus the carbon appears to favor radon over the other air molecules when the pressures of all of them are increased by the same proportion. In Figure 4 the relative outlet concentrations have been plotted for both the atmospheric pressure test and the elevated pressure test along with the best fit equation 2 curves for each.

Measurements of K with Varying Radon Concentrations

An implicit assumption of equation 2 is that the value of K is independent of the airborne radon concentration of the system. That is to say that the adsorption isotherm is linear. In the practical sense it need be linear only over some expected range of airborne concentrations that is to be encountered. Because of the importance of this assumption, we felt that it was necessary to verify this for concentrations up to 7 μCi/L, for a simple air-radon-activated carbon system.

Limitations in the total activity of radon sources available at the GJPO Radon Laboratory influenced the methodology used in these measurements, as well as the maximum airborne radon concentration that could be used. The equilibrium airborne radon concentrations used in these measurements ranged from 229 pCi/L to 7.23 x10^6 pCi/L, more than four orders of magnitude.

Five measurements of K were made in the following manner. Approximately 1 g of the same activated carbon used in the column experiments was placed in a small container, covered with a wire screen, and mounted on the piston of a 1.5 L

syringe. The syringe was connected to a known radon source, and a known quantity of radon was admitted into the syringe. The syringe was allowed to rest for approximately 2 hours to allow an equilibrium distribution of radon between the air and carbon phases to be achieved. An aliquot of the air in the syringe was transferred into a 0.5 L scintillation cell, which was used to determine the airborne radon concentration.

By knowing the volume of the syringe and the equilibrium airborne radon concentration, the total amount of radon in the air phase could be determined. This total equilibrium activity of airborne radon was subtracted from the total radon activity admitted into the syringe at the start of the measurement, yielding the total equilibrium radon activity on the activated carbon. Dividing this activity by the mass of the carbon yields the equilibrium activity concentration on the carbon. *K* is then determined by dividing the activity concentration of the carbon by the activity concentration of the air, e.g. (pCi/g)/(pCi/L) or (L/g). The total radon activity delivered to the 1.5 L syringe was decay corrected to the end of the two hour rest period. Table 1 lists the measurement results.

Table 1
Results of *K* Measurements

No.	Radon Concentration on Carbon (pCi/g)	Radon Concentration in Air (pCi/L)	*K* (L/g)	Temperature °C
1	1.22×10^3	2.29×10^2	5.3	23.5
2	1.32×10^3	2.49×10^2	5.3	23.5
3	1.38×10^6	2.60×10^5	5.3	23.5
4	2.64×10^6	5.20×10^5	5.1	25.0
5	4.26×10^7	7.23×10^6	5.9	24.0

Because the mass of the carbon was small, the potential existed for significant biases in the results due to sample inhomogeneity. To eliminate this source of error we chose to use the same aliquot of activated carbon for each of the five measurements. The adsorbed radon was removed from the carbon aliquot at the end of the measurement by placing the carbon and its container in an oven at 105 °C for a minimum of one hour.

For the low radon concentration measurements (Nos. 1 & 2) the resulting equilibrated air was transferred directly into 0.5 L scintillation cells, and counted on a 5-inch photomultiplier tube, connected to a Ludlum 2200-12 scaler. The combination of the individual scintillation cells and counting system have been calibrated as a unit, with the calibration traceable to NIST radium solutions.

The equilibrium airborne radon concentrations resulting from the higher level runs (Nos. 3, 4, & 5) were too high to be directly transferred into the scintillation cells without dilution. The very high count rates would cause serious dead time errors. Dilution of the air sample was effected during the transfer by employing a gas tight syringe to transfer a 0.25 ml aliquot of the air in the 1.5 L syringe into a partially evacuated 0.5 L scintillation cell. Following transfer of the gas sample, the scintillation cell was pressurized up to the standard counting pressure (760 mm of mercury). By knowing the volume of the gas sample (0.250 ± 0.4%, 1 σ) and the volume of the scintillation cell (measured to ± 0.2%, 1σ), the volumetric dilution may be determined. The dilutions used were approximately 2000 : 1.

For runs 3, 4, & 5, the equilibrium airborne radon concentration was measured with two different scintillation cells, providing an estimate of the uncertainty in determining this radon concentration. The standard deviation (1σ) of the two cell results, corrected for small sample size, and expressed as a percentage of the average radon concentration is 0.5%, 8.4 %, and 20%, for runs 3, 4, & 5; respectively . This uncertainty dominates the uncertainty in the value of *K*, at least for run Nos. 4 & 5. In no case is the estimate of *K* believed to be better than ± 5%.

Given these results, we believe that there is no indication that *K* is not linear with airborne radon concentrations up to 7 x10^6 pCi/L. Therefore equation 2 should hold for a simple air-radon-activated carbon system up to at least 7 x 10^6 pCi/L.

DISCUSSION

The results described above do not yet represent a complete understanding of the behavior of an activated carbon column for controlling radon emissions. Work still remains to evaluate the effects of competing gases and time on carbon performance. Nevertheless, enough has been learned to be able to apply equation 2 to the Fernald Pilot Plant Carbon Bed Absorber design to generate a preliminary projection of the best performance that can be expected from it.

Judging from the values of the radon adsorption coefficient for activated carbons that have been published, the value of 6.0 L/g that we obtained is unusually high. This is probably due to the exceptionally dry air and lower atmospheric pressure at which the experiments were performed. Therefore a somewhat more realistic

upper limit for the adsorption coefficient of 5.0 L/g was used for this calculation. For a flow rate of 250 CFM (7080 L/min) and a carbon mass of 2×10^7 g (assuming 1400 ft^3 of carbon with a density of 0.5 g/cm^3), equation 2 predicts an outlet to inlet radon concentration ratio of 0.17. If the inlet concentration is 40,000 pCi/L, for example, then the predicted outlet concentration is 6,800 pCi/L.

If the fixed radon source parameter is a radon production rate instead of radon concentration, then equation 3 can be used to predict the relative column performance at flow rates other than 250 CFM. Figure 5 is a graph of the outlet radon concentration relative to the outlet concentration at 250 CFM that is predicted to occur at different flow rates. This graph shows that for a fixed radon source strength, the outlet radon concentration can be significantly reduced by reducing the rate of air flow through the column. For example, running at half the flow rate (i. e. 125 CFM) reduces the outlet concentration by 66% even though doing so doubles the inlet concentration.

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Strong, K. P.; Levins, D. M. Dynamic adsorption of radon on activated carbon. In: Proceedings of the 15th DOE Nuclear Air Cleaning Conference; 1978: 627-639.

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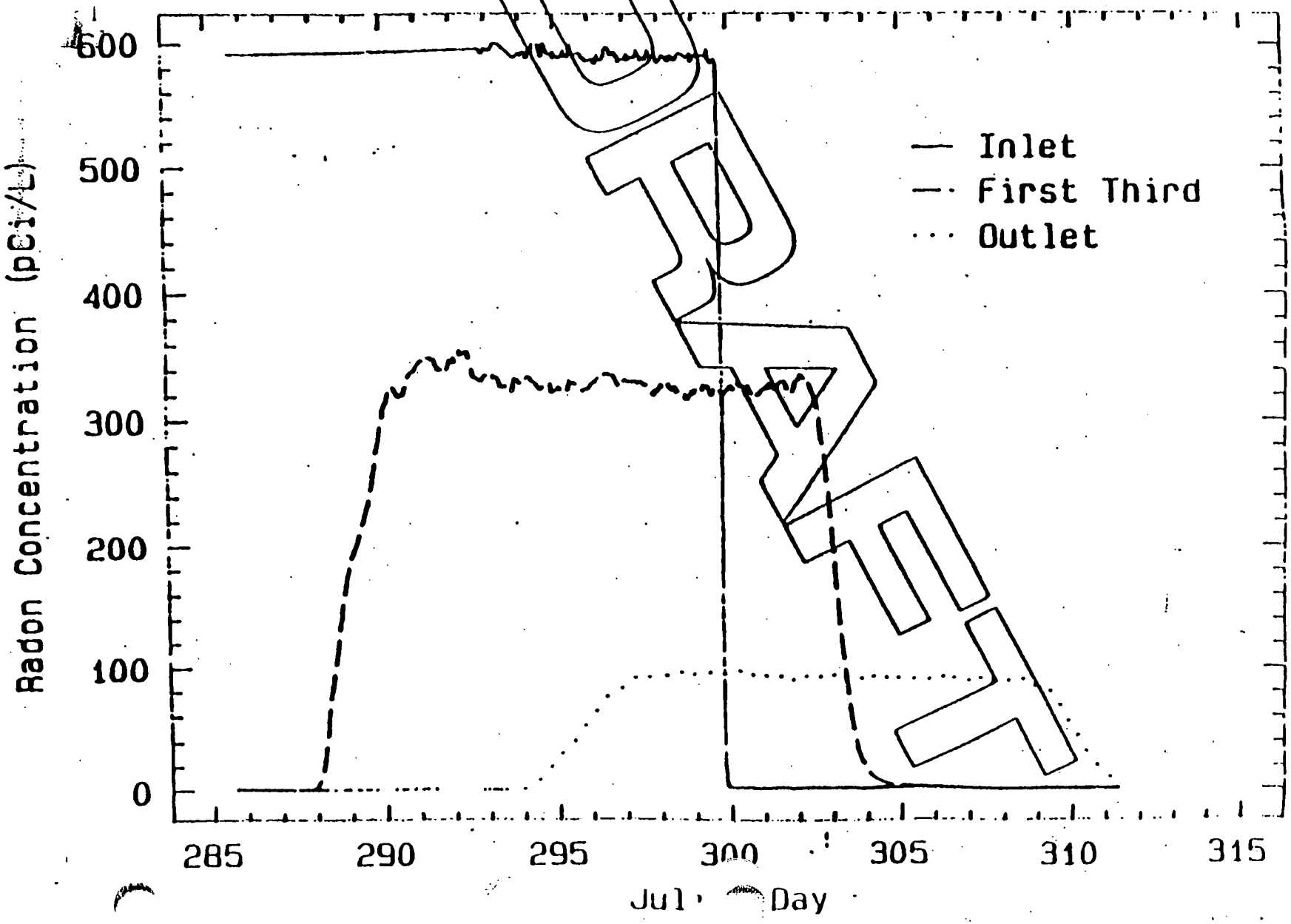
Figure 2. Time Plot of the First Activated Carbon Column Test Radon Concentrations



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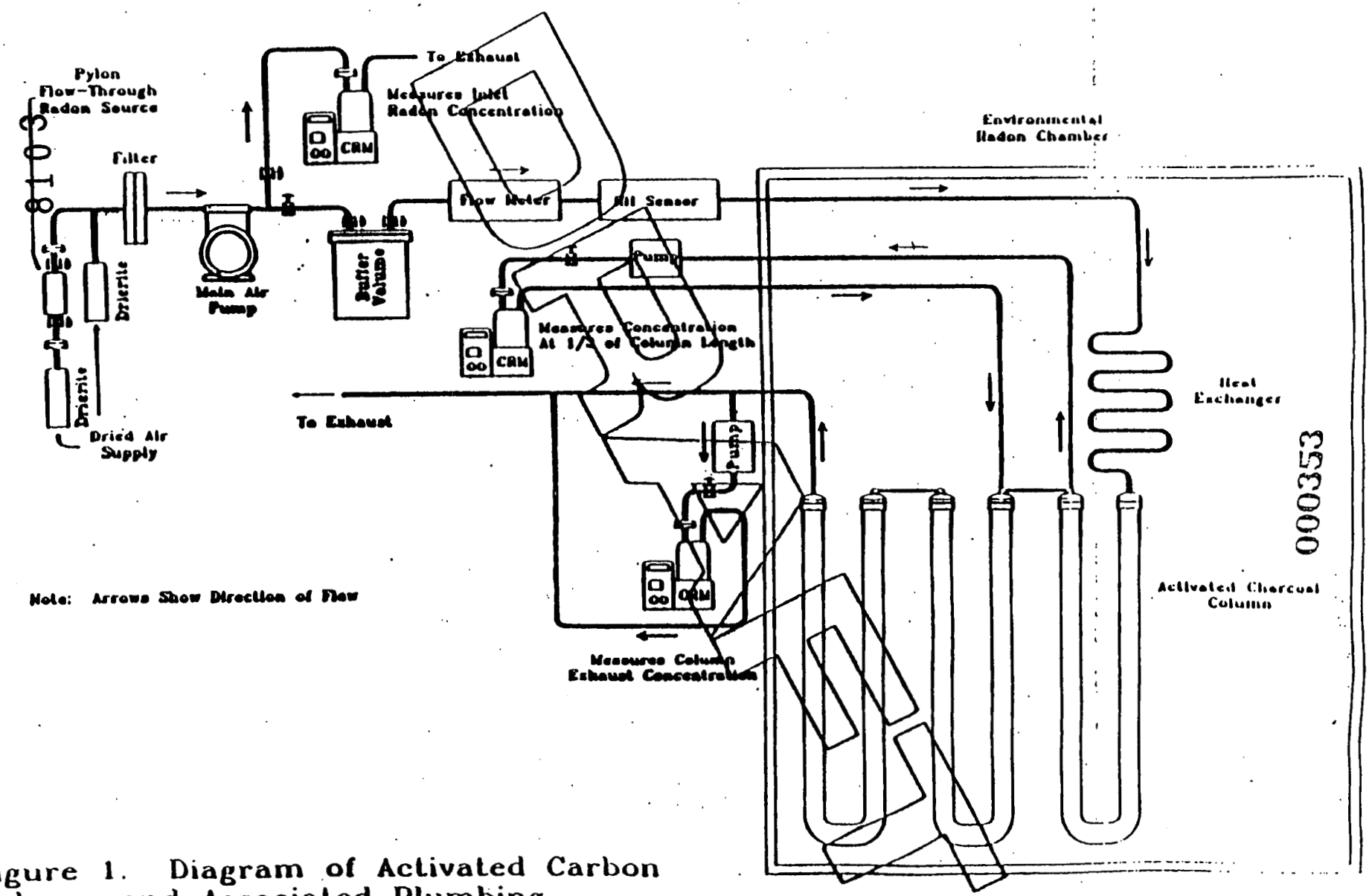

Figure 1. Diagram of Activated Carbon Column and Associated Plumbing.

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Figure 4. Relative Remaining Radon Concentrations Versus Carbon Mass

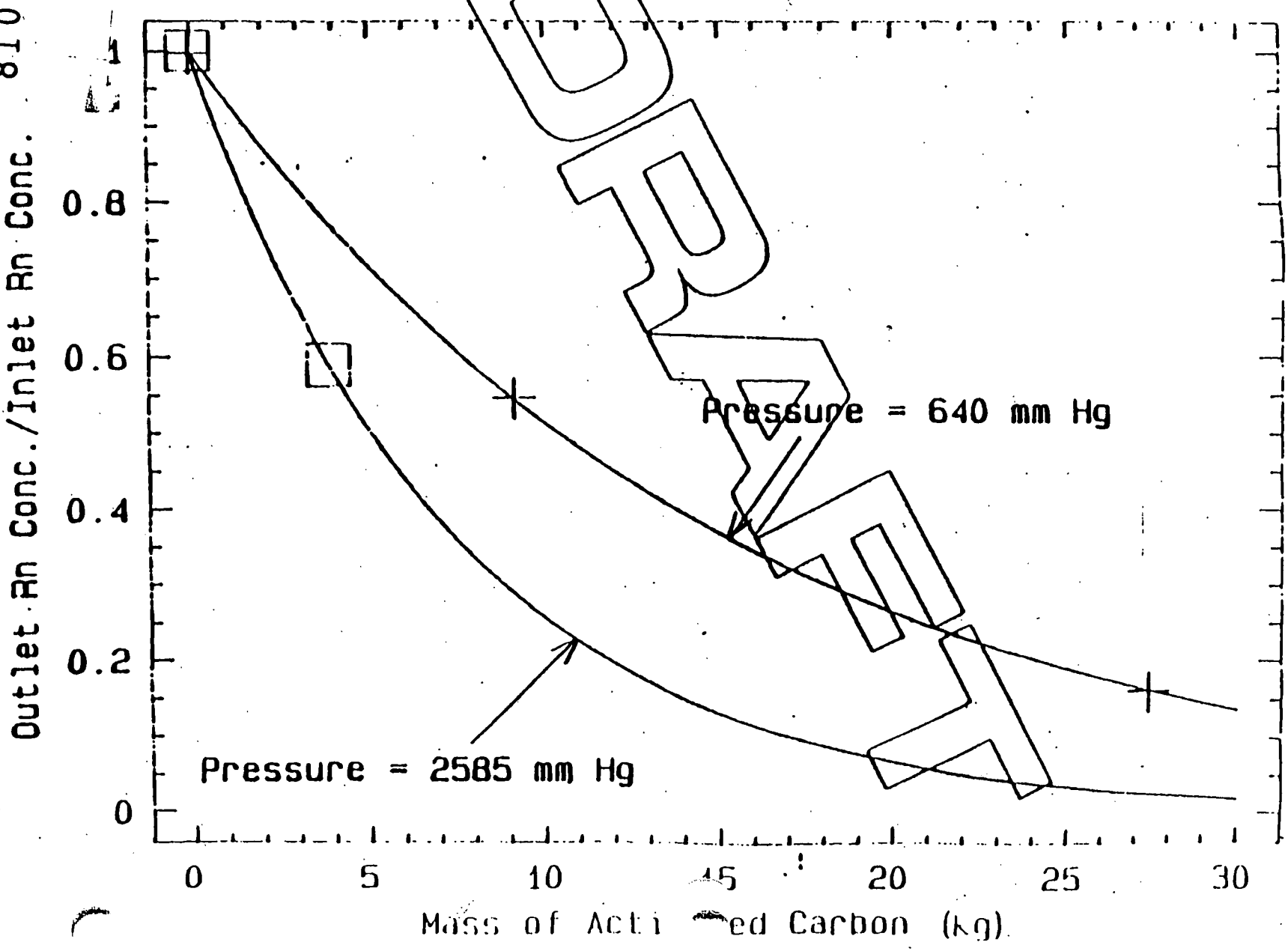

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Figure 3. Predicted and Observed Radon Concentrations vs Carbon Mass

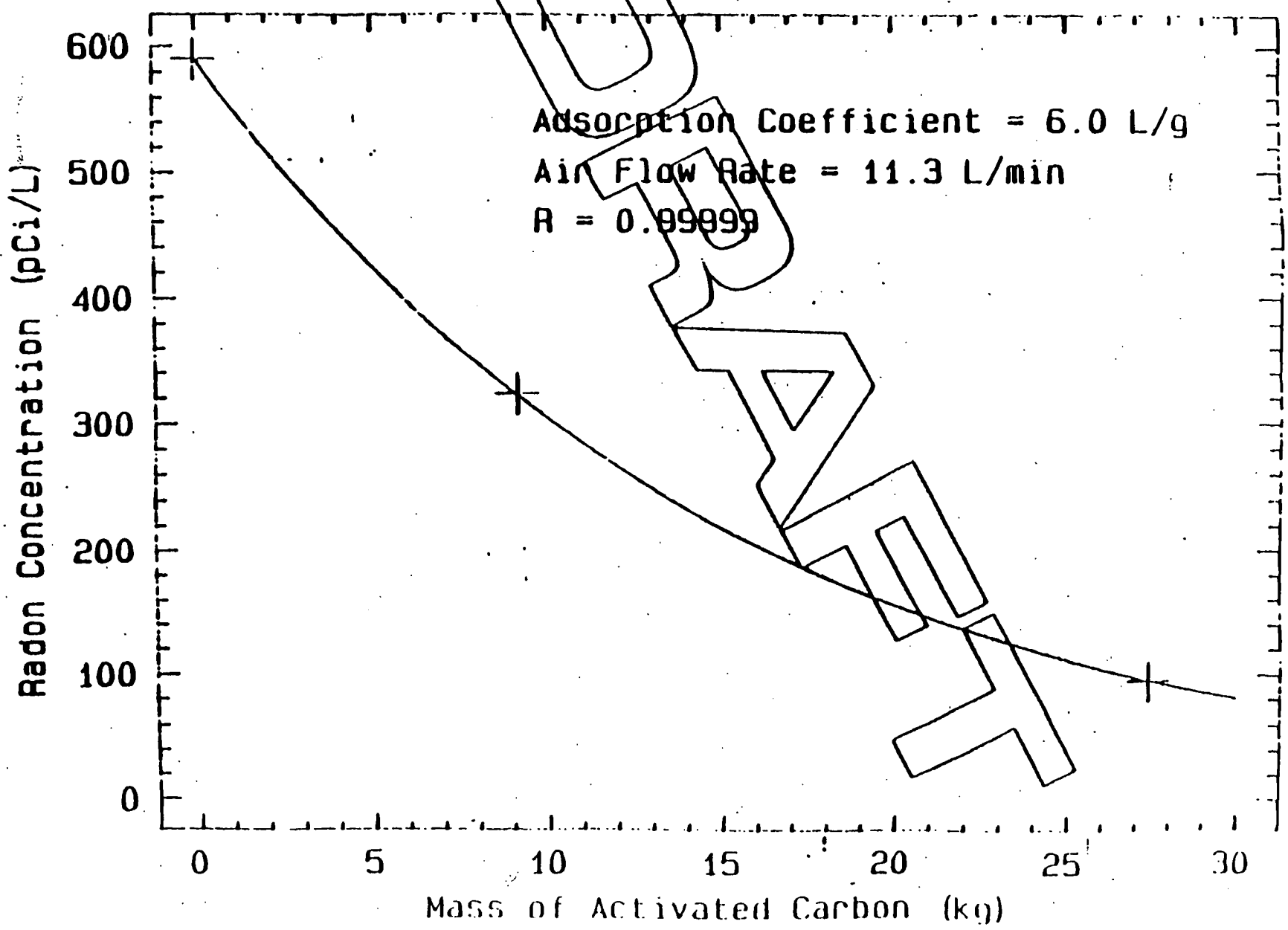

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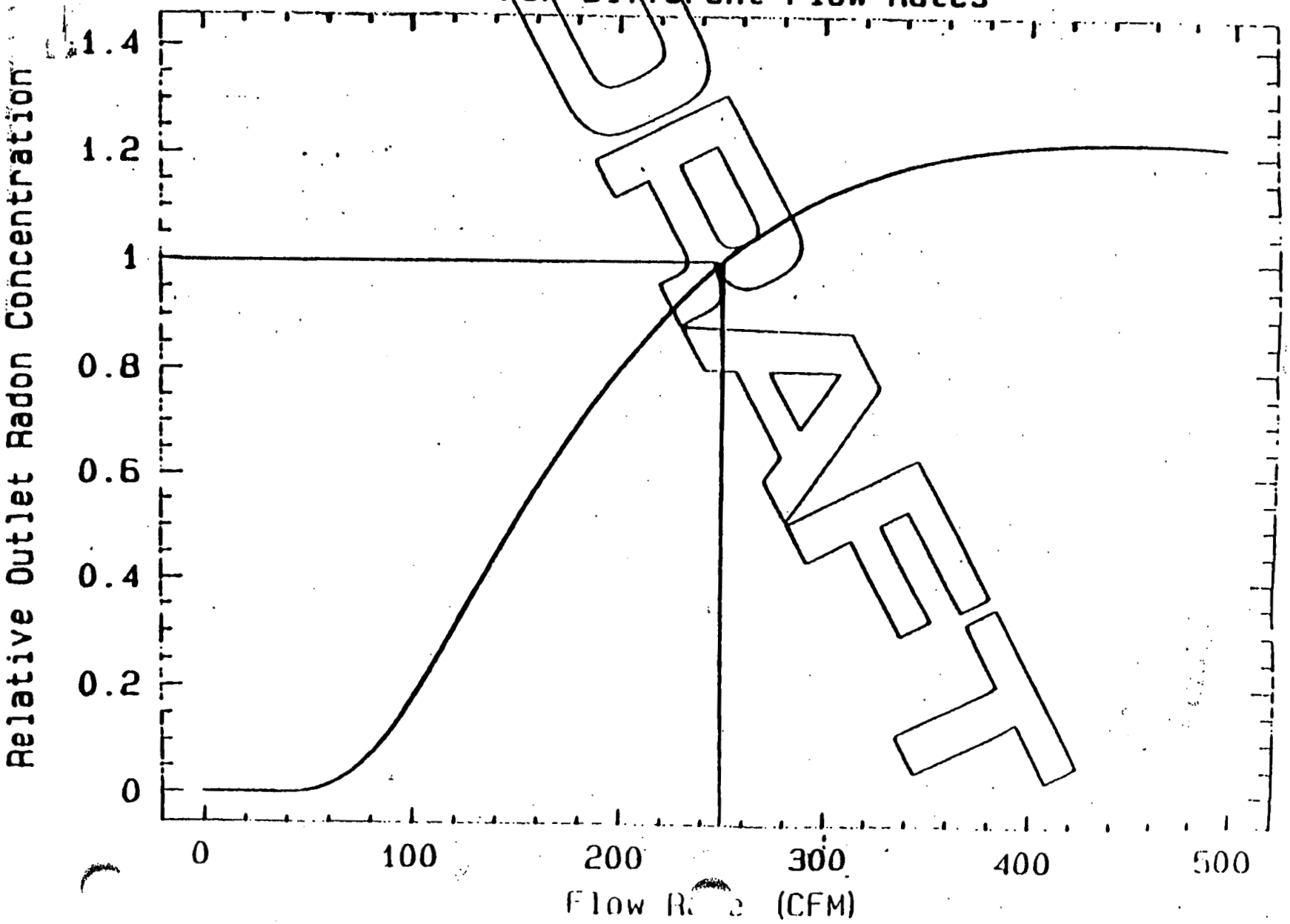
Figure 5. Outlet Radon Concentration
Relative to the Concentration at 250 CFM
For Different Flow Rates



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Controlling Radon Emissions With Activated Carbon Columns: Phase II Results

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INTRODUCTION

In Phase I of this project, two important aspects of the steady state adsorption of radon on activated carbon columns were demonstrated (Langner and Kendrick 1994). The first finding was that for a given inlet radon concentration (C_i), temperature, and pressure, the steady state outlet radon concentration (C_o) at the same temperature and pressure could be predicted by a simple equation of the form

$$C_o = C_i e^{\frac{-\lambda K M}{f}} \qquad (1)$$

where

λ = the decay constant for radon = 1.258×10^{-4}/minute,
K = the adsorption coefficient of activated carbon for radon (L/g),
M = the mass of dry carbon (g), and
f = the rate of air flow through the column (L/minute).

Second, we demonstrated that the adsorption coefficient is a constant for all radon concentrations up to 7×10^6 pCi/L.

Applying these results to the FEMP Pilot Plant Carbon Bed Adsorber design, the lowest outlet to inlet concentration ratio would be around 0.17. To meet the FEMP absorber design objectives, this ratio must be no greater then 0.01.

There are essentially three ways to improve the efficiency of an activated carbon bed for adsorbing radon gas:

1) Reduce the rate of air flow through the column for the same radon source strength. This will increase the inlet radon concentration but will reduce the outlet concentration. For the FEMP project, this is not an option. In fact, the actual flow rate through the system will probably be higher than originally called for due to other system constraints.

2) Improve the adsorber efficiency by operating the column at elevated pressure. A test of this concept that was performed in Phase I indicated that increasing the pressure by

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a factor of four would cut the outlet concentration in half. However, due to safety considerations identified by FEMP, operating an adsorber at increased pressure would be considered only as a last resort.

3) Operate the column at reduced temperature. The temperature dependence data reported by Strong and Levins (1978) indicate that there is a high probability that the adsorption can be sufficiently improved by reducing the operating temperature of the adsorber to about 0°C. While this increases the cost of the system somewhat, there does not appear to be any reason why using temperatures as low as 5°C would not be feasible.

Before committing to incorporating a refrigeration system into the adsorber design, testing needed to be performed to verify that such a system would in fact achieve the desired result. In particular, it was necessary 1) to establish the relationship between temperature and the adsorption coefficient for the particular type of activated carbon to be used in the FEMP adsorber, and 2) verify that, at the lower temperatures, the equation still accurately predicts the performance of an activated carbon column. In addition, it was necessary to characterize the flow velocity range within which Equation 1 is valid, in anticipation of the need to operate the system at flow rates higher than originally intended.

This second phase of the activated carbon column investigations therefore consisted of the following three tasks. Task 1 was to measure the static adsorption coefficient at several temperatures between 0°C and room temperature on a small aliquot of the carbon with the same technique used in Phase 1. Task 2 was to verify that the static determination of the adsorption coefficient combined with Equation 1 accurately predicts the performance of a carbon column at 5°C. Task 3 was to perform a series of tests to define the upper flow rate limit within which the equation is valid. These were tests performed in columns that were smaller in diameter than the one used in task 2, to facilitate increasing the flow velocity, and shorter, to reduce the time needed for the tests.

EXPERIMENTAL METHODS

Task 1. Low temperature adsorption coefficient.

The carbon used for all of the tests described below was United Manufacturing International type UMI 612 CX, lot# JA 94-63 that was shipped to the GJPO by FEMP on January 27, 1995. The relationship between temperature and radon adsorption coefficient was determined for this carbon at temperatures of 0, 5, 10, 15, 20, and 24°C. One test was conducted at each temperature in one of the GJPO walk-in refrigerated chambers. The determination at each temperature was made in the following manner. A sample of the activated carbon having a dry mass of 1.004 g was placed in a shallow metal container covered with a wire screen. The carbon was preconditioned by drying in an oven at 105°C. The container of carbon was then mounted on the piston of a 1.5 L syringe. The syringe was then connected to a known radon source, and a known quantity of radon was admitted into the syringe. The syringe was allowed to rest for approximately 2 hours to allow an equilibrium distribution of radon between the air and carbon phases to be achieved. Then an aliquot of air in the

syringe was transferred into a 0.5 L scintillation cell, which was used to determine the equilibrium airborne radon concentration.

By knowing the volume of the syringe and the ratio of equilibrium airborne radon concentration to admitted radon concentration, the adsorption coefficient was computed using the equation

$$K = \frac{V_1 (C_1/C_2 - 1) - V_2}{M} \qquad (2)$$

where

V_1 = The volume of air drawn into the syringe = 1.4725 L,
V_2 = The initial dead volume of the syringe = 0.0823 L,
C_1 = The radon concentration in the air drawn into the syringe,
C_2 = The equilibrium radon concentration in the syringe, and
M = The dry mass of the activated carbon in the syringe = 1.004 g.

Task 2. Low temperature model behavior

The degree to which the mathematical model of activated carbon column behavior makes valid predictions was tested at 5°C in the following manner. An experimental column filled with 9,477.62 g of dried activated carbon was set up in the walk-in refrigerated chamber maintained at approximately 5°C. A block diagram of the system is shown in Figure 1. The column consisted of sections of 3 inch PVC pipe nominally 12 feet in length. The humidity control and radon generating parts of the system were located outside the chamber.

The inlet radon concentration was maintained at about 600 pCi/L by flowing dried air through a 58.4 μCi Pylon flow-through radon source. The flow rate of air through the column was about 11 L/min. Radon concentration was monitored at the inlet and outlet with GJPO model radon monitors calibrated by the GJPO Radon Laboratory.

The parameters monitored included inlet, outlet, and intermediate radon concentration, as well as inlet temperature, pressure, dew point, and flow rate. Also monitored were the temperatures of the columns, chamber air, and laboratory at several points. All data were recorded with a Campbell Scientific CR10 data logger that was located outside the chamber programmed to store one data record every hour.

Radon laden air with a dew point of about -37°C was supplied to the column until the breakthrough of radon occurred and a steady state outlet radon concentration was established. The humidity was then adjusted to a dew point of about -19.5°C until steady state of all relevant parameters was established for a period of six days. The six day average inlet and outlet radon concentrations were then determined for use in Equation 1.

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Task 3. Flow velocity limit of the model

An attempt was made to determine the upper air velocity limit for which Equation 1 makes valid predictions in the following manner. Six five-foot-long sections of 1/2 inch copper tube were loaded with 749.50 g of activated carbon. Air with a radon concentration of about 500 pCi/L was made to flow through the tube with a superficial velocity of 114 cm/s. The test was carried out in the refrigerated chamber at 5°C. The air flow was maintained until the outlet radon concentration stabilized. Figure 2 is a block diagram of the experimental setup.

This same test was repeated with 368.50 g of carbon at a velocity of 193 cm/s in a column made from three five-foot-long sections of 1/2 inch copper tubing and at a velocity of 3.43 cm/s with 24.57 g of carbon in a twelve-inch-long section of 1/2 inch copper tubing.

RESULTS and DISCUSSION

The results of the static adsorption coefficient measurements determined in Task 1 are shown in Table 1. They display the same strong dependence of adsorption coefficient on temperature as was reported by Strong and Levins (1978). As suggested by Strong and Levins, these data are shown plotted according to the Arrhenius equation in Figure 3. It can be seen that the data are readily fit by a straight line with a correlation coefficient of 0.994. The equation for the line shown in Figure 3 is

$$K = 4.287 \times 10^{-5} e^{\frac{3113}{T(^\circ C)+273}} \quad (3)$$

Table 1
Results of the Adsorption Coefficient Measurements

Temperature (°C)	Beginning Radon Concentration (pCi/L)	Ending Radon Concentration (pCi/L)	Adsorption Coefficient, K (L/g)
0	904.3	73.4	16.5
5	614.8	59.5	13.6
10	579.1	64.1	11.7
15	615.0	85.2	9.0
20	643.7	113.2	6.8
24	601.0	114.6	6.1

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The adsorption coefficient at 5°C was found to be 13.6 L/g. When this value is used along with the design parameters for the Fernald Pilot Plant Carbon Bed Absorber (flow rate = 250 CFM = 7080 L/minute, carbon mass = 2 x 10^7 g), Equation 1 predicts an outlet to inlet ratio of 0.008. This value is substantially smaller than the ratio of 0.114 calculated for 24°C and is low enough to satisfy the requirements of the project.

The time plots of the monitored data from the low temperature model test (Task 2) are shown in Figures 4 through 8. The average values for each parameter over the last six days of the test are shown in Table 2. From these data, Equation 1 yields an effective adsorption coefficient of 15.5 L/g. The adsorption coefficient found from Equation 3 at 4.85°C is only 13.7 L/g. The ratio of 13.7/15.5 = 0.88 is the same as the corresponding ratio found in Phase I at room temperature (5.3/6.0 = 0.88).

If 15.5 L/g is used as the adsorption coefficient, Equation 1 predicts an outlet to inlet radon concentration ratio of 0.004 for the FEMP Pilot Plant Carbon Bed Absorber operated at 5°C.

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Table 2
Average Steady State Values of the Parameters Measured
During the Low Temperature Model Test

Chamber Temperature	4.85°C
Dew Point	-18.9°C
Relative Humidity	16.0%
Inlet Radon Concentration	657.7 pCi/L
Outlet Radon Concentration	117.4 pCi/L
Flow Rate	10.7 L/minute
Adsorption Coefficient	15.5 L/g

The results of the flow velocity limit tests (Task 3) are shown in Table 3. The effective adsorption coefficients calculated using Equation 1 are substantially higher than the static coefficient. This result is most likely caused by the fact that at the increased flow rates the average column pressure is also increased. In Phase 1 we demonstrated that increasing the column pressure increases the effective adsorption coefficient by increasing the concentration of radon in contact with the carbon. This also is the most likely explanation for why even the low speed large column tests always show higher effective adsorption coefficients than do the static tests.

If there is a reduction in the efficiency of the carbon for adsorbing radon as the air velocity increases, it is not possible to observe the effect from these test results because the pressure

effect is much stronger in the opposite direction. It would be highly desirable to have a version of Equation 1 that incorporates the effect of pressure. With such an equation the performance of carbon column could be more accurately predicted and the existence of flow rate limitations could be inferred.

Table 3
Results of the Flow Velocity Limit Tests

Test Number	1	2	3
Column Length (cm)	914	457	30.5
Mass of Carbon (g)	749.5	368.50	24.57
Flow Rate (L/minute)	11.4	19.4	0.32
Superficial Velocity (cm/s)	114	193	3.14
Inlet Pressure (PSI)	15.8	18.3	0.01
Inlet Radon Concentration (pCi/L)	516.4	368.5	271.8
Outlet Radon Concentration (pCi/L)	425.6	339.5	239.1
Adsorption Coefficient (L/g)	23.4	34.3	13.1

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CONCLUSIONS

The static adsorption results are consistent with those observed in the literature obtained on other types of carbon using other techniques. They confirm the hypothesis that the FEMP design for an activated carbon radon control system will meet the required level of radon emission control if it is operated at 5°C.

The low temperature model behavior test in the large column at 5°C indicated that a flowing system will perform at least as well as predicted by Equation 1 with static adsorption coefficients. Using this equation to predict design performance will not overestimate the effectiveness of a design, and at the kinds of pressures and flow rates to be used at the FEMP, it will produce slightly conservative predictions.

The flow velocity tests were unable to demonstrate any reduction in the effective adsorption coefficient due to the more than compensatory pressure effect. It would be highly desirable to have an equation that takes pressure into account in predicting the behavior of a carbon column. Derivation of such an equation should be part of any future work on the design of the carbon bed adsorber.

REFERENCES

Langner, G.H.; Kendrick, D.T. Controlling radon emissions with activated carbon columns: preliminary investigations, December 1, 1994.

Strong, K.P.; Levins, D.M. Dynamic adsorption of radon on activated carbon. In: Proceedings of the 15th DOE Nuclear Air Cleaning Conference; 1978: 627-639.

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Figure 1. Block diagram of the system used for the low temperature model behavior test.

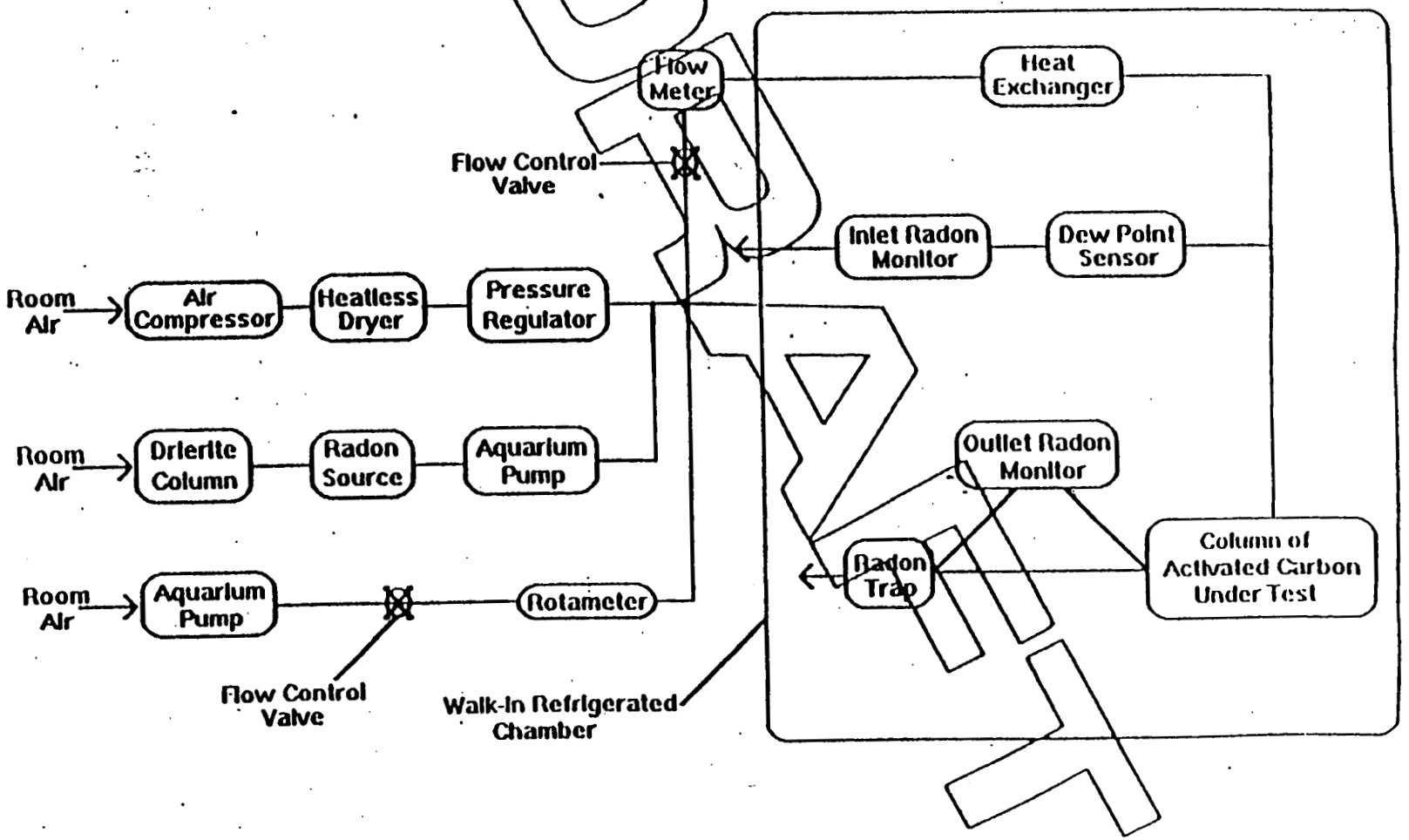

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Figure 2. Block diagram of the system used for the flow velocity limit tests.

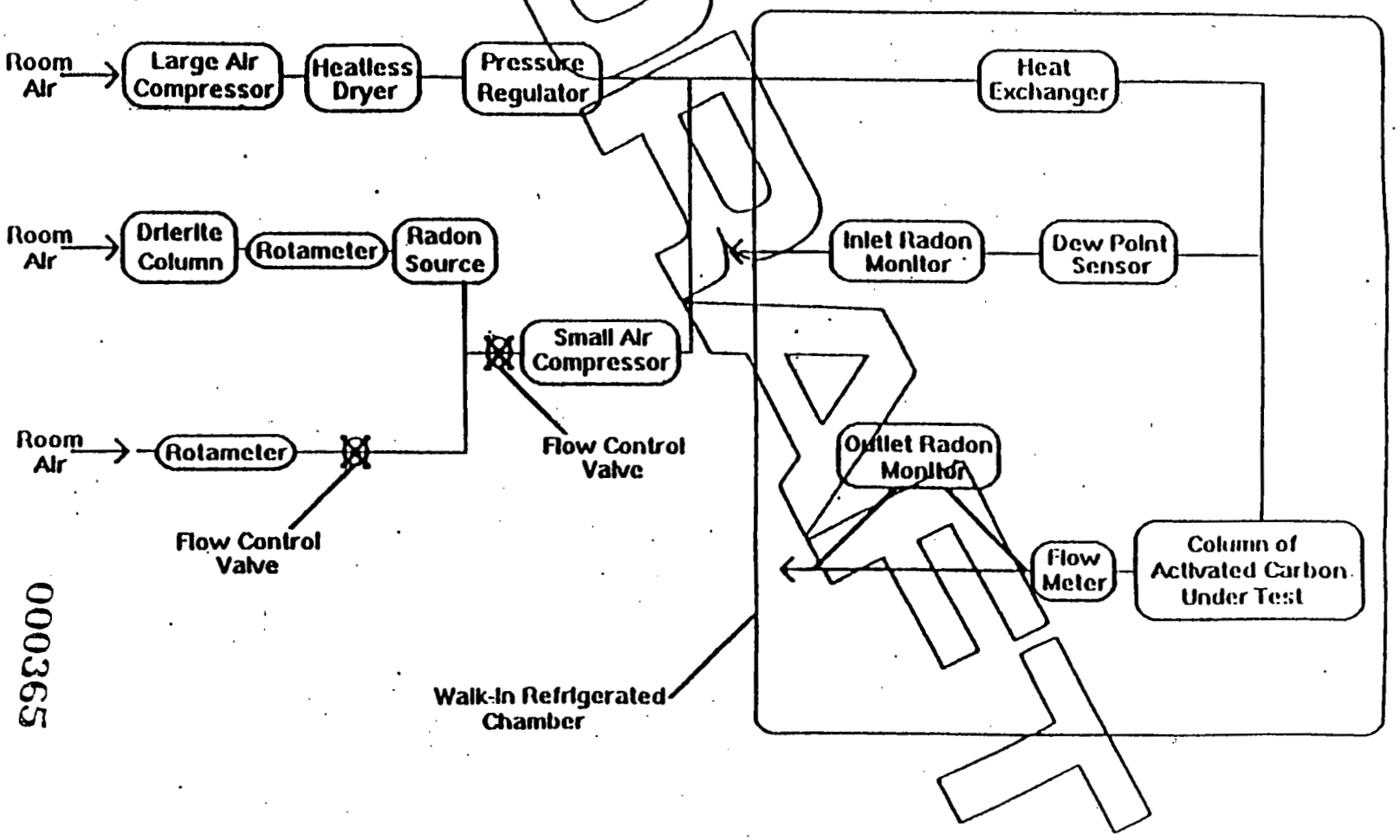

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Figure 3

Linear Regression of the Natural Logarithm
of the Adsorption Coefficient on 1/Temperature

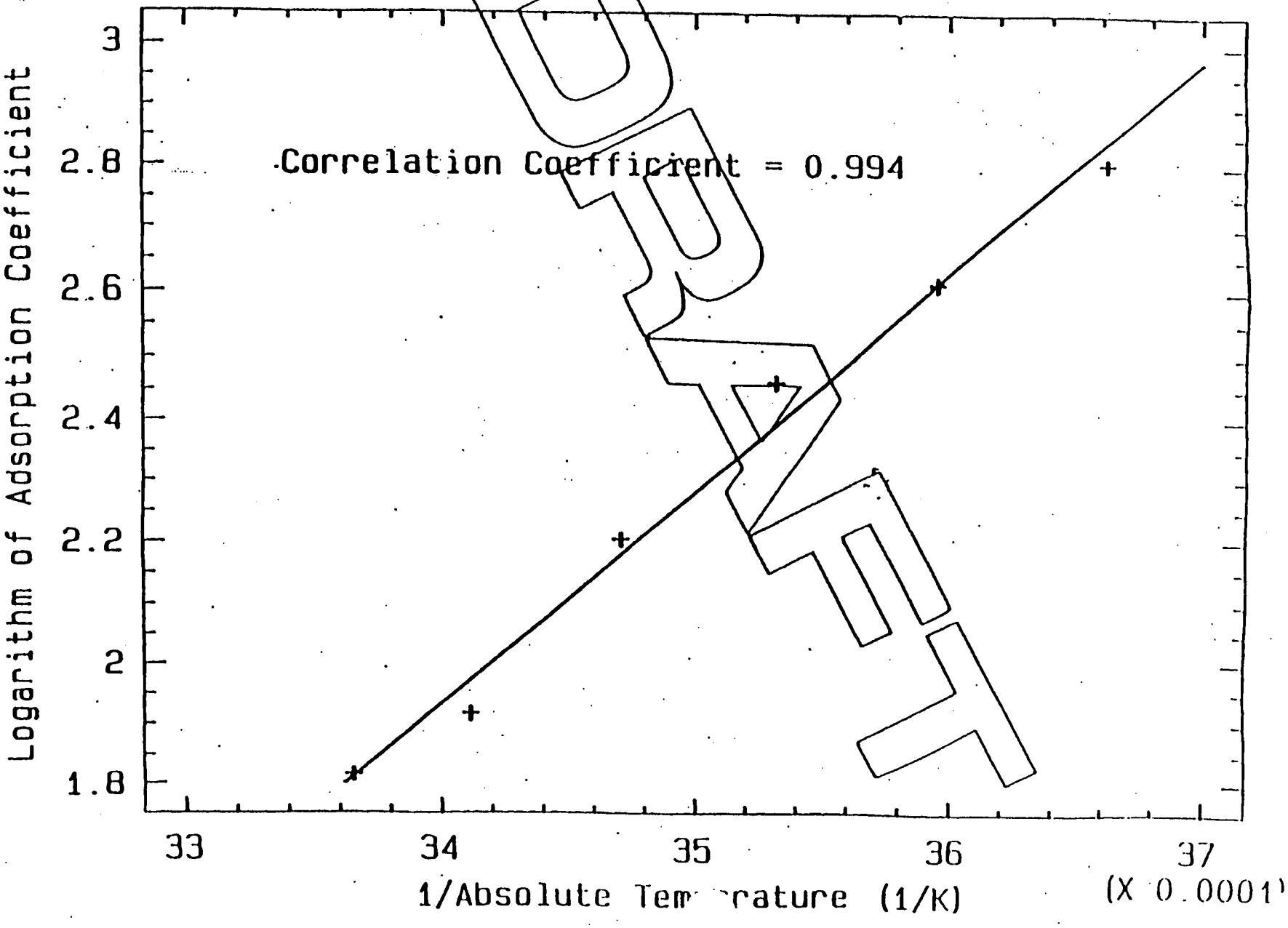

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Figure

Time Plot of Air Flow Rate During the Low Temperature Model Behavior Test

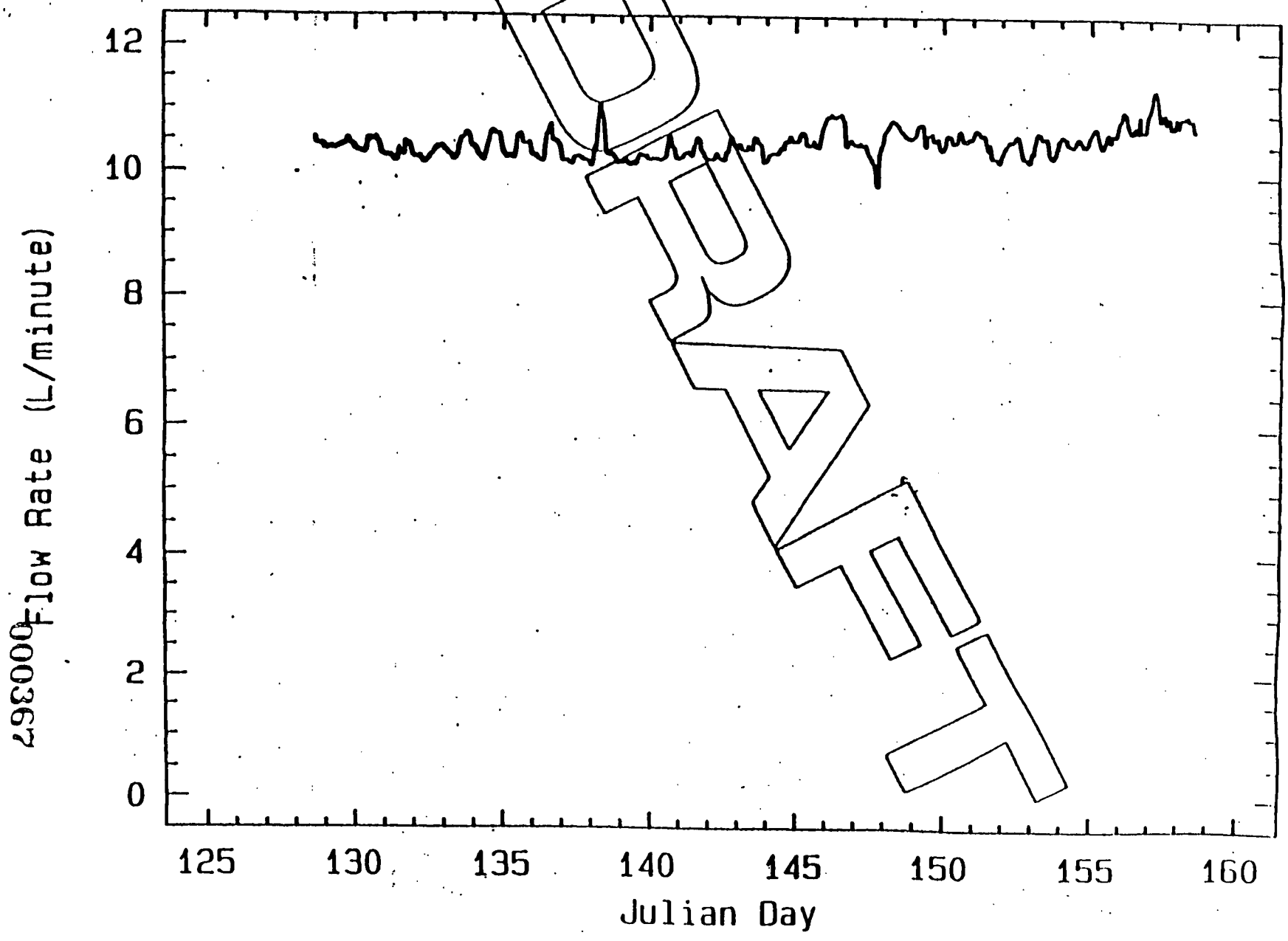

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Figure 5

Time Plot of Temperatures During the Low Temperature Model Behavior Test

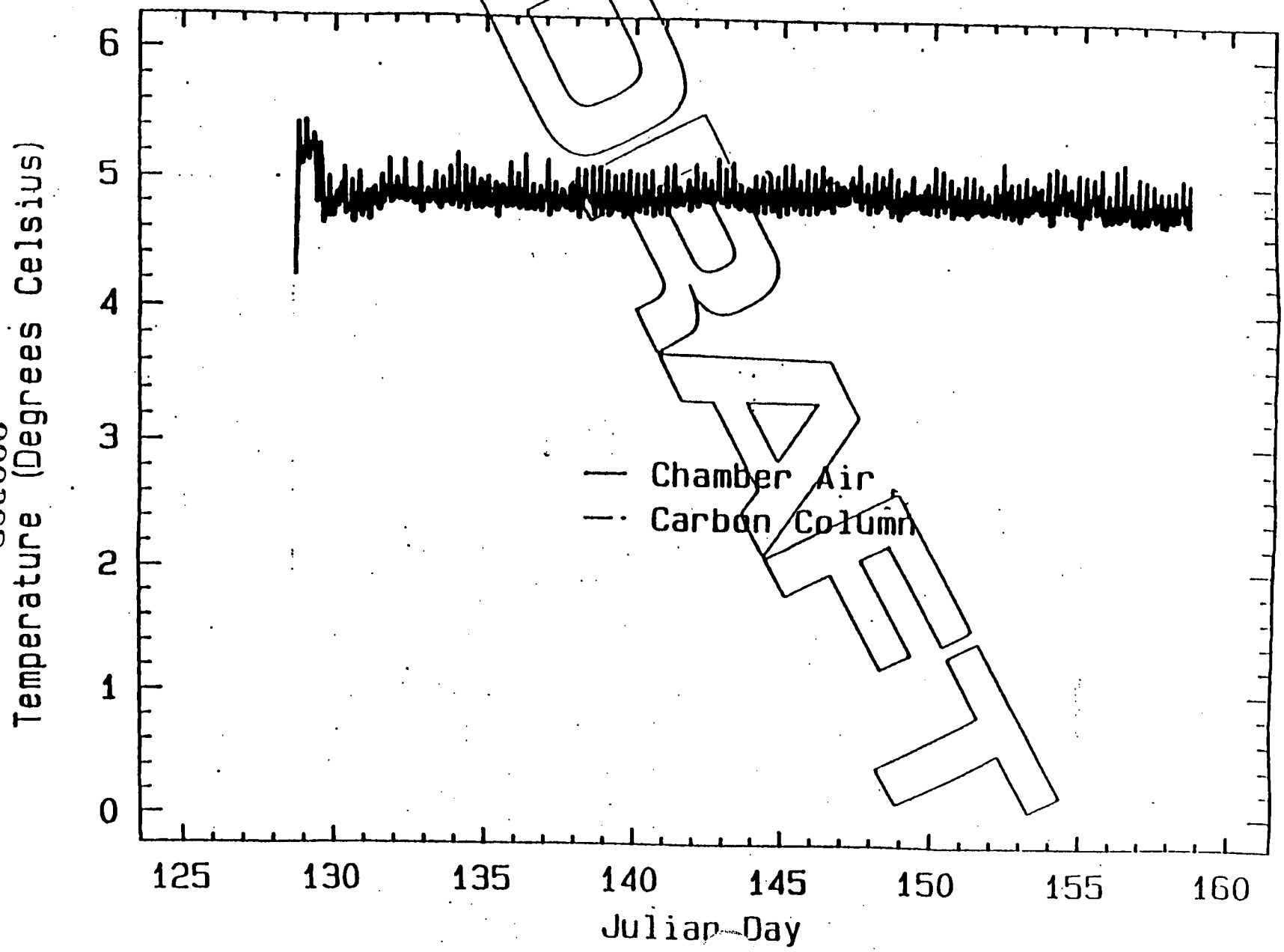

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Figure

Time Plot of Dew Point During the
Low Temperature Model Behavior Test

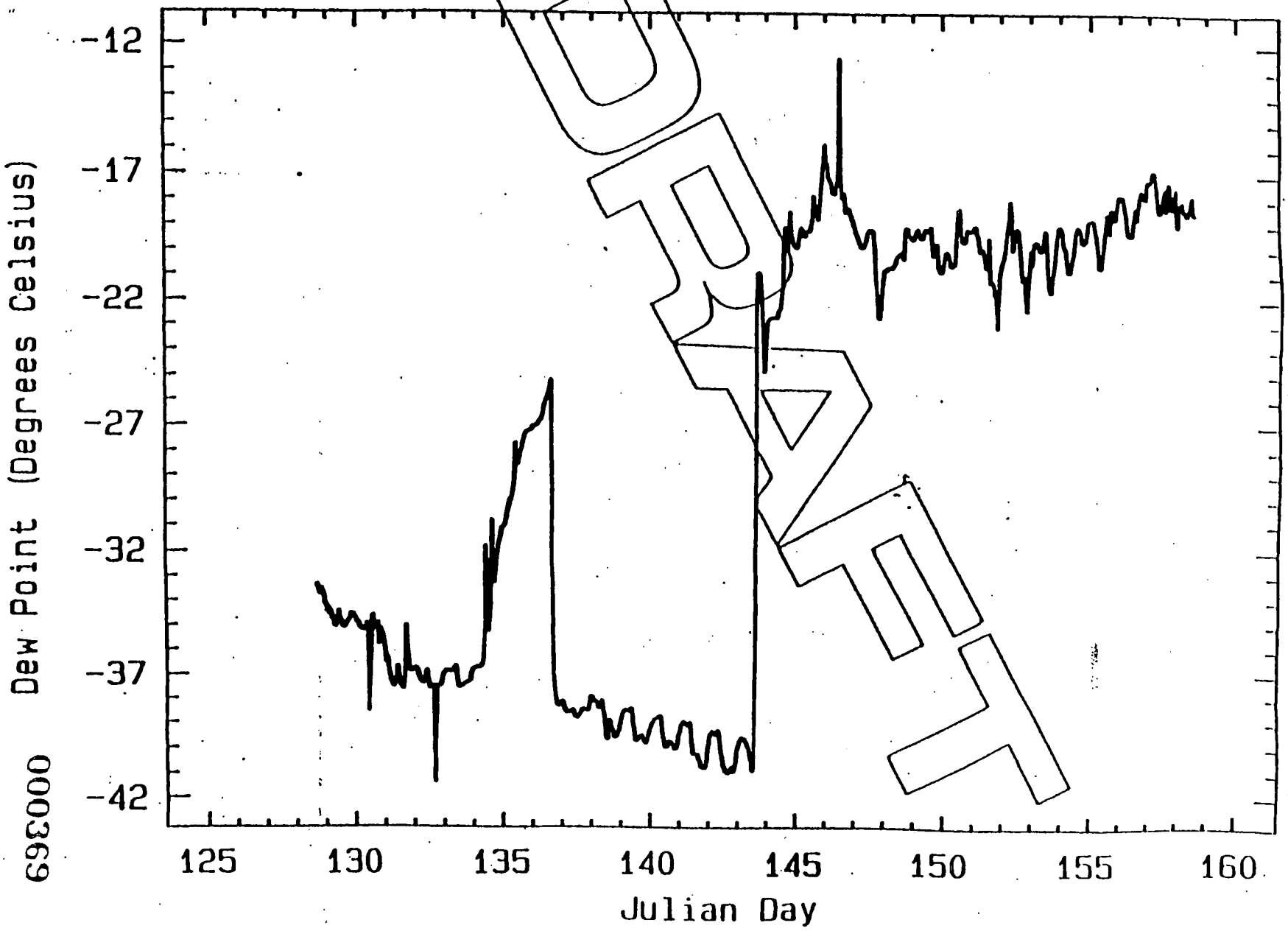

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Figure 7

Time Plot of Inlet and Outlet Radon Concentration
During the Low Temperature Model Test

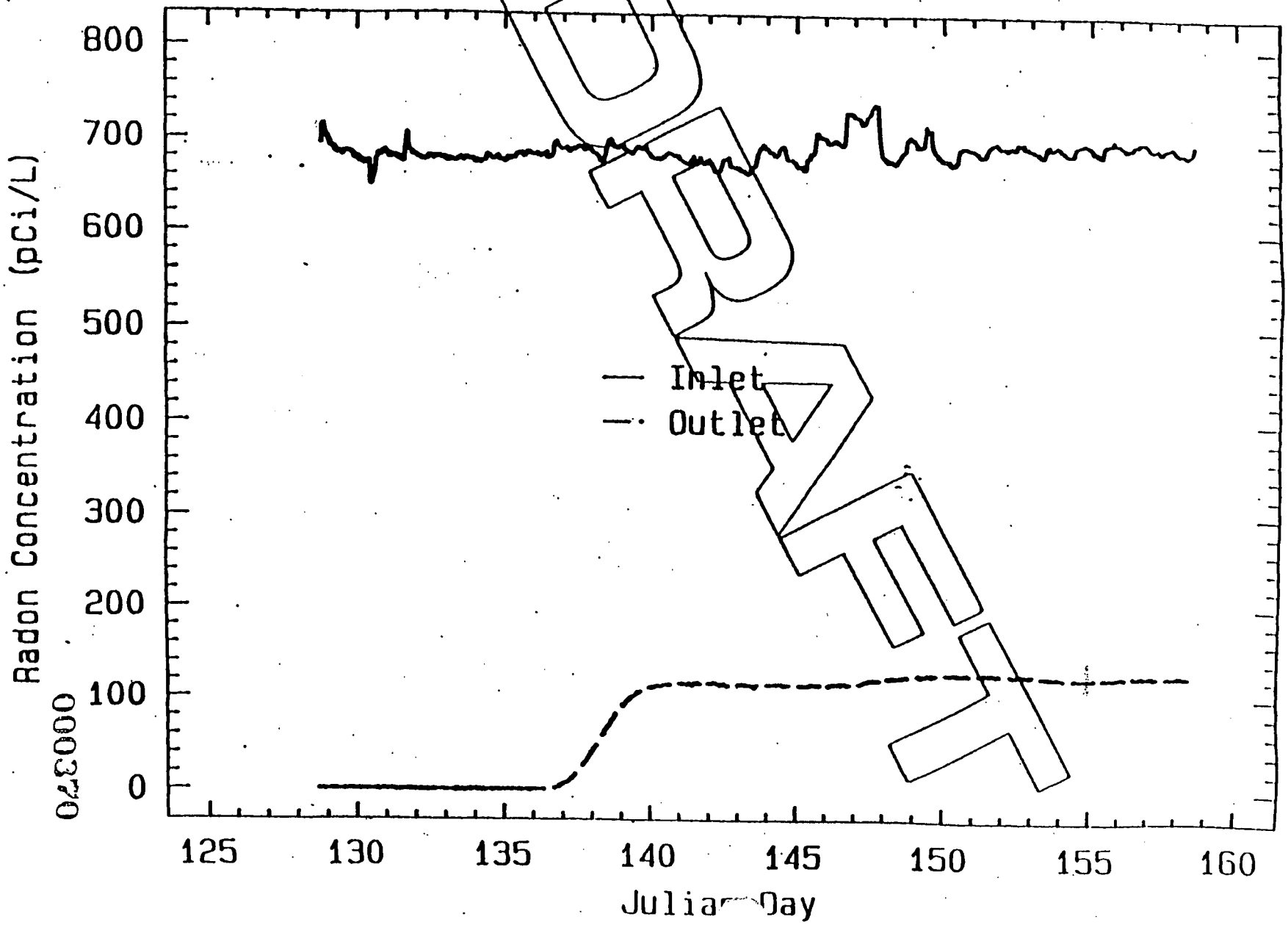

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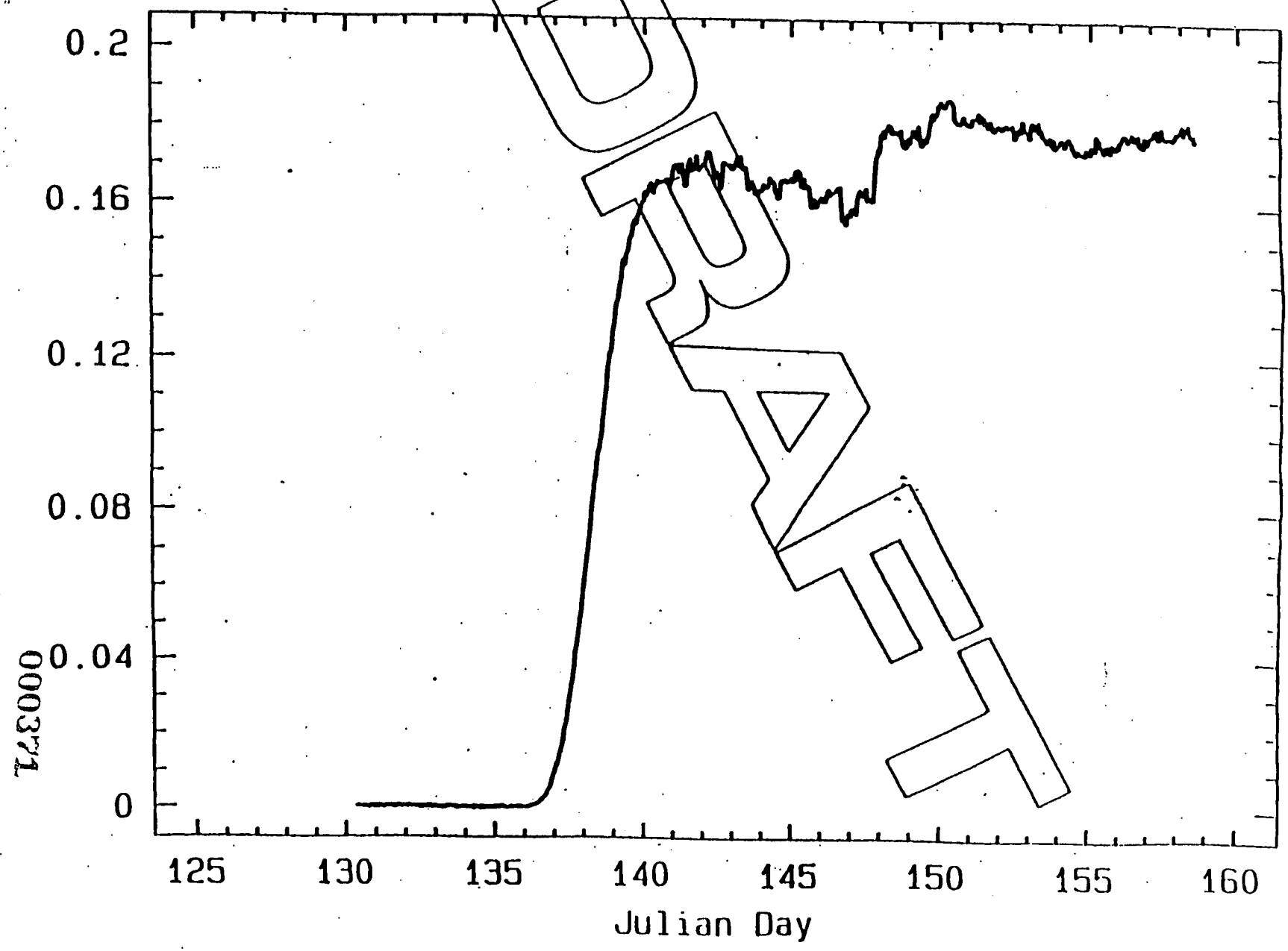
Figure

Time Plot of Outlet/Inlet Radon Concentration Ratio During Low Temperature Model Test



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The Radon Sorption Properties of Some Zeolites

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January 20, 1998

INTRODUCTION

From the activated carbon work performed earlier (Langner and Kendrick 1994; Langner 1996), it was demonstrated that for a given inlet radon concentration (C_i), the steady state outlet radon concentration (C_o) could be predicted by a simple equation of the form

$$C_o = C_i e^{\frac{-\lambda K M}{f}} \qquad (1)$$

where λ is the decay constant for radon, K is the adsorption coefficient of activated carbon for radon, M is the mass of carbon, and f is the rate of air flow through the column. It was also demonstrated that for a given type of activated carbon the adsorption coefficient is a constant for all radon concentrations up to 7×10^6 pCi/L.

However, the air stream from which the radon is to be removed will also contain NO_x gases, and a question has arisen as to whether the activated carbon will adsorb enough NO_x to become a fire hazard.

In order to prevent the NO_x reaching the activated carbon, the FEMP design will incorporate zeolite and silica gel beds upstream of the carbon to remove NO_x and water vapor. In operation, these beds will need to be periodically taken out of service and regenerated by purging the accumulated gases to the atmosphere. The equation for the steady state amount of radon (I) contained in the beds is readily derived from Equation 1 and is

$$I = \frac{C_i f}{\lambda}\left(1 - e^{\frac{-\lambda K M}{f}}\right). \qquad (2)$$

If the beds contain too much radon, then too much radon will be released to the atmosphere. The following work was therefore performed to experimentally determine the radon adsorption properties of various zeolites and silica gel in order to determine if the amount of radon to be released to the environment is acceptable.

EXPERIMENTAL METHODS

Static Screening Tests.

The radon adsorption coefficients were determined for samples of four sorbents at a temperature of 10°C. The sorbents tested were silica gel and the zeolites 4A, 5A, and AW-500. One test was performed on each sorbent at 100% relative humidity. A fifth test was performed on zeolite 5A at a relative humidity as close to 0% as possible. The other constituents of the test air were nitric oxide (NO) at a concentration of 1000 parts per million and radon at a concentration of approximately 700 to 1000 pCi/L. A block diagram of the system is shown in Figure 1.

The determination on each material was made in the following manner. Approximately 10 g of the material was "reconditioned" by heating over night in a drying oven at 177° C. The 10-g sample was then placed in a shallow metal sample holder covered with a wire screen. The sample holder was placed in a 0.5 L flow-through pretreatment cell through which the test air without radon was allowed to flow at about 6 liters per minute for two hours to complete the pretreatment of the sample. Pretreatment was considered complete when the sample temperature returned to ambient (see Figure 2 for example). The sample holder was then mounted on the face of the piston of a 1.5 L syringe connected to a source of the test air containing radon, and a known quantity of radon was admitted into the syringe. The syringe was then allowed to rest for 2 hours to allow an equilibrium distribution of radon between the air and sorbent phases to be achieved. An aliquot of air in the syringe was then transferred into a 0.5 L scintillation cell, which was used to determine the equilibrium airborne radon concentration.

By knowing the volume of the syringe and the ratio of equilibrium airborne radon concentration to admitted radon concentration, the radon adsorption coefficient was computed using the equation

$$K = \frac{V_1 (C_1/C_2 - 1) - V_2}{M} \qquad (3)$$

where

V_1 = The volume of air drawn into the syringe = 1.4725 L,
V_2 = The initial dead volume of the syringe (in liters),
C_1 = The radon concentration in the air drawn into the syringe,
C_2 = The equilibrium radon concentration in the syringe, and
M = The dry mass of the sorbent in the syringe (in grams).

Column testing.

Two of the sorbents that were tested in the static screening tests were further tested by filling an experimental column with each of the sorbents and testing its ability to reduce the concentration

of radon in the test air flowing through it. The sorbents tested in this task were 5A and silica gel The column used for these tests was 33 feet long and consisted of 6 sections of ½ inch stainless steel tube connected in series with sections of ½ inch Viton tubing. The temperature of the column was maintained as close to 10°C as possible. The inlet NO concentration was held constant at 0.1% by volume by mixing a stream of 10% NO in nitrogen with the incoming air in a ratio of 1 to 99 The flow rate of air through each column was 0.90 L/min. A block diagram of the system is shown in Figure 3.

Radon concentrations were measured at the inlet and outlet with GJO model continuous radon monitors. Outlet NO and NO_2 concentrations were monitored with an API model 200AH $NO/NO_2/NO_x$ Analyzer. Other parameters monitored included inlet dew point and the temperatures of the columns and laboratory. All data were recorded with a Campbell Scientific CR10 data logger programmed to store one data record every six minutes.

For the test of zeolite 5A, the air supplied to the system was treated with a heatless drier to maintain a relative humidity as close to 0% as possible. The mass of 5A contained in the column was 694 g. The test air was allowed to flow through the column at 0.90 liter per minute for 141.7 hours. Then using a hypodermic needle, the progress of the NO_x front was investigated by sampling through the viton tubing connecting sections 4 and 5 and through the tubing connecting sections 5 and 6.

For the test of silica gel, the air was treated with a humidifier to maintain a relative humidity as close to 100% as possible. In order to obtain NO_x and water breakthrough in a reasonable length of time, the original column was separated into a small column consisting of only the first two sections containing 100 g of dried silica gel and a large column consisting of the other four sections containing about 470 g (mass after drying) of silica gel that was pretreated with 100% relative humidity air. The high humidity air was allowed to flow through only the small column until both NO_x and water vapor broke through. Water vapor breakthrough was determined by measuring the rise in temperature produced by water sorption on a Drierite column placed at the small column outlet. Then the large column was attached to the outlet of the small column and allowed to continue running until the outlet radon concentration stabilized.

RESULTS and DISCUSSION

The results of the static adsorption coefficient measurements are shown in the table below. None of the four sorbents showed a statistically significant radon adsorption in the presence of high humidity. Only zeolite 5A when tested with dry air was found to have an adsorption coefficient that was statistically significantly different from zero and its value was only 0.25 L/g. For comparison, the activated carbon tested for FEMP in 1996 (Langner 1996) has a radon adsorption coefficient at 10°C of 11.7 L/g.

Results of the Static Radon Adsorption Coefficient Measurements

Sorbent	Humidity	Temperature (°C)	Adsorption Coefficient, K (L/g)
Zeolite 5A	Dry	10.4	0.25
Zeolite 5A	Wet	10.1	-0.01
Zeolite 4A	Wet	10.3	-0.01
Zeolite AW-500	Wet	10.4	0.01
Silica Gel	Wet	10.0	0.00

The static adsorption coefficient for dry 5A of 0.25 L/g when used in Equation 1 predicts that the outlet/inlet radon concentration ratio for the dry 5A column test should be 0.98. The steady state outlet/inlet ratio actually observed was 0.97 (Figure 4) which confirms the finding from the static test within experimental error.

After the 5A column had run for over 141 hours, there was still no indication of any NO_x breakthrough. However, the sampling between column sections indicated that the NO_x front had progressed 5/6 of the way through the entire column and would have soon broken through the entire column if allowed to continue running.

Figure 5 is a time plot of the outlet oxides of nitrogen concentrations during the wet column test with the small silica gel column that contained only 100 g. There was a rapid breakthrough of NO followed by a decline in NO concentration and an accompanying sudden increase in NO_2 concentration. Both NO and NO_2 concentrations remained relatively constant for about a day. During the day just before water breakthrough (see Figure 6), there was a rapid increase in outlet NO_x.

After water breakthrough, the large column was attached to the outlet of the small column to determine the dynamic radon sorption coefficient of wet silica gel. From Figure 7 it can be seen that the outlet radon concentration is not measurably different from the inlet concentration. In other words, the dynamic radon sorption coefficient of wet silica gel is zero thus confirming the result from the static test.

CONCLUSIONS

The static adsorption results indicate that none of the sorbents have significant radon sorption coefficients. Both column tests confirmed the results of the respective static tests. Therefore, no significant quantity of radon will be released to the atmosphere during regeneration of the zeolite or silica gel beds.

The results of the outlet NO_x measurements indicate that there is some interesting chemistry taking place within the columns as NO oxidizes to NO_2 in the presence of changing moisture conditions. The data also seem to suggest that as water begins to break through the silica gel column, it displaces NO_x and briefly produces an outlet NO_x concentration greater than the inlet concentration.

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Langner, G.H.; Kendrick, D.T. Controlling radon emissions with activated carbon columns: preliminary investigations, December 1, 1994.

Langner, G.H. Controlling radon emissions with activated carbon columns: phase II results, August 8, 1996.

Figure 1. Block diagram of the system used for the static screening tests.

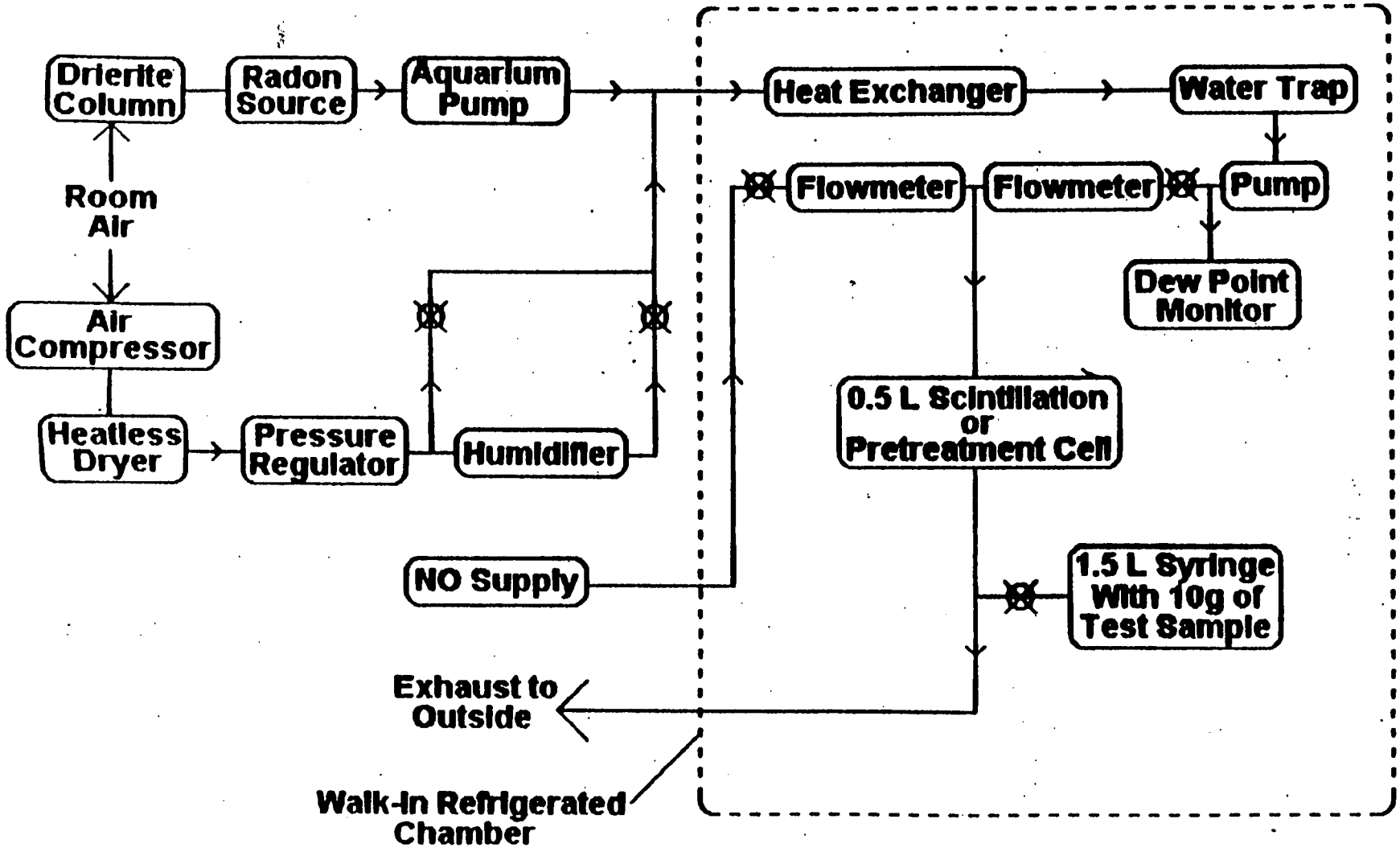

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Figure 2. Sample Temperature During the Wet Silioa Gel Static Adsorption Test

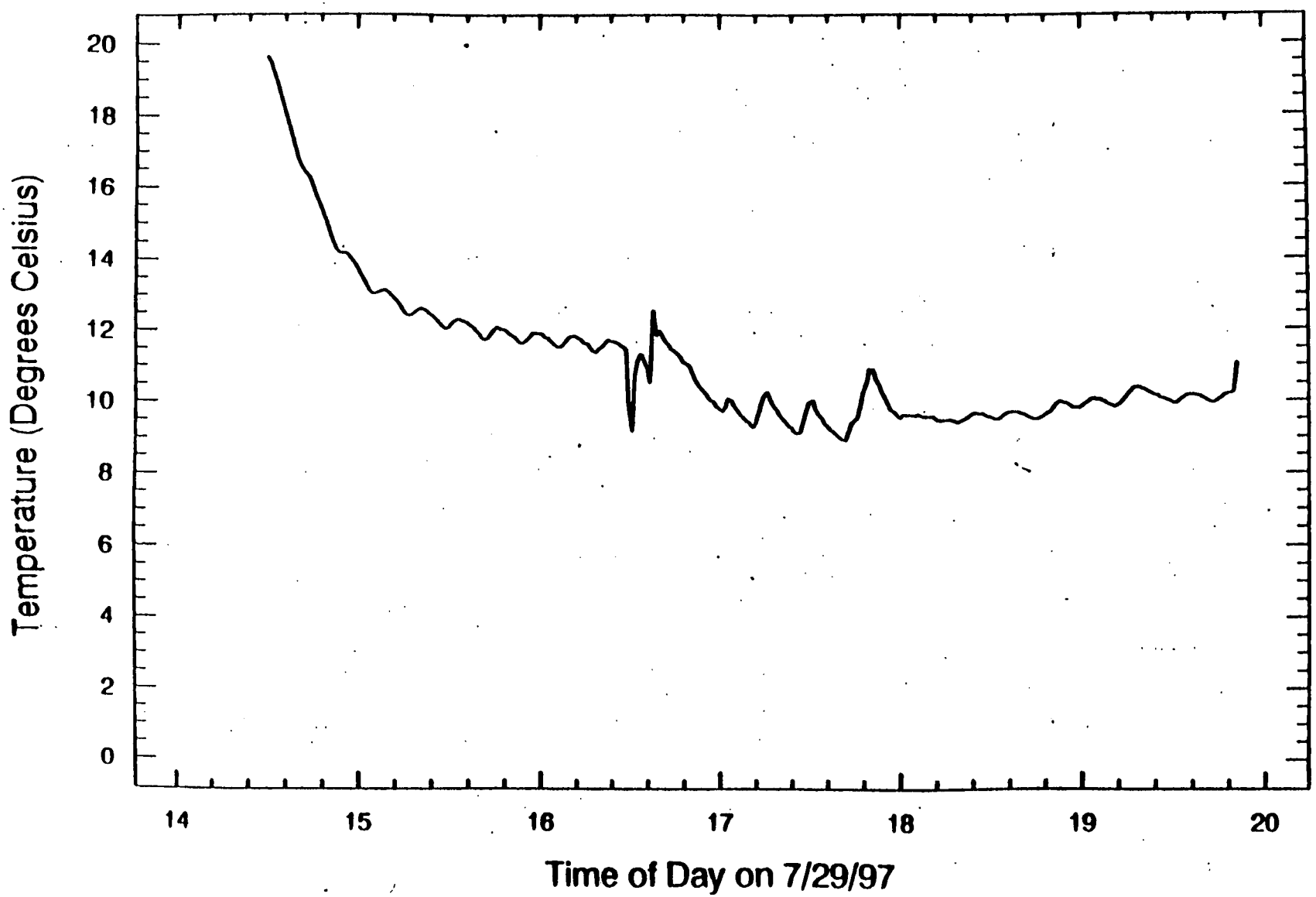

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Figure 3. Block diagram of the system used for the column tests.

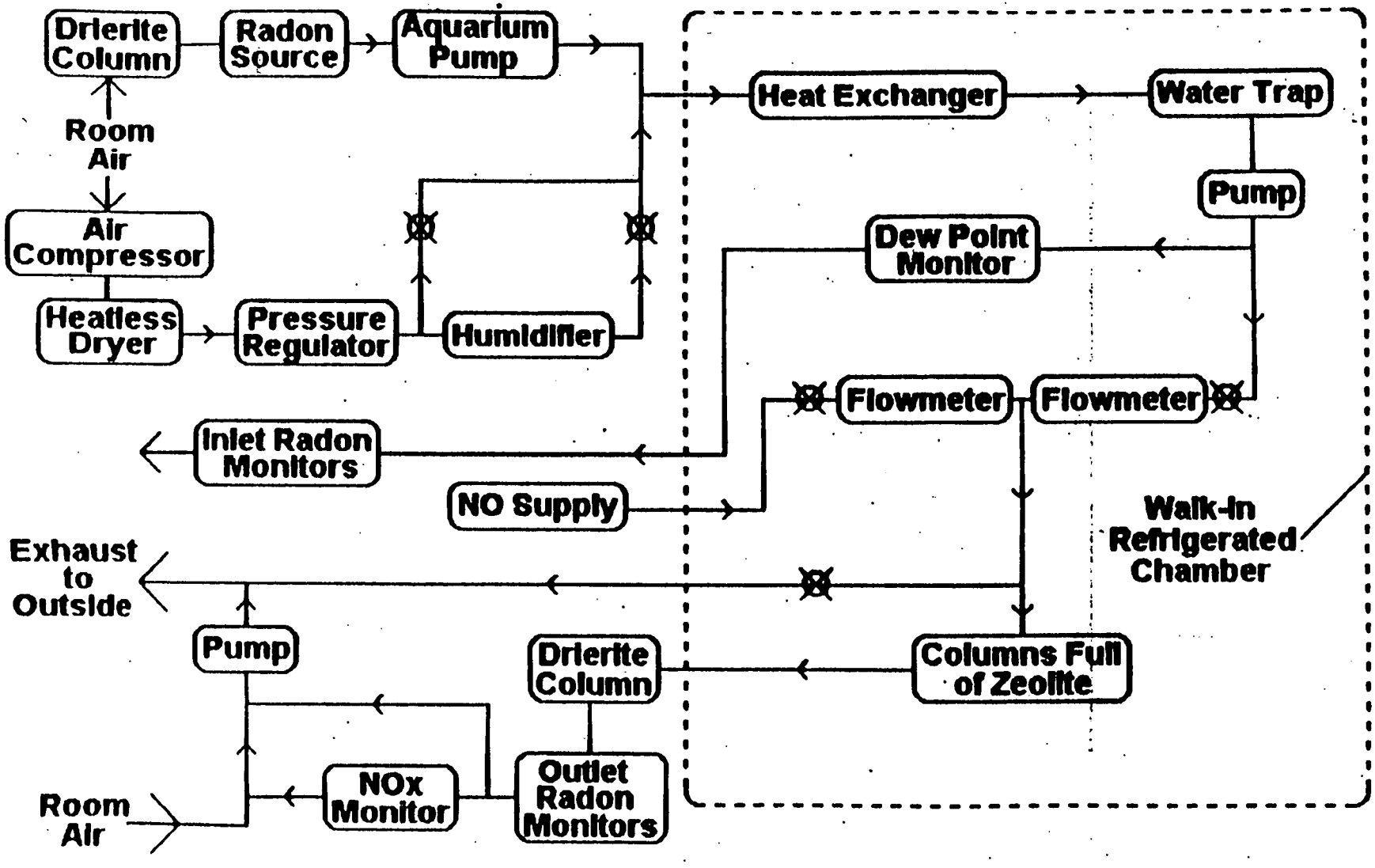

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Figure 4. Outlet/Inlet Radon Concentration Ratio During the Dry Zeolite 5A Column Test

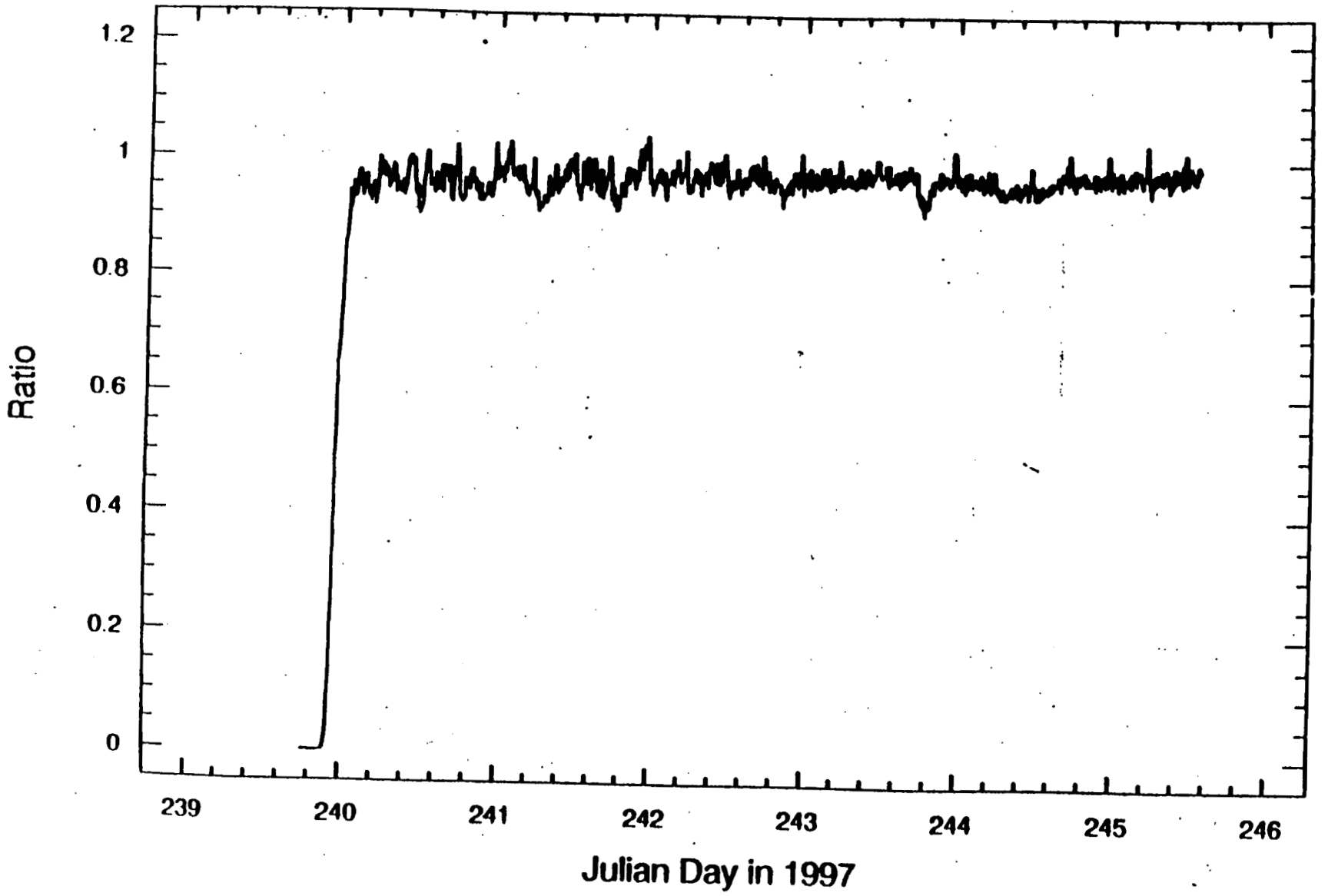

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Figure 5. Outlet Oxides of Nitrogen
During the Wet Silica Gel Column Test

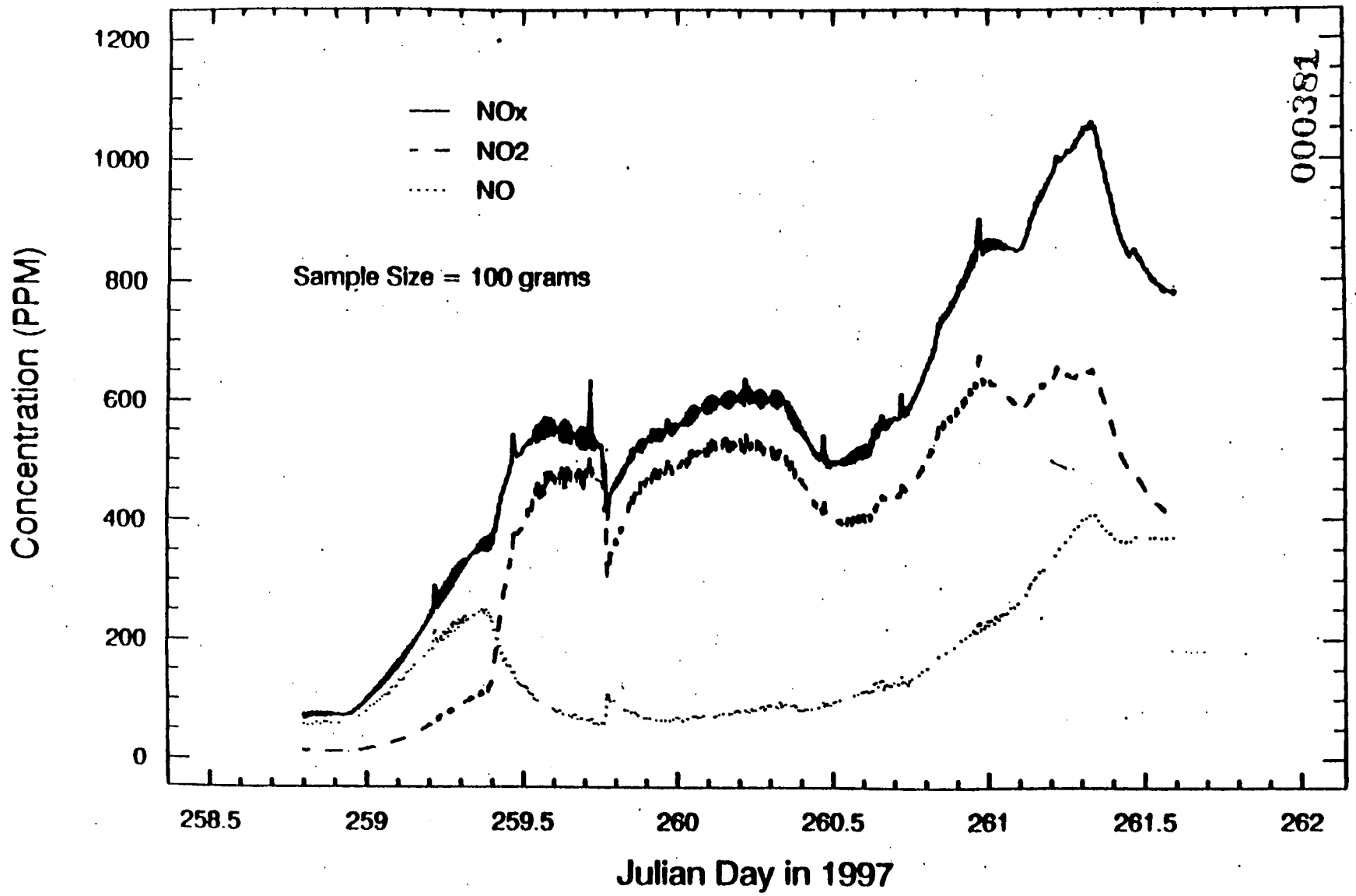

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Figure 6. Outlet NOx Concentration and Drierite Column Temperature Elevation

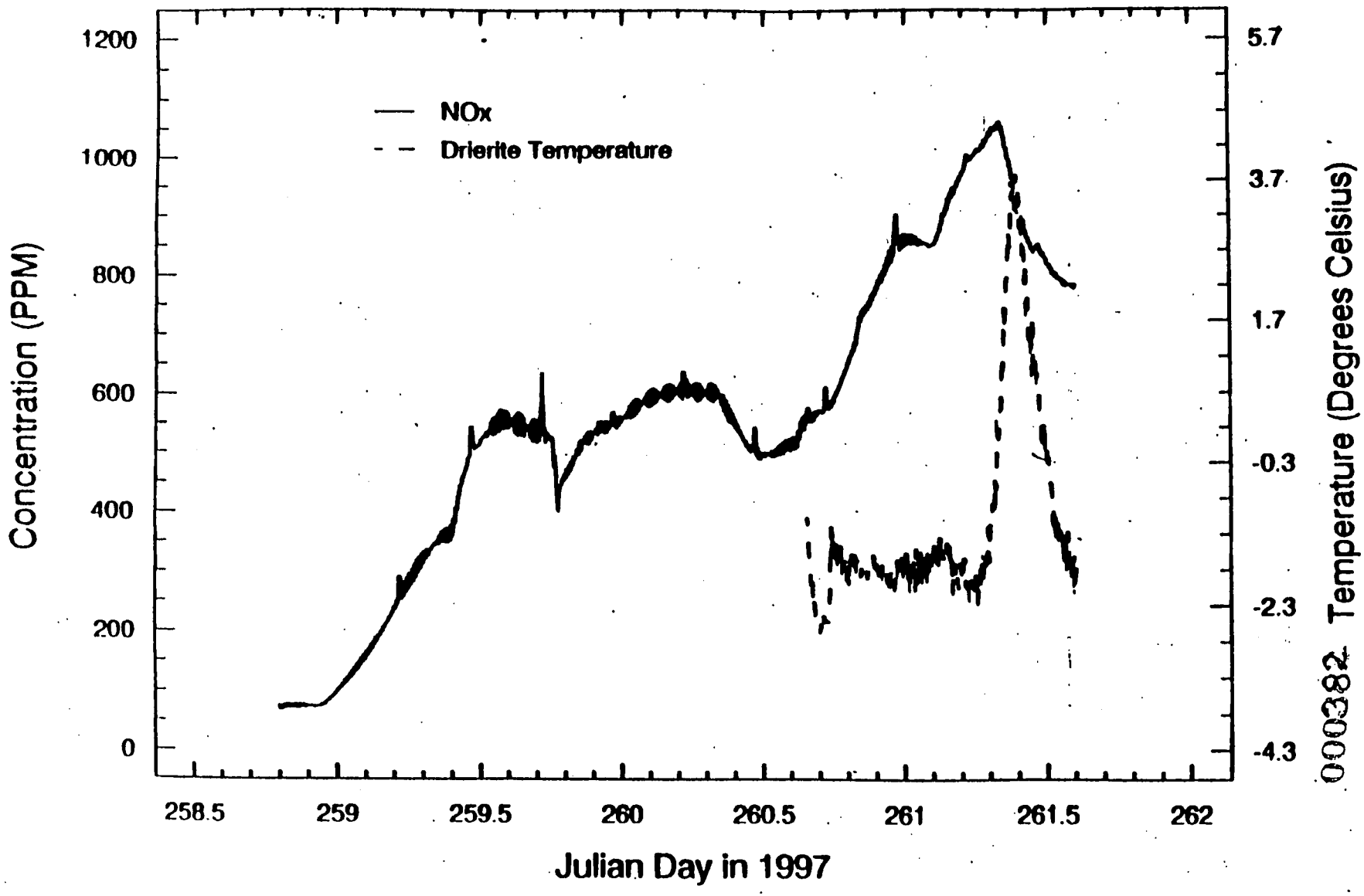

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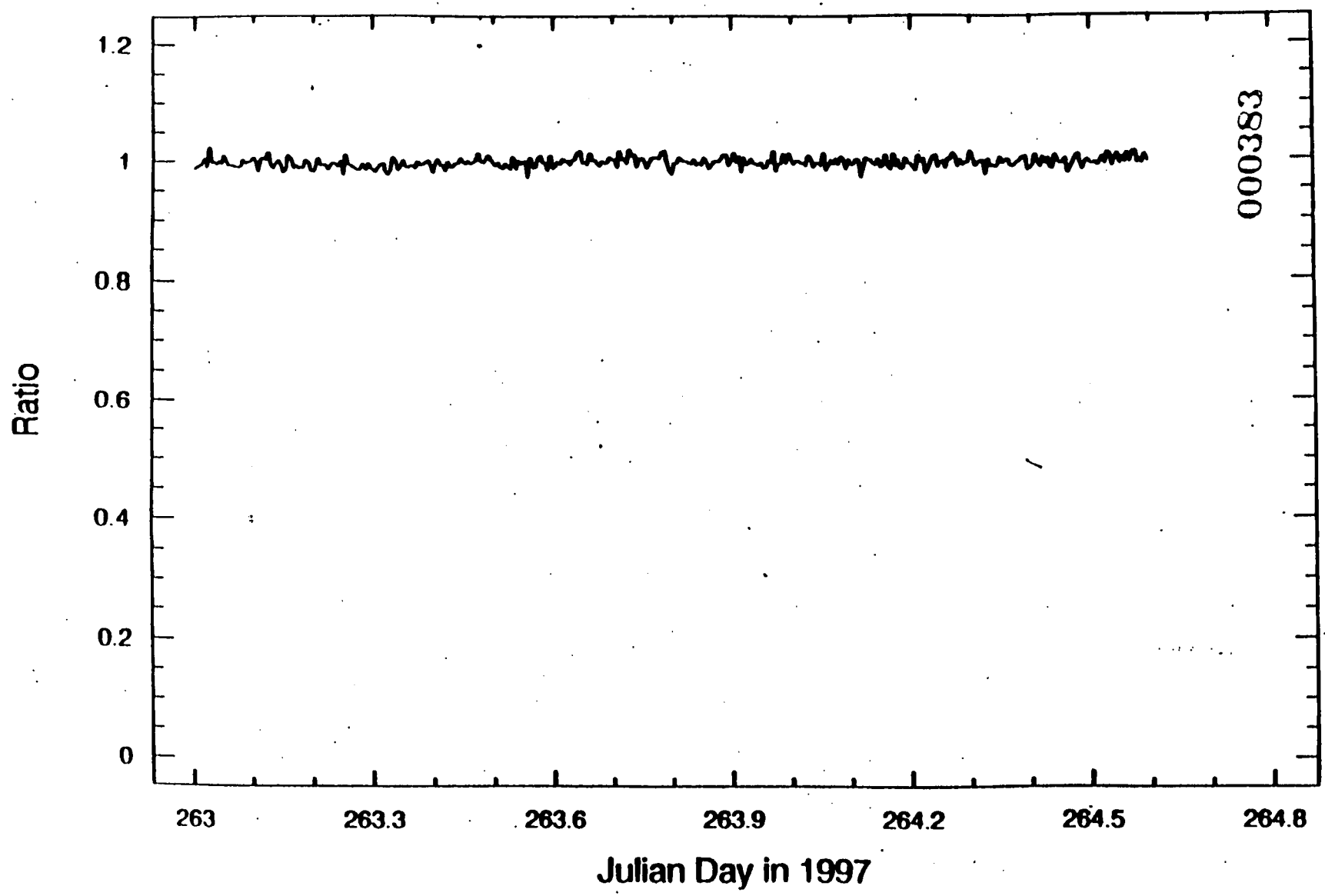
Figure 7. Outlet/Inlet Radon Concentration Ratio During the Wet Silica Gel Column Test



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APPENDIX E
Con-Ops Matrix

8103

Document No: PSM-105
Issue Date: 07/14/97
Rev No. 0

ORIGINAL

Fernald Environmental Management Project (FEMP)

SILOS PROJECT

Conduct of Operations Applicability Matrix

Effective Date: July 15, 1997

Submitted: Roger Hiss Date: 7/14/97

Approved:

Project Manager: Donald Paine Date: 7/15/97

Concurrence:

Operations Assurance Manager: James Curry Date: 7/24/97

FLUOR DANIEL FERNALD

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Document No: PSM-[illegible]
Issue Date: 07/14/97
Rev. No.: 0

RECORD OF ISSUE/REVISION

DATE	REV. NO.	DESCRIPTION AND AUTHORITY
07/14/97	0	Matrix needed to document Conduct of Operations standards for the Silos Project.

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GENERAL NOTES APPLICABLE TO MATRIX

1. This matrix is applicable to current operations at the Vitrification Pilot Plant (VitPP), which is in a long-term shutdown configuration with selected support systems in operation. It is also applicable to future remediation operations at Silos 1, 2, and 3.

2. Although Chapter 2 Guideline C8 (Load Changes), Chapter 3 (Control Area Activities), and Chapter 12 Guideline C3 (Control Panel Walkdown) are not applicable to current operations, they will be implemented if appropriate to future Silos remediation operations.

DOCUMENTS REFERENCED IN MATRIX

ED-12-4016	Equipment and Piping Labeling
EM-0010	Event Notification and Occurrence Reporting
EM-0028	Audible Communications
M-134	Standing Orders for Vitrification Pilot Plant/Silos Project Operations
M-140	Facilities Closure and Demolition Projects Division Procedure System
OP-0004	FERMCO Lockout/Tagout (Hazardous Energy and Material Control) Procedure
OP-1001	Operations Organization and Administration
OP-1002	Shift Routines and Operating Practices
OP-1005	Control of On-Shift Training
OP-1008	Control of Equipment and System Status
OP-1010	Independent Verification
OP-1011	Logkeeping
OP-1012	Operations Turnover
OP-1013	Operations Aspects of Facility Chemistry and Unique Processes
OP-1014	Required Reading
OP-1015	Timely Orders to Operators
OP-1016	Operations Procedure Availability and Use
OP-1017	Operator Aid Postings

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DOE ORDER 5480.19 CHAPTER GUIDELINES		APPLICABILITY/JUSTIFICATION	IMPLEMENTATION
CHAPTER 1: OPERATIONS ORGANIZATION AND ADMINISTRATION	P		OP-1001 M-134
CHAPTER 1 Guideline C1: *Written Standards for Operations*	A		OP-1001 M-134
CHAPTER 1 Guideline C2: *Adequate Resources for Operations*	P	VitPP has a long range staffing plan. Staffing plans for Silos operations will be developed as work plans are defined.	OP-1001 M-134
CHAPTER 1 Guideline C3: *Periodic Monitoring and Assessment of Performance*	A		OP-1001 M-134
CHAPTER 1 Guideline C4: *Personnel Accountability and Job Performance*	A		OP-1001
CHAPTER 1 Guideline C5: *Management Training*	A		OP-1001
CHAPTER 1 Guideline C6: *Safety Pre-planning Requirements for Operational Activities*	A		OP-1001 M-134

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DOE ORDER 5480.19 CHAPTER GUIDELINES		APPLICABILITY/JUSTIFICATION	IMPLEMENTATION
CHAPTER 2: SHIFT ROUTINES AND OPERATING PRACTICES	P	Guideline C8 is Not Applicable.	OP-1002 M-134
CHAPTER 2 Guideline C1: *Notifications of Facility Supervisor of Status Changes*	A		OP-1002
CHAPTER 2 Guideline C2: *Adherence to Requirements of Facility Industrial Safety Program*	A		OP-1002
CHAPTER 2 Guideline C3: *Operator Inspection Tours*	A		OP-1002 M-134
CHAPTER 2 Guideline C4: *Round/Tour Inspection Sheets*	A		OP-1002
CHAPTER 2 Guideline C5: *Personnel Protection*	A		OP-1002
CHAPTER 2 Guideline C6: *Response to Indications*	A		OP-1002
CHAPTER 2 Guideline C7: *Resetting Protective Devices*	A		OP-1002 M-134
CHAPTER 2 Guideline C8: *Load Changes*	N	Project operations do not involve power or process rate changes.	

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DOE ORDER 5480.19 CHAPTER GUIDELINES		APPLICABILITY/JUSTIFICATION	IMPLEMENTATION
CHAPTER 2 Guideline C9: *Authority to Operate Equipment*	A		OP-1002
CHAPTER 2 Guideline C10: *Shift Operating Bases*	A		OP-1002 M-134
CHAPTER 2 Guideline C11: *Potentially Distractive Written Material and Devices*	A		OP-1002
CHAPTER 3: CONTROL AREA ACTIVITIES	N	Project has no Control Areas or At-The-Controls Areas	
CHAPTER 4: COMMUNICATIONS	A		EM-0028 M-134
CHAPTER 5: CONTROL OF ON-SHIFT TRAINING	A		OP-1005 M-134
CHAPTER 6: INVESTIGATION OF ABNORMAL EVENTS	A		EM-0010
CHAPTER 7: NOTIFICATIONS	A		EM-0010 M-134
CHAPTER 8: CONTROL OF EQUIPMENT AND SYSTEM STATUS	A		OP-0004 OP-1008 M-134

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DOE ORDER 5480.19 CHAPTER GUIDELINES	APPLICABILITY*	APPLICABILITY/JUSTIFICATION	IMPLEMENTATION
CHAPTER 9: LOCKOUTS AND TAGOUTS	A		OP-0004
CHAPTER 10: INDEPENDENT VERIFICATION	A		OP-1010 M-134
CHAPTER 11: LOGKEEPING	A		OP-1011 M-134
CHAPTER 12: OPERATIONS TURNOVER	P	Guideline C3 is Not Applicable	OP-1012 M-134
CHAPTER 12 Guideline C1: *Turnover Checklists*	A		OP-1012 M-134
CHAPTER 12 Guideline C2: *Document Review*	A		OP-1012
CHAPTER 12 Guideline C3: *Control Panel Walkdown*	N	Project has no control panels.	
CHAPTER 12 Guideline C4: *Discussion and Exchange of Responsibility*	A		OP-1012
CHAPTER 12 Guideline C5: *Shift Crew Briefing*	A		OP-1012 M-134

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DOE ORDER 5480.19 CHAPTER GUIDELINES		APPLICABILITY/JUSTIFICATION	IMPLEMENTATION
CHAPTER 12 Guideline C6: *Reliefs Occurring during the Shift*	A		OP-1012
CHAPTER 13: OPERATIONS ASPECTS OF FACILITY CHEMISTRY AND UNIQUE PROCESSES	A		OP-1013
CHAPTER 14: REQUIRED READING	A		OP-1014
CHAPTER 15: TIMELY ORDERS TO OPERATORS	A		OP-1015 M-134
CHAPTER 16: OPERATIONS PROCEDURES	A		OP-1016 M-134 M-140
CHAPTER 17: OPERATOR AID POSTINGS	A		OP-1017 M 134
CHAPTER 18: EQUIPMENT AND PIPING LABELING	A		ED-12-4016 M-134

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APPENDIX F
Radon Control System, Phase I

F.1 Introduction
F.2 Functional Requirements for RCS
F.3 Design Criteria
F.4 Design Requirements
F.5 Design Description

ATTACHMENTS

RCS Phase 1 Process Flow Diagram — Figure F-1
RCS Phase 1 Mechanical Flow Diagram — Figure F-2
RCS Phase 1 Equipment Arrangement — Figure F-3
Detail of RCS Carbon Beds — Figure F-4
RCS Carbon Data Sheets — Figure F-5

RCS Phase 1 Equipment List — Table F-1

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F.1 Introduction

Radon control at the silos has historically been of a passive nature. Actions performed in the past include sealing the vents in the silo domes, sealing the cracks in the domes, covering the domes with urethane foam, and adding BentoGrout™ slurry inside the headspace gas to seal the residue surface. All of these measures represent primary containment.

Prior to the addition of BentoGrout™, the silo headspace gases typically reached radon concentrations of about 30 million pCi/L. This radon level resulted in unacceptably high surface penetrating dose to workers performing work activities on the domes. As a response, a 1,000 CFM recirculating Radon Treatment System (RTS) containing 16,000 lb of activated charcoal was installed as a means of secondary containment. The RTS was used several times to temporarily reduce surface dose on the domes and permit workers access on the silo dome. After the BentoGrout™ addition, surface dose at the dome was acceptably low and it was determined that the RTS was no longer needed. Since the BentoGrout™ installation, radon concentrations in the headspace gases and surface doses on the domes have steadily crept upward as a result of the apparent drying and cracking of the BentoGrout™ layers.

The ability of coconut-based activated carbon to adsorb radon has been documented since at least 1906. The need to control radon at the high levels that exist in the silo headspace gases is unprecedented; therefore, Rust Geotech (DOE Grand Junction Projects Office) was tasked to test coconut shell carbon and develop scale-up methodology. The primary result of this testing was a determination of the dynamic adsorption coefficient and the design equation with which carbon beds can be sized. (Reference Appendix D)

Regardless of the method chosen to remove the residue, a Radon Control System (RCS) is required to control the radon emitted into the silo headspace gases during retrieval activities.

F.2 Functional Requirements for RCS

The primary functions of the Phase I RCS is to reduce radon concentrations in the silos headspace gases. Reduced radon concentrations in the silos will lower personnel exposure during routine maintenance and monitoring and during construction of the SWRS.

- The carbon beds, and other equipment as determined necessary via the ALARA process, shall be shielded to limit the gamma dose rate to less than 5.0 mRad/hr at any equipment that requires periodic maintenance;

- The facility shall be designed and laid out such that space around equipment provides for ease of general operations and maintenance requirements. Equipment requiring planned periodic maintenance shall be readily accessible to personnel with limited PPE requirements;

- The carbon beds in each train shall be piped symmetrically to ensure equal air flow through each carbon bed;

- The facility should be designed to facilitate modular construction to the fullest extent practicable to help limit required field work;

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- The design shall consider the construction sequencing to accommodate installation of the carbon beds and other large equipment;
- While the RCS will replace the functions of the existing RTS, it shall be located such that the existing RTS building can remain in place;
- The RCS shall be installed under a covered pad to help protect personnel and equipment from the elements, limit solar insolation on the carbon beds, and limit stormwater run-on and treatment requirements. Freeze protection shall be included for equipment and piping as necessary;
- The RCS design shall utilize equipment/material that is readily decontaminated;
- The existing Data Logging System, which utilizes one of the sounding pipes on each silo, shall remain intact;
- Control and monitoring of the RCS shall be from a local control panel utilizing a Programmable Logic Control (PLC). The PLC shall have the capability to integrate with the Phase 2 RCS and the central control room at a later date. RCS design shall not include control room or central control computer;
- Area radon monitoring shall be provided. A high level alarm shall be connected to the Emergency Operations Center.
- The RCS facility shall be connected to the site emergency message system to receive plant-wide alarms and announcements.

F.3 Design Criteria

- Radon release from residue into each silo headspace gas: 6.0E+9 pCi/min into 7.1E+5L;
- Radon decay constant: 1.26E-4 min^{-1};
- Equilibrium headspace radon concentration (no ventilation): 3.0E+7 pCi/L;
- Headspace temperature and relative humidity: 75°F and 100 percent RH;
- Design adsorption constant for radon on carbon: k_d = 6.0 L/g.

F.4 Design Requirements

- The Contractor shall complete the pre-conceptual design presented in this appendix.
- The Contractor shall utilize the following Government Furnished Equipment:

Government Furnished Equipment

Quantity	Description	Reference
2	Activated Carbon Vessels	Drawing
80,000 16	Activated Carbon	Appendix A
	Radon Monitors	Pylon

F.5 Design Description

Phase 1 of the RCS is a recirculation system using the existing two carbon beds (GFE) at a new location adjacent to and east of the Silo berm. Headspace air is pulled from the Silos at 250 CFM per Silo and combined into one stream. The 500 CFM combined stream passes first through a cooler to condense out moisture and cool the air to 45°F. The chilled air then passes through an automatic dual-tower desiccant dryer which removes the remaining moisture and heats the air up to about 80°F. The air stream then passes through another cooler to cool it back down to 45°F prior to entering the carbon beds. The cool, dry air stream then passes through the two carbon beds in parallel for radon removal. Finally, the air stream passes through the recirculation fan before splitting and reentering the Silo headspace gases. The total 80,000 lb of carbon in this system should maintain the Silo headspace gases at <1,000,000 pCi/L based on pre-BentoGrout™rates of radon emanation into the Silo headspace gases.

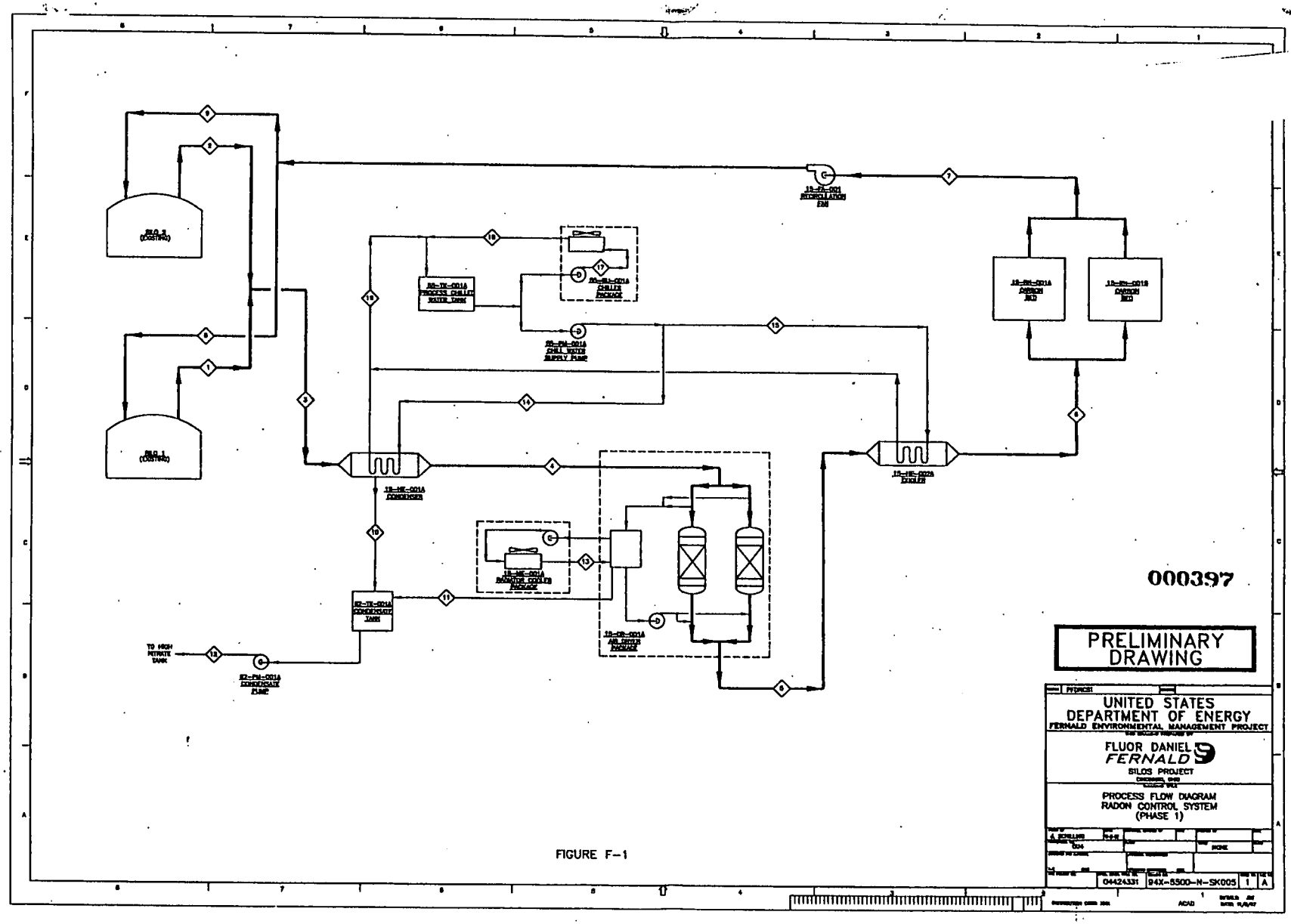

FIGURE F-1

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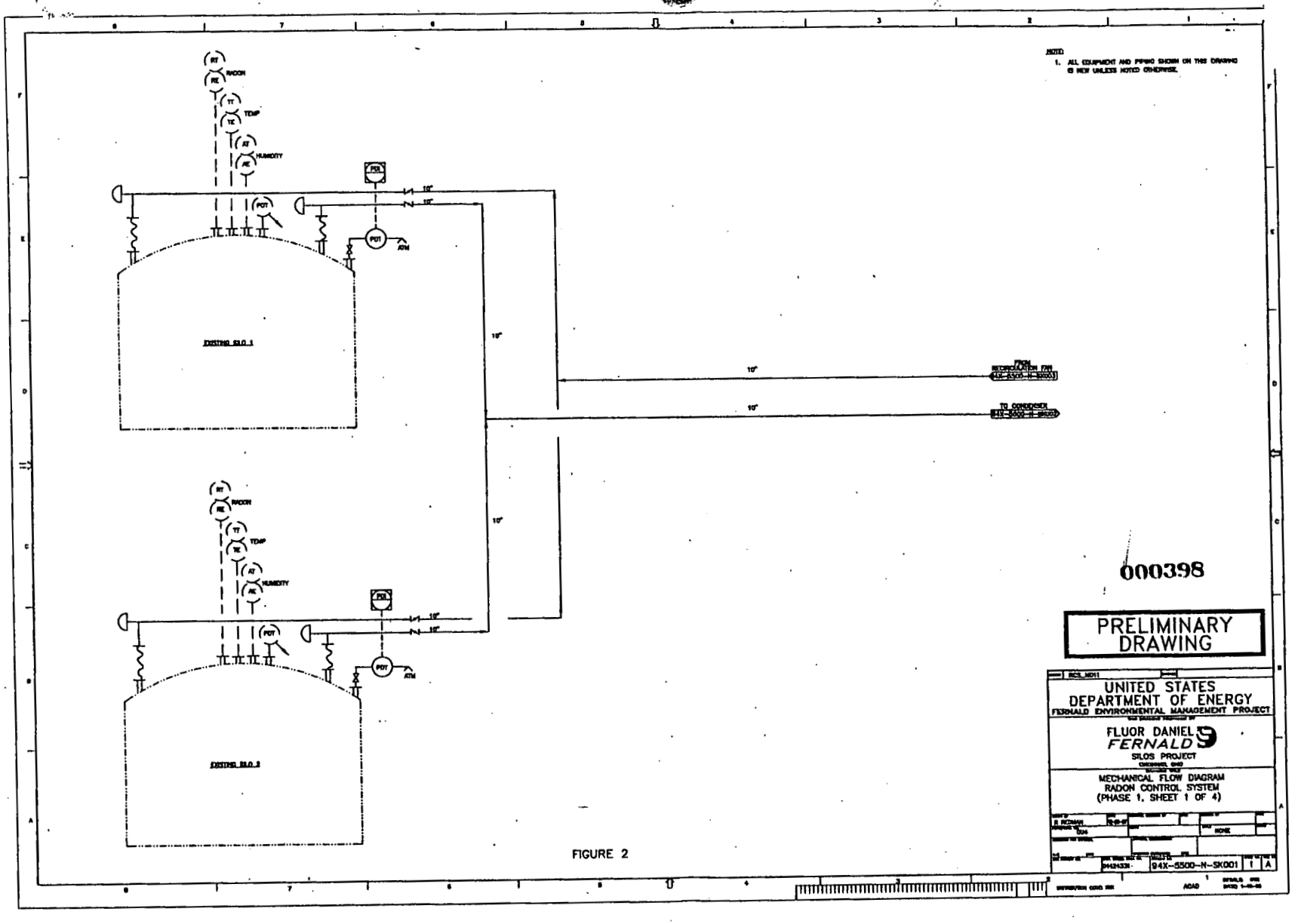

FIGURE 2

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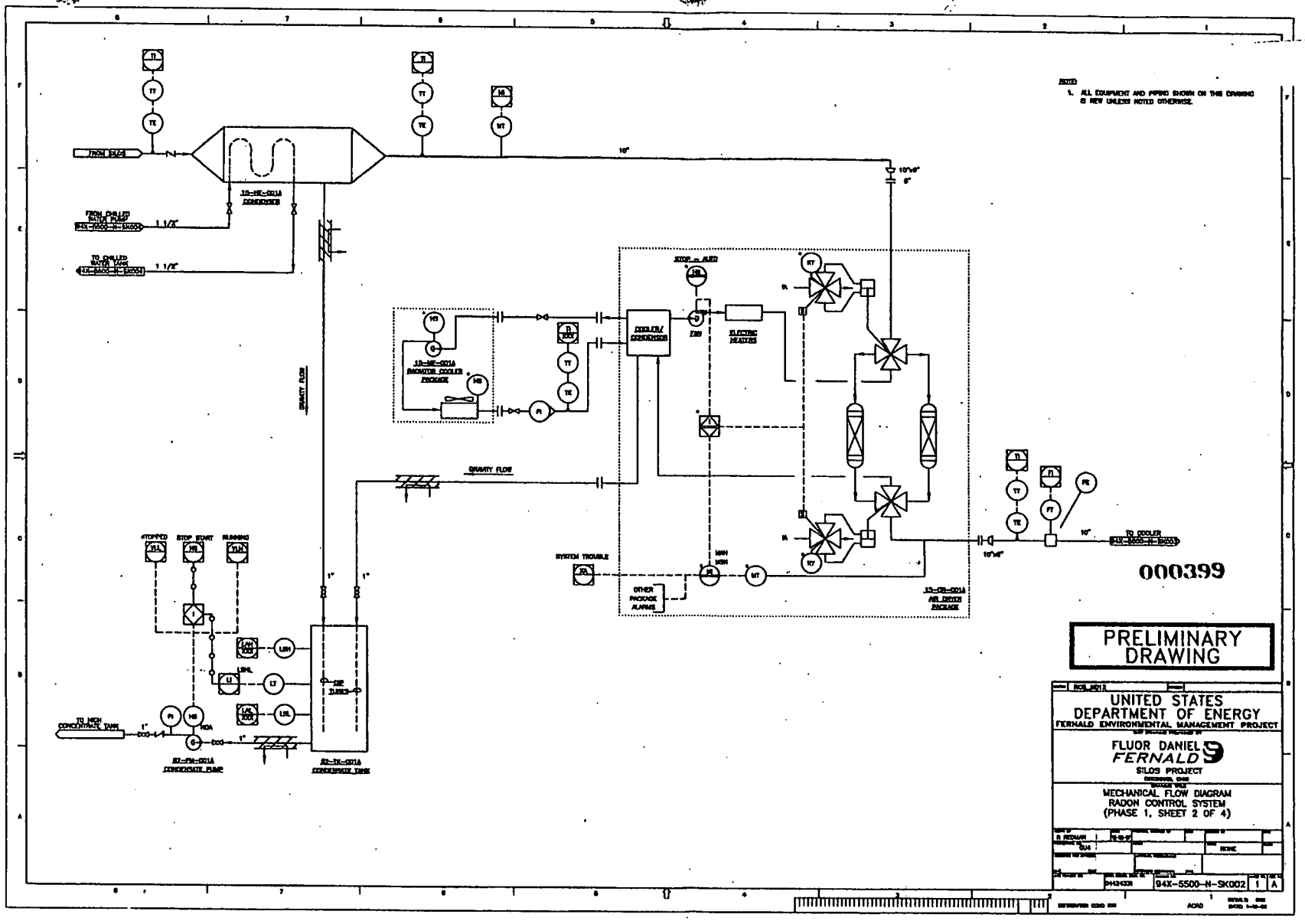
NOTE
1. ALL EQUIPMENT AND PIPING SHOWN ON THIS DRAWING IS NEW UNLESS NOTED OTHERWISE.
FROM BLOWER
10"
10"x6"
6"
FROM CHILLED WATER PUMP
TO CHILLED WATER TANK
1 1/2"
GRAVITY FLOW
COOLER/ CONDENSER
ELECTRIC HEATERS
STOP or AUTO
SYSTEM TROUBLE
OTHER PACKAGE ALARMS
TO COOLER
STOPPED
STOP START
RUNNING
TO MCN CONCENTRATE TANK
1"
CONDENSATE TANK
000399
PRELIMINARY DRAWING
UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FLUOR DANIEL FERNALD
SILOS PROJECT
MECHANICAL FLOW DIAGRAM
RADON CONTROL SYSTEM
(PHASE 1, SHEET 2 OF 4)
NONE
94X-5500-N-SK002
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A

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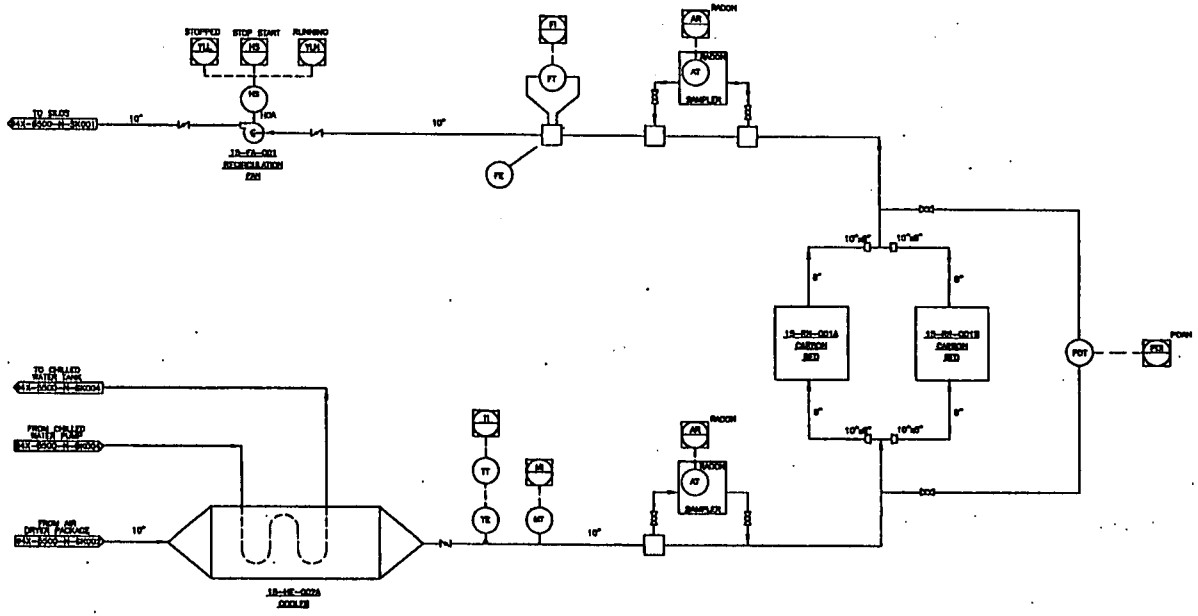
NOTE
1. ALL EQUIPMENT AND PIPING SHOWN ON THIS DRAWING IS NEW UNLESS NOTED OTHERWISE.



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PRELIMINARY DRAWING

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FLUOR DANIEL FERNALD
SILOS PROJECT

MECHANICAL FLOW DIAGRAM
RADON CONTROL SYSTEM
(PHASE 1, SHEET 3 OF 4)

DGH
NONE
94X-8500-N-SK003 | 1 | A

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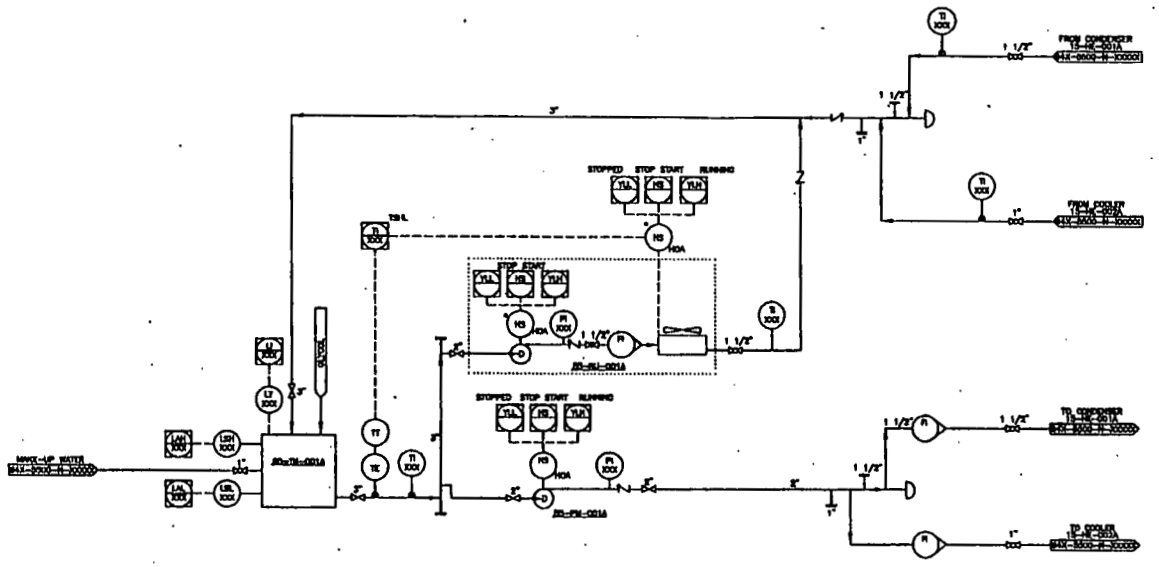
NOTES

1. ALL EQUIPMENT AND PIPING SHOWN ON THIS DRAWING IS NEW UNLESS NOTED OTHERWISE.



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PRELIMINARY DRAWING

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FLUOR DANIEL FERNALD
SILOS PROJECT

MECHANICAL FLOW DIAGRAM
RADON CONTROL SYSTEM
(MODULE L SHEET 4 OF 4)

R. MCNAIR
DLH
NONE

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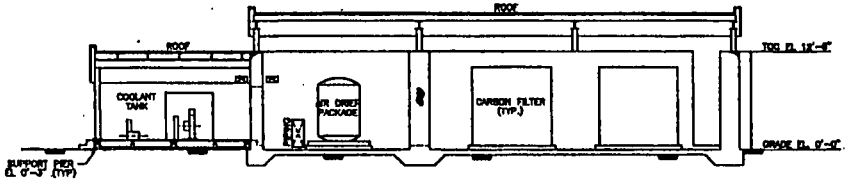
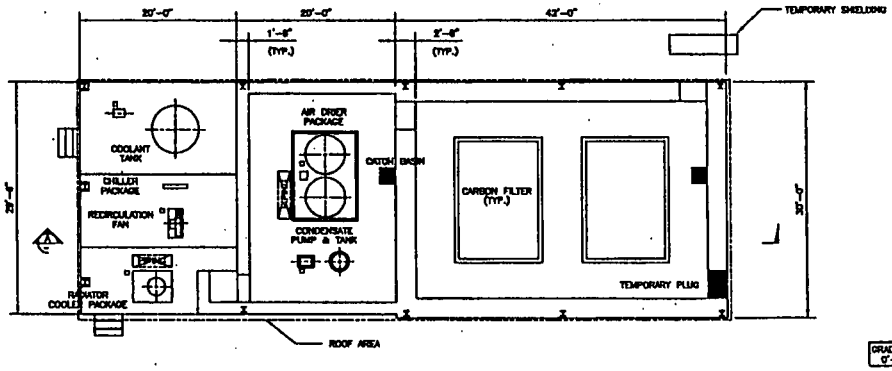


SECTION A THIS DWG



PLAN VIEW

FIGURE 3

NOTES:

1. CONCRETE FLOOR SLAB AND FOUNDATIONS
2. STEEL FRAME STRUCTURE
3. INSULATED METAL SIDING.
4. MEMBRANE ROOFING SUPPORTED BY STEEL DECKING AND INSULATION BOARD.
5. CONCRETE SHIELDING ONLY AS NOTED.
6. THIS DESIGN INCLUDES 3 MODULES
   1 = COOLANT TANK AND PUMP
   2 = CHILLER AND RECIRCULATION FAN
   3 = RADIATOR COOLANT PACKAGE
7. MODULES TO BE MAXIMUM BOLT-UP CONSTRUCTION. LIMITED FIELD ERECTION.
8. MAXIMUM 24 FEET WIDE ON MODULES. OVERSIZED PERMIT FOR TRANSPORT ON OHIO STATE HIGHWAYS REQUIRED.
9. MODULES TO FIT ON MAXIMUM TRAILER AND TRACTOR FOR OHIO. MUST MEET ALL OHIO STATE ROAD LOADING REQUIREMENTS.
10. ROOF TO BE ASSEMBLED AFTER MODULES HAVE BEEN LOCATED AND ANCHORED.

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PRELIMINARY DRAWING

UNITED STATES DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FLUOR DANIEL FERNALD
SILOS PROJECT

EQUIPMENT ARRANGEMENT
RADON CONTROL SYSTEM
(PHASE 1)

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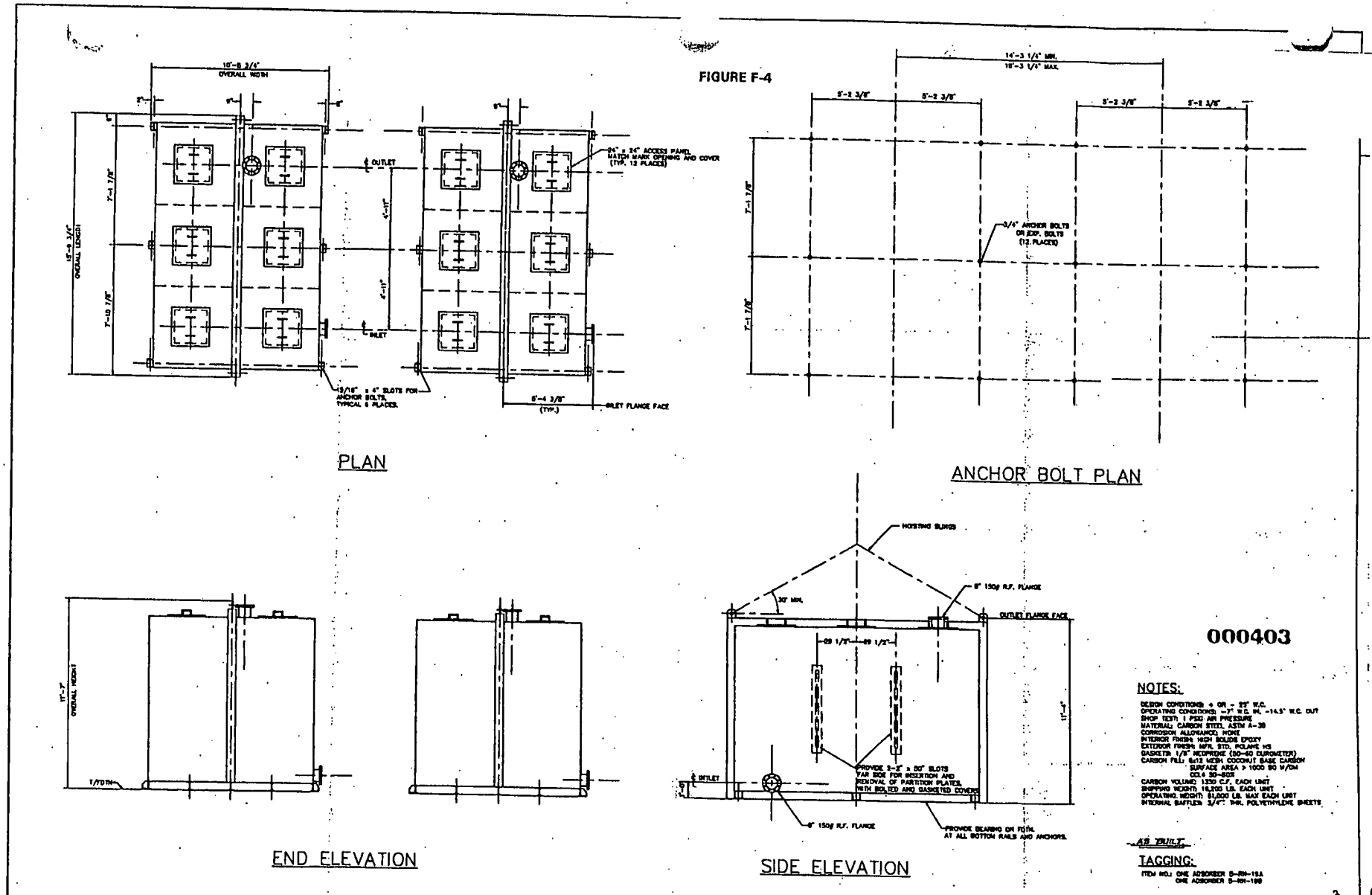
FIGURE F-4



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NOTES:

DESIGN CONDITIONS: + OR - 22" W.C.
OPERATING CONDITIONS: -7" W.C. IN, -14.5" W.C. OUT
SHOP TEST: 1 PSIG AIR PRESSURE
MATERIAL: CARBON STEEL, ASTM A-36
CORROSION ALLOWANCE: NONE
INTERIOR FINISH: HIGH SOLIDS EPOXY
EXTERIOR FINISH: MFR. STD. POLAR HS
GASKETS: 1/8" NEOPRENE (50-60 DUROMETER)
CARBON FILL: 6x12 MESH COCONUT BASE CARBON SURFACE AREA > 1000 SQ M/GM COLE 50-BOX
CARBON VOLUME: 1350 C.F. EACH UNIT
SHIPPING WEIGHT: 14,200 LB. EACH UNIT
OPERATING WEIGHT: 61,000 LB. MAX EACH UNIT
INTERNAL BAFFLES: 3/4" THK. POLYETHYLENE SHEETS

AS BUILT

TAGGING:

ITEM NO.: ONE ADSORBER S-RH-19A
ONE ADSORBER S-RH-19B

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK	APPD	DESIGN	DESCRIPTION	BY	CHK	APPD
1	7/13/92	REVISE PER REVISED SCS	RJ	CH						
2	11/20/92	REVISED SLOTS & TANKS PER FERMCO	RJ	CH						

REFERENCES

DATE	DESCRIPTION

THE CORPORATION
ESTABLISHED 1920
OFFICES SINCE 1920 - FAX (440) 943-5400

FERMCO
DOE CONTRACT DE-AC05-92OR21972

BOXSORBER MODEL S3 (2 EA.)
GENERAL ARRANGEMENT

DRAWN BY: RJ
DATE: JULY 13, 1992
SCALE: 1/2" = 1'-0"
D94-1002-AB-2
REV. 1

8103

FIGURE F-5
(2 OF 3)

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FERMCO

☐ A- APPROVED

☑ B- APPROVED AS NOTED

R.E. King 2/8/94

☐ C- NOT APPROVED, REVISE AND RESUBMIT

APPROVAL TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER.

DATA SHEET B

VENDOR DATA

PILOT PLANT CARBON BED ADSORBER

Name of Seller: TIGG Corporation

Address: 31 Moffett Street, Pittsburgh, PA 15243

Technical Contact and Telephone Number: Wayne Schuliger (412) 563-4300

Equipment Tag Number: 5-RN-19A. 5-RN-19B

1.0 Model and Number: Boxsorber S3

2.0 Arrangement

Number of Vessels per Set: One

Arrangement of Vessels: Two sets in parallel.

Footprint Area: ~~10'~~ 10'x10'x14'9" per unit (W x L)

Total Height: 12' (approximately)

3.0 Dimensions - Each Vessel

Shell Inside ~~Diameter:~~ Dimension 10'x10'x14'9" (H x W x L)

Shell Height (straight side): 10'

Shell Thickness: 1/4"

Inlet/Outlet Nozzle Size: 8" Type: 150 psig ANSI raised-face flange

Carbon Bed Depth: 28.5'

Weight, Vessel: 12,000 lbs. Carbon: 28-32 lbs/cf (approximately 1400 cf)

Top Access: 2-24"x24" openings per cell. Three cells per unit.

Date: 7/7/94

Approval Signature: 000404

CRU6:ENGR:20NOV93

FIGURE F-5
(1 OF 3)

DOCUMENT TRANSMITTAL
Transmittal No. T:CRU4(ENG):94-0023

Fernald Environmental
FERMCO
Restoration Management Corporation

DOCUMENT FILE NO._____

TO:	TIGG Corporation 31 Moffett Street Pittsburgh, PA 15243	DATE:	July 8, 1994	8103
		CONTRACT:	DE-AC05-92OR21972	
		AUTHORITY	W. S. Pickles	
ATTN:	Amy M. Bartek	BY:	R. C. Emerton	

REMARKS: PILOT PLANT CARBON BED ADSORBER

No. of Copies	Description
1	Vendor Data, Data Sheet B, Rev. C, Page 1 of 2 - Approved As Noted.
1	Vendor Data, Data Sheet B, Rev. C, Page 2 of 2 - Approved
	Proceed with Approval Drawings

cc: <u>With Attachment</u>
Document Control
Bob King
Mark Smith

<u>Without Attachment</u>
Chuck Martin

P094PP004317

R. C. Emerton
Signature

Date

ACKNOWLEDGEMENT: Please acknowledge receipt of the attached listed items by signing and returning one copy of this form.

Signature

Date

FIGURE F-5
(3 OF 3)

FERMCO

R.E. Eng 7/8/94

☒ A. APPROVED

☐ B. APPROVED AS NOTED

☐ C. NOT APPROVED, REVISE AND RESUBMIT

[illegible] TO PROCEED DOES NOT [illegible] CTOR/VENDOR OF ITS [illegible] OR LIABILITY UNDER THIS CONTRACT/PURCHASE ORDER.

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DATA SHEET B

VENDOR DATA

PILOT PLANT CARBON BED ADSORBER

4.0 Materials of Construction

Shell: *Carbon Steel*

Interior Coating: *High Solids Epoxy*

Internals: *Noncorrosive Polymer and High Solids Epoxy Carbon Steel*

Gaskets: *Neoprene*

5.0 Granular Activated Carbon

Manufacturer: *Barneby Sutcliffe or equivalent*

Source Material: *Coconut*

Shape: *Granular*

Mesh Size: *6x12*

Bulk Density: *0.49 g/cc*

Specific Surface Area: *> 1000 m^2/g*

Other Activity Data Available: *CCl_4 50-60%*

How Packaged?: *Bulk Bags*

6.0 Operating Parameters

Pressure Drop, Per Ft Bed Depth: *0.2 "/foot*

Total Pressure Drop: *6-3/4" H_2O column*

Superficial (Empty-Bed) Air Velocity: *5.2 feet/minute*

CRU6:EHGR:20NOV93

TABLE F-1

RADON CONTROL SYSTEM EQUIPMENT LIST , PHASE I

EQUIP_ID	EQUIP_DESCRIPTION	CAPACITY	PHYSICAL_SIZE	MATERIAL	POWER	COMMENT
15-DR-001	Air Drier Package	500 SCFM	94"W x 130"L x 88"H	CS	7.5 hp	Includes 2 driers and 36 KW regen heater (w/blower). 4" or 6" connections. 11,000 lbs
15-FA-001	Recirculation Fan	500 SCFM @ -50 in W.G.	22" W x 45" L x 47" H	CS	7.5 hp	Rotary lobe blower
15-HE-001A	Condensor	63,000 Btu/hr	7.5"O.D. x 17.25"L	CS		Water Cooled
15-HE-002	Cooler	20,000 Btu/hr	7.5"O.D. x 17.25"L	CS		Water Cooled
15-ME-001	Radiator Cooler, Package System	XX Btu/hr	4' L x 5' W x 1' H	CS		Use existing Young unit (VIIPP). Mounted on 4' stand
15-RN-001A	Carbon Bed Vessel #1	250 SCFM				Use existing carbon bed (VIIPP)
15-RN-001B	Carbon Bed Vessel #2	250 SCFM				Use existing carbon bed (VIIPP)
55-PM-001	Pump, Chill Water Supply	35 gpm @ XX psig discharge	12" W x 18" L	CS	1.0 hp	Process Chill Water System
55-RU-001	Chiller, Package System	75,000 Btu/hr	37" W x5.5" L x 79" H	CS	7.5 hp	Integral air cooled condensor& pump (35gpm). 60/40 H2O/ethylene glycol. 3/60/460 power.
55-TK-001	Tank, Process Chilled Water	1,000 gal capacity	6' x 6' x 6'	Plastic		Stand mounted (CS), Insulated
62-PM-001	Pump, Condensate	5 gpm @ XX psig discharge	12" W x 18" L	CS	0.5 hp	Radioactive Liquid Waste System
62-TK-001	Tank, Condensate	55 gal capacity	24" W x 24" L x 60" H	Plastic		Stand mounted (CS)

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APPENDIX G
AWR Surrogate Formulation
< Insert from Rod Heistand >

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APPENDIX H
Silos Integrity
<Insert from Bob Bromm, being developed>

000409